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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

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705TH MEETING

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

+ + + + +

WEDNESDAY

MAY 3, 2023

+ + + + +

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

COMMITTEE MEMBERS:

- JOY L. REMPE, Chairman
- WALTER L. KIRCHNER, Vice Chairman
- DAVID A. PETTI, Member-at-Large
- RONALD G. BALLINGER, Member
- VICKI M. BIER, Member
- CHARLES H. BROWN, JR., Member
- VESNA B. DIMITRIJEVIC, Member
- GREGORY H. HALNON, Member
- JOSE A. MARCH-LEUBA, Member
- MATTHEW W. SUNSERI, Member

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ACRS CONSULTANTS:

DENNIS BLEY

STEPHEN SCHULTZ

DESIGNATED FEDERAL OFFICIAL:

WEIDONG WANG

AGENDA

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Kairos (HERMES) Construction Permit Application Review
Discussions, Commission Meeting
Preparation, Report Preparation, Retreat
Follow-up Items

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P R O C E E D I N G S

8:30 a.m.

CHAIRMAN REMPE: So, good morning. This meeting will now come to order. This is the first day of the 705th meeting of the Advisory Committee on Reactor Safeguards.

I'm Joy Rempe, Chairman of the ACRS. Other members in attendance are Ron Ballinger, Vicki Bier, Charles Brown, Vesna Dimitrijevic, Greg Halnon, Walt Kirchner, Jose March-Leuba, Dave Petti, and Matthew Sunseri. We do have a quorum. Today, the committee is meeting in person and virtually.

The ACRS was established by the Atomic Energy Act and is governed by the Federal Advisory Committee Act. The ACRS section of the U.S. NRC public website provides information about the history of this committee and documents such as our charter, bylaws, Federal Register notices for our meetings, letter reports, and transcripts of all full and subcommittee meetings, including all slides presented at these open meetings.

The committee provides its advice on safety matters to the Commission through its publicly available letter reports. The Federal Register notice announcing this meeting was published on April 18,

1 2023. This announcement provided a meeting agenda, as
2 well as instructions for interested parties to submit
3 written documents or request opportunities to address
4 the committee. The designated federal officer for
5 today's meeting is Mr. Weidong Wang.

6 A communications channel has been opened
7 to allow members of the public to monitor open
8 portions of the meeting. Members of the public are
9 invited to use the MS Team link to view slides and
10 other discussion materials during these open sessions.

11 The MS Teams link information was placed
12 in the Federal Register notice and the agenda on our
13 public website. We've received no written comments or
14 requests to make oral statements from members of the
15 public regarding today's session.

16 Periodically, the meeting will be opened
17 to accept comments from participants listening to our
18 meetings. Written comments may be forwarded after the
19 meeting to Weidong Wang, today's designated federal
20 officer.

21 During today's meeting, the committee will
22 consider the following topics, the Kairos Hermes
23 construction permit application review, and if there's
24 time, we'll start on Commission meeting preparations
25 and our retreat follow-on items. Note that portions

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1 of Kairos' meeting may be closed as stated in the
2 agenda.

3 A transcript of the open portions of the
4 meeting is being kept and it's requested the speakers
5 identify themselves and speak with sufficient clarity
6 and volume so they can be readily heard.
7 Additionally, participants should mute themselves when
8 not speaking.

9 Before we start our meeting, or our first
10 topic today, I do have one item of interest. I'd like
11 to thank Andrea Torres for her technical assistance to
12 PMDA in supporting the committee, in particular, for
13 her work in the international outreach activities
14 during her rotation with the ACRS.

15 So, I'd like to ask members to join me in
16 a round of applause to thank Andrea for her willing
17 Service to the committee. And so, now I'd like to ask
18 if any other members have any opening remarks? If
19 not, then I'd like to ask Dave to lead us in the first
20 topic for today's meeting.

21 MEMBER PETTI: Okay, Drew, are you -

22 CHAIRMAN REMPE: Dave, your mic.

23 MEMBER PETTI: Oh, sorry. Drew, are you
24 going to lead us off or do you want us to start -- oh,
25 Mo wants to say something? Okay, Mo, please, go

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1 ahead.

2 MR. SHAMS: Yeah, I just, I have a couple.
3 Good morning. So, this is Mo Shams. I'm with the
4 staff from NRR. I want to start by thanking Chairman
5 Rempe and the distinguished members of the committee
6 for the opportunity to say a couple of words this
7 morning.

8 For the past few months, the staff has
9 been reviewing the construction permit application for
10 the Kairos Hermes test reactor which encompasses a
11 number of unique and first-of-a-kind attributes. I'm
12 proud to say that --

13 (Audio interference.)

14 MR. SHAMS: -- I hope that gets us closer
15 there. I'm proud to say that the staff has conducted
16 a safety-focused, risk-informed review, and
17 efficiently and effectively completed their review and
18 ran its safety evaluation on an aggressive schedule.

19 That said, I'd say that the staff alone
20 would not have been able to accomplish this milestone.
21 Kairos played a critical role in the efficiency of
22 this review through a high-quality application and
23 timely and complete responses to the staff's questions
24 throughout, so for that, we thank Kairos for their
25 contribution.

1 Likewise, the ACRS Committee played an
2 equally important role in reaching this milestone
3 through a safety-focused, risk-informed review of its
4 own. The committee also engaged the staff with
5 remarkable flexibility in scheduling meetings and
6 receiving staff comments.

7 We are grateful for this flexibility along
8 with the invaluable comments and insights provided by
9 the committee members throughout the review. No
10 doubt, the bases and soundness of our findings have
11 benefitted from our interactions with the committee
12 members.

13 You know, I am truly humbled to be part of
14 this extraordinary effort and grateful for your
15 contributions to its success. We look forward to
16 presenting highlights of the safety review to the
17 committee and answer any of your questions for us.
18 Thank you.

19 MEMBER PETTI: Thank you, Mo. Drew?

20 MR. PEEBLES: Thank you, Dave. My name is
21 Drew Peebles and I'm a Senior Licensing Manager at
22 Kairos Power. I would like to thank the committee for
23 the opportunity to present today and I would also like
24 to thank the NRC staff for their comprehensive and
25 efficiency review.

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1 I will be providing a brief overview of
2 Kairos, our non-power reactor Hermes, and the
3 preliminary safety analysis report that has been
4 reviewed by the NRC staff and the ACRS Kairos Power
5 Subcommittee. Next slide, please.

6 I'm sure you've all seen this slide many
7 times at this point, but as a mission-driven company,
8 we begin every presentation by restating our mission.
9 Our mission is to enable the world's transition to
10 clean energy with the ultimate goal of dramatically
11 improving people's quality of life while protecting
12 the environment. We can only achieve this mission if
13 we ensure that the KP-FHRs that we plan to deploy are
14 safe. Next slide, please.

15 So, this slide provides a high level
16 overview of Kairos. As I mentioned on the previous
17 slide, we are very mission driven, and in order to
18 achieve that mission, we are singularly focused on
19 commercializing our reactor technology which are
20 fluoride salt-cooled high-temperature reactors that we
21 refer to as KP-FHRs.

22 We have been around since 2016 and have
23 grown in size to over 300 employees that are mostly
24 engineering focused. Kairos is privately funded to
25 support engineering, design, and licensing, with a

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1 heavy focus on physical demonstration through both
2 nuclear and non-nuclear iterations of our technology.

3 Our aggressive schedule and cost targets
4 are set to make our technology competitive with
5 natural gas, which has a large capacity set to retire
6 in the 2030s.

7 So, this slide provides a high level
8 overview of the first nuclear iteration in KP-FHR
9 development, which is a non-power reactor we call
10 Hermes. The purpose of Hermes is to demonstrate key
11 features of KP-FHR technology. Hermes is a 35
12 megawatt thermal reactor that we are licensing for a
13 short, four-year lifetime.

14 The site we acquired for Hermes is located
15 in Oak Ridge, Tennessee at the East Tennessee
16 Technology Park. As we discussed in the subcommittee
17 meeting, this is a brownfield site that was the former
18 Oak Ridge Gaseous Diffusion Plant.

19 We identified several research and
20 development programs in the application to resolve
21 safety questions, and we committed to resolving those
22 questions before the completion of Hermes
23 construction.

24 It's also worth noting that although our
25 commercial reactors may include multi-unit

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1 applications, Hermes is a single-unit reactor that
2 does not share any safety systems or equipment, excuse
3 me, any systems or equipment to perform safety
4 functions. Next slide, please.

5 These next few slides provide an overview
6 of the Hermes preliminary safety analysis report or
7 PSAR. We are using the two-step licensing pathway in
8 10 CFR 50 to license Hermes.

9 The PSAR that is in front of the
10 committee, along with the environmental report, were
11 part of the construction permit application that we
12 submitted in the fall of 2021. The next step in this
13 process will be to file an operating license
14 application which will include our final safety
15 analysis report.

16 We developed the PSAR using the non-power
17 standard review plan in NUREG-137 and we have
18 presented the preliminary design and safety analysis
19 consistent with the requirements in 10 CFR 50.34(a).

20 As we discussed in the subcommittee
21 meetings, we are not requesting Commission approval of
22 any design feature or specification at the
23 construction permit application phase, which is
24 allowed by 10 CFR 50.35(b). Next slide, please.

25 So, this slide provides the chapter format

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1 for the Hermes PSAR. I won't read through all of the
2 titles, but they are consistent with those presented
3 in NUREG-1537. However, some of the chapter topics do
4 not apply to the Hermes design and therefore do not
5 have any content. Those sections are indicated with
6 an asterisk.

7 Additionally, the NUREG does not always
8 differentiate between content that is required at the
9 PSAR stage versus content that's required at the FSAR
10 stage, so there are several chapter topics that
11 provide minimal content at the PSAR stage. Those
12 chapters are indicated with two asterisks on this
13 slide. Next slide, please.

14 We have been in front of this committee
15 many times over the past few years with various
16 topical reports that were under NRC review. All of
17 these topical reports have now been approved and we
18 are heavily leveraging the content in those reports in
19 the Hermes PSAR. This slide lists all of the topical
20 and technical reports referenced in the PSAR.

21 This is my last slide and it's just a
22 summary level slide showing where we are in the NRC
23 review process. The NRC completed the safety review
24 of the PSAR and Kairos has addressed all of the open
25 questions from the NRC, including questions received

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1 in several audits and a handful of RAIs.

2 The ACRS Kairos Power Subcommittee has
3 completed their review of the PSAR, culminating in
4 several review meetings conducted on March 1, 4, 23,
5 and 24, as well as two meetings on April 18 and April
6 19.

7 There were a couple of minor
8 inconsistencies in the PSAR that we discussed in those
9 meetings. We have corrected those inconsistencies by
10 submitting changes to the application on the docket.

11 And that brings me to the conclusion,
12 which is that Kairos Power is not aware of any
13 unresolved PSAR questions at this time that precludes
14 the issuance of a construction permit, and that
15 concludes my remarks. I'm happy to take any questions
16 if you have any.

17 MEMBER PETTI: Members, any questions?

18 MEMBER HALNON: Yeah, this is Greg. I
19 just had one. Can you go back to your slide six? You
20 had all of the chapters on it?

21 MR. PEEBLES: Sure.

22 MEMBER HALNON: So, on Chapter 17, I
23 understand that it's not -- it has minimal impact, but
24 you will have to decommission this at some point, so
25 to say it's not applicable is not -- I mean, that

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1 leads me to believe that you're not going to feel like
2 you ever have to decommission it, but what you're
3 really concentrating on is there's no technical
4 content at this time. Is that what you're saying?

5 MR. PEEBLES: That's correct.

6 MEMBER HALNON: So, it is applicable to
7 the Hermes reactor?

8 MR. PEEBLES: At some point, yes, for
9 decommissioning.

10 MEMBER HALNON: I just wanted to clarify
11 that. I wanted to make sure that we weren't just
12 discarding it. I mean, I can understand, like Chapter
13 16, you're not going to use it for any medical uses or
14 anything like that, so it truly is not applicable, but
15 Chapter 17 is applicable, just no content at this
16 time.

17 MR. PEEBLES: Correct.

18 MEMBER HALNON: Okay, thank you.

19 MEMBER PETTI: Okay then, staff?

20 MR. HISER: Is that going to pull up the
21 slides?

22 MEMBER MARCH-LEUBA: Try to get the
23 microphone close to you.

24 MR. HISER: Yeah, thanks. Good morning,
25 everyone. My name is Matt Hiser. I am a Senior

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1 Project Manager in the Office of Nuclear Reactor
2 Regulation in the division of advanced non-power
3 production utilization facilities, and I appreciate
4 the opportunity to brief the committee.

5 We have kept it fairly short and sweet
6 this morning, just a handful of slides. I know you
7 guys have heard extensively chapter by chapter through
8 the staff's review, so we've tried to not belabor it
9 too much, so, and maybe hop to the next slide?

10 So, just a brief overview, and much of
11 this is repetitive to what Kairos just presented, but
12 they have submitted an application for a construction
13 permit for a 35 megawatt non-power reactor facility
14 known as Hermes.

15 The primary purpose they have identified
16 for this is to test and demonstrate the technologies,
17 design features, and safety functions for their future
18 commercial KP-FHR design, and they are proposing that
19 this would be built in Oak Ridge, Tennessee on the
20 former site of the gaseous diffusion plant.

21 From a licensing perspective, Hermes will
22 be licensed as a non-power reactor under 10 CFR Part
23 50. This will be a Class 104 license that, per 10 CFR
24 50.21©, is for testing, research, and development.
25 Next slide?

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1 So, just a brief overview of the
2 construction permit application review and in the
3 construction permit process. So, we've noted here on
4 the first bullet the latest revision of the PSAR, Rev
5 2 that was provided just before we began ACRS review
6 in late February.

7 As Kairos noted, they did initially apply
8 in fall of 2021 with Revision 0. They have done a
9 couple revisions of their PSAR through the course of
10 our review, and you can note the ADAMS number there
11 for the latest PSAR revision.

12 In terms of the construction permit
13 process, I just want to highlight that it allows the
14 licensee to proceed with construction based on
15 preliminary design information.

16 Final design would be required for the
17 operating license application, but that's a provision,
18 and I know you guys are familiar with this from a lot
19 of our discussions of how many things are, you know,
20 are awaiting the final design.

21 And then the other point with the
22 construction permit I just want to note is that there
23 is a provision that Kairos could request approval of
24 the safety of certain design features. They have not
25 chosen to do that, so the staff's review is not an

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1 approval of the safety of any design feature or
2 specification.

3 MEMBER MARCH-LEUBA: Let me interrupt a
4 moment. Just for the record, can you explain, we
5 didn't, we, the staff, didn't approve the safety
6 because Kairos didn't request it or it isn't part of
7 the regulation?

8 MR. HISER: Because Kairos didn't request
9 it. So, the regulation --

10 MEMBER MARCH-LEUBA: Because they're not
11 requesting it?

12 MR. HISER: Correct, the regulation
13 specifies that if the licensee requests it, then, you
14 know, obviously you'd need to have a final design for
15 those, you know, aspects that you're requesting
16 approval for and then the staff could provide that.
17 Because Kairos didn't request it --

18 MEMBER MARCH-LEUBA: That would have saved
19 time for the operating license review.

20 MR. HISER: Correct, I think the trade-off
21 is right. They'd get some level of finality on at
22 least aspects of their design --

23 (Simultaneous speaking.)

24 MEMBER MARCH-LEUBA: But in relation, it's
25 a perfectly acceptable part?

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1 MR. HISER: Correct.

2 MEMBER MARCH-LEUBA: Okay.

3 MR. HISER: So, then just shifting gears
4 to sort of how the review was handled in terms of
5 regulatory guidance and acceptable criteria, the
6 primary guidance, which if you were reading the safety
7 evaluation and going through the briefings, NUREG-1537
8 provides guidelines for preparing and reviewing
9 applications for licensing of non-power reactors.
10 That was the primary guidance that the staff used, but
11 not the only guidance.

12 In various places, Kairos referenced reg
13 guides and various standards, ANSI/ANS, ASME, as well
14 as, obviously, the staff is always using engineering
15 judgment as they review these things, particularly for
16 a new technology that's presented here to make their
17 findings.

18 And then I'd also note we didn't highlight
19 this explicitly on the slides, but obviously, as
20 Kairos did on their slides, topical reports, the work
21 that was done outside of the construction permit
22 really went a long way to handling a lot of the more
23 complex technical issues related to the fuel and the
24 coolant, et cetera, and so that, you know, the heavy
25 technical lift on some of those issues really didn't

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1 have to be a part of this CP, but was sort of handled
2 by reference and we made sure we reviewed that they
3 were within the limitations and conditions and scope
4 of those topical reports.

5 MEMBER MARCH-LEUBA: Going back to my
6 previous question, the topical report, SERs, actually
7 do have some finality, right? They could just
8 reference the topical report and don't have to issue
9 a supplement? The safety question we were asking
10 earlier applies only to the SER, not the topical
11 report.

12 MR. HISER: Yes, the topical report would
13 provide finality, but they -- we always, almost always
14 have limitations and conditions, right. The topical
15 report itself has to define a scope of what, you know,
16 applies, doesn't apply, and then typically, the staff
17 SER will have conditions on it as well to make sure,
18 generally to make sure that when it's referenced, that
19 it's being referenced appropriately and is within the
20 scope of what that topical report approval provided,
21 but yes. Okay, next slide?

22 So, just a -- and we've seen this slide
23 probably before at the subcommittee level, I think
24 maybe back on March 1, but we just want to highlight
25 the risk inform review that the staff did. The staff

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1 strived to scale the depth and scope of its review
2 commensurate with the risk and safety significance of
3 the items under review.

4 The staff also, along the same lines,
5 maintained a big picture safety perspective on the
6 design, recognizing what different systems, what role
7 they played in the overall safety case, the size of
8 the reactor, the expected radiological consequences of
9 Hermes.

10 This was licensed with a maximum
11 hypothetical accident, so you could sort of bound in
12 your mind some of the, you know, worst consequences
13 that would be possible, and then also keeping in mind,
14 as we highlight on the last slide, what's needed for
15 a construction permit application for a non-power test
16 reactor. Those have provisions in both regulations
17 and guidance that helped to scope our review.

18 And then finally, we focused on or
19 tailored our review recognizing the unique and novel
20 technology described in the application, some of the
21 inherent safety in the design with the fuel and the
22 coolant, and the low pressure of the system, and we
23 kept in mind Reg Guide 1.232, which is the non-light
24 water reactor guidance. That also helped to inform
25 our considerations as we did the review. Next slide?

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1 And this is actually my last slide and it
2 just captures the overarching findings of the staff's
3 review of the construction permit. The staff finds
4 that the information in the Hermes PSAR is sufficient
5 for the issuance of a construction permit in
6 accordance with 10 CFR 50.35 and 50.40, and that
7 further information can be reasonably left for the
8 operating license application.

9 And some of the -- this is a subset of the
10 sort of underpinnings of that overall finding, that
11 the staff finds that applicable standards and
12 requirements of the AEA and Commission regulations
13 have been met, that preliminary design information is
14 consistent with the applicable criteria in NUREG-1537,
15 and that based on the preliminary design of the
16 facility, there is reasonable assurance that the final
17 design will conform to the design basis with adequate
18 margin for safety.

19 And then just the final bullet there,
20 just, in fact, sort of, I think, a couple of weeks ago
21 at the final subcommittee meetings, we finally were
22 able to publicly put together an approved draft of the
23 NRC staff safety evaluation. I think this was shared
24 with the committee previously, but, you know, for
25 those in the public, we do have the ML number with a

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1 link there, so that's sort of the latest and most
2 complete version of the safety evaluation at this
3 point.

4 It will have to be, you know, the final
5 ACRS letter and a few other things in terms of
6 references will need to be updated to make sure that
7 any, you know, minor details from, if another PSAR
8 revision or the latest PSAR revision, but it's very
9 close to sort of what the final product will look
10 like.

11 So, anyway, to echo what Mo said earlier,
12 you know, we appreciated the interactions with ACRS
13 and, you know, we're happy to answer any questions.

14 MEMBER PETTI: Questions?

15 CHAIRMAN REMPE: I have a question that
16 actually pertains to that slide, and it pertains to
17 some discussions that we've had at our last
18 subcommittee meeting.

19 I think it's prudent to say that there was
20 reasonable assurance the final design will conform to
21 the design basis with adequate margin for safety.
22 What would it take for the NRC to ever -- and I've
23 seen that phrase in other things over the last decade.
24 What would it take for the staff to say that it has
25 large margin for safety with a construction permit?

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1 MR. HISER: I don't know that I have a
2 great answer to that. You know, I think that language
3 --

4 CHAIRMAN REMPE: It's a difficult
5 question.

6 MR. HISER: Well, I think it --

7 CHAIRMAN REMPE: And I just am curious
8 because I've discussed this in the meetings with the
9 committee and I just was kind of wondering what it
10 would take knowing that it is just a construction
11 permit. There's uncertainty and things like that.
12 There's a hand raised out there? Is that from someone
13 --

14 MR. HISER: Oh, yeah, Jeff Schmidt, it
15 looks like --

16 CHAIRMAN REMPE: Yeah, okay.

17 MR. HISER: -- wants to take a stab at
18 this, so I'll let him jump in before I limp.

19 MR. SCHMIDT: I thought I'd help answer
20 that somewhat difficult question, somewhat subjective
21 question. Yeah, I think it just depends on, you know,
22 how close you are to certain, say, physical limits,
23 like, say, you know, in my opinion, and this is
24 obviously just my opinion, is I think the operating
25 conditions, say, for the TRISO fuel, I would put that

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1 in the category of larger, right? This is all
2 subjective, so you have to make some type of
3 subjective. Things like the vessel temperature may
4 not be in that large category, but be adequate.

5 So, I don't know if there's, you know, a
6 great definition. I don't think there's anything
7 written that would provide a definition, but more of
8 just engineering judgment and kind of the known
9 physical limits that you're aware of. Hopefully that
10 helps.

11 CHAIRMAN REMPE: Yeah, I don't think so.
12 I've never seen the staff ever say that there's -- I
13 mean, adequate's all that's needed and why would you
14 step over that line is kind of what I'm thinking is
15 the answer to the question, and there are
16 uncertainties. But anyway, again, this is probably an
17 unfair thing to even ask the staff, but I've been --

18 MEMBER PETTI: You may not be surprised to
19 see the ACRS use the word large.

20 MR. SHAMS: It's not, and this is Mo Shams
21 with the staff. It's not. Actually, it's probably
22 something that grounds us back to our mission and
23 continue to ground us. We're not looking for ample
24 margin. We're looking for adequate margin that
25 addresses uncertainty, addresses what we know about

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1 the technology, you know. So, we should be able to
2 meter that to get us to reasonable assurance, not much
3 more beyond that.

4 CHAIRMAN REMPE: Yeah, going beyond that
5 --

6 MR. SHAMS: Yeah, yeah.

7 CHAIRMAN REMPE: -- is just like stepping
8 over a line that one shouldn't do because there's
9 uncertainties, but thank you for this discussion time
10 since we have time today.

11 MR. SHAMS: Sure, sure.

12 MEMBER HALNON: This is Greg. I just
13 wanted to kind of have a conversation about the four-
14 year operating cycle and how that might, in your
15 minds, make it more complicated in that five-year, you
16 know, within five years, you start targeting spent
17 fuel and these other decommissioning issues.

18 Have you had internal discussions talking
19 about how that might play out? As soon as you hit the
20 operating license, you're within that five-year
21 period.

22 MR. HISER: Yeah, so I think there's
23 definitely been some issues, you know, a number of
24 issues that I think we're envisioning we'll handle
25 more at the operating license level.

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1 I think this would be one of those that,
2 you know, we haven't spent a lot of time internally,
3 you know, discussing how that looks, but I think we
4 recognize with the operating license, that will
5 obviously have to be --

6 MEMBER HALNON: So, we're going to have to
7 unwrap that down the road, but certainly we'll see how
8 those regulations apply relative to the
9 decommissioning funding assurance. It can't just be
10 we'll get you later.

11 MR. HISER: Yeah, we'll certainly make
12 sure with the operating license review that, you know,
13 whatever the requirements are for decommissioning are
14 met appropriately.

15 MEMBER HALNON: Because I would assume
16 that some of the decommissioning experience and
17 knowledge is going to come from the operating cycle
18 relative to how much rad waste there would be, kind,
19 and classes, and that sort of stuff, so you may have
20 a large level of uncertainty that you have to deal
21 with, okay.

22 MR. SHAMS: Yeah, my thoughts on that if
23 I may share is so we tailored the CP application to
24 what the regulations are looking for, and we'll go
25 back and recalibrate when we go through the operating

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1 license and what findings need to be made.

2 And then to your point, we cannot suggest
3 that the Commission or recommend to the Commission to
4 approve an operating license without all of these
5 requirements are clearly, you know, met. Part of it
6 would be the decommissioning plan and the funding
7 associated with it, just like we do for any other
8 research test reactors.

9 MEMBER HALNON: Yeah, okay, thanks.

10 MR. SHAMS: Sure.

11 MEMBER MARCH-LEUBA: Yeah, but I wanted to
12 reemphasize what Greg was saying from a different
13 point of view.

14 MR. SHAMS: Sure.

15 MEMBER MARCH-LEUBA: We have seen these
16 new small reactors that come in and they're super
17 safe. Again, they're so safe. The reactor is safe
18 while they're operating and then after you shut it
19 down.

20 And this facility clearly would also have
21 higher risk to the population after you terminate and
22 start doing the decommissioning. There's all the
23 radium and contamination that is there. During
24 operation, it doesn't, the calculations show that it
25 doesn't pose any risk whatsoever.

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1 So, it's a different paradigm that we need
2 to start thinking about with the new reactors, that
3 they're not like the old reactors. The old reactors,
4 the best thing you can do is shut it down and turn it
5 off to a different company. With this one, there is
6 more risk after you shut it down, so we need to handle
7 that somehow and it's not handled in regulations.

8 MR. SHAMS: I'd say thank you. I'm
9 confident on the staff side as we are -- I'm confident
10 you're going to guide us, you know, on the areas that
11 we're not, you know, if we're not paying attention to
12 them.

13 But I'm also comfortable that the
14 regulations, the approach that we take as a staff, as
15 a committee, we're not going to miss anything, and
16 we'll apply the right attention to the right areas.

17 The Part 50, you know, process is a bit,
18 sort of represents, you know, an introduction of that
19 concept. It's start first, take some risk, you know,
20 go with the construction permits and then -- so, we're
21 all adopting to that and we're all seeing what that
22 looks like in this time, but in my mind, there is no
23 doubt that we'll catch all of it at the right time,
24 you know, as it comes.

25 I saw it in my division with SHINE. We

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1 did the same thing. We allowed them to start and then
2 we just issued an operating, or not issued the
3 license, ruled the SE and we had to go through every
4 part of the design and, you know, the programs that
5 are needed, the specs that are needed to be written.
6 I feel we'll do the same thing.

7 MEMBER MARCH-LEUBA: Since you mentioned
8 SHINE --

9 MR. SHAMS: Sure.

10 MEMBER MARCH-LEUBA: -- the old example I
11 was thinking of where we panelists came to, I came to
12 the realization that the safety of the public is
13 better served by SHINE operating and producing moly-
14 99. The moment you shut it down for whatever reason
15 and you don't produce moly-99, you're causing more
16 statistical deaths than you can possibly cause by
17 operating. So, our regulations are not thinking that
18 way and we need to start thinking differently.

19 MR. SHAMS: Great point, great point.
20 Thank you.

21 MEMBER PETTI: Any other questions,
22 members? Okay, hearing none, thank you. At this
23 point, let's turn to public comments. If you have a
24 comment, please state your name and your comment.
25 Unmute yourself, *6.

1 Okay, not hearing anything, I want to
2 thank Kairos and the staff. This has been our first
3 non-light water reactor application, yeah,
4 construction permit, so interesting. Thank you.
5 Okay, do you want to --

6 CHAIRMAN REMPE: Sure, okay, so at this
7 point, as I mentioned previously, we are going to go
8 off the record, James, and we'll ask you to return
9 tomorrow at 8:30.

10 (Whereupon, the above-entitled matter went
11 off the record at 9:00 a.m.)

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NRC Staff Safety Review of the Kairos Hermes Testing Facility Construction Permit Application

Briefing for the Advisory Committee on Reactor Safeguards

Wednesday, May 3, 2023

By the Division of Advanced Reactors and Non-Power Production and
Utilization Facilities, Office of Nuclear Reactor Regulation

Introduction

- Kairos Power LLC has requested a construction permit for a 35 MWth* non-power reactor facility known as Hermes
 - **Purpose:** test and demonstrate key technologies, design features, and safety functions for the commercial Kairos Power fluoride salt-cooled, high temperature reactor (KP-FHR) structures, systems, and components (SSCs)
 - **Location:** East Tennessee Technology Park in Oak Ridge, TN
- Hermes would be licensed as a non-power reactor under Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50
 - Class 104 license per 10 CFR 50.21(c) for testing research and development

*MWth = megawatts of thermal power

Construction Permit Application Review Overview

- Preliminary Safety Analysis Report, Revision 2, dated February 24, 2023 (ADAMS Accession No. ML23055A672)
- Construction Permit
 - Allows licensee to proceed with construction based on preliminary design information
 - Does not approve of the safety of any design feature or specification because no such approvals were requested by Kairos
- Regulatory Guidance and Acceptance Criteria
 - NUREG 1537, “Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors”
 - Other guidance (e.g., regulatory guides and ANSI/ANS standards) and engineering judgment used, as appropriate, to make construction permit findings

Risk-Informed Review

- The depth and scope of staff's review was commensurate with the risk or safety significance of items under review
- Staff maintained a “big picture” safety perspective of the Hermes design
 - Scope and level of detail of the review considered the size, safety case, and expected low radiological consequences of Hermes
 - Requirements for a testing facility construction permit application
- Staff's review was tailored to the unique and novel technology described in the construction permit application

Hermes Construction Permit Regulatory Findings

- The staff finds that the information in the Hermes PSAR is sufficient for the issuance of a construction permit in accordance with 10 CFR 50.35 and 50.40, and further information can be reasonably left for the operating license application.
 - Applicable standards and requirements of the Atomic Energy Act and Commission regulations have been met
 - Preliminary design information is consistent with the applicable criteria in NUREG-1537
 - Based on the preliminary design of the facility, there is reasonable assurance that the final design will conform to the design basis with adequate margin for safety
- Approved draft NRC staff safety evaluation publicly available: [ML23108A119](#)

April 27, 2023

Docket No. 50-7513

US Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Subject: Kairos Power LLC
Presentation Materials for Kairos Power Briefing to the Advisory Committee on Reactor Safeguards on Hermes Preliminary Safety Analysis Report

References: Letter, Kairos Power LLC to Document Control Desk, "Submittal of the Preliminary Safety Analysis Report for the Kairos Power Fluoride Salt-Cooled, High Temperature Non-Power Reactor (Hermes), Revision 2," February 24, 2023 (ML 23055A673)

This letter transmits the presentation slides for the May 3, 2023 briefing for the Advisory Committee for Reactor Safeguards (ACRS). During the May 3 meeting, participants will discuss the Hermes Preliminary Safety Analysis Report.

Enclosure 1 provides the non-proprietary slides for the May 3, 2023 briefing. Kairos Power authorizes the Nuclear Regulatory Commission to reproduce and distribute the submitted content, as necessary, to support the conduct of their regulatory responsibilities.

If you have any questions or need additional information, please contact Drew Peebles at peebles@kairospower.com or (704) 275-5388, or Darrell Gardner at gardner@kairospower.com or (704) 769-1226.

Sincerely,



Peter Hastings, PE
Vice President, Regulatory Affairs and Quality

Enclosure: Presentation Slides for the May 3, 2023 ACRS Meeting (Non-Proprietary)

KP-NRC-2304-009

Page 2

xc (w/enclosure):

William Jessup, Chief, NRR Advanced Reactor Licensing Branch

Benjamin Beasley, Project Manager, NRR Advanced Reactor Licensing Branch

Edward Helvenston, Project Manager, NRR Advanced Reactor and Licensing Branch

Samuel Cuadrado de Jesus, Project Manager, NRR Advanced Reactor Licensing Branch

Matthew Hiser, Project Manager, NRR Advanced Reactor Licensing Branch

Weidong Wang, Senior Staff Engineer, Advisory Committee for Reactor Safeguards

Enclosure 1
Presentation Slides for the May 3, 2023
ACRS Meeting
(Non-Proprietary)




Kairos Power

Hermes PSAR Overview

DREW PEEBLES – SENIOR LICENSING MANAGER

ACRS FULL COMMITTEE MEETING

MAY 3, 2023



Kairos Power's mission is to enable the world's transition to clean energy, with the ultimate goal of dramatically improving people's quality of life while protecting the environment.

Overview of Kairos Power

- Nuclear energy engineering, design and manufacturing company *singularly focused* on the commercialization of the fluoride salt-cooled high-temperature reactor (FHR)
 - Founded in 2016
 - Current Staffing:
 - Over 300 Employees (*and growing*)
 - ~90% Engineering Staff
- Private funding commitment to engineering design and licensing program and physical demonstration through nuclear and non-nuclear technology development program
- Schedule driven by the goal for U.S. commercial demonstration by 2031 (or earlier) to enable rapid deployment in 2030s
- Cost targets set to be competitive with natural gas in the U.S. electricity market

Kairos Power Headquarters



Kairos Power Team



Hermes Overview

- The purpose of Hermes is to test and demonstrate the key technologies, design features, and safety functions for KP-FHR technology
- 35 MWth non-power reactor facility, 4-year licensed lifetime
- Located in Oak Ridge, Tennessee at the East Tennessee Technology Park (Former site of Oak Ridge Gaseous Diffusion Plant)
- Research and development programs to resolve safety questions will be resolved before the completion of construction
- Hermes is a single unit reactor that does not share any systems or equipment to perform safety functions

Hermes PSAR Overview

- 10 CFR 50 Licensing Pathway
 - Construction Permit Application – Submitted Fall 2021
 - Environmental Report
 - Preliminary Safety Analysis Report (PSAR)
 - Next Licensing Step: Operating License Application
 - Final Safety Analysis Report (FSAR)
- Hermes PSAR Application Format and Content
 - Developed using guidance in NUREG-1537
 - Presents preliminary design and preliminary safety analysis consistent with 10 CFR 50.34(a)
 - PSAR does not request commission approval of the safety of any design feature or specification
 - *10 CFR 50.35(b) A construction permit will constitute an authorization to the applicant to proceed with construction but will not constitute Commission approval of the safety of any design feature or specification unless the applicant specifically requests such approval and such approval is incorporated in the permit.*

* Not Applicable to Hermes –
Chapter has no technical
content

** Minimal Content at PSAR

Hermes PSAR Format

- Chapter 1 – The Facility
- Chapter 2 – Site Characteristics
- Chapter 3 – Design of Structures, Systems, and Components
- Chapter 4 – Reactor Description
- Chapter 5 – Heat Transport System
- Chapter 6 – Engineered Safety Features
- Chapter 7 – Instrumentation and Control Systems
- Chapter 8 – Electric Power Systems
- Chapter 9 – Auxiliary Systems
- Chapter 10 – Experimental Facilities and Utilization*
- Chapter 11 – Radiation Protection Program and Waste Management**
- Chapter 12 – Conduct of Operations**
- Chapter 13 – Accident Analysis
- Chapter 14 – Technical Specifications**
- Chapter 15 – Financial Qualifications**
- Chapter 16 – Other License Considerations*
- Chapter 17 – Decommissioning and Possession-only License Amendments*
- Chapter 18 – Highly Enriched to Low Enriched Uranium Conversion*

Kairos Power Reports Referenced in PSAR

- Topical Reports
 - KP-TR-003 – Principal Design Criteria
 - KP-TR-004 – Regulatory Analysis
 - KP-TR-005 – Reactor Coolant
 - KP-TR-010 – Fuel Performance Methodology
 - KP-TR-011 – Fuel Qualification Methodology
 - KP-TR-012 – Mechanistic Source Term Methodology
 - KP-TR-013 – Metallics Qualification Methodology
 - KP-TR-014 – Graphite Qualification Methodology
- Technical Reports
 - KP-TR-017 – Core Design Methodology
 - KP-TR-018 – Postulated Event Methodology

Hermes PSAR Review Status

- ✓ NRC staff has completed the safety review of the PSAR
 - Kairos Power addressed all questions received from the NRC
- ✓ The ACRS Kairos Power subcommittee has completed their review of the PSAR during meetings conducted March 1, 4, 23, 24, and April 18 and 19
 - Kairos Power submitted changes to the PSAR to resolve internal PSAR inconsistencies identified during the subcommittee review

Kairos Power is not aware of any unresolved PSAR questions at this time that preclude issuance of a construction permit.



Questions