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UNITED STATES NUCLEAR REGULATORY COMMISSION'S
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

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KAIROS POWER LICENSING SUBCOMMITTEE

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TUESDAY

APRIL 4, 2023

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The Subcommittee met via hybrid in-person and Video Teleconference, at 8:30 a.m. EDT, David Petti, Chairman, presiding.

COMMITTEE MEMBERS:

DAVID PETTI, Chair
RONALD G. BALLINGER, Member
CHARLES H. BROWN, JR., Member
VICKI BIER, Member
VESNA DIMITRIJEVIC, Member
GREGORY HALNON, Member
WALT KIRCHNER, Member
JOSE MARCH-LEUBA, Member
JOY L. REMPE, Member
MATTHEW SUNSERI, Member

ACRS CONSULTANT:

DENNIS BLEY

STEPHEN SCHULTZ

DESIGNATED FEDERAL OFFICIAL:

WEIDONG WANG

ALSO PRESENT:

JOSEPH ASHCRAFT, NRR

BENJAMIN BEASLEY, NRR

NORBERT CARTE, NRR

CALVIN CHEUNG, NRR

ALEXANDER CHERESKIN, NRR

ANTHONIE CILLIERS, Kairos Power

AUSTIN CLARK, Kairos Power

DARRELL GARDNER, Kairos Power

VIJAY GOEL, NRR

MICHELLE HART, NRR

EDWARD HELVENSTON, NRR

MATT HISER, NRR

ANDREW LINGENFELTER, Kairos Power

AUGUSTUS MERWIN, Kairos Power

DREW PEEBLES, Kairos Power

SHEILA RAY, NRR

JEFFREY SCHMIDT, NRR

NICOLAS ZWEIBAUM, Kairos Power

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

8:30 a.m.

CHAIR PETTI: Good morning, everyone. The meeting will now come to order.

This is a meeting of the Kairos Power Licensing Subcommittee of the Advisory Committee on Reactor Safeguards. I'm David Petti, Chairman of today's subcommittee meeting.

ACRS members in attendance are Jose March-Leuba, Joy Rempe, Matthew Sunseri, Ron Ballinger, Walt Kirchner, and Greg Halnon. We anticipate Charlie Brown will arrive once traffic subsides a little. And Vesna Dimitrijevic and Vicki Bier may join us virtually.

MEMBER DIMITRIJEVIC: Yes, (audio interference).

CHAIR PETTI: Okay. Great. You're both there. Great. Thank you.

Consultants Dennis Bley and Steve Schultz are also online.

Weidong Wang of the ACRS staff is the designated federal official of this meeting.

During today's meeting the subcommittee will continue its review of the staff's safety evaluation on Kairos Power Hermes Non-Power Reactor preliminary safety analysis.

The subcommittee will presentations by and hold discussions with the NRC staff, Kairos Power representatives, and other interested persons regarding this matter.

Parts of the presentation by the applicant and the NRC staff may be closed in order to discuss information that is proprietary to the licensee and its contractors pursuant to 5 USC 552b(c)(4). Attendance at the meeting that deals with such information will be limited to the NRC staff and its consultants, Kairos Power, and those individuals and organizations who have entered into an appropriate confidentiality agreement with them. Consequently we need to confirm that we have only eligible observers and participants in the closed part of the meeting.

The rules for participation in all ACRS meetings including today's were announced in the Federal Register on June 13th, 2019. The ACRS section of the U.S. NRC public website provides our charter, bylaws, agendas, letter reports, and full transcripts of all full and subcommittee meetings including slides presented there. The meeting notice and the agenda for this meeting were posted there.

We have received no written statements or requests to make an oral statement from the public.

The subcommittee will gather information, analyze relevant issues and facts and formulate proposed positions and actions as appropriate for deliberation by the full committee.

A transcript of the meeting is being kept and will be made available.

Today's meeting is being held in person and over Microsoft Teams by ACRS staff and members, NRC staff, and the applicant. There's also a telephone bridge line and a Microsoft Teams link allowing participation of the public.

When addressing the subcommittee the participants should identify themselves and speak with sufficient clarity and volume so that they may be readily heard. When not speaking we request that participants mute their computer microphone or their phones by pressing *6.

We can now proceed with the meeting and we'll call upon Kairos to begin.

Kairos?

MR. PEEBLES: Thank you, Mr. Chairman. This is Drew Peebles. I'm a senior licensing manager at Kairos Power. I'd like to thank the subcommittee for the opportunity to continue to provide an overview of the Hermes PSAR. I think we had some good discussion at the past few meetings and look forward to more of that.

First up is Chapter 5, so I'm going to hand it over to the responsible director, Nico Zweibaum.

MR. ZWEIBAUM: Good morning, everyone. Rapid sound check just making sure that everyone can hear me correctly.

CHAIR PETTI: You're fine. Go ahead.

MR. ZWEIBAUM: Thank you very much.

So as Drew Peebles mentioned, my name is Nico Zweibaum. I'm the Director of Salt Systems Design of Kairos Power and today I will be presenting on Chapter of the Hermes preliminary safety analysis report on heat transport system.

Next slide, please? So first for a description of the primary heat transport system, which is provided in Section 5.1 of the PSAR, the PHTS, the primary heat transport system, is responsible for transporting heat from the reactor to the ultimate heat sink which is environmental air during power operation and during normal shutdown. Of note the PHTS operates near atmospheric pressure and it does not provide a safety-related heat removal function.

The members of ACRS may remember the presentation on Chapter 6 a couple weeks ago that mentioned the decay heat removal system, or safety-related system, but the PHTS in contrast does not provide a safety-related heat removal function.

In particular there is no driving force thanks to the near-atmospheric pressure operation for energetic releases during a pipe break. Again, the PHTS is a non-safety-related system.

There are a number of parameters that are shown here to further describe that system. It is sized for a thermal duty of the reactor of 35 megawatts thermal. It is equipped with one heat rejection radiator, or HRR. This is the heat exchanger between the FLiBe salts and air. There is one hot leg and two cold legs returning to the reactor vessel. The nominal size for the piping in the PHTS will be between 8 and 12 inches. The temperature of the coolant entering the heat rejection radiator will be somewhere between 600 and 650 degrees Celsius depending on operating mode. The cold leg coolant temperature will be 550 Celsius.

Nominal flow rate of the coolant in the primary heat transport system will be 210 kilograms per second and the design pressure here is (audio interference).

MEMBER HALNON: So just a question for clarification, make sure I have it in -- pictured my in mind. So the hot leg let's say comes into the top of the heat exchanger and out the bottom comes two cold legs?

MR. ZWEIBAUM: The split for the two cold legs happens closer to the reactor vessel. There's a very simple notional diagram I believe on the next slide, but that's --

MEMBER HALNON: Okay.

MR. ZWEIBAUM: -- probably not going to be sufficient. But, yes, it happens -- yes, you can see it here. It's obviously very notional, but yes, it would happen closer to the vessel.

MEMBER HALNON: Okay.

MEMBER MARCH-LEUBA: And this is Jose. Can you remind me, on the top of your head do you know what the freezing temperature is of FLiBe?

MR. ZWEIBAUM: Yes, it's around 460 degrees Celsius.

MEMBER MARCH-LEUBA: Sixteen?

MR. ZWEIBAUM: Four-six-zero. Sixty.

MEMBER MARCH-LEUBA: Oh, 60? So we have

like a little less than 100 degrees C to freezing?

MR. ZWEIBAUM: That's correct.

MEMBER MARCH-LEUBA: All right. Okay. Thank you.

MR. ZWEIBAUM: Okay. Continuing on the description of that system. Here the major subsystems are listed starting with primary loop piping. That piping transports reactor coolant which is FLiBe salt between the reactor vessel and the heat rejection radiator. This is a non-safety-related portion of the reactor cooling boundary.

The primary salt pump, or PSP, is a variable-speed cartridge-style pump which is located on the head of the reactor vessel. Its inlet extends downwards through the reactor coolant-free surface. It has an anti-siphon function on the hot leg which is performed by the geometric features of that downward-facing inlet of the PSP. There is no safety-related function for the PSP itself as a subsystem, however there is a safety-related trip of that pump should a leak occur on the hot leg to maintain reactor coolant inventory level.

The heat rejection subsystem provides for heat transfer from the reactor coolant to environmental air, which is the ultimate heat sink.

It consists of a heat rejection radiator, heat rejection blower, and associated ducting and thermal management. There is no safety-related function for the heat rejection system, however there is a safety-related blower trip upon tube failure to minimize forced air ingress into the PHTS.

And finally, we do have a primary loop thermal management function to provide non-nuclear heating and insulation to the PHTS as needed for various operations which again has not safety-related function.

MEMBER HALNON: Just a quick question. This is Greg. The environmental air reject for the heat, is that -- do you have dimensions on the stack? Is it high or it surface level? What is the release there?

MR. ZWEIBAUM: So we'll provide more details with the operating license application. The factors that will get into that is not only for thermal management and kind of heat balance, but there's also considerations associated with tritium and dilution and source term. So there is a combination of factors that leads -- or will lead to the specifics provided for that stack height.

MEMBER HALNON: Thank you.

MEMBER MARCH-LEUBA: And this is Jose. Can you explain to us -- you have a safety-related function to prevent air going into the system. What will be the safety significance of air getting into the system?

MR. ZWEIBAUM: So there's really -- and actually there was a request for additional information by the NRC specifically on oxidation of reactor internals. There's really two regimes: During normal operation there is a technical specification around the quantity of air that could be ingested into the primary heat transport system to limit oxidation. During an accident that includes a break in the heat rejection radiator the trip is intended to limit forced air ingress. And then the natural convection that would result in some amount of air introduced into the system and causing oxidation of reactor internals would be bounded by what we'll be testing based on our materials qualification topical report. So this is all related to oxidation and bounded by acceptable values up to seven days during any postulated event.

MEMBER MARCH-LEUBA: So summarizing, is more of a chemical reaction of the oxygen, not flow blockage or prevention of circulation or change of flow factors, things like that?

MR. ZWEIBAUM: That is correct.

MEMBER MARCH-LEUBA: Nothing --

MR. ZWEIBAUM: That's correct. The natural circulation that we are relying upon for decay heat removal happens strictly within the reactor vessel, so the PHTS which is described in Chapter 5 is not involved in that function.

MEMBER MARCH-LEUBA: Thanks.

MR. ZWEIBAUM: Next slide? Our reactor coolant, although part of the functional containment function that was described in Chapter 6 is also architecturally a part of a heat transport system, so this is why it's also described in Section 5.1. This is FLiBe, the liquid fluoride salt coolant that's been described multiple times. Of note is its negative temperature coeffience of reactivity as well as the fact that it acts as a secondary barrier to fission product release.

For thermal physical properties there is a topical report, Reactor Coolant for the Kairos Power Fluoride Salt Cooled High-Temperature Reactor, KP-TR-005, that provides all of the thermophysical properties. And another important aspect here is the high heat capacity of the coolant, which from a safety perspective provides large thermal inertia for transients so that any transient don't result in any kind of rapid evolution of temperature.

MEMBER KIRCHNER: This Walt Kirchner. Could you tell us what we're looking at in the picture on the right?

MR. ZWEIBAUM: Yes, so this picture I believe was the first time that we did some static exposure of a metallic coupon in FLiBe in our own salt lab in Alameda, California. So we're looking at a small trinket if you will that contains liquid FLiBe. The red glow is because of the temperature that we have to heat up the system to for melting of the salt and then introduce that little machined Kairos Power logo made of 3/16th stainless steel into the salt there.

MEMBER KIRCHNER: Could you tell us what happens with FLiBe sitting in -- exposed to air, whether it's dry air or humid air, or water?

MR. ZWEIBAUM: In what context? With materials and materials oxidation or just the chemical reaction between FLiBe and other chemicals?

MEMBER KIRCHNER: Well, if you have a break in this primary heat transport system what happens with the FLiBe being exposed to air?

MR. ZWEIBAUM: Yes, so this is something that we'll be continuing to investigate and bound from I guess a reaction perspective. There's a number of factors here, the main thing being the corrosion of the materials exposed to the combination of FLiBe and oxygen. And this is what we'll be testing for and bounding from what we've committed to in our materials topical report that's been submitted and approved by the NRC.

MEMBER KIRCHNER: So what happens in if you have a spill of FLiBe?

MR. ZWEIBAUM: Also (audio interference) --

MEMBER KIRCHNER: You don't have a confinement, so just talk through what issues you have with FLiBe exposed to air.

MR. ZWEIBAUM: Well, I guess the main thing would be the release of radionuclides or aerosols that would be contained in the FLiBe. And this is something that we are also bounding in our analysis, and it's part of our Chapter 13 analysis. I think we have our manager of salt chemistry Gus Merwin on the line if you have more questions related to chemistry specifically.

MEMBER KIRCHNER: Well, is it toxic? Do

you have an occupational hazard if it's spilled?

MR. MERWIN: This is Gus Merwin, manager of Salt Chemistry here at Kairos. I'd say the chemical toxicity is sort of out of scope of the PSAR. There's a -- so the beryllium hazards are assessed separately into different regulatory domain.

I would note that there is no chemical reaction between oxygen and FLiBe itself, so a pool of FLiBe does not chemically react with oxygen. There is the corrosion concerns that Nico Zweibaum mentioned, and those are assessed as part of the materials topical program.

For a salt spill scenario there is the potential for radiological releases from circulating activity which is handled as part of our postulated event analysis.

MEMBER MARCH-LEUBA: And in that line of questioning what happens to hot FLiBe falling onto a concrete floor? Does it interact with the concrete? Releases gases?

MR. MERWIN: The chemical reactions between FLiBe and concrete are precluded by design. There is a safety-related drip tray that precludes chemical reactions between FLiBe and concrete.

MEMBER MARCH-LEUBA: Oh, so you have a

metal barrier? But if it were to fail, is it really bad? I mean, all this gas it goes -- it fizzles and produces lot of gases.

CHAIR PETTI: I don't think it's a good day.

Yes, I was -- on the trays -- I know you -- I don't see any slides -- I mean are they basically like below all the welds? Is that where they're putting -- or is it really the whole reactor compartment in under a big steel tray above the --

MR. MERWIN: This is Gus Merwin again. We've not specified where the trays will be or their geometric configuration, but the general bulk chemical reactions are precluded by design. But I will note that for Kairos' internal learnings and investment protections we have done experiments reacting FLiBe with concrete as part of test program to develop prototype systems and those reactions are extremely, extremely slow. We're talking about functionally chemically inert. The FLiBe does not want to form oxides. It's the same reason there's no driver for FLiBe reactions with air. So the reactions are over the course of many hours and we probably freeze the system before you get any bulk degradation of the concrete.

MEMBER BALLINGER: This is Ron Ballinger. I guess I understand that part, but I've had some experience when you drop something very hot on concrete it's not the reaction with the concrete that's the issue. It's the literally explosion of air bubbles in the concrete that blows the concrete surface away. Have you looked at that?

MR. MERWIN: That is a primary motivator for why we precluded this by design.

MEMBER BALLINGER: Thank you.

CHAIR PETTI: Okay. Keep going. No more questions here.

MR. ZWEIBAUM: Okay. This is --

MEMBER REMPE: I guess I'm just kind of wondering a little bit more about this tray. So you plan to specify the thickness of the -- and the material of the metallic tray as well as -- do you need to have a lip to contain a certain amount of FLiBe? I mean all of those things will be determined based on some estimated release amount by the time of the operating license. I haven't looked for that specific detail anywhere, but that's the plan?

MR. MERWIN: Yes, that is correct.

MEMBER REMPE: And is that in Appendix A also as something that you're expecting to get from them?

MR. SCHMIDT: This is Jeff Schmidt from Reactor Systems. I don't think it's specifically in Appendix A that I remember other than it's precluded by design and we just don't have the design details of it.

MEMBER REMPE: But that's something a level of detail you'll expect to iron out?

MR. SCHMIDT: Yes, I mean there's a -- as they pointed out there's a Chapter 13 event, a salt spill. So obviously we'll be looking at that and where the salt goes from that salt spill. And they've committed to looking at a variety of locations for break sizes through the primary system.

MEMBER REMPE: You'll have to --

MR. SCHMIDT: Yes.

MEMBER REMPE: -- think hard about does it flow and spread out or does it -- I mean (audio interference) --

MR. SCHMIDT: Yes. No.

MEMBER REMPE: -- concrete interaction concerns (audio interference) --

MR. SCHMIDT: No, right. Right.

MEMBER REMPE: -- severe accident stuff in the past. And I'll be looking at Chapter 13 a little bit more carefully on those kind of --

MR. SCHMIDT: Yes, it is -- as they pointed out it's precluded by design, by the design details are not available.

MR. ZWEIBAUM: This is Nico Zweibaum again, Director of Salt Systems Design. I would like to note that by OLA we'll also have more definition of plant layout including the specific routing of any salt-containing system. So that will allow for a lot better definition on location and sizes and geometry of those drip trays. And this will all be part of the operating license application.

MEMBER KIRCHNER: Yes, in particular; this is Walt Kirchner, you point out in your own Chapter 6 that FLiBe is an external hazard for your decay heat removal system.

MR. ZWEIBAUM: What we did point out in Chapter 6 is that we are precluding water and FLiBe interactions by design. And since the major system containing water in the plant is our safety-related DHRS, that system does include a leak barrier so that should there be a leak in the primary barrier of that water-containing system that the water is still contained and not introduced into the reactor cavity where it could come into contact with FLiBe. If that makes sense.

CHAIR PETTI: Okay. Keep going.

MR. ZWEIBAUM: Shall we proceed? Okay.

So on the design basis for the PHTS the structure systems components that are part of the reactor cooling boundary will be designed to ASME B31.3 and Boiler Pressure Vessel Code Section 8, Codes and Standards.

Consistent with PDC 2 failure of the non-safety-related PHTS components during seismic events will not affect the performance of nearby safety-related SSEs.

Consistent with PDC 10 adequate coolant flow will be maintained to assure SARRDLs will not be exceeded under any condition of normal operation.

Consistent with PDC 12 the PHTS is designed with features that ensure power oscillations cannot result in conditions exceeding SARRDLs.

Consistent with PDC 16 and 60 the reactor coolant provides control of the release of radioactive materials during normal operations and postulated events through the accumulation of radionuclides.

Consistent with PDC 33 the casing for the primary salt pump, PSP, is designed with geometric features to prevent reactor coolant from being siphoned below the pump casing inlet elevation to maintain reactor coolant inventory in the event of a break in an external portion of the PHTS.

Consistent with PDCs 33 and 70 the PHTS is designed with features that support maintaining reactor coolant inventory and maintaining reactor coolant purity by eliminating air ingress.

The PHTS will be designed according to 10 CFR 20.1406 to the extent practicable to minimize contamination and support eventual decommissioning.

CHAIR PETTI: This is their last slide, members, Chapters 5. Any questions?

(No audible response.)

CHAIR PETTI: If not, we'll turn to staff.

MR. HISER:

Thank you. My name is Matt Hiser. I am a senior project manager in the NRR's Division of Advanced Reactors and Non-Power Production and Utilization Facilities. I've been one of four project managers focused on Hermes and I'd like just to offer a few introductory slides sort of for all the presentations today hopefully to make it a little more efficient, a little less repetitive on the material that we're going to cover and the regulatory basis.

So the four chapters that we're going to cover today are Chapter 5, as Kairos has already jumped into; Chapter 7 on Instrumentation and Control; Chapter 8 on Electrical Power Systems; and then Chapter 11 on Radiation Protection and Radioactive Waste Management. And towards the bottom of this slide I just have sort of included a rough common agenda for each chapter, so we'll sort of have a brief overview in more than a slide or two of the PSAR information and the relevant principal design criteria for that chapter. Then if there are some topical reports that are referenced for that chapter, those will be noted. And then the bulk of each chapter we'll discuss the staff's technical evaluation and then wrap up with findings and conclusions.

Next slide? And so just to cover sort of the common regulatory basis; and you guys saw these slides in about every chapter a couple weeks ago, so we thought we'd boil it down to one slide up front. These are the relevant regulations: 50.34a, which describes what expected in a preliminary safety analysis report, or PSAR; 50.35, the expectations for the agency, the findings that need to be made for issuance of a construction permit; and then the common standards in 50.40; and finally, the guidance, NUREG-1537, Part 2, the SRP and acceptance criteria. Those are all applicable guidance and regulations. And we'll have noted for each chapter if there are other regulations or guidance or PDCs that are applicable to that chapter.

So with that I'll happily turn it over to Alex Chereskin to cover Chapter 5.

MR. CHERESKIN: Good morning. This is Alex Chereskin from the NRC staff. Can everyone hear me?

(No audible response.)

MR. CHERESKIN: Okay. Thanks.

I'll be covering the NRC staff's review of Chapter 5 for the primary heat transport system.

Next slide, please? This slide covers the overview of the staff's review of Chapter 5. And to start off the primary heat transport system is a non-safety-related system. A general overview, not to repeat too much of what Kairos just said, but it includes the primary salt pump, heat rejection subsystem and the associated piping. And the purpose is to transport heat from the reactor core to the ultimate heat sink through the heat rejection radiator. It's also meant to manage thermal changes and provide normal heat removal. And the design will provide for potential in-service inspection, maintenance, and replacement activities.

Next slide, please? These are the principal design criteria that are applicable to Chapter 5. I will get into more detail on the next couple of slides for each of these PDCs, but in general they cover -- PDC 2 discusses the requirement for safety-related systems, structures, and components to be protected against the effects of natural phenomena; PDC 10 requiring that specified acceptable system radionuclide design limits are not exceeded; PDC 12 for ensuring power oscillations aren't possible or can be reliably readily detected; PDC 16 and 60 which deal with controlling the release of radioactive materials to the environment; PDC 33 requiring a system to maintain coolant inventory; and also PDC 70 which deals with reactor coolant purity based on design limits that I will get into on a subsequent slide.

Next slide, please? So this slide just covers a list of applicable topical reports to this section. And as they come up in the subsequent slides we can add more detail, but I don't have much to say on this specific slide.

So next slide, please? This slides contains the staff evaluation of PDC 2, which as I mentioned requires safety-related systems, structures, and components be protected against the effects of natural phenomena. And so information in the PSAR notes that the PHTS piping and supports are designed in accordance with ASME Code B31.3 and the heat exchanger is designed in accordance with ASME Code -- Section 8 standards. And the design of the non-safety-related primary heat transport system will be such that a failure of that system would not affect the performance of safety-related SSCs due to something like a design-basis earthquake. In the PSAR it notes that the sufficiently small pipe thickness will be used so that the failure of these pipes would not impact the vessel nozzles and the staff had found that the preliminary design information provided for the primary heat transport system is consistent with PDC 2.

Next slide, please?

MEMBER MARCH-LEUBA: Can we --

MR. CHERESKIN: Yes. Sorry.

MEMBER MARCH-LEUBA: -- go to the previous slide with the topical reports?

MR. CHERESKIN: Yes.

MEMBER MARCH-LEUBA: Yes, notice that the last two, 13 14 are not approved yet or reviewed.

That's correct, right?

MR. CHERESKIN: Those were recently issued, I think maybe last month.

MEMBER MARCH-LEUBA: And there's an SE out on them?

MR. CHERESKIN: Yes.

MEMBER MARCH-LEUBA: That's what I -- but it doesn't say A.

CHAIR PETTI: This slide is a little old.

MR. CHERESKIN: Yes, that was --

CHAIR PETTI: At the time they did the review it was not A, but today it's A.

MR. CHERESKIN: That is correct. They're A today. It was just a matter of timing.

MEMBER MARCH-LEUBA: I was just going to comment that the issue of going between CP and OL, we're kind of pushing things to next year and we need to keep a mental picture of what's missing. And if something were to change what would effect on our conclusions?

MR. CHERESKIN: It's understood.

MEMBER MARCH-LEUBA: But fix the slides, what is says, and that way it won't make a problem.

MR. CHERESKIN: I think we covered this slide. I think I went through my notes here.

Next slide, please? All right. So this is the staff evaluation of PDC 10 which requires that the SARRDLs aren't exceeded during normal operations or unplanned transients. And the staff had found that the preliminary information in the PSAR is consistent with PDC 10. As Kairos noted, the coolant properties are found in the cited topical report on this slide. Additionally there's a chemistry control system that can maintain FLiBe composition. There's also a proposed technical specification to maintain the coolant within allowable limits.

And this all rolls up to the coolant being resistant to thermal hydraulic instabilities due to its high heat capacity. And I would note that the actual evaluations of thermal hydraulics to demonstrate consistency with this PDC are found in Chapter 4 of the staff SE. And then Chapter 6 of the staff SE actually evaluates the decay heat removal capabilities of the system.

Next slide, please? So this is the staff evaluation of PDC 12 requiring coolant systems to ensure power oscillations that could result in exceeding SARRDLs aren't possible or can be reliably and readily detected and suppressed. And the staff had found that the preliminary information in Chapter

5 is consistent with PDC 12 as the primary heat transport system can limit and suppress inlet temperature and mass fluoride oscillations and limited train gas in the coolant, maintain coolant specifications.

And as I mentioned on the previous slide, the resistance of the coolant to thermal hydraulic instabilities. And also similar to the last slide, other sections of the staff's safety evaluation contain the full evaluations of consistency with PDC 12, Chapter 4 for the nuclear design and Chapter 7 for the required instrumentation and controls.

Next slide, please? Okay. So this slide combines the evaluation for PDCs 16 and 60 as they are pretty similar. And the function of the FLiBe to be consistent with these is also very similar. PDC 16, which requires a functional containment to control release of radioactivity and PDC 60 requiring the plant design to control the release of radioactive materials including during postulated events in the PSAR.

In Chapter 5 it describes the ability of FLiBe to retain fission products that may escape from the fuel and credits FLiBe as a radionuclide barrier in the safety analysis. And the staff had found that the preliminary information in the PSAR is consistent with these PDCs as the ability of FLiBe to retain radionuclides was previously evaluated by the staff in the cited topical report here, the Mechanistic Source Term Topical Report, which contains the methodology for evaluating the ability of FLiBe to retain fission products with a KP-FHR design. Additionally Chapter 14 in the PSAR contained a proposed tech spec to limit circulating activity which also supports assumptions made in that topical report.

Next slide, please? This slides contains the staff's evaluation of PDC 33 which requires a system to maintain coolant inventory to protect against small breaks in the safety-related portion of the coolant boundary. And so on this slide we have a discussion of the anti-siphon features for when the loss of the reactor coolant.

And so just to expand on that a little bit because I know we've had some discussions a couple weeks ago on this topic, there are a couple different anti-siphon features, and I think Kairos was talking about some of them during their presentation starting with the pump -- the primary salt pump suction inlet being above the required coolant level. So when the coolant drops below that it would help to break the siphon in the hot leg.

And additionally for the cold legs if there is a break in the primary heat transport system, gas flowing out of the covered gas system would also help to break the siphon from the cold leg as the argon gas could flow out of the cold leg as the coolant level decreases breaking the siphon. And that's facilitated by the cutout features in the core barrel which is mentioned in Section 4.3.

And so the information on these design features is -- the preliminary information is consistent with PDC 33. It's also consistent with the guidance given in NUREG-1537. And I think that's actually all I had on that slide. Sorry about that.

Next slide, please? Okay. So this slide contains the staff evaluation of PDC 70. PDC 70 requires a system to maintain purity of the reactor coolant based on design limits that consider chemical attack, fouling and plugging passages, radionuclide concentrations, and air or moisture ingress due to leaks. And the preliminary information in the PSAR and also the RAI response that Kairos mentioned describes how the primary heat transport system is designed to either withstand or mitigate fouling, air ingress, chemical attack, and also manage radionuclide concentrations.

The staff had found this preliminary information is consistent with PDC 70 as there is coolant purity control and temperature monitoring that can detect the fouling or plugging of passages, the previously discussed ability of FLiBe to retain radionuclides combined with the circulating activity limits, and the ability to also remove those radionuclides from FLiBe. As discussed previously there are the Material Qualification Topical Reports which assess chemical attack and FLiBe.

And the last bullet here that I wanted to cover is the ability of the primary heat transport system to limit forced air ingress due to the design features that Kairos described during their presentation in order to remain within bounds of qualification testing, and as described in Chapter 13 of the PSAR, the availability of compensatory measures after I believe the seven days that Kairos described.

Next slide, please? I think this is one of the last slides here covering testing and inspection. And the PSAR states that the design of the PHTS allows for inspection, maintenance, or replacement activities and it states that any testing or inspection will be submitted with the OL application. And so this is a future review item for the NRC staff to look at these programs at the time of the operating license application.

This might be my last slide.

Next slide, Ed? Oh, sorry.

And so this slide is just the technical findings in conclusion here that the preliminary design information in the PSAR is consistent with the applicable criteria in NUREG-1537 and the PDCs discussed on the previous slides and that the information in Section 5 of the PSAR is sufficient for issuance of a CP in accordance with 10 CFR 50.35 and 50.40 with the rest of the reviews being left for the operating license application.

Next slide, please? All right. And that was the last slide. Are there further questions?

MEMBER HALNON: Yes, Alex, this is Greg. Given the unique nature and I guess first-of-a-kind-type reactor this is, can you -- are you going to handle technical specifications in the same way that you would normally do it? In other words, I'm looking at PDC 70, to maintain reactor coolant purity. I mean, clearly there were tech specs proposed for radionuclide inventory of the FLiBe. Are you going to go deeper than that to make sure that in this situation the secondary systems that are supporting those types of attributes of the PDC will be maintained in spec? I guess what I'm thinking about is there going to be the auxiliary systems that we talked about in Chapter 9 that may have tech specs requirements, non-safety systems, but tech spec requirements?

MR. CHERESKIN: So I think I'll answer that in two parts.

And, Ed, I might ask you to chime in because I believe you did the full review of Chapter 14 here.

But given that these are only proposed tech specs at this time obviously there's no final proposed -- no final technical specifications or a final staff finding on it. But I would note that even in the proposed tech specs in Section 3.3 there are some of the proposed tech specs, for example, for inner gas system pressure. And so I mean there's at least something in here in the preliminary information that indicates that could be a possibility. But again, the final determination of that would obviously be made with the operating license.

MEMBER HALNON: Okay. So there wouldn't be tighter controls placed on a first-of-a-kind through tech specs? It would be through other means? Or do you think that those discussions -- I mean, they have to be had, I understand that, but I'm curious how deep we're going to go with that.

I realize that there were a lot proposed high-level tech specs, but some of these things -- when we talk about maintain reactor coolant purity, chemical attack, fouling and plugging -- so those radionuclide concentrations, those just beg of limits being put somewhere, being monitored consistently and inspectable, if you will, from the standpoint of normal operations.

So I guess it's -- again we're going to start from pretty much scratch looking at the PSAR going to the FSAR, but I was just curious how deep we're going to go with the tech specs and requirements being the first-of-a-kind. Is it going to be more stringent than you think down the road when all these things are proven? That's probably more of a statement than a question. You don't have to answer.

MR. HELVENSTON: Yes, this is Ed Helvenston from the staff. I'll just clarify that in PSAR Chapter 14 Kairos did list a number of the probable subjects of what the tech specs are going to be. There were some things related to coolant purity and other items, but it's understood that perhaps that list could be considered to cover some of the most significant items, but we certainly, at least from the staff's standpoint, don't consider that to be a comprehensive list.

We will do a much more detailed review of the tech specs at the operating license application and we'll certainly consider the level of importance to safety of various systems in those tech specs. And I think just because something is not necessarily safety-related, that doesn't automatically preclude it not having a tech spec limit on it if necessary.

MEMBER HALNON: As these progress I'm just interested in how those support systems will be controlled, the cooling systems in the same way. So like I said, more to be talked about later. Thanks.

MR. HISER: And this is Matt Hiser. I just wanted to offer one -- I think Alex was trying to mention this. There is an indication in their PSAR of inert gas system pressure, argon purity in the covered gas. So that's a non-safety-related system, but they've indicated they probably will have tech specs associated with those items. And to Ed's point and Alex' point, there may be more as they finalize the design. And then as we go through the review process, they may find that additional tech specs on non-safety-related aspects of the design are needed to ensure safety. If that's helpful.

MEMBER HALNON: Yes, it is. Are all the attributes of PDC 70 sort of like -- I mean, this is probably an easy one to look at, like moisture ingress and air moisture, measurement of that in the gases and whatnot. Are each one of those items going to kind of filter down into some limits somewhere in tech specs or is it too early to really go through that discussion?

MR. CHERESKIN: It might be a little early to determine if it would end up in somewhere like tech specs because there are also things like chemistry control programs which might not be explicit in the tech specs. And so I think it's a little premature to say exactly where they would end up, but I think the design criterion is pretty clear that purity limits need to be based on those factors. And so I think they would be somewhere.

MEMBER HALNON: Okay. Yes, it's like fouling and plugging. I mean, how do you measure it? How do you make sure that PDC 70 is being met from a fouling perspective? I know in light water reactors we do eddy currents and we do heat transfer and whatnot. We have plugging limits and all those types of things. Are those types of things going to be part of this as well? Again, you have to get the actual heat exchanger design in front of you to be able to talk about that. So, I got it. Thanks.

CHAIR PETTI: I had a question, but it may be more for Kairos. A chemistry control system, does it actually remove stuff from the coolant? I understand the whole keeping the composition correct, but there's going to be fission products in it. What I'm really worried about is the uranium. When you get beryllium you get uranium with it. And that's going to see the neutron field and could produce a mixed hazardous waste. It may make it difficult. It depends on the numbers. I've not run the numbers, but the presence of uranium in beryllium has historically been a problem with the disposal. This is more solid beryllium, blocks for instance, that are used in some reactors.

And so if the chemistry system can clean up some of that, they may be helping themselves in terms of at the end of the day with the way -- with what -- how to disposition the FLiBe. I just -- I don't know what functionalities that system has.

MR. MERWIN: This is Gus Merwin, Manager

of Salt Chemistry. Appreciate the question. As stated in the PSAR and mainly in Chapter 9, the chemistry control system is only credited for ensuring the salt is within those tech specs that were just discussed. The circulating activity tech spec as part of -- I believe in the environmental report, is stated that the FLiBe will be ensured to be low-level radiological waste. And so we are aware of those effects. They're monitored. And we will ensure the FLiBe has a disposal path.

CHAIR PETTI: But saying that it's low-level waste, doesn't the presence of beryllium -- make it a RCRA mixed waste? I'm not an expert in this area. I always thought it was the combination of the two that did it.

MR. MERWIN: Yes, as part of our ER we did ensure that there was a disposal path in partner with a vendor for disposal of radiological materials. And they specifically were aware of the chemical form and the chemical composition of the waste.

CHAIR PETTI: Okay.

MEMBER KIRCHNER: You know there are pointers to control -- this is Walt Kirchner -- I think it's Chapter 9 has pointers to controlling chemistry. You also have to be concerned about transmutation products accumulating. So it suggests to me that the system will have the ability to strip out impurities.

CHAIR PETTI: Yes, if the system can take out some of that stuff that helps a lot. Again, not credited per se, but what is it actually going to do?

MEMBER KIRCHNER: Well, there's two ways to look at this. What's credited in terms of an accident scenario?

CHAIR PETTI: Right.

MEMBER KIRCHNER: And then what do you need to do to maintain the system?

CHAIR PETTI: Yes, I mean the other thing -- I mean I'm sure they're doing this, but the assumptions on how much fission products gets out is very high compared to what I think they're going to see. You want to make sure you design the system to see what you're going to see, not just what the safety limit is. Otherwise, what good is your system?

Any other questions?

(No audible response.)

CHAIR PETTI: Okay. Let's --

MR. HISER: I just want to make one clarification on the discussion earlier about topical reports and dash A. So typically the way it works is

NRC issues the final safety evaluation and then the vendor develops a dash A version, it may be a month or two after, that incorporates the SE. I just want to be clear, we don't have a dash A yet, but we have a final SE out. So they're approved --

MEMBER MARCH-LEUBA: I wouldn't worry whether a revision 4 was in the future. You're revision 4 is in the past.

MR. HISER: Right. Yes. Correct. I just want to make clear for the record what -- we don't have a dash A today, but we will certainly by the time this CP is issued or down the line.

MEMBER MARCH-LEUBA: All they do is prepend the SER --

MR. HISER: Right.

MEMBER MARCH-LEUBA: -- and topical report and make the conforming changes to the --

MR. HISER: And stick dash A in the tape. Just wanted to make sure that was 100 percent clear.

MEMBER MARCH-LEUBA: Revision 4 is in the past. That's important.

MR. HISER: Yes, yes.

CHAIR PETTI: Okay. Then let's now talk about the memo.

Walt?

MEMBER KIRCHNER: Okay. While we're bringing the memo up I think the good thing here is that Kairos is building a prototype to demonstrate some of the key features of their design approach.

So I'm not going to read my memo to you. Basically I would be repeating what Kairos and the staff have already presented. So let me get to the bottom line.

CHAIR PETTI: Oh, yes. Hold on, Walt. Just so that the court reporter doesn't have to record this part of the memo reading discussion. Thank you.

(Whereupon, the above-entitled matter went off the record at 9:20 a.m. and resumed at 9:36 a.m.)

MR. CILLIERS: Good morning, everyone. This is Anthonie Cilliers. I'm the Director of Instrumentation, Controls & Electrical. And I thank you for the opportunity to be able to present this Chapter 7 of the PSAR on instrumentation and control systems to you. Next slide.

So the chapter consists of a couple of systems, the first system notably being the reactor protection system. It's a safety related system that provides protective, protection for reactor operations by initiating signals to mitigate the consequences of postulated events and ensure a safe shutdown.

The second one, the plant control system, is a non-safety related system. And that's responsible for controlling the plant parameters during normal operations and providing data to the main control room control consoles.

The main control room provides means for the operators to monitor the behavior of the plant and control room performance of the plant. The remote onsite shutdown panel provides a separate means to shut down the plant and to monitor plant parameters in response to postulated event conditions.

Of course, the system receives its inputs from various sensors throughout the system that are used to provide information about the plant parameters as inputs to the plant control system as well as the reactor protection system as safety related inputs into that system.

Sensors that are provided into the RPS are safety related as I've said. And the plant control system receives its inputs from non-safety related sensors, as well as has access to the safety related sensor data through safety related isolation device or data diode. Next slide.

I want to start off with taking you through the architectural system. Since we have presented this work to the committee previously, we have made a couple of changes in form of change packages, not fundamental design changes, but as details developed in the development of our reactor protection system we've added that information.

Notably, you will find that you'll see on the right-hand side the red box where the reactor protection system is. And I apologize. This is really small. But I believe you've got a printout, larger printout that you could be looking at.

So, on the right-hand side of the reactor protection system, we've moved the data diode into the reactor protection system itself. So you'll see the data diode there. And the reason for that is it is built into the architecture of the HIPS platform that we are using as our reactor protection system.

The reactor protection system is an FPGA based system. The HIPS platform I think you're all aware of the HIPS platform architecture. And it's both in hardwired, one-way communication. So we've moved that data diode, instead of being a separate device, to being part of the architecture.

You will also note that we have added the thermal management systems as systems on the little (audio interference).

MEMBER SUNSERI: We're getting a bit of feedback. If participants could mute themselves, we could keep moving. Thank you.

MR. CILLIERS: Thank you. You will also note that in the previous version of the architecture we had four non-safety related systems that were tripped. But we added the thermal management systems of both the reactive thermal management system as well as the primary loop thermal management system trips to that as well. And that makes logical sense, because those are heaters, and when we trip the system, we do not want to add heat while we are trying to remove heat at the same time.

So those are the big changes to the system.

Jumping back to the reactor protection system on the right-hand side, it receives four inputs from safety related instrumentation. And you'll find those four inputs are directly related to protecting the safety systems of the reactor.

So that would be the temperature of the coolant in the reactor, the level of the coolant in the reactor, as well as the flux that's being created inside the reactor during operations. And for that flux monitoring, we do have a maximum flux trip, as well as a rate of change trip.

In addition, you'll see the PHSS bubble there. And that has been defined the inert gas pressure sensor that will be tripping on, as stated in previous chapters as well, to trip the reactor on any break in the inert gas system to prevent air increase or limit air increase into the system.

I think it's key to note that the separation between the reactor protection system and the plant control system is absolute. The only link between the two systems is through the physical operation of the plant itself. And that is specifically to prevent any adverse effects of the plant control system to affect the reactor protection system's safety functions.

So, basically, the reactor protection system removes power from the safety related relays, which will then remove electricity from all of the active systems. Notably, it will trip the shutdown elements into the core. It will trip the primary salt pump. It will prevent heaters from heating up the plant and a number of other systems that stop functioning until the reactor protection system finds that the parameters have returned back to normal.

I think we can move to the next slide, or if there's any questions.

MEMBER BROWN: Yes, let me ask one. Can you go back to that again?

MR. CILLIERS: Yeah, sure.

MEMBER BROWN: And I'm looking at your -- I think you've got another slide where you show the RPS trip logic. Is that --

MR. CILLIERS: That's correct --

MEMBER BROWN: Okay. I'll save my one comment for that.

We've got a safety related system for the RPS, do all the right things on the relays. But there's no safety related power supply. Is it not -- I couldn't tell from Chapter 8 whether that was a dual redundant power supply fed from separate somethings.

Whether it's safety related, it's not -- but there's no dual power supply anywhere. It's a single power supply. That was the implication I got from the other diagrams in Chapter 8.

So I guess that's a question that's hanging out there that I guess should be addressed at some point.

MR. CILLIERS: I think it's very important to note that we do not create any electrical supply for safety functions. In fact, we remove electrical supply for the activation of safety functions.

So the reactor protection system actively keeps the system alive while in operation and removes the voltage from those relays to shut the reactor down. The same would happen in the event of a loss of power. We would automatically shut down.

That being said, we do have, and we'll talk about it in Chapter 8, but we do have a backup power supply system, because clearly as an investment protection system we would not want to lose electricity supply to our systems. We would rather take it away with the reactor protection system. Also -- yep.

MEMBER BROWN: I understand that point. The backup system, though, is just another set of generators that replaces the grid.

What I was talking about was the UPS power supply that you have feeding the RPS. And what you're, from a safety standpoint, you're saying it doesn't, you're just setting yourself up for a plant shutdown in case you lose the UPS.

MR. CILLIERS: That is correct --

MEMBER BROWN: And that's okay. I got it. I got it. I just, it was just a matter of reliability. I'm not questioning the duality that you've got in the RPS at this point. Okay?

MR. CILLIERS: Correct.

MEMBER BROWN: And you're willing to accept that is all I'm saying.

MR. CILLIERS: Yes, we do.

MEMBER BROWN: Okay. All right. Go on then.

MEMBER HALNON: Yeah, this is Greg. A real quick question on the reactor trip or vessel level monitoring. Is that perceived to be straight vessel level, or is that going to be triggered off of the inventory management system type parameters, such as when the PSP gets tripped based on leakage detection or something to that effect? I guess the question is, is it going to be an indirect or is it just vessel level? So --

MR. CILLIERS: It is a safety related, direct indication of the vessel level inside the core. So we have a vessel level indication directly from the core itself.

MEMBER HALNON: Okay. So, if the PSP gets tripped because the inventory management system determines that there's a leak, how will the reactor get tripped?

MR. CILLIERS: The reactor will be tripped through the same systems that, the inputs that's coming into the reactor protection system. So it's very important to note that, as I said, there's a separation of operations between the reactor protection system and the plant control system.

All parameters that would trip the reactor is when any parameters move outside of the boundary that may challenge the safety systems of the reactor, in other words, if the temperature goes higher than a specific set point, if the level goes lower than a specific set point, or the neutrons or the pressure in the system. If any of those does not happen, the safety systems are not being challenged and the plant will continue basically operation in normal until that happens.

I have to add to that, if anything happens on the plant control system side where the pump is tripped or any of those systems are tripped, the plant control systems also maintain full functionality until you're able to shut down the reactor itself or shut down various systems around that, although those will not be deemed as safety functions because it's not within the scope of challenging any of the safety systems that we're protecting with the reactor protection system.

MEMBER HALNON: Okay. So the reactor trips will protect from safety limits or whatever --

MR. CILLIERS: Correct.

MEMBER HALNON: -- whatever margin, and the plant control system may also trip the reactor based on parameters going so far out that, even though they haven't challenged the reactor safety limits, they are not a good place to be operating. Is that correct?

MR. CILLIERS: That is correct. That is absolutely correct.

So any of the trips, like you mentioned, the primary salt pump trip would result in a sequence of events all coming from the reactor, the plant control system while in operation.

MEMBER HALNON: Okay. So there will be a distinction between non-safety trips and safety trips in other words.

MR. CILLIERS: Correct.

MEMBER HALNON: Okay. Thanks.

MEMBER BROWN: Okay. I have one other -- are you done?

MEMBER HALNON: Yes.

MEMBER BROWN: Okay. I have one other question, this is Charlie Brown again, relative to the power supply routine.

I understand the backup goes away. Right now you show in Chapter 8 a UPS for that. And then you show in the Chapter 8 discussion, as well as the figure, that it can maintain itself for 72 hours on a UPS performance basis.

So, even though you lose the grid and you, if your other backup power supply doesn't come on, you've still got RPS systems in place for any other things that happen in the reactor to take care of at least for a three-day period while you're taking other actions. Is that -- I'm just trying to connect the dots between Chapter 8 UPSs and the concept.

I have no problem with the idea that if you lose power you shut down the reactor, that the UPS does shut down the reactor. And that's a reliability issue. And that's, if you accept that, that's okay. But is the 72 hours accurate?

MR. CILLIERS: I believe so, yes. I believe --

MEMBER BROWN: All right. That's fine. I just wanted to make sure. There's little subscripts under the UPS in the figure. So thank you.

MR. CILLIERS: Yeah, I know it's very small.

The purpose of that 72 hours is, of course, we would like to have power during any event. Although we do not rely on it, it's better to have it and to be able to monitor the system continuously. But it doesn't provide any safety functions.

MEMBER BROWN: I got that. I'm not questioning that issue.

MR. CILLIERS: All right.

MEMBER BROWN: Thank you. Okay. Go ahead.

MR. CILLIERS: Okay. Next slide.

So the plant control system consists of three larger systems. The one is the reactor control systems. We perform the functions associated with the reactivity control and power level adjustments. Members --

MEMBER BROWN: Oh, can --

MR. CILLIERS: Sorry?

MEMBER BROWN: Can I interrupt you again for --

(Simultaneous speaking.)

MEMBER BROWN: Don't flip slides. I just noticed on the RPS slide that's in Rev. 2, as opposed to Rev. 0, there is a new acronym called HRCS, but it's not listed in the acronym table. And I keyworded it for all of Rev. 2, and it's not listed anywhere. So I have no idea what HRCS is as a --

MR. CILLIERS: That's the heat rejection control system.

MEMBER BROWN: Oh, okay. Well, you might mention it in the text somewhere, because it --

MR. CILLIERS: Thank you for that. That was a system that was added a little later.

MEMBER BROWN: Okay. Thank you. Sorry to interrupt.

MR. CILLIERS: Thank you. So the three systems in the plant control system, this is a non-safety system. So this is during normal operations. The plant control system will be operating the reactor itself, including its reactivity control and power level adjustments, as well as monitoring the core neutronics in the pebble handling and storage systems.

The reactor coolant auxiliary control system performs functions associated with chemistry control, inventory management system control, the inert gas system control, and the tritium management system and monitoring control.

And then we've got the primary heat transport control system, which perform the functions associated with control of the flow rate through the primary heat transport system, the primary heat transport system's thermal management, as well as the control of the heat rejection system that we've just been talking about, and the primary loop draining, filling, and piping monitoring.

The plant control system receives input from non-safety related sensor inputs as well as safety related sensors from the reactor protection system through the data diode, as described previously. And it's electronically and functionally isolated from the safety related RPS using a safety related isolation device or data diode.

The plant control system generates control outputs based on sensor inputs and set points provided by the control system. And these set points are adjusted automatically based on the plant operating mode or in some cases by operators via the main control room console. So the operators do have control over this system, while it is not changing any safety systems before reactor protection system takes over. Next slide.

Moving on to the reactor protection system, this is the safety related system that is created for tripping the reactor system and initiating protective --

MEMBER BROWN: Can I interrupt again?

MR. CILLIERS: Yes.

MEMBER BROWN: Please. This is Charlie Brown again. Can you go back to the previous slide? Oh, no, go all -- now that you're on the plant control system, can you go back to the overall figure? That's it. That can't be. Does everybody have a bigger picture of this?

MR. CILLIERS: Yes, right here.

MEMBER BROWN: Okay. I'll just bring this up now from a single failure standpoint. All the data from the plant control system goes up into a distributed, as you all -- let me see it to make sure I get the -- it's a microprocessor based distributed control system --

MR. CILLIERS: Correct.

MEMBER BROWN: -- individually controls plant systems using inputs. That's the -- but all that data goes up into a gateway. Then it goes to the supervisory controller, then up into this redundant dual -- I can't read the rest of it. I've got to get the right chart here. Real-time data highway, and then through another gateway and up into the main control room.

So those are all, that's a single line of everything. If that bus fails or the gateways fail, there's no data going to the main control room. That seems to be not a particularly useful design approach to maintain your overall visibility of what's going on in the plant.

In addition, now the gateway up in the main control room connects to, as you all noted, TCPI/IP modems and/or fiber optic modems, however they want to phrase them, which effectively sounds to me like connections to the outside world, and doesn't mention -- it says, I'm not talking cyber security at this point. It's just control of access to this bus, which seems to be totally open to the universe the way it's designed.

So I don't know what your all's thought process is. That just seems to be a weakness in terms of control of access from whatever external source is to the main control room and other, and the local systems are. But it also sets you up for a major cyber security issue.

Now, you talk about using IEC, whatever it is. I've forgotten the numbers for that. That means you're embedding cyber, you know, malicious code detection stuff enveloped in all the software that you've got to manage, all the data going up in managing the plant. Just bringing that up as a point.

That's, a single failure is one point, and then the control of access is another point that I -- so I'm just mentioning that so you will be aware, from my thought process. That's my thought process, not the committee's. You can go back and finish the rest of the slides now. This was just --

MR. CILLIERS: Thank you. Can I respond?

MEMBER BROWN: Of course.

MR. CILLIERS: Yeah, I'd like to respond to it. Thank you very much for that. That is something that from this architecture we did not include or show any of the redundancy systems.

In our subsequent development, and I did not feel that it's necessary to put that in the piece or at this stage, but in further developments of the architecture we do indicate redundant, both redundant controllers on the plant control system side. So we have two controllers. So, if there's a fail, it moves over to the other controller, as well as redundant highways. So thank you very much for that. We've also included that into our design that will be presented in the OLA phase.

The connection to that cloud, the TCPI/IP connection, we've also built (audio interference) into that part of the design since we've spoke about this previously. It's very important to note that that internet connection or that TCP/IP connection to the outside world, although --

(Simultaneous speaking.)

MEMBER BROWN: Excuse me. Can I interrupt you a second? We're losing you. You're fading in and out. I don't know what -- and it's reverberating.

MEMBER MARCH-LEUBA: Yeah. Can you speak closer to the mic?

MEMBER BROWN: Yeah, stay closer to the mic.

MR. CILLIERS: I'm moving the microphone. Is that better?

MEMBER BROWN: Yeah, we just --

MEMBER MARCH-LEUBA: Yeah, speak slowly, because you're going a little garbled, but keep going --

MR. CILLIERS: Okay. I'll speak slowly. So the connection to the outside world, in our development of that system, we use a specific control protocol. And we only provide read-only connections to the outside world. So there's no routes of control or any sort of communication path back into the control system using that connection. So that's a very specific one-way communication. Other than that, it's for monitoring of plant parameters from remote locations such as headquarters or remote support safeway where the engineers will be supporting from --

MEMBER BROWN: Okay. Can I interrupt again for a second? Okay. I got that. That's fine. Not a problem with that, if it's a one-way. But is it a one-way, how do I phrase this, a hardware based one-way not configured by software, or is it a fancy-dancy bidirectional transmission device which is configured by software to make it one-way?

It's just something to consider in your, in the longer term when we see the final operating license design, as you say, you're working on for the subsequent submittals. I just wanted to bring that point up, is how that one-way is configured does make a difference.

MR. CILLIERS: Yeah, thank you very much.

MEMBER BROWN: Okay? Thank you.

MEMBER MARCH-LEUBA: Yeah, let me say it in a different language with the same concept. On the top left of that blue box on the control room, you have a cloud connection via TCPI/IP encrypted --

MEMBER BROWN: Yeah, that's what I was talking about.

MEMBER MARCH-LEUBA: -- I assume it's a VPN. If you totally intend it to be unidirectional, yes, or monitoring and no action can be taken from the outside, it would be best if you put the diode in there so that it is enforced.

MEMBER BROWN: Thank you. That's two out of two.

MEMBER MARCH-LEUBA: Yeah, I mean, the diode on the red box on the right side into the protection system, that's fantastic.

MEMBER BROWN: Yeah, that's excellent. That's a --

MEMBER MARCH-LEUBA: Yeah.

MEMBER BROWN: Love to see that when you're doing your RPS setup.

MEMBER MARCH-LEUBA: If you truly intend to have a functional diode on the control room box going into the cloud, put a real one. And then you don't have to worry about it.

MEMBER BROWN: It makes it easy when you submit it also. Thank you.

MR. CILLIERS: Well, thank you for that.

MEMBER BROWN: You can go on. I'm sorry.

MR. CILLIERS: No, this is good. Thank you.

So, back to the reactor protection system, it's a safety related system created for tripping the reactor and initiating protective functions. It gets its inputs, as I've described, from specific safety related inputs.

It also allows for manual initiation of a trip from the main control room or the onsite shutdown panel, although this is not created as safety functions in the system, but it allows the operators to trip the system in the event of noticing that something is going in a specific direction.

It will also trip the reactor on loss of power with a small time delay to allow for backup systems to come on. And that is discussed more in Chapter 8.

It's got three predictive functions that result from the RPS actuation. It inserts the control rod and shutdown elements into the core. It inhibits actions from the plant control systems, and I've already mentioned a couple of them that could interfere with the reactor protection system. So it really puts the plant into a passive state where we rely on the decay heat removal system to remove the heat.

And the RPS is built on a logic-based

platform that utilizes discrete components and field programmable gate array technology.

I may add, and we've already discussed that in a previous chapter, that the reactor protection system also activates the DHRS system once the DHRS system is a required safety functions, in other words, when enough fission products has been accumulated in the system to have sufficient decay heat that needs to be removed by the DHRSs.

So it will activate that system and remove all manual deactivation capability from the operators and only hand that back once, after a shutdown and then once temperature has reduced sufficiently as to not challenge any of our safety related systems. Next slide.

So I'll go a little bit into the reactor protection system trip logic schematic. You will notice that we've got the inputs at the bottom in, multiplied by four. So there's four inputs from all the safety related inputs.

The reason for the four is we use two out of four voting logic. And it allows for one of these planes to be removed for maintenance purposes, and then we will move to two out of three voting logic in the system. So it allows for maintenance channel as well.

As the signals go in, the signals are conditioned, and it is determined if a trip should take place from each of these signals. And once those signals, if there's a trip determination coming in from any of those signals, it goes into the voting and actuation system, which then votes on the two out of four or two out of three voting system. And it then decides on which part of the systems need to be activated.

And you will see, you've got safety related relays from both of these trains that get shut down to remove power from the various non-safety related systems.

And you'll see that we've subsequently added two more systems to this list, which is not in this figure. We've got a change package in place to cover for that just for consistency's sake. And in addition, you'll also see the DHRS system, which is basically toggled on/off by this system itself.

MEMBER MARCH-LEUBA: This is Jose again. Can you --

MR. CILLIERS: Yes.

MEMBER MARCH-LEUBA: -- the difference in the actuation logic for the blue boxes, the non-safety related trips versus the DHRS, the safety related one? I see that the switches are in series of the non-safety related line parallel for the safety related.

MR. CILLIERS: Yeah, so any of the priority logic systems could activate the DHRS system. And it ultimately happens the same to activate the other two, the other systems as well. If any of them should activate -- well, sorry, both of them should be activated to shut down the system itself. But the DHRS system, any of the two priority logic systems will allow the DHRS to be activated.

It's important to note that the DHRS systems are not activated on trip, although if it has been necessary, it can be done. But that is activated prior to any of the events based on the collection of data from the safety related sensors, and as I've said before, the activation of the --

MEMBER MARCH-LEUBA: Maybe I don't, I'm not reading correctly your diagram. But what you're saying is that DHRS, if either priority logic 1 or priority logic 2, only one --

MR. CILLIERS: Correct.

MEMBER MARCH-LEUBA: -- of the two is activated, DHRS will activate, just the blue boxes, HRCS, PSP, and so on. It requires both of them to be activated, both of them have to --

MEMBER KIRCHNER: It's cutting power to them. It's cutting power to the --

MEMBER MARCH-LEUBA: I know.

MEMBER KIRCHNER: -- to the boxes.

(Simultaneous speaking.)

MEMBER MARCH-LEUBA: The way I read this is the blues trip if only one of the logics are tripped, but DHRS requires both.

MEMBER BROWN: It turns on with either one.

MEMBER MARCH-LEUBA: It's the same thing --

MEMBER BROWN: Either one of the priority logics will actuate --

MEMBER HALNON: You're saying this in its activated state.

MEMBER BROWN: Say again.

MEMBER HALNON: You're saying this in its activated state. So --

(Simultaneous speaking.)

MEMBER BROWN: -- in its deactivated state, only one to activate.

MEMBER HALNON: Well, I mean, I'm talking about the RPS is actuated in this state.

MEMBER MARCH-LEUBA: I think it's --

(Simultaneous speaking.)

MEMBER HALNON: So you're turning, either one can turn off the non-safety system or either one can turn on. So, if you follow just electrons through the wires --

MEMBER MARCH-LEUBA: Okay, okay. So the blue trips, you turn them off --

MEMBER HALNON: Right.

MEMBER MARCH-LEUBA: -- when you trip. And DHRS on --

MEMBER BROWN: Yeah.

MEMBER HALNON: Correct.

MEMBER MARCH-LEUBA: Okay.

MEMBER BROWN: They tried to show that on the other diagrams as well.

MR. BLEY: This is Dennis Bley. I've got a related question. Over in Chapter 8, it says if you do get an activation of DHRS, RPS then removes 24 volt power so that operators can't inadvertently disable DHRS. Is that done through the same area, or is that different, handled somewhere else in RPS?

MR. CILLIERS: Yeah, that is actually done in the same area, but it's not shown on this picture. So --

MR. BLEY: And there's --

MR. CILLIERS: It's opening up the manual control so that there's no more path from manual controls to deactivate the DHRS system.

MR. BLEY: Okay. And it's done in the same kind of logic that's been used for everything else. It's not done through relays or something like that.

MR. CILLIERS: No, it's done through the same logic. When the DHRS system is activated by the RPS, it also removes the path for manual actuation by the operator.

MR. BLEY: Okay. I'm just -- when you do something like that, I always wonder if there's some way that can get you into trouble. But I'm not, I can't think of it, if there is. Okay. Thanks.

MEMBER HALNON: So what is the input from the pebble handling system. I can't remember. Was that in the PSAR or was it --

MR. CILLIERS: Oh, I mentioned it earlier. That is an inert gas pressure sensor. You're talking about the PHSS at the bottom?

MEMBER HALNON: Yeah, yeah --

MR. CILLIERS: Yes.

MEMBER HALNON: So that's the inert gas

system feeding into that?

MR. CILLIERS: Yeah, so the inert gas system is a larger system that maintains inert gas slightly above ambient pressure on the system, as well as within the pebble handling system. And should a break be detected other than the pebble handling system or anywhere in the inert gas system, that input will be triggered --

MEMBER HALNON: Okay. So it's more of an inert gas input than the PHSS. Sorry. I missed that earlier.

MEMBER BROWN: You done, Greg?

MEMBER HALNON: Yes.

MEMBER BROWN: I have one other question on this. Is there a reason the two manual trip switches only go to priority logic 2, priority logic 1 is ignored?

MR. CILLIERS: There's no specific reason why it would go to only one. It could go to two as well, because it's not a safety related input. We just added it as an input to priority logic 2.

MEMBER BROWN: So it's got to go somewhere to trip the plant, right, if you --

MR. CILLIERS: Right.

MEMBER BROWN: And if you look back at

your big overall diagram, those two switches go into a single box, which says priority logic 1 and 2. It says priority logic times two. It's just an inconsistency in how you represent the operation of the manual trip switches. I would think you'd go to both of them. That's my, again, that's a personal thought. It's kind of a wiring diagram issue, not a --

MR. BLEY: I don't know, Charlie. It's -- if you're going to have two switches, why not run them -- it doesn't cost you anything different. Why not run them through both so you get a little better reliability?

MEMBER BROWN: I agree with you. The words, the figures imply one thing in one figure. That's the overall diagram. And when you get to the details, it's only one of them. It's an --

MR. BLEY: And there's a difference between something you have to do and something that just common sense says you probably ought to do.

MEMBER BROWN: Yeah. Anyway, you can put that on your plate for what you do with this figure the next time.

MR. CILLIERS: Right. Thank you.

MEMBER REMPE: So I have a question. I

thought I heard you say somewhere during this discussion that you're in the process of submitting a change package to this. Could you elaborate what's being changed and what impact that will have on what we're hearing today and have in our documentation and the staff's SC?

MR. CILLIERS: Yeah, thank you for that. So it was -- I basically picked up that in our main diagram we have, we've added the two thermal management systems, the reactor thermal management system as well as the primary coolant loop thermal management system as a trip, as one of the non-safety related boxes.

So there's four boxes in the one figure. In this one, we only have -- there's six boxes, non-safety related ones, in the third figure. There's only four in this one. So it's just for consistency that we're adding those two to this figure as well.

MEMBER REMPE: So the PSAR is changing?

MEMBER BROWN: If you look at Rev. 0, they've --

MEMBER REMPE: So is it in Rev. 2?

MEMBER BROWN: Yes, they're in Rev. 2 --

MEMBER REMPE: Okay.

MEMBER BROWN: -- but they're not in Rev.

1, not in Rev. 0, which is --

MEMBER REMPE: That's fine. But he said --

MEMBER BROWN: I went back and looked at Rev. 2 when we got that just to see for consistency.

MEMBER REMPE: So Rev. 2 has what we are, is the current version.

MEMBER BROWN: Yes. That's the one, that's the -- we got this one --

MEMBER REMPE: Okay. Yeah, I know we have it in Rev. 2. But it sounded like you're submitting something beyond Rev. 2. And that's not the case, right?

MR. PEEBLES: This is Drew Peebles, the senior licensing manager. It is an inconsistency that we're updating now. And --

MEMBER REMPE: So Rev. 2 is changing.

MR. PEEBLES: Right.

MEMBER BROWN: But that's, you're saying Rev. 2 did not pick up everything.

MR. PEEBLES: Correct. And again, this is just a change to make the figures consistent. The text is still correct.

MEMBER REMPE: Okay. And the staff is aware of this, and their SC, even though it's dated a while back, will not change.

MEMBER BROWN: Yeah, the main figure for the overall plant stuff made a couple of what it turns out to be fairly significant changes relative to the data diodes and where they'd be and how they're fed, through gateways or not through gateways. And they've now taken them out of the gateway operation.

MEMBER REMPE: But the staff's SC is not going to change from these corrections. Thank you.

MEMBER BROWN: I'm done. You can go. I'm sorry about that.

MR. CILLIERS: Thank you. The main control room remote onsite shutdown panel, it contains a capability related to the normal operations of the plant, including operator and supervisor workstation terminals, which provides alarms, annunciations, and personnel and equipment interlocks.

And it provides information from both the plant control system, as well as the reactor protection system, a manual trip switch that propagates through the gateway and into the safety related isolation to allow operators to initiate a plant trip, and the central alarm panel for the fire protection system to monitor the status of fire protection equipment in the reactor building and controlling the ventilation and extinguishing systems related to the fire response.

The remote onsite shutdown panel provides a human system interface for the plant staff to monitor indications from the reactor protection system, including the operating status of the reactor trip system and the decay heat removal system in the event that the main control room could become inaccessible or uninhabitable.

The remote onsite shutdown panel features one-way communication with the RPS and the ability to initiate a manual trip signal that actuates the RPS. And I will note that that is also not a safety related function. It's just an additional function that we've discussed before. Next slide.

The design basis for these, the RPS and safety related sensors are designed using relevant industry codes and standards such as the IEEE 603-2018 and the quality assurance program to be included PDC 1.

The RPS and safety related sensors are designed to extend and to be able to perform these safety related functions during adverse natural phenomena, PDC 2.

The RPS and safety related sensors are

designed and located to minimize the probability and effects of fires and explosions, PDC 3.

The RPS is designed for the environmental conditions associated with normal operations, maintenance and testing and postulated events, PDC 4.

The RPS provides an active trip and decay heat removal actuations that ensure radionuclide release design limits are not exceeded during normal operations as a result of postulated events and upon reactor trip actuation, including in the event of a single failure of the reactivity control systems. These are PDCs 10, 20, and 25.

The reactor protection system as well as the plant control system and safety related sensors are designed to monitor plant parameters over the anticipated ranges of normal operations and postulated event conditions, PDC 13.

The design of the main control room allows actions to be taken to operate the reactor on a normal operating and postulated event conditions. It provides radiation protection allowing access and occupancy during postulated event conditions with occupants not receiving radiation exposures in excess of 5 rem TEDE for the duration of the event and maintains habitability, allowing access and occupancy during normal operations and postulated event conditions.

The remote onsite shutdown panel is located outside of the main control room and provides the capability to promptly shut down the reactor and monitor the unit during shutdown and provide capability for subsequent safe shutdown of the reactor through use of suitable procedures. That's PDC 19.

The reactor protection system and safety related sensors are designed with sufficient redundancy and independence to ensure no single failure results in a loss of protection functions, PDC 21.

The result of natural phenomena and of normal operating maintenance, testing, and postulated event conditions do not result in loss of protection function of the RPS, all safety related sensors, PDC 22.

The RPS fails to a safe state upon loss of electrical power or detection of adverse environmental conditions, that's PDC 23.

The RPS and safety related sensors are functioning independent from non-safety related control systems, that's PDC 24.

The RPS safe points are designed to limit the potential amount and rate of reactivity to ensure sufficient protection from postulated events involving reactivity transients, PDC 28.

The RPS and safety related sensors are designed to be redundant to show that there's a high probability of accomplishing the safety related functions of the RPS in postulated events.

And I think most of those should be clear from this discussion we've had on the design itself. Next slide.

That's it. Any further questions?

MEMBER BROWN: Yes. You didn't show -- going back to the big diagram, this is a small question, the overall --

MR. CILLIERS: The architecture?

MEMBER BROWN: Yeah, the big architecture picture.

MR. CILLIERS: That one, yes.

MEMBER BROWN: In the main control room, you show, you know, two operator workstations and a supervisor workstation. And in your comments relative to the single bus sending all that data, you said that's, you just didn't show the redundancy you intend to incorporate.

Do those workstations both, is the

intention to feed those workstations with both of the redundant, independent busses bringing all that plant control system data up to the main control room so that you can select them. You don't want them to interfere. But I presume you can select one bus or the other to maintain continuity.

MR. CILLIERS: Yeah, we haven't made a final decision on how we will be using the redundant systems. So I will not comment on that right now.

MEMBER BROWN: Okay. That's fine. Thank you. The question will come up. You know that.

MR. CILLIERS: Yeah.

MEMBER BIER: Hi. Question from Vicki Bier. On the discussion of control room habitability basically, that it provides adequate radiation protection to be usable during an emergency, have you also looked at habitability due to emergencies at other nearby facilities, whether chemical or radiological?

MR. CLARK: Hi, this is Austin Clark with the licensing team at Kairos Power. So we do, in the environmental report, go through an analysis of the impacts of events at nearby facilities, as well as nearby transportation routes. As far as the details of that analysis, you're welcome to review them in the environmental report.

We did go through that analysis in Chapter 2 a couple weeks ago. The big one I think is there is a potential for chemical spills on Highway Tennessee 58 to potentially drift to the control room. But the dispersion over that distance is not anticipated to cause a major impact.

MEMBER BIER: Okay. Thank you.

CHAIR PETTI: Okay. I'm hearing no questions.

We're a little ahead of schedule. So let's take a -- I'm trying to do the math in my head. Okay. Let's just come back at 10:40. That's what the agenda said. We'll take a break. Thank you.

(Whereupon, the above-entitled matter went off the record at 10:23 a.m. and resumed at 10:40 a.m.)

CHAIR PETTI: Okay, we're all back. It's time for the staff to talk about Chapter 7.

MR. ASHCRAFT: Hello, my name's Joe Ashcraft. I'm a -- hello, my name's Joe Ashcraft. I'm a NRR DEX electrical and control branch, and I'm a technical reviewer.

And myself and Calvin Cheung, we're the I&C reviewers for Chapter 7.

Next slide. Who's running the slides?

Okay, oh, they took out my agenda so let's just go to this slide. You've seen it. I know some of our initial interfaces with Kairos, there was discussion about the diode for protection system.

They also had the displays up on the remote shutdown, you know, for safety related.

So, there was some discussions. We didn't really highlight or discuss too much, the non-safety side because our review is really supposed to be focused on safety.

But we did look at it. We had some comments.

As far as what you saw down at the bottom, I guess Joy asked a question. So there was a supplement that was issued, and that's where they introduced the RTMS, and the other one.

That supplement didn't update that back figure, so that's why you know, it's just an editorial concern.

But anyway, I was, figure we would spend a lot of questions here, but I think, I think Charlie, you done asked them all.

But if there's any additional questions, it's basically you know, the architecture is designed in four pieces.

You've got your safety related RPS; your PCS, which you know, they tend to control just about everything; and then main control room; and, remote shutdown.

And I think everything, we're going to get into the HRS, or at least what I think's going to happen.

You know, they mention they're using a HIPS now, but in the SAR that we have right now, that's not part of it.

So we didn't review it thinking that, but that last --

(Simultaneous speaking.)

MEMBER BROWN: Well but in the PSAR, they did, that's what you're talking about? It talked about a FPGA type system, which implied.

MR. ASHCRAFT: Yes, but it could be --

(Simultaneous speaking.)

MEMBER BROWN: It could be another one?

MR. ASHCRAFT: Right.

MEMBER BROWN: So you're saying it didn't explicitly call out --

(Simultaneous speaking.)

MR. ASHCRAFT: Right.

MEMBER BROWN: -- that? I noticed that. I just didn't say anything.

MR. ASHCRAFT: And at some point, you know, they made the comment so I'm assuming they'll either come in with the IBR and the topical report, and it's already been reviewed.

And at that time, which makes life a lot easier because it's been approved, and then we just have to focus on the ASAIs.

And even some of those, they might not apply to them but they'll have to at least discuss that.

So that makes, you know, the OL portion a lot easier.

But there's other areas that still need to be addressed. And I think it was brought up before. There's an Appendix A and we put you know, a lot of bullets.

One of them was the I&C platform, you know, that stuff. So there's areas --

(Simultaneous speaking.)

PARTICIPANT: Excuse me, could you lean into the mic? The people on the line are having trouble hearing.

MR. ASHCRAFT: Okay, sorry.

PARTICIPANT: Thanks.

MR. ASHCRAFT: Sorry about that. I'll lean. Do I need to repeat all that, or are we good?

(No audible response.)

MR. ASHCRAFT: Okay, so if there's no additional questions --

(Simultaneous speaking.)

MEMBER HALNON: Just one other question. There will be another system, I mean some kind of input for the other systems, like chilled water or plant water systems?

I mean they're going to need some kind of control room interface, cooling water to the RB HVAC system. Cooling water to some of these pumps and stuff.

I mean it will be something in there, right? So there will be another block somewhere else that?

MR. ASHCRAFT: Well, not necessarily in Chapter 7. I mean those I&C type stuff is really dealt with the chapters.

But now as far as the you know, if you took a dive into the control panels and stuff, that you know, all that would be there. But that's not something we review in Chapter 7.

MEMBER HALNON: Okay, because like the treated water system interfaces with decay heat removed. There's some, something there.

MR. ASHCRAFT: Well, when you say in the descriptions, or it definitely will be in the logics. We'll see you know, schematics in the OL that will show all those ties to the various things.

MEMBER HALNON: Yes, that's what I'm saying, so there's going to be something else?

MR. ASHCRAFT: Oh, yes, yes.

MEMBER HALNON: As far as this?

MR. ASHCRAFT: Yes, I've been chomping at the bit. You know, as I look at, so right now the architecture's really just kind of a skeleton.

MEMBER HALNON: Right.

MR. ASHCRAFT: We don't know you know, the logic and stuff. And you know, so when I see, when I hear the discussion about the HRS, you know, I've already, I'm doing the you know, creating the logic in my mind.

But you know I'm not designing it. So, but I do have a sort of a different take on what I thought I heard when we did Chapter 6 on the VHRS. But let's go on.

So, but basically, and I'll just describe.

So when you have your safety sensors, I can't read them but it's temperature, power and level, and the PHSS, if that trips the RPS or provides sufficient, then what happens is it'll cut power to the rod control.

So the control rods and shutdown elements, not rods, will go down. Then they talk about the DHRS is already the thimbles are full of water when they're operating, so it's not like it says it actuates the DHRS.

I believe what happens and what I've read in the description, it prevents them from shutting the water valves because that's that 7-day supply.

So that's effectively what that actuation from the RPS is doing. It's just keeping them from closing those valves.

And then you know, whether there's six blue boxes or four, effectively and they describe their process, what they're trying to do there is they don't want to overcool you know, and have their Flibe go solid.

They don't want to add additional heat, and they don't want to be you know, pumping in more Flibe and TRISO fuel.

So really, you know, and as their design fully gets vetted, you know, maybe there might be another box, but I think what they've shown there is pretty much the final.

And once they update the other figure, you know, I don't anticipate you know, any significant changes.

Next slide.

MEMBER BROWN: Before you, no, before you flip, I just wanted to re, or not reiterate, but to clarify somewhat my comments on the bus and feeding outwards was really, it's really a control of access.

It has nothing, we're totally not interested in fighting the cybersecurity and the rest of the plants and all the other stuff. There are guns and guards, and we're just trying to get it back to control of access, the way we do all other type of control of access.

We don't want external electronic control of access to be compromised. That's fundamentally it.

So cyber, that's just the words they put in and you all had in your SE, that's why I used them, so that we would have the same words.

But it's really a control of access. That's the same thing we've emphasized in other designs.

MR. ASHCRAFT: Yes, and I don't want to start anything here, Charlie.

MEMBER BROWN: I, no, no, I just, I don't --

(Simultaneous speaking.)

MR. ASHCRAFT: No, I only wanted to say that you know --

MEMBER BROWN: That's all we're thinking about is control of access.

MR. ASHCRAFT: No, and I agree 100 percent. And any time we have any discussions with applicants coming in, we have that discussion.

MEMBER BROWN: Okay.

MR. ASHCRAFT: But.

MEMBER BROWN: I don't want to deal with the rest of the 5.71, all the other stuff that's going to get tied up in whatever else they're doing in the plant.

I don't care what they do with the telephones, and water fountains.

MR. ASHCRAFT: Okay.

All right, I was only going to say that though that is on the non-safety side, so I don't know that there's a specific criteria that, that forces them to do that. It's just good design, like you said.

All right, well if Charlie's happy with this, I'm definitely happy.

MEMBER BROWN: Well, with a diode I'd be really happy.

MR. ASHCRAFT: Well, and I think they took that down. I mean, you know.

MEMBER BROWN: Well, that's what they talked of. That's what they said they're doing, and they might as well do it the easy way.

MR. ASHCRAFT: Exactly, because you know, we'll be back here sometime in the future.

MEMBER BROWN: Yes.

MR. ASHCRAFT: Okay.

MEMBER BROWN: If I'm still alive.

MR. ASHCRAFT: All right, next slide.

Yes, I'm not even looking at my notes, but so here are all the PDCs for Chapter 7, and they're typical of what you would see at any I&C design.

I didn't evaluate them because I didn't have the design yet. So, but we did line them up with the various sections and they seemed to be appropriate.

And they will be, you know, when they come in with their OL, they will demonstrate meeting these, and we will review it intensely.

I'll just point out, I don't think you mentioned it, but PDC 19 for the control room. I don't think they're taking any exceptions, since they're having a remote shutdown.

And I guess at this, you know, I know Matt talked about NUREG-1537. So in my sections with various areas, I pulled out what I thought were appropriate bullets that could be discussed, and a construction permit.

And also, I used the DSRS Chapter 7 for the I&C principles, and also the appendix on architecture. Not as a you know, an extensive review, but just to help me look at the architecture and focus on the areas.

So I did use that, and it's listed in the SC. And as I tell all the applicants, I'm going to be using that to look at their architecture. I want to see good architecture.

Next slide.

So, the plant control system. These are the areas that we looked at. It's all in the SC. I mean I don't have the SC here so I don't, you know, if there's any questions on any particular spot, I'd be happy to answer it.

There's a lot of it we didn't necessarily have that much information. Like I said, I kind of put in bullets where I thought maybe there would be something.

So we did make a, not a finding, but we did look at these areas and had a discussion of what we saw.

And like I said, we had that Appendix A so there's a lot more that will be coming in the OL.

So I mean, well, and I, maybe I will talk a little bit. One of the things that we look at when I look at the architecture, and when I look at non-safety systems, is how does it, could impact the you know, safety system.

So that bottom one failure modes, that was an important -- communication to load. Charlie got me on that one.

But at any rate, so that's our review. It's in the SC. If there's any questions, otherwise we go on.

(No audible response.)

Next.

The reactor protection system. Lot more, but keep in mind a lot of that stuff like safety settings, I so much wanted to talk about set points today.

But there are no set points. There's a table I think it's Table 731, that has a lot of permissives and so forth.

And that, you know, we don't have values there, but I think a lot of those permissive is how the DHRS gets activated, et cetera. And deactivated, actually. It's in there, as well.

I&C platform. We don't have it now, but it should be coming since they talked about it.

So these are, you know, these are the areas that we focused on and did a write up. Like I say, nothing's conclusive because without the platform, most of everything's internal to the platform.

So, you know, we're still just kind of looking at architecture and what we read.

But codes and standards. Here's another thing. They're not required to follow IEEE 603, but they did say they are.

And knowing that the HIPS platform, if that indeed comes in, has been you know, reviewed and approved using 603.

So I feel confident that their I&C platform is going to be sufficient.

MEMBER BROWN: They only use one point, 152 in the main control room discussion. They didn't mention that anyplace else in their PSAR.

I mean that's --

(Simultaneous speaking.)

MR. ASHCRAFT: It's not required.

MEMBER BROWN: I guess but it like the DPSRS 603, it is an enunciation of some, a lot of the fundamentals that we talked about.

And they did mention a number of those, so.

MR. ASHCRAFT: Yes, I --

(Simultaneous speaking.)

MEMBER BROWN: Little surprised by its absence.

MR. ASHCRAFT: Well, so am I, and if you talked with Ed or Ben, you would, you know, I'm a power guy so I like to look for all that stuff.

But you know, this is different. You know, but the fact they're committing to 603 and you know, I think they're putting a good system together.

MEMBER BROWN: Okay, thank you.

MR. ASHCRAFT: Next slide.

You know, once again here are the bullet points.

MEMBER BROWN: I presume it's 603 1991?

MR. ASHCRAFT: No, I believe they --

(Simultaneous speaking.)

MEMBER BROWN: They're using 2016, or 2008, or whatever?

(Simultaneous speaking.)

MR. ASHCRAFT: -- it's 98. 2018, oh geez, you know, what, I have no --

(Simultaneous speaking.)

MEMBER BROWN: Don't worry about it. There's a date in there, I remember seeing it in the PSAR.

MR. ASHCRAFT: Yes, I don't think it's --

(Simultaneous speaking.)

MEMBER BROWN: Don't sweat it, keep going. 91 though. Keep going.

MR. ASHCRAFT: So the main control room remote shutdown. You know, we talk about you know, this is a passive design, so there is no 1E power.

Now when you get inside the RPS, that is considered 1E power. I mean just to make all the safety aspect of the platform work.

But it is provided, I mean supplied with non-1E and you'll probably hear more about Chapter 8.

You know, it's a reliability thing. You

know, you don't want your plant shutting down. Well, you want it as reliable as you can make it, and I'm sure they're thinking about that in their final design.

But at this point as you pointed out, that's not a aspect of power to the RPS.

At any rate, you know, control displays, alarms, you know, a lot of that's probably going to be looked at by HFE people.

We do evaluate it and we see power paths, and once again, we're looking for any you know, communication into the RPS. And that's shown to be independent.

So you know, using the dependents and redundancy, and diversity and stuff, I think we looked at all the different main control room, PCS and RPS, for you know, that sort of thing.

And it's not conclusive yet because there's a lot of communication that you know, you always maybe find when a operating license comes in.

But we'll be looking for that. Typically they would have a table or something, that would show all the ins and outs.

But once again, if they're used to HIPS platform, I don't think there's too many ways other than the shutdown switches, which I think despite the way the HIPS is laid out, it will go to both, both sides.

So, I think their drawing probably was as correct as it could have been.

Boy I got a lot of notes here, but I think they cover most of it Kairos.

MEMBER HALNON: Will you be looking for some hardwiring in the remote shutdown area, some hardwired switches?

I know it said a manual switch, is that a hardwired switch where it's I guess back to the analog days, where you can actually hear a click and something happens?

MR. ASHCRAFT: Well --

(Simultaneous speaking.)

MEMBER BROWN: That actually doesn't change. If you look at the earlier diagram, it showed those remote switches going through a gateway, which implies software and intermediary.

But then when they showed the last diagram, it appears to be a direct wired --

(Simultaneous speaking.)

MR. ASHCRAFT: Right.

MEMBER BROWN: -- switch now directly onto the priority box.

MR. ASHCRAFT: Other --

MEMBER HALNON: That's what it looks like.

MEMBER BROWN: That was, I'm going to just springboard off of your question, thank you for asking.

MEMBER HALNON: Yes.

MEMBER BROWN: When you look at the final main control room, everything's coming out through the gateway.

I guess, and I'm of all the systems that you've got, are there any critical systems that when you turn a switch, you really want to make sure the motor starts, or the pump stops, or the whatever.

I'm big on having not three computers in the intermediate spaces between one turn of a switch, and something happening down at the pump level. Or valve level, or whatever it is.

I know you can't mandate it, I'm just saying that's something --

(Simultaneous speaking.)

MR. ASHCRAFT: Well, --

MEMBER BROWN: -- to question if we can.

If people indicate there's a couple of these systems that are very, very critical to make sure they actuate, then we ought to ensure that there's a very, very reliable means of making sure the thing starts, as opposed to, in other words, a separate hardwired like the spring switch.

MR. ASHCRAFT: Right, well you know, as far as critical making sure it starts, I mean all that sort of, well it is covered with HMP as far as you know, take the switch, turn the switch, get indication.

So we don't really review that in Chapter 7, but we, you know, I would say that's maybe this is, that's standard you know, sort of stuff, main control room type stuff, that's a known, a known thing.

MEMBER BROWN: From what I understand, their people are looking at is the all glass, it would be their work station.

So, now it's click and all I can do is see click and a pump starts somewhere.

MR. ASHCRAFT: Well, right.

MEMBER BROWN: Or with a touch screen, or something like that.

MR. ASHCRAFT: When you think about other designs like say NuScale, that's essentially what they have.

But they had a mechanism from a HIP

perspective of when they started a pump, or whatever, to ensure they got it.

MEMBER BROWN: Okay, I'm just saying we need to think about that on this design, so.

MEMBER HALNON: I was a little bit more simplistic. I was thinking common mode failure, you know, with a fire.

And even with the remote shutdown, there's no unless you can predict where the fire is going to be, you don't know what necessarily all the failure modes might be.

MR. ASHCRAFT: Well, those manual switches, they are hardwired. We get the supplement, and I'm not sure if it shows up in Chapter 3 or not, but it talks about the switch and the cabling, and then similar.

You know, and it goes in the HIPS as a hardwiring. But kind of --

(Simultaneous speaking.)

MEMBER HALNON: Okay.

So, part of your failure review on the operating license will include those types of cross-cutting looks at these?

In other words, you'll take a scenario like a fire and say is there any common modes, from a

Chapter 7 perspective?

MR. ASHCRAFT: Well, we kind of look at that, but that's not really our area. But as far as a shutdown switch you know, for fire or whatever, that's the last thing they do as they run out is hit the switch.

So, yes. I don't want to pin myself down in Chapter 7 for reviewing that stuff.

MEMBER HALNON: You'd be doing everything, you know? I got it. It is a cross-cutting issue from the standpoint you know, when the fire starts going across electrical chapters, safety --

(Simultaneous speaking.)

MR. ASHCRAFT: Well, I've sort of been involved with the smoke in the control room, and how that works. You know, so we're kind of involved, but that's not really in our SE portion.

Next slide, if there's no more questions.

(No audible response.)

MR. ASHCRAFT: Okay, since there's the little light here, now they provided a section for sensors but when you look at NUREG-1537, the sensors is actually part of the system.

So, when you talk about the sensors for PCS, they have to meet criteria for PCS. And for safety sensors, they really need to meet all the PDCs for the safety system.

So, we looked at them and I did put some you know, we don't have much for sensors right now. I mean they gave us a range for the temperature, normal and, and well, an accident.

So they have us two, safety, safety range and then a normal range. But that's about it. We don't have anything for the level.

They talked about what they were you know, thinking about. But once we get that and they fill out those tables and stuff, when we look at it and then start thinking of sub-points and everything else.

So it's you know, at this point it looked like they you know, the sensors are independent, and there's redundancy.

So you know, that's --

(Simultaneous speaking.)

MEMBER BROWN: Are there sensors available that will actually work? I mean this is, my brain's in --

(Simultaneous speaking.)

MR. ASHCRAFT: Well, you know --

MEMBER BROWN: -- the water world and now here, these are very, very high temperature. You've got a different interface for these things.

Do you have the little things you can stick a temperature sensor in, okay, a well? Can you measure levels with a differential pressure, or do you have to have something else, a radar detector that does it, or?

MR. ASHCRAFT: Well, so.

MEMBER BROWN: Do you have any idea what the sensors are going to be like? Joy is not here; I know she'd love to talk about sensors.

MR. ASHCRAFT: I know, that's how convenient.

MEMBER BROWN: I'm just trying to work on it.

MR. ASHCRAFT: Well.

MEMBER BROWN: Help out with the sensor part a little bit.

MR. ASHCRAFT: You know, back when all this started, in my mind it was you know, the sensors was going to be you know.

And I talked with Kairos I think in some of our pre-meetings. And they're going to maybe not the same as NuScale, but they're looking, they're trying to find sensors that's going to meet their needs.

MEMBER BROWN: Yes, but NuScale was water.

MR. ASHCRAFT: I understand, but you know, when you're talking temperature --

(Simultaneous speaking.)

MEMBER BROWN: And they did use an unusual.

MR. ASHCRAFT: But when you think about the level, I mean it could be a connectivity level, or it could be radar.

I mean I don't know what their thinking, or what they're considering.

MEMBER BROWN: Or flow.

CHAIR PETTI: So Charlie, I looked at level sensors and it's contradictory. There's a DOE presentation that says we don't have anything that works for these high temperature systems.

But there's a paper from India, saying that they have one that they're using in their fast reactor.

MEMBER BROWN: Oh.

CHAIR PETTI: Today. So, take that for what it's worth.

MEMBER BROWN: It's just, I mean this is way out from anything that we typically use. Are we measuring flow for everything in this thing? I've forgotten; I've got to look back at the diagram.

There's an F in here, so I presume we're measuring flow of some kind.

MR. ASHCRAFT: Well --

(Simultaneous speaking.)

MEMBER BROWN: And, I'm just kind of interested how we're going to measure flow rate, I guess. And you're right, this is light on sensors. It's one paragraph plus we'll do it later.

MR. ASHCRAFT: Right, but in order, you know, what we look at anyway is you know, ranges. And you know, that sort of stuff.

The fact that it works or not, that's, you know.

MEMBER BROWN: That's not your issue, I understand that. But you've got to be thinking about that.

MR. ASHCRAFT: Oh, yes, yes.

MEMBER BROWN: I mean.

MR. ASHCRAFT: Between set points and sensors, that's always on my mind, Charlie.

MEMBER HALNON: They'll be subject to the environment qualification.

MR. ASHCRAFT: Oh, yes, all the safety related sensors --

(Simultaneous speaking.)

MEMBER HALNON: Right.

MR. ASHCRAFT: -- will you know, PDC.

MEMBER HALNON: And, that will look at compatibility and longevity.

MR. ASHCRAFT: Yes, so it will have the pedigree, whatever they decide to end up using.

MR. HISER: This is Matt Hiser. I just wanted to on the sensor piece, I just wanted to point out that they did identify that as one of the research and development items in Chapter 1.

So, develop process sensor technology for key reactor process variables. So, it's something that they've acknowledged there's work to be done on.

And they don't expect to just pull something off the shelf.

MEMBER BROWN: I did one of those dumb things with Googling high temperature this, high temperature that level and got blanks.

You know, lot of people want to sell little things, but they were little piece part type stuff.

Oh yes, we'd have some of those. There was no definition of what they were, what their ranges were, or what they were even compatible with.

So, and there's a material compatibility it seems to me is another issue relative to this line up. And, the interesting coolant that we're using.

MR. HISER: Yes, just wanted to fill in the licensing regulatory piece.

MEMBER BROWN: Yes, and I know they've got to make it work.

MR. HISER: Right.

MEMBER BROWN: I understand that. I'm not, you all don't have to make it work. They do.

CHAIR PETTI: Yes, and I think they have a, it's in our draft letter. Don't worry about it.

MEMBER BROWN: It is? Okay.

CHAIR PETTI: Yes, the whole list.

MEMBER BROWN: Okay, all right.

MR. ASHCRAFT: I think they're doing something similar to what NuScale is as far as evaluate and trying to determine, you know, that kind of process.

Next.

Okay, I think the end result is we, you know, feel that they're able to you know, construct a plant and meet, meet all their safety requirements at the OL.

So, that's effectively what this says. And you seen this in all the chapters, but pretty much we feel that they can, we should issue them a CP.

MEMBER BROWN: The one question I had relative to the OL versus this, because I'm not used to doing it in this order.

Construction permit. That's what this is, right? That sounds like building something.

CHAIR PETTI: Well, it's a start.

MEMBER BROWN: And who's building -- huh?

CHAIR PETTI: It's an authorization to start.

MEMBER BROWN: Yes, that means, that means you got to build, you're starting to design and build systems. And the control systems, and the shutdown systems.

And now, and we've got this is sparse relative to, from any standpoint, whether it's I&C or whether it's something else, it's pretty sparse.

MR. ASHCRAFT: Well, you know --

(Simultaneous speaking.)

MEMBER BROWN: In detail.

MR. ASHCRAFT: -- I've been around for a while although I'm not aware of what, I mean all the existing plants were construction permits.

And they had you know, they had maybe more detail, maybe less. But at the end of the day, they're at risk because once they build it, they got to come in and get their operating license.

So that's why --

(Simultaneous speaking.)

MR. BLEY: This is Dennis Bley, and just a question on this. Yes, none of us were around back in the 60s when they really had to deal with this with novel designs, with not much experience.

We're getting a prototype here and they're going to collect data. And once they get the construction permit, they can build everything and they can put the sensors in and everything else.

Is there an expected path by the staff or the applicant during the construction process, to come back in to the staff and say hey, here's the kind of sensors we've picked, and here's why they think they're going to work.

To kind of get preliminary approval on things that will come up for the operating license?

MR. ASHCRAFT: Well, as the expert on this, I am going to turn it over to Ben or Ed, for the answers.

MR. HELVENSTON: Yes, this is Ed Helvenston, from the staff.

You know, as you may know, there is a

construction inspection process in which you know, we'll have inspectors that will be on the site during construction, that looking at what they're doing, and making sure that it's conforming to the design bases that we're approving as part of our CP review.

But you know, just to clarify, we're not approving a final design as part of a construction permit approval.

We're essentially approving the design bases, and finding that there's reasonable assurance that Kairos will conform to those, you know, that Hermes can, the final design will conform to the design bases.

But the final design itself is still subject to change, and those details could still be worked out as they go through the construction process.

MR. BLEY: All right, I guess my question was orthogonal to your answer.

The question is, is there a way during this process, and maybe it's coming in with a topical report or something like that to get approval on, to as it becomes possible to clarify some of these areas with substantial uncertainty, to make sure the staff's onboard with the design as it evolves, before they come in for the operating license?

MR. HELVENSTON: That would certainly be if Kairos wanted to do something like a topical report. I mean they would certainly free to submit that to us.

But there isn't really a formal process where they would sort of confirm those things to us. I mean it's a responsibility of an applicant to the NRC, to comply with their licensing basis.

And you know, part of the licensing basis for the --

(Simultaneous speaking.)

MR. BLEY: Yes, of course.

(Simultaneous speaking.)

MR. HELVENSTON: -- part of the licensing basis for the construction permit is that you know, we've approved a certain, certain design basis that they described to us.

And if Kairos identifies a situation, you know, they have some flexibility in how they, how they meet that.

But if they identify a situation where they don't think that their design is going to be able to conform to what they told us in the CP, you know, that's, they may have to consider a process like an amendment to the construction permit, or something else.

MR. BEASLEY: And this is Ben Beasley with the staff as well. I'll chime in a little bit.

So, certainly Kairos is accepting this risk for the 2-step process, and they have acknowledged that. They understand it.

From a practical standpoint, they're looking at submitting their OL application about the same time that they begin construction. So, there will be opportunity for us to see the final design, you know, as they are building.

And so if you know, if there is some feedback that they gain from our review as we're doing the review and asking for additional information, you know, they can modify their design as they go.

But just from a practical standpoint, those will be somewhat running in parallel.

MR. BLEY: Yes, thanks, I guess I missed that part of the schedule, I'm glad to hear that.

MEMBER BROWN: Thanks, Dennis.

One of the things that's and I appreciate the input, that was good input from what you said.

My perception was they can now go off and design their entire architect, whatever they want to do, they can design an I&C system to do what they want to do, based on this PSAR.

And the one thing they talk about is they're going to have an FPGA system. Well, there was no mention of diversity in this entire, in this entire write up.

Okay, so now are we saying that's okay because we've, you're writing an SE. You're all putting the Betty Crocker Good Housekeeping seal of approval on this construction permit, and yet now we're saying that diversity is no longer a requirement?

You know, D3, defense in depth, diversity? And it doesn't have to be across the board, I'm just talking about in the fundamental area such as the reactor protection system, is the argument going to be if it doesn't work at all, it doesn't matter?

And if that's the case, seems to me that the NRC should be agreeing with that up front, as opposed to in arrears. That's my only point from that standpoint.

But all the rest of our protection systems and other systems, have been, and safeguards, have been based on you know, a defense in depth philosophy, as well as a you know, the independence, redundance, and all the other, and they've got that in the RPS design.

I'm not arguing about that, but the diversity aspect is not there.

MR. ASHCRAFT: Well, they haven't --

(Simultaneous speaking.)

MEMBER BROWN: You didn't address it in your SE. At least I don't think you did.

MR. ASHCRAFT: You didn't see it? Well, but I mean so I mean when you think about diversity, I mean there's sensors coming in, they're protecting --

(Simultaneous speaking.)

MEMBER BROWN: I'm talking about the FPGA reactor protection system. There has been diversity defined for that in other, in the one system we've approved on the FPGA basis.

MR. ASHCRAFT: Well --

(Simultaneous speaking.)

MEMBER BROWN: And we've approved that in what I would call the microprocessor based world, in terms of diversity for the other earlier, some of the earlier plants.

But there's no mention of it in this.

MR. ASHCRAFT: Well, as I said --

(Simultaneous speaking.)

MEMBER BROWN: And that's one of your old major standpoints relative to how you evaluate these protection systems, is from the diversity defense in depth standpoint, which seems to be not mentioned.

MR. ASHCRAFT: Well, so as of right now, we don't have the platform so it's hard to you know, to go into that depth.

MEMBER BROWN: But you didn't say anything in your SE about that was missing.

MR. ASHCRAFT: Because we had nothing in the SE to evaluate.

MEMBER BROWN: But that's something you normally insist on as part of the design.

MR. ASHCRAFT: Well --

(Simultaneous speaking.)

MEMBER BROWN: You demonstrate it at some point and if it's not part of the --

(Simultaneous speaking.)

MR. ASHCRAFT: And, it will. I mean once they establish the platform, which I think maybe they did in there, then a lot of your concerns will be taken care of.

But say they go with another platform. Once they come in with a topical for their platform, then all that will be evaluated on some merit.

So, I guess that's my answer there.

MEMBER HALNON: But and your review standards would drive you to that, right? I mean you're not just making this up.

You've got review standards, Reg Guides that they'll be using in this, the light that, the design?

MR. ASHCRAFT: Well, so we have NUREG-1537 and I don't, I know it speaks to diversity at some part. But at this time, without the platform it's hard to you know.

MEMBER BROWN: But the concept doesn't depend on a platform though. The concept of diversity is part of the overall architecture fundamentals, that safeguard systems and reactor protection systems design.

It's not, and it's built in you know, to a number of the Reg Guides, as well as BTB 7-19 and et cetera, which is very extensive.

This is a different approach. It's more narrowly focused, but there is a protection system and it talks about a, what platform, two different platforms.

One for the plant control system where they're talking about they're going to have dual whatevers, and they've got independent things.

But all the data goes up in this big mishmash of how everything's done, just in presentation.

But the RPS is a separate little box that says, I can shut things down. We've got four channels, two channels for voting, fine.

But then they talk about an FPGA base, not a software base, so you've eliminated one possible compromise, but you still have the failure modes of particular FPGAs.

And others have used diverse FPGAs, whether they be volatile, non-volatile, whatever you have.

MR. ASHCRAFT: Well --

(Simultaneous speaking.)

MEMBER BROWN: And there's no, nothing in the SE about that. That's all, it doesn't address, it does not address diversity at all.

MR. ASHCRAFT: And I agree, and the fact that potentially as they stated they're using HIPS, that a lot of that --

(Simultaneous speaking.)

MEMBER BROWN: They didn't say HIPS. Did they say HIPS? Okay, maybe I.

CHAIR PETTI: I don't think it was written.

MR. ASHCRAFT: No, it's not provided at this point, but they mention it.

MEMBER BROWN: I'm just saying, it's not in the PSAR.

MR. ASHCRAFT: No.

MEMBER BROWN: It's not in Rev 2. That's all I'm saying.

MR. ASHCRAFT: And the --

(Simultaneous speaking.)

MEMBER BROWN: It just says FPGA base, and which I agree with, I like. You know, because it eliminates some problems, okay.

MR. ASHCRAFT: Right.

MEMBER BROWN: Software wise.

MR. ASHCRAFT: But in the Appendix A, what that tells me is I'm waiting, I need to know what they're platform is so that I can look at all that.

Until I've gotten that.

MEMBER BROWN: Appendix A, I keep --

(Simultaneous speaking.)

MR. ASHCRAFT: Well, that just states --

(Simultaneous speaking.)

MEMBER BROWN: It says what?

MR. ASHCRAFT: That's just a list of things that we expect, and it's not all inclusive, but.

MEMBER BROWN: You're talking about Appendix A to part?

MR. ASHCRAFT: Of the SC.

MEMBER BROWN: Okay.

CHAIR PETTI: There is a punch list of the staff's items that they.

MEMBER BROWN: Yes, okay.

MR. ASHCRAFT: You know, because people keep saying what are we going to --

(Simultaneous speaking.)

MEMBER BROWN: Have we seen that yet?

MEMBER KIRCHNER: It's the Appendix to Chapter 1, right? Just to make this for the entire SE, yes.

MR. HISER: So I just want to be clear, Appendix A is things that the Kairos has identified to us either through the audit or in the PSAR, that they are planning to provide with the OL application.

It's not an all-inclusive list. It's also not --

(Simultaneous speaking.)

MEMBER BROWN: Where is it listed? Where is Appendix A? Is it a document?

MR. HISER: Yes, yes, it's Appendix A to

the SE. To the safety evaluation.

MEMBER BROWN: Oh, I was looking for that.

MEMBER HALNON: But we got it, we don't have it posted though.

MEMBER BROWN: Okay, I'll have to go find it.

MR. ASHCRAFT: We also had input to that.

MEMBER KIRCHNER: Charlie, can I raise one question?

MEMBER BROWN: Yes, go ahead. It's a free for all.

MEMBER KIRCHNER: This is more specific. It's probably more of a design options going forward for the OL.

I don't understand this, I guess the question should go to Kairos, not the staff, but that having the DHRS in the loop with the RPS, I don't get that.

The one simpler diagram where it shows it's just a lock, an interlock or whatever, makes much more sense than it being an active part of the, the RPS system.

Unless it blocks you from pulling rods or something, or it's just kind of just dangling out there in this RPS architecture.

MEMBER BROWN: We had a discussion of that at one of the earlier chapters, a decay heat removal meeting.

MEMBER KIRCHNER: Right.

MEMBER BROWN: And there's not a consistent, there's, and what I heard today and you can correct me, was there's two different pieces.

There's one if the RPS trips, it makes sure the DHRS comes on. That's the way that diagram reads.

Then there's something else. There's another widget in there that operates a valve somewhere, which we don't show.

MEMBER KIRCHNER: Yes, but if they don't have a large decay heat inventory, they don't want it coming on because you could actually then freeze the fluid in the --

(Simultaneous speaking.)

MEMBER BROWN: Worry about overcooling.

MEMBER KIRCHNER: -- in the vessel, et cetera, et cetera.

And it goes back to Greg's point. What's missing I think right now, at least just notionally in this control system, is something about showing that before you go ahead and run at power, you've got a level indication that these tanks are filled.

And I mean this can be done I think through tech specs and just a manual interlock, as part of the operating instructions I suppose.

But anyway, me, I don't, I'm not getting why it's part of an active system unless you've got the actual instrumentation feeding in to tell you you have water level or something.

CHAIR PETTI: Turn on your mic, please.

MR. ASHCRAFT: All right, so I've gone through you know, and I've heard Chapter 6 and I heard today, and I've heard a lot. So here's, but we don't have the schematic so it's hard.

So, but what I heard is the thimbles are dry, that's part of your DHRS. And it does dissipate some heat, but not enough, at a lower power level.

So once you reach a certain power level, which is not defined yet, but it is in Table 731 as a permissive, that is going to open the valves to those tanks and put water into the thimbles. So now you got a fully operational DHRS.

So as you're going up in power and as you're operating, those thimbles are full.

MEMBER BROWN: 10 megawatts is where that trigger was in the Chapter 6.

MR. ASHCRAFT: Right, but it hasn't, right now in Chapter 7 it's just a permissive. And so you're up in power running. Thimbles are full, everything's fine.

Your tanks, you know, are being supplied from outside. And then you get to a trip. So what happens on the trip is, well first of all you drop the control elements.

They drop and you turn off all the non-safety stuff. But for the DHRS, it ensures that the DHRS stays activated by preventing you from closing the valves from that tank. So that you will have a water supply.

That's --

(Simultaneous speaking.)

MEMBER KIRCHNER: Yes, and I get all that. It just doesn't make sense in the schematics to me. I get the simpler schematic where it just shows something which may be an interlock, or a switch.

And then there's no indication that this is part of what the operators will see. So that's, I'm nitpicking the schematics.

MR. ASHCRAFT: Well --

(Simultaneous speaking.)

MEMBER KIRCHNER: It may be more of a

question of U graphs than --

MEMBER BROWN: It would make more sense --

MEMBER KIRCHNER: -- than substance, but.

MEMBER BROWN: It would make more sense if somehow power tells this DHRS it's got to turn on.

This just says if it trips, it turns it on. But there's also an activation so if you get above 10 megawatts, it's supposed to come on.

That's not shown in this diagram.

MR. ASHCRAFT: No, it's not shown and a lot of this is in the details. You won't know until you get the schematics, and you get a table of displays and whatnot.

But even now, so your DHRS is fully functional when you reach that permissive.

MEMBER BROWN: The 10 megawatts it's supposed to come on.

MR. ASHCRAFT: Right.

MEMBER BROWN: But that means all the systems that support the DHRS, the tanks have got to be full.

MR. ASHCRAFT: Right.

MEMBER BROWN: Blah blah blah, whatever the other pieces are.

MR. ASHCRAFT: Exactly.

MEMBER BROWN: And that's where, where is the data, where is the signal that says my tanks are full, therefore, I can actuate?

MR. ASHCRAFT: Well, that --

(Simultaneous speaking.)

MEMBER BROWN: I didn't, there's no, the control of the DHRS, the integrated control and turn it on and off, is not present in a single schematic to show how these things work together.

We had that big discussion in Chapter 6, and I came and walked away very unsatisfied with the results.

MEMBER MARCH-LEUBA: I wasn't here for that discussion, but the DHRS tanks are sized for a 7-day operation. And they're supposed to be filled by tech specs, I assume.

So, you don't check levels before you open the valve.

MEMBER BROWN: No, that's fine that you've got to open a valve, but there's still not, what opens the valve? Is it?

MR. ASHCRAFT: Well, yes --

(Simultaneous speaking.)

MEMBER MARCH-LEUBA: Losing power to that.

MEMBER BROWN: That's losing, that's the

power, that's when you shut down, you scram.

MEMBER MARCH-LEUBA: Uh huh.

MEMBER BROWN: Then you turn it on. But you also turn on DHRS when the power goes above 10 megawatts.

MR. ASHCRAFT: All right, from my reading of Chapter 6 and Chapter 7, and all the chapters, is when you reach that 10 megawatt and those thimbles fill with water, and those valves from the tanks are open, it's fully operation.

MEMBER BROWN: Yes, but where does that come from? Does it come from the PCS?

MR. ASHCRAFT: Well, the PCS --

(Simultaneous speaking.)

MR. ASHCRAFT: -- well, the PCS are not, that tank is non-safety. But there are safety valves, I remember hearing that.

MEMBER BROWN: There is one of the valves in there that does something for the --

(Simultaneous speaking.)

MR. ASHCRAFT: Right.

MEMBER BROWN: -- hit the water.

MEMBER KIRCHNER: No, the tank is, the tank is safety.

(Simultaneous speaking.)

PARTICIPANT: The DHRS tanks is definitely safety related.

MR. ASHCRAFT: The system is safety related.

MEMBER BROWN: And the valve is safety related.

MR. ASHCRAFT: Right, but we don't have that detailed logic.

MEMBER KIRCHNER: I'm just saying Joe, it's not even showing up on the schematic. I mean in the core functions, I would have put DHRS in this, this box here, of the schematic.

For the people who are remote, I'm looking at the integrated --

(Simultaneous speaking.)

MEMBER BROWN: It's 7.1.1.

MEMBER KIRCHNER: Yes, diagram and the central box. There's no indication that you would feed the operators for example, the level in the tanks.

CHAIR PETTI: But it up above is DHRS status on the computer, little computer screen. Its own little computer.

Highly reliable display.

MEMBER BROWN: Yes, but that's a display, not a control function.

MEMBER KIRCHNER: Yes, that's a display. So there's nothing, I'm just saying there's no box down --

(Simultaneous speaking.)

CHAIR PETTI: Yes, yes, I understand what you're saying.

MEMBER BROWN: Somewhere a nuclear power signal has to go, activate, turn one of those switches or another switch somewhere, and turn on the DHRS.

MEMBER HALNON: I think you all --

(Simultaneous speaking.)

MEMBER BROWN: Then there's a valve.

MEMBER HALNON: I think you all need to make sure that you're not looking at this as the schematic. This is a presentation.

MEMBER BROWN: That is the architecture.

MEMBER HALNON: The schematic is behind --

(Simultaneous speaking.)

MR. ASHCRAFT: Yes.

MEMBER HALNON: -- the architecture, but it doesn't show the behind the scenes.

MEMBER BROWN: Like I said, there's a lot of other stuff.

MEMBER HALNON: Lot of communication going on.

CHAIR PETTI: Outside the pinkish color, is more notion.

MEMBER BROWN: A controlled diagram for the DHRS is not present.

MEMBER KIRCHNER: Correct.

MEMBER BROWN: In either Chapter 6 or Chapter 7.

MEMBER HALNON: Nor the other channels I was talking about with the treated water systems that I was --

(Simultaneous speaking.)

MEMBER BROWN: Well, but that, the treated water, that's down running the air conditioner. I agree with you, but those are so non, those are non-safety and non-safety.

MEMBER HALNON: But no, it interfaces and provides cooling water to the DHRS.

MEMBER BROWN: Then it ought to have something. There's a lot of incompleteness, that's all.

MEMBER HALNON: Yes, that's what I'm saying, but.

MR. ASHCRAFT: I was only going to point out on this diagram, that little toggle switch is when

DHRS is supposed to be activated and remain activated, it prevents, that toggle switch from you turning it off.

Which means you cannot close the valve. So the water is going to keep coming down. And at such time that you no longer, as you know, as power comes down --

(Simultaneous speaking.)

MEMBER BROWN: Is that manually?

MR. ASHCRAFT: As power comes down and you don't need full DHRS, there is another permissive which is in that Table 731, which is going to allow them to switch that. And, I believe it is made.

And then the operator can turn it and close it off, because what you don't want is to have DHRS fully operational once you get back down to that 10 megawatts.

MEMBER BROWN: Absolutely, we're not disagreeing with that point.

MR. ASHCRAFT: So, yes but all that's, no, all that's in the details that we don't have yet. And we won't have until we have detailed schematics that, and then we'll see what those levels are.

CHAIR PETTI: Okay, all right, we're running behind.

MEMBER BROWN: All right, we've mouse milked this thing, we've mouse milked this good enough.

CHAIR PETTI: You're done, right, Joe?

MR. ASHCRAFT: Yes, I'm done.

MEMBER BROWN: Okay, thank you, Joe.

So let's get the memo out and court reporter, you're off again till we tell you you're back.

(Whereupon, the above-entitled matter went off the record at 11:30 a.m. and resumed at 1:02 p.m.)

CHAIR PETTI: We're back. We have most members. A couple are still coming in. But let's get going on Chapter 8.

Kairos?

MR. CILLIERS: Sound check. Can you hear me?

MEMBER BLEY: Excuse me. This is Dennis Bley. Before you get started, I wanted to pose something that I don't want you to answer now, but as you go through the discussion, I would appreciate it.

I have no problems with almost everybody here, except there is one area that we and the staff have raised with other applicants, and that is emergency lighting, communications, and monitoring.

Well, if everything works fine from the design basis events, you are golden. But if something goes wrong and you really need to do something in the plan, those are crucial.

And one of the previous applicants ended up making that equipment and their power supplies 1E. Another one came up with an approach that demonstrated essentially equivalent reliability to the 1E, and I guess it all hinges on the 72-hour UPSs that you have really being able to do their job for that length of time.

So when you go through, maybe you can raise this. I'm sure we will raise it toward the end. Go ahead.

MR. CILLIERS: Thank you very much. This is Anthony Cilliers again, Director of Instrumentation, Controls and Electrical, and I'll just jump straight into Chapter 8.

Next slide, please.

I'm going to start with the -- with the single -- the electrical power system drawing that we have here. It's -- I'll start at the top, and I hope you've got a bigger printout there, assignments that you've had with the other systems, if it's a little bit too small for you.

I'll just start by saying that primarily and this is a -- this is a key aspect here -- we do not rely on any electrical systems for any safety functions. There is no safety functions that requires electrical power. That being said, of course electrical power and the reliability of electrical power is extremely important to us.

And for that reason, you will see a lot of systems that's built in to support the reliability of these power systems. But it has to be said that they are known safety systems that depend on these electrical systems.

So starting at the top, the power -- the normal power supply would be coming from the -- from the utility and be stepped down through a stepdown transformer to 480 volts. We also have onsite backup generators with automatic transfer switch that allows switching between the normal power supply, should that go off, to the backup power supplies.

And there is roughly a 20-second switching time between the -- from the one to the other. So we are -- have accounted for that -- for that stoppage time as well.

In addition, there is also --

MEMBER BROWN: Could you repeat that

again, please?

MR. CILLIERS: Okay.

MEMBER BROWN: I missed the point.

MR. CILLIERS: There is a roughly a 20 second transfer time between the main -- from the main power going off to the diesel that -- not necessarily diesels --

MEMBER BROWN: Okay.

MR. CILLIERS: -- but the backup power to

MEMBER BROWN: All right. That's the automatic transfer switch you're talking about.

MR. CILLIERS: Correct. Correct.

MEMBER BROWN: Okay. That's a typical transfer switch, not atypical transfer switch response after --

MR. CILLIERS: Yes.

MEMBER BROWN: -- transfer panel.

MEMBER BLEY: This is Dennis Bley. You're about to get to the portable generator connection. I just had a question. With that kind of connection, are you setting it up with the -- what is now the standard FLEX connectors, or are you doing your own and figuring you don't need any outside help?

MR. CILLIERS: That hasn't been defined

yet, how we will -- we are just indicating that connection at the moment for having a portable generator supply, if that were to be needed for an extended period of time. So --

MEMBER BLEY: Okay. And I guess the other applicants to this -- and I don't expect an answer right now, but I wonder if you've considered whether your customers would want to be involved in FLEX and in the SAFER system. And this is something for the Committee to think about later.

I don't know that the industry SAFER system has set up any options for people who don't need the full power of it. And some of these smaller plants, there might be something that would work really well for them. But I -- I don't expect you guys to answer that question.

Go ahead.

MR. CILLIERS: Thank you. Right. So we've covered the supply side of things. That goes on to a 480-volt bus bar, and in many cases a lot of our systems, I mean, you will see a lot of these little blocks all being supplied by that 480-volt. And if there is specific lower voltage requirements within that system, there is -- they will be stepped down as per -- as required within those various system blocks to take it to the required voltage.

MEMBER BLEY: May I ask you a kind of dumb question? This is Dennis again. UPS 120-volt that supplies the heat rejection control and double-handling systems, that stuff, so it's a 20-second duration capacity. Well, you don't buy one of those, but would you be designing this with very little capability or is that just a definition of what you think you'll need to support the rest of the fleet?

MR. CILLIERS: That's correct. Yeah. So you've asked the question, so maybe I'll just jump right into that. So for the reactor protection system and the plant control systems, we start off with having a 72-hour UPS supply system, so that we can supply those systems in the event of any power failure, so that we still have that capability of monitoring.

As I've said, this is really important to us, although it doesn't add -- doesn't have any safety functions. We want the monitoring there, and we want the systems to be available. So that is really a reliability function that we have built in.

The 20-second part is very much the systems that keep the relays going to supply power to the -- to the various systems that we need to shut off.

Now, the reason we have specified 20 seconds there is it should be 20 seconds or longer, but as short as possible, meaning that it should allow us to do the transfer between the main power supply and the backup power supply without a trip. We don't necessarily want the system to trip while we transfer power from the main to the backup power supply.

If that main -- that transfer between the main and the backup power supply does not happen within a specified period of time, and that would roughly be just over 20 seconds, that UPS would be drained and the system would then trip. And that's the reason why we say 20 seconds.

So it's roughly 20 seconds of what we will be needing, so it will just specify very small -- very small capacity supply there.

MEMBER BLEY: So ---

MR. CILLIERS: Yeah.

MEMBER BLEY: -- you are going to design this, and you can't count on the power running down, so you must be thinking of putting some kind of timing circuit in there to disconnect it?

MR. CILLIERS: It's designed specifically on the -- on the power requirements for the system, so that it should run down. So it should be a very small many-hour battery supply for that system.

MEMBER BLEY: No kidding. Because that sounds -- something about that sounds dicey. I have never seen anybody design for a power to -- a battery to run out that quickly. And those batteries are wanted to do -- but somewhere along the line they might run out faster than you expect.

That was one, at least for me, I'm going to be thinking about when you come back with the operating license. This seems a little odd.

MR. CILLIERS: Right. Thank you.

MEMBER BROWN: Another question from Charlie Brown. Alongside Dennis' comment, that implies then that if your -- that main bus is totally deenergized because the automatic transfer switch didn't transfer, for whatever reason, that means all those four systems, you've lost them. They will stop.

I presume those are not necessary for any safety function as well. Is that correct?

MR. CILLIERS: That is correct.

MEMBER BROWN: Okay.

MR. CILLIERS: So I think it came from Chapter 7 as well. All our systems are designed to be passive, and we really want to shut them down to put the system in a safe state. So one of the systems of course is our reactor shutdown system, which inserts the rods into the system. So if that power fails, it drops in there.

Now, of course a reactor protection system can initiate that as well. But if there is a loss of power, that will -- that will drop the systems in. And the same as what we had in our diagram in Chapter 7. All the other systems we -- we actually want to shut down and --

MEMBER BLEY: Okay.

MR. CILLIERS: So it fails to safety on loss of power. That's the --

MEMBER BROWN: All right. I'm just confirming that I heard -- heard it all correctly. Thank you.

MEMBER HALNON: Are you going to explain the safety-related isolation down in the bottom right of the --

MR. CILLIERS: Yeah. So this is -- this is very much a repeat of what we have seen in the other diagrams in Chapter 7 as well. Although those are safety-related relays, the power supply going through them are not safety-related. So the only safety-related part is the relay itself that should fail open in all cases. So that makes it a safety-related component.

Also, the power supply that keeps it closed is not a safety-related power supply. So if that power should fail, it should fail open and the power is shut off to it.

So the isolating device is the same devices that you will see in the -- in the Chapter 7 figures. If there is a power loss to those relays, either through the signal that keeps it closed that comes from the RPS, or the power itself that goes through the system, those systems basically lose power and they shut off.

MEMBER HALNON: Okay. And you're not going to rely on that for any safety-related function, right? I mean, you're not going to rely on loss of power to open the relay.

MR. CILLIERS: No. We don't rely on the loss of power to open the relay. We shut the power off, the signal to it, from the RPS. We rely on that part, that the RPS would send that signal. But also, loss of power would result in the same outcome as what would come from the RPS. Does that make sense?

MEMBER HALNON: Yeah. I guess my point was, I mean, you're showing one relay there. But if you're going to rely on it as a tripped RPS, you would have a redundant relay there.

MR. CILLIERS: Yeah. I think that's implied in the -- in the statement, that it's a safety-related system.

MEMBER HALNON: Right.

MR. CILLIERS: In Chapter 7, it says times four as well. So there is four of them.

MEMBER HALNON: Okay. That makes sense.

MR. CILLIERS: That's not indicated in this, yeah.

MEMBER DIMITRIJEVIC: This is Vesna Dimitrijevic. I have one question. So you said that the loss of power, all of those systems fail in the same position, right? So there is shut down or, you know, the RPS is tripping, things like that, right?

MR. CILLIERS: Correct.

MEMBER DIMITRIJEVIC: Okay. Now the question is, so all of the -- before you boot in 20 seconds, right, this all happened in 20 seconds after you get the power back from the diesel generators. So all of those trips will occur within those 20 seconds, right?

MR. CILLIERS: It's important to note that the DHRS -- or, sorry, that RCSS system is supplied through -- where is the supply coming from? I believe that's supplied by -- or it's not.

Yeah. It's got 20 seconds while it will stay on. And if the power doesn't switch over, then it will -- it will shut off.

MEMBER DIMITRIJEVIC: Run this again by me. I didn't hear you well.

MR. CILLIERS: Sorry. Should I --

MEMBER DIMITRIJEVIC: I didn't hear you well, if you can --

MR. CILLIERS: Yeah.

MEMBER DIMITRIJEVIC: -- just repeat what you just said.

MR. CILLIERS: So we've got 20 seconds for the transfer to happen from the main power to the backup power.

MEMBER DIMITRIJEVIC: Right.

MR. CILLIERS: If the power does not transfer, then all those systems shuts down.

MEMBER DIMITRIJEVIC: But I think the power transfers, they will stay on diesel generator. Is that what you're saying? If the power stays, would all those systems stay -- be supplied from the diesel generator?

MR. CILLIERS: That's correct. Yes. The

idea is that they can -- they can keep running, and then we could shut them down if we realized we're not going to get the main power supply back within a specified period of time.

MEMBER DIMITRIJEVIC: All right. Thanks.

MEMBER BROWN: This is Charlie Brown again. I had one other question relative to Vesna's question sort of, or related. So once they shut down, you lose all that power, so those four systems shut down, and then the power comes back, do they restart or do they have to be manually restarted?

MR. CILLIERS: They should continue running. They should --

MEMBER BROWN: Nope. That's not what I asked. That's not what I asked.

MR. CILLIERS: They should restart.

MEMBER BROWN: You've lost power. They've gone off. ATS didn't transfer --

MR. CILLIERS: Oh, okay. Sorry.

MEMBER BROWN: -- put everything -- there is no electrical power on that 480 bus. Now, all of a sudden, a minute, two minutes, three minutes later, the power comes back. Those didn't shut down. Now, do they automatically restart?

MR. CILLIERS: Okay. Got it. I

understand your question now. No, they do not --

MEMBER BROWN: Thank you.

MR. CILLIERS: -- automatically restart. There is a manual reset to all of these systems that will have to be reset before you can start them back up again.

MEMBER BROWN: Okay. Thank you.

MR. CILLIERS: Next slide?

MEMBER BLEY: On Charlie's question, but that UPS that is designed to fail in something just over 20 seconds, it will start recharging itself once you get power back. True?

MR. CILLIERS: Yeah. I would say so. But the reactor protection system would have opened the relay. So the reactor system has to be reset.

MEMBER BLEY: Okay.

MR. CILLIERS: So from the normal power system, the normal power system does not perform any circulated functions and is not credited for the mitigation of any postulated events.

AC power is distributed to the plant electrical loads during startup and shutdown, normal operation, and off-normal conditions.

The DC power supply is limited to the I&C functions that require the 24-volt DC for operations, and that is the signals that is supplied to those relays.

The passive design features do not rely on electrical power for safety-related SSCs to perform the safety function. During postulated events PDC 17 and 18, the normal power system is designed so that the differential displacements do not preclude a safety-related SSC from performing its safety function. That's PDC 2. And the normal power system is designed in accordance with the National Fire Protection Association, NFPA 70, or the National Electric Code.

Next slide?

Now going to the backup power system, the backup power system does not perform any safety-related functions and is not credited for the mitigation of postulated events. The backup power system provides AC electrical power to essential loads when normal power is not available.

The backup power system includes the backup generators, which will automatically start in the event of offsite power with one redundant generator and built in by design. It includes the interruptible power supplies, a highly reliable and continuous AC electrical supply.

And, again, this is really for -- because we want to have electrical -- reliable electrical supply, electrical equipment to connect the backup generators to the low voltage AC electrical power distribution system and space for a plug-in connection for reportable 480-volt AC generator.

Next slide?

So the backup power system design basis, to ensure fail to safety in the event of a complete loss of AC electrical power system, the reactivity control and shutdown system and the primary sump pump relays require on 24-volt DC to remain closed.

On a loss of power, the RCS relay opens, and the shutdown elements drop into the reactor by gravity. On loss of power, the PSP relays open to prevent inadvertent pump and blower restart on power restoration. And this includes all other systems that we would like to shut off during such an event, similar to what a trip would be.

On activation of the decay heat removal system, the reactor protection system will remove the 24-volt DC from the activation circuit relay to prevent inadvertent shutdown of the DHRS by operator error. So there is a relay that opens as well, which I believe wasn't in the -- in the pictures before, but that is there.

Equipment for monitoring the reactor status will be supplied by UPS until the normal power supply or backup generators are restored.

Passive design features do not rely on electrical power for safety-related SSCs to perform the safety functions. During postulated events -- that's PDCs 17 and 18 -- the backup power system is designed so that differential displacement do not preclude safety-related SSCs from performing its safety function. That's PDC 2. And the backup power system is also designed according to the National Electrical Code.

And if there is any more questions, I'm happy to answer them.

MEMBER BLEY: Well, this is Dennis Bley again, and I guess one comment -- I think everything is fine for the construction permit. But the things I mentioned earlier, the emergency lighting communications and monitoring, are really essential if things don't go the way we expect them to go. And I know you are putting in what you consider to be very reliable 72-hour UPSs.

But for the staff, you know, in the past people were eventually persuaded to go 1E on these or to have some kind of justification that they were equivalent. And I think we need at least some kind of treatment and pedigree requirements for those things, because they are very important.

I don't know if the Committee would want to say anything about that in their reports or not.

And the other one is that 20-second UPS capacity is just kind of gnawing at me. I've been involved in testing batteries in powerplants, and, yeah, they almost always last a lot longer than predicted, which is usually great. Here you're counting on them to fail in a certain amount of time, and I don't recall anybody who has designed batteries to do that.

And I think you've got to be careful with that. You might need some additional circuitry to make sure it does what you want it to do. And I don't think it's a killer for now, but I think it is -- needs to be addressed by operating license time.

That's the only comments from me.

MR. CILLIERS: Thank you very much. We've got some -- some systems in the works for that, so, yeah, we will definitely consider that for OLA.

CHAIR PETTI: Any other questions, members? Go ahead, Charlie.

MEMBER BROWN: Just a minute. I've got to find it. Problem with the computers. I've got to make the page bigger.

In Section 8.3.1.1 under your backup generators, in the last paragraph, it talks about the backup generator coming on, start up automatic transfer switch, a load-shedding scheme is employed to ensure that only essential loads are supplied.

So that implies to me that the backup diesel generator cannot support the load of everything in its normal configuration at the time you lose the main grid power source. Is that correct? That's what

MR. CILLIERS: Yeah. That would be correct. But the specific scheme of what systems we want to remain on and what systems we do not, what is deemed as non-essential supplies that we will just simply not have on the backup power supply, that has not been defined yet.

So all systems really related to the reactor operations will be on the generator system. We just didn't want to leave it open so that we have the entire plant running off the -- off the generators.

MEMBER BROWN: Yeah. I saw the list about not going to be supplied, but I also didn't see any load, even an approximate load analysis that you would need to be drawing on from the grid anyway that would size that. It just --

MEMBER HALNON: Well, you need to get equipment specs.

MEMBER BROWN: No, I understand. Exactly. But shedding the load when the backup generator comes on is not a real, real good idea, although it can be done. So --

MEMBER HALNON: It's all right as long as you do it, so you don't get an overstated trip.

MEMBER BROWN: Exactly.

MEMBER HALNON: I mean, that's pretty common and, you know, load shed, load schemes are pretty --

MEMBER BROWN: Well, you've got everything trying to restart. So some start -- some things won't restart and others will.

All right. You answered my question. I just -- just kind of hanging that one out to dry. Thank you.

MEMBER BLEY: Charlie?

MEMBER BROWN: Yeah.

MEMBER BLEY: And I guess for these guys.

You probably have some kind of load sequence or something that you didn't describe at this early stage. Is that what you expect?

MR. CILLIERS: That's correct. We do not have the information on what those loads would look like at the time of issuance. But, yes, the simple answer is the -- all essential loads, which will include an exhaustive list of systems, will run from the backup power supply.

We do not want to leave the impression that the entire plant, with all -- with all systems and offices and everything else will be running off that. But that specific list of what is -- what is deemed as essential would be operations and doing safe shutdown will be included in the OLA.

MEMBER BROWN: Okay. You answered my question. I'll leave it up to Dennis to deal with the other side. Thank you.

MEMBER BLEY: And that's for later. Yeah.

MEMBER BROWN: Okay.

CHAIR PETTI: Okay. Then let's move to the staff slides.

PARTICIPANT: I'll turn it over to Sheila Ray, who will present the staff's review of Chapter 8.

MS. RAY: Good afternoon. My name is

Sheila Ray. I'm currently a senior electrical engineer in the Electrical Engineering Branch. I'm also a licensed professional engineer in the State of Maryland.

The review of the electrical power systems was completed by myself and Vijay Goel. He's an electrical engineer, and he is participating virtually.

Next slide.

So we have had an overview from Kairos that talked about the non-Class 1E normal and backup power system. Due to the passive design of Hermes, safety-related structures, systems, and components do not require electric power to perform safety-related functions for a minimum of 72 hours following a design basis event.

As such, AC and DC power are not required to mitigate a design basis event and the power --

MEMBER BROWN: Can I interrupt you?

MS. RAY: Yes. Always.

MEMBER BROWN: You said that they have determined that they -- they didn't need these systems to operate -- how did you phrase that? It was how you phrased it that triggered my thought process.

No, it wasn't -- you don't need them on

more than 72 hours under -- you said something. How did you --

MS. RAY: So I said they do not require safety -- SSCs do not require electric power to perform safety-related functions for a minimum of 72 hours.

MEMBER BROWN: They don't need them for the minimum of 72 hours.

MS. RAY: Correct.

MEMBER BROWN: In other words, they don't need them at all.

MS. RAY: Correct.

MEMBER BROWN: Okay. That's the -- that's not the way I heard it. Thank you.

MS. RAY: Okay. You said it right. I was just -- my ears were behind.

MEMBER MARCH-LEUBA: Yeah. It's the same for ESFs, not only protection systems. Anything else

MEMBER BROWN: Yes, right. Nothing used anything.

MEMBER MARCH-LEUBA: They just deenergize POMs on the drops, and there you go. It's a good design.

MS. RAY: So the slide also provides the

principle design criteria as listed here, PDC 17 and 18.

Next slide, please.

So we had the AC and DC system provided by an offsite source, and we heard that the normal power system is designed in accordance with the National Electrical Code.

The staff conducted an audit, and during the audit the staff confirmed that no electrical systems were required for performing any safety-related function for safe shutdown of the plant or to keep the plant in safe shutdown condition.

Next slide.

MEMBER MARCH-LEUBA: Just one back. In the previous slide, you mentioned one power -- offsite power supply. But they are going to have two, right?

MS. RAY: I believe it's one.

MEMBER MARCH-LEUBA: I mean, you have Kingston and Bull Run powerplants within five miles. Yeah. Anyway, I will have to -- even if I don't need emergency power, I will be more comfortable.

MS. RAY: I understand.

MEMBER MARCH-LEUBA: For the record, I was involved in -- I used to be at Oak Ridge, and I was involved in the design of a reactor in Oak Ridge

National Laboratory. And we were making a case to DOE that Oak Ridge has the lowest incidence of tornado hits in the United States. And we were succeeding, and that weekend a tornado hit our office and broke it down.

(Laughter.)

MEMBER MARCH-LEUBA: I mean, it destroyed all the computers in the office. So, anyway --

MEMBER BLEY: But their design says one line coming in.

MEMBER MARCH-LEUBA: It's all they need for sure, but let's hope it's a high reliable -- highly reliable line.

MS. RAY: The normal power system is not credited for postulated events or safe shutdown, and it is classified as non-Class 1E or non-safety, and no technical specifications for the normal power system are required.

Staff concluded that the PDCs 17 and 18 are not applicable, since there are no Class 1E electric power systems, and non-safety power is available for non-safety functions not credited for DBE.

Next slide.

We heard about the backup power system,

which provides AC electrical power to the essential facility loads when the normal AC power supply is not available.

Once again, the backup power system is designed in accordance with the National Electric Code.

Next slide.

As the backup power system does not perform any safety-related functions, is not credited for the mitigation of postulated events, and is not credited with performing safe shutdown functions, the non-safety classification is appropriate. The staff finds that the PDC 17 are not applicable. There are no Class 1E electric power systems, and non-safety-related power is available for non-safety functions, not credited for DBE.

Next slide.

So, once again, the staff finds that the PDC 17 and 18 are not applicable, since there are no safety-related electrical power systems. Non-safety-related power is available for non-safety functions not credited for DBE, and the staff finds that the design of the Hermes normal power system and backup power system are sufficient and meet the applicable regulatory requirements and guidance for the issuance of a CP, construction permit, in accordance with Title 10, CFR 50.35 and 50.40.

That concludes my presentation.

MEMBER BLEY: What -- I'm sorry. Go ahead.

MEMBER KIRCHNER: Go ahead, Dennis.

MEMBER BLEY: Yeah. This is Dennis Bley. The same thing I was talking to them about, both questions deal with UPSs. I think you'll remember there were a couple of places where we had systems that for design basis didn't need electric power and didn't have 1E power. But in the two cases I'm remembering, eventually they agreed to some sort of requirements on what here would be the 72-hour UPS, to make sure its pedigree and the required treatment of it gets the sort of reliability we really want for systems that we need to monitor and see things around the plant and communicate.

You didn't say anything about that in the SE. What are your thoughts about that?

MS. RAY: So in our Regulatory Guide 1.232, we do have the PDC 17 state that if electric power is not needed for AOOs or postulated accidents, the design shall demonstrate that power for safety significant functions is provided.

But when we wrote that, we intended to include items like emergency lighting, communications, et cetera. So the staff's position is that can be non-safety-related power.

MEMBER BROWN: And the communications in lighting are on a 72-hour UPS just once.

MEMBER BLEY: Yes, they are. And so is the monitoring step, so they are. I just remember those cases in the past where you kind of added some extra requirements to make sure that they were there.

Second question was about their UPS that is going to trip in 20 seconds. Are you guys aware of any designs that are guaranteed to trip in a required time period? Not trip, but lose power. I'm not.

MS. RAY: I'm not aware of any. I would have to go back and look.

MEMBER BLEY: There wasn't anything in the chapter that said that was important, but today they said, yeah, they really needed to lose power in 20 seconds. I think that's something for later, but I just wanted to bring it to your attention.

MS. RAY: Thank you.

MEMBER KIRCHNER: This is not a question, Sheila, just an observation. And it -- and it's -- and I was saving it for here. As an operator, you always want to have electric power, so you can do things to mitigate things. We have seen now, you know -- I get it. When they say the system doesn't have a safety function that's not credited, okay, fine, that's more so you can bend things in terms of economics and other considerations.

But I keep stumbling over this not needed to mitigate anything, and yet we have a first-of-the-kind reactor and who knows what happens at the 73rd hour, like I don't know, all of a sudden you find you are losing primary coolant inventory. I would want my inventory management system which they are designing to be functional to help cope with that loss. I'm making up a rhetorical scenario. I haven't thought it through.

So I understand the rules of engagement, but the constant onslaught on all the viewgraphs, that none of this needed to mitigate anything, after a while cumulatively bothers me because that assumes now we have looked at the design basis -- we have a very thorough design, and we have looked at all of the events, and we have a PRA, and we have laid all these kind of rhetorical kind of challenges against the system which we haven't.

So I would just observe that we are

constantly saying we don't need electric power to mitigate anything, and I -- it just leaves me a little concerned. I know that's part of the regulatory engagement and game that is being played, but as a former operator, I'm thinking, oh boy, you know, if this goes wrong or that goes wrong, that's when you need electric power to try and --

MEMBER HALNON: Well, there are two backup generators and a portable connection. You can back a tractor up with a PTO to --

MEMBER KIRCHNER: Yeah. So it's -- so they do have the FLEX provision.

MEMBER HALNON: Yeah. So, you know, as an operator, I want to have no stone unturned on, you know, what is the next option.

MEMBER KIRCHNER: Yeah.

MEMBER HALNON: But it seems like --

MEMBER KIRCHNER: That's where I was going, Greg.

MEMBER HALNON: Yeah.

MEMBER KIRCHNER: It's just -- I'm not objecting. I'm not raising any major safety issues. Just --

MEMBER HALNON: Because when you get down to those accidents and other issues, operators don't think safety-related/non-safety-related. They think electrons and volts.

MEMBER KIRCHNER: Right. That's where I was going. Just an observation.

CHAIR PETTI: And I'm sure we'll see this with other advanced reactor designs.

MEMBER KIRCHNER: What?

CHAIR PETTI: We'll see this with other advanced reactor designs.

MEMBER KIRCHNER: No. No, of course we will. Yeah.

CHAIR PETTI: This is characteristic and

MEMBER BROWN: Let me -- my memory may have failed me, but when I read this chapter, I now vaguely remember -- this is very vague, an old brain that the figure that shows two backup generators was noted in the text to maybe only be one. I saw that somewhere, and I don't remember where it was. I know it's in here somewhere.

MEMBER HALNON: I don't remember that, Charlie, but could they -- the backup generator running doesn't mean there's not two backing up to the

MEMBER BLEY: I don't remember either.

MEMBER BROWN: For some reason, don't ask, my mind is blowing right now. I probably just ought to be quiet.

MEMBER HALNON: We'll put a bookmark in it and come back later.

MEMBER BROWN: All right. Put a cork in me would be -- probably be a better approach. Plus, it does say generators, plural, in the text. Somewhere I saw something where I thought it said only one, or possibly only one. That's fine. Let's go on.

MEMBER MARCH-LEUBA: Charlie, the slide number 2 says backup supply (N minus 1 contingency). Is that what you are thinking about?

MEMBER BROWN: No. I saw that. That is -- you have two of them, so they -- if one of them doesn't start, then the other one -- hopefully the other one will. So that -- that didn't bother me. That --

MEMBER MARCH-LEUBA: So they probably --

MEMBER BROWN: I'm wrong. Just --

MEMBER MARCH-LEUBA: They probably mean that only one is created, but it's a backup. Let's continue.

CHAIR PETTI: Okay. If there's no other questions, we can move to the memo.

And the court reporter can stop transcribing. Thanks.

(Whereupon, the above-entitled matter went off the record at 1:42 p.m. and resumed at 1:44 p.m.)

CHAIR PETTI: Okay. Court reporter, we are back on.

MR. CLARK: This is Austin Clark. I'm an engineer with the licensing team here at Kairos Power, and I am presenting on PSAR 11, Section 1, radiation protection.

Chapter 11 of the Preliminary Safety Analysis Report addresses commitments regarding radiation protection and waste management for the Hermes non-power reactor. Radiation protection includes identifying radiation sources, describing the radiation protection program, the ALARA program, and the environmental monitoring program, and describing radiation monitoring and surveying, radiation exposure control, dosimetry, and contamination control.

Radioactive waste management includes describing the radioactive waste management program, radioactive waste handling systems and controls, design bases, and disposal of the radioactive wastes. For the PSAR, these programs are designed at the commitment level only.

Next slide, please.

MEMBER MARCH-LEUBA: While you're changing the slides, we mentioned earlier this morning -- so we mentioned earlier -- this is Jose. Mentioned earlier this morning about the possibility of mixed waste where you have both chemical and radioactive disposal, especially during decommissioning.

Can you tell us anything more about that? Or you just stand by the comment earlier? So the question is you have -- we have beryllium, which is a chemical waste mixed with some degree of contamination, radioactive contamination, that has to be disposed of.

MR. CLARK: I think -- so as far as handling onsite, obviously, because it's radioactive waste we will have to have radiological protection programs in place.

As far as the mixed waste aspect of beryllium waste, that falls under OSHA and we intend to be compliant with all OSHA requirements. And then as far as disposal, as we mentioned this morning, we have already contacted a vendor and received a written letter from them that they will be able to handle fly as a mixed waste.

MEMBER MARCH-LEUBA: And we've heard

rumors that the fly, because the lithium is going to be enriched, could be worth a significant amount of money. Are you considering reprocessing for future reactor, or this is beyond the scope for this analysis?

MR. CLARK: It's beyond the scope at this point.

MEMBER MARCH-LEUBA: Okay. Thank you.

MR. CLARK: Sources of radiation include fission products, decay products, fuel, and activation products, including tritium. Sources of airborne, liquid, and solid radiation identified for the facility are given in Table 11.1-1 of the PSAR.

The radiation protection program, as required by 10 CFR 20.1101, will implement the regulations in 10 CFR 19 and CFR 20 to ensure compliance with the requirements for radiation protection. The radiation protection program contents and implementation will be reviewed periodically.

The ALARA program, as required by 10 CFR 20.1101, will include provisions for the facility to maintain worker and public doses and radiological releases as low as is reasonably achievable.

The ALARA program will be consistent with the guidance in Regulatory Guide 8.10, operating philosophy for maintaining occupational and public radiation exposures as low as is reasonably achievable, Revision 2. And a description of the program will be provided with the application for an operating license.

Radiation monitoring and surveying will be conducted as required by 10 CFR 20 to identify and control potential sources of radiation exposure and release.

Next slide, please.

All facility effluents are monitored prior to release. SSCs in the facility are designed to limit effluent releases both to work areas and to the environment. A screening analysis of the long-term radioactive effluents from the facility was completed. That analysis used the NRC's XOQ/DOQ and Gas Power 2 codes for dispersion and dose model calculations, respectively, site-specific validated meteorological data covering the five-year period of record, and a bounding tritium admissions rates set equal to the first year tritium generation rate.

The limits for airborne radioactive emissions and for all licensed operations are given in 10 CFR 20.1101(d) and 10 CFR 20.1301(a)(1), respectively. All model doses are conservatively bounded and are below the limits specified in 10 CFR 20.

Next slide, please.

MR. SCHULTZ: Excuse me. This is Steve Schultz. A question on your last slide.

MR. CLARK: Mm-hmm.

MR. SCHULTZ: You have assumed a bounding tritium emission, as you have indicated, equal to the first year tritium generation rate. My question is really looking forward either -- to the OL information that will be presented. Do you intend to take credit for any plant retention associated with tritium? And the reason I'm mentioning this is that if you look at -- not you look, but looking into the literature associated with tritium emissions, which has a key focus in -- both in the industry and with respect to the public, the information generally looks at emissions from various types of powerplants.

And, in that regard, they take credit for plant retention in their evaluation of tritium emissions. Are you planning to do that in the future and have just done this bounding calculation for this -- for this permit evaluation, construction permit?

MR. PEEBLES: This is Drew Peebles, the senior licensing manager. We're not prepared to discuss the final analysis that will be in the FSAR, only that we'll meet the Part 20 regulations.

MR. SCHULTZ: Okay. My comment is really a suggestion for activities in the future. Thank you.

MR. PEEBLES: Understood. Thank you for your comment.

MEMBER MARCH-LEUBA: Yeah. And while we're bringing the tritium issue, the analysis assumed that all of the tritium generated in one year gets released today with an accident, because now tritium will be released over the year. It will be slowly released.

MR. CLARK: So the Chapter 11 analysis looks at long-term effluent releases. It looks at the first year tritium generation rate because for the reactor life that is the highest generation rate for tritium. But it assumes a continuous release.

MEMBER MARCH-LEUBA: So it's a chronic dose.

MR. CLARK: Chronic dose.

MEMBER MARCH-LEUBA: Okay.

CHAIR PETTI: I had a different question. Probably the answer is you don't know yet. But have you looked at all into concentrations of tritium in the reactor cell and in the building, and what sort of worker protections may be necessary? Will they need bubble suits? You know, will you be above the DAC, the derived airborne concentration? Or you just don't -- you're not there yet in terms of the detailed design?

MR. CLARK: Yeah. That's another one that will be -- those details will be available in the OLA phase.

CHAIR PETTI: So if I ask the same question about beryllium in NIOSH standards, it's the same answer?

MR. CLARK: Correct.

CHAIR PETTI: Don't -- you know, it put high on your list. Those numbers are incredibly low, particularly the beryllium numbers. And I think you're going to have to monitor. There are technologies. That's good. But the numbers are really tight.

MEMBER MARCH-LEUBA: The unfortunate thing, it is very easy to capture tritium. Hydrogen reacts with everything at low temperatures, at 600 degrees.

CHAIR PETTI: I mean, that is -- I mean, tritium is going to be everywhere in this plant, because of the high temperature.

MEMBER MARCH-LEUBA: Yeah.

CHAIR PETTI: And, you know, go talk to the guys that are doing the TP baths and power reactors. That's a low temperature, and it's -- the tritium is in lots of places. So it's from a worker perspective. I'm not worried about public safety. This is all about workers, because we've never had a real high temperature tritium system like this. CANDUs are much lower temperature.

Thank you.

MR. CLARK: Thank you. Consistent with 10 CFR 20.1406, SSCs that may contain or handle radiological materials include design considerations to limit leakage and to provide contamination control in support of eventual decommissioning of the facility.

Environmental radiological monitoring will be conducted as required by 10 CFR 20.1302 and under an operational radiation affluent monitoring program, or RAMP, which will consider the guidance provided in Regulatory Guide 4.1, radiological environmental monitoring for nuclear powerplants, Rev 2, and NUREG 1301 offsite dose calculation manual guidance, standard radiological effluent controls for pressurized water reactors.

Due to the extensive environmental characterization of the brownfield site by the Department of Energy, the RAMP will be implemented coincident with the start of operation.

MEMBER HALNON: But along with the characterization, do you have I guess what's equivalent of the 70 -- 10 CFR 50.75(g) records of the site you are building on right now? In other words, when you look at 20.1406, I assume that's mainly geared towards just preventing spills. That may have to be cleaned up at a -- can't be totally cleaned up during operations, may have to be cleaned up during decommissioning. Is that consistent with your thinking?

MR. CLARK: This is another thing that we will have more details at the FSAR.

MEMBER HALNON: Okay. Well, you should know from the last statement that you say it's well characterized by the -- by the DOE. Do you have the records of what's left on the brownfield? Because, obviously, greenfield would be below, you know, a certain millirem into the soil, but if it's a brownfield, do you understand how that may affect your ultimate decommissioning?

MR. GARDNER: Okay. So this is Darryl

Gardner, senior director of licensing. All good questions. We have the site release from DOE. We have -- there's lots and lots of data about this site that's addressed as part of our environmental report.

As we mentioned, we will be discussing the environmental monitoring plan as we move into the OL stage, including decommissioning. That's just information we're not prepared to discuss for the PSAR.

MEMBER HALNON: All right. Thanks.

MR. LINGENFELTER: All right. Hi, everyone. I'm Andrew Lingenfelter, lead engineer of Engineering Integration. I will be talking today about Section 11.2, radioactive waste management.

But, first, we'll go through a description. Radioactive waste management systems are provided in the Hermes design for the collection, packaging, storing, and dispositioning of low level liquid and solid radioactive waste.

The systems' functions include decontamination capability for components and materials, vents and drains for collection of liquid rad waste, liquid rad waste handling, and solid rad waste handling.

These systems are not credited to perform any safety-related functions, and the design bases include the following. In accordance with PDC 2, they are designed so that seismic-induced failure does not impact the safety-related -- impact any safety-related SSCs. In accordance with PDC 60, the design is such that releases of radioactive material to the environment do not exceed the limits of 10 CFR 20.

In accordance with PDC 63, they are equipped with a radiation monitoring system to monitor effluent radiation levels. And in accordance with 10 CFR 20.1406, they are designed to the extent practicable to minimize contamination of the facility and the environment, and facilitate eventual decommissioning.

Additional system description information will be provided with the OLA.

We will talk about the program side here. The low level radioactive waste, including all solid and some liquid radioactive waste, is expected to be packaged and disposed using a licensed and qualified low level radioactive waste disposal vendor.

Gaseous radioactive effluents are filtered as practicable and monitored prior to release. Rad waste will be managed as described by the radioactive waste management plan, and we will be providing more details on this program in the OLA.

CHAIR PETTI: Members, questions?

MEMBER KIRCHNER: Just one point that you raised, Dave. This is Walt Kirchner. How does beryllium handling -- obviously, beryllium is regulated under OSHA in terms of occupational exposures and such. But you've got -- even if we don't -- you don't have a mixed waste stream of beryllium and their radioactive effluents, you've got to deal with beryllium detection, at least at an occupational level. What are the general constraints that beryllium introduces to your Chapter 11 considerations?

MR. CLARK: So as was pointed out, beryllium is handled under OSHA and under NIOSH. So as far as Chapter 11, there won't be much more specifically on beryllium handling and even in the operating license application. But it will be something that is addressed, because compliance with OSHA and NIOSH is required.

MEMBER KIRCHNER: No. I'm just thinking aloud with you. What complications does it present in terms of your -- does it become more dominant than your -- for example, your tritium management requirements?

MR. GARDNER: So this is Darryl Gardner again, director of licensing. Again, these are interesting questions. I think it's just important to point out you are talking about chemical hazards, which are not within the scope of what we need to address for the PSAR, and so we have not.

It's not to suggest that we aren't addressing those, as Austin mentioned that we are. I'm just not sure this is the forum for us to get into those details when the complete plant hasn't been designed yet.

MEMBER KIRCHNER: No. I understand that. Where I'm going with this is, does the beryllium management wind up being more of a constraint on things like your ventilation systems, et cetera, than the tritium or other concerns?

MR. GARDNER: That's a fair question. I'm not sure we -- I don't want to say prepared to answer. I'm not sure we have enough information to tell you which one would be which. But suffice it to say, I mean, it certainly is a factor in the ventilation and confinement design, the non-safety-related portion of the building design.

CHAIR PETTI: So the concern that I have, you know, this is fairly unique. There are rules on chemical hazards. There are rules on radiation hazards. But if all -- if there is beryllium particulate, which there will be because of the dendritic deposition of fluoride and cold spots like on pump stem or something, if MSRE is any indication. There could also be some tritium absorbed onto that material.

So the material could both be chemically hazardous and radioactive, and the rules don't even address that. That co-hazard if you will, you know

MEMBER KIRCHNER: But it's called a mixed waste.

CHAIR PETTI: Well, that's from a waste perspective. I'm talking about from an operational perspective. I have not thought that -- what does that mean? Does that imply anything? I don't know. So, because the rules never envisioned it coming together, right? There were different types of facilities, so each --

MEMBER MARCH-LEUBA: You are talking about worker protection.

MEMBER KIRCHNER: Worker protection.

CHAIR PETTI: Yeah. Worker protections.

MEMBER KIRCHNER: The extreme that I would just be concerned about -- and, again, this is more having dealt with beryllium in the past, you've got -- that was in the metal form, solid metal form.

So less of a hazard until you start machining, for example, then dealing with a liquid, but not -- never done in the context of also having to worry about radioactivity separate.

MEMBER MARCH-LEUBA: I'm not --

MEMBER KIRCHNER: What I'm concerned with is, does the beryllium -- for example, you don't have a confinement system per se for the reactor where the beryllium issues drive you to a more restrictive airflow in that cavity, et cetera, et cetera. Those are the kind of concerns I would have that -- when you have the two -- you have regulations concerning the beryllium, and then you have regulations concerning Chapter 11, 10 CFR 20 to be specific.

CHAIR PETTI: Well, the other --

MEMBER KIRCHNER: That was my question.

CHAIR PETTI: The other question, I mean, again, it's way outside our scope, but you need a good health physicist. And all the limits that we have, assume everything is independent, is the -- is the burden on the individual different when it's mixed? I don't know what the answer is to that. You know, is it a synergistic effect between a worker picking up some beryllium and some tritium?

MEMBER MARCH-LEUBA: Clearly, it can be because the absorption in the body is completely different depending on the chemical form. Hopefully, they won't be close to limits; they will be very far away from limits. All this is academic, but we need to know what you guys will have. I'm pointing at the staff. At the OL's stage, you have to make sure that that is the case. Wishful thinking is really not -- for other people, not for us.

CHAIR PETTI: Okay. Let's move on. Staff?

MS. HART: Good afternoon. My name is Michelle Hart. I'm a senior reactor engineer in the Office of Nuclear Reactor Regulation, and I'm here to talk about my review of PSAR Chapter 11. This is the radiation protection and radioactive waste management sections of the PSAR.

Next slide, please.

So in our review of Chapter 11, as I said, there was preliminary information on the design and programs. You just heard from Kairos the level of information, and there were commitments to develop more detailed information in the operating license application.

When we went through this review, there is a lot of discussion about how they will meet Part 20. They do not need to meet Part 20 for the construction permit, because there is no special nuclear material onsite. So we -- when we did the review, we looked at how they would be able to accomplish that in the future. Did they describe the systems and programs such that they would be able to do that during operation? And also, did they identify appropriate general design criteria?

Next slide, please.

So these are the topics in each of the sections. I won't go through them. You can read them for yourself.

Next slide, please.

Radioactive waste management for these particular topics. Okay?

So next slide, please.

So I wanted to talk a little bit more about radiation protection. We had questions about the PSAR information that we included in the general audit for this particular topic, radiation sources. The staff audit confirmed that Kairos did develop preliminary isotopic values for fuel and five radiation sources for use in preliminary shielding design to support the information that's in the PSAR.

As Kairos has discussed several times, and we have discussed several times, there will be more detailed information in the FSAR for the operating license application.

We also audited their conservative screening analysis of the gaseous tritium emissions that was described in Section 11.1.5, and we noted that it was a conservative assumption for the tritium release rate, was equal to the generation rate for the year. It does not account for retention in the reaction, as was your question.

The release rate for other gaseous radionuclides was taken from the Clinch River ESP environmental report as kind of a representative set of information that may be released from a reactor. We thought it was a reasonable assumption for a preliminary analysis considering the relative power levels and the design differences between the reactors.

They did not model a liquid effluent release directly to the environment, and it was not expected based on the preliminary design, and we agree with that. So --

CHAIR PETTI: Michelle, just a couple of questions. Do you happen to recall what the release rate was in curies per year?

MS. HART: I do not. I think --

CHAIR PETTI: Even an order of magnitude?

MS. HART: I didn't put it in the SE? I guess I didn't put it in the SE.

CHAIR PETTI: I wasn't sure if it's -- I can't believe that number would be proprietary, but

MS. HART: Yeah. It was over --

CHAIR PETTI: I mean, microcurie, millicurie, curie.

MS. HART: It was curies.

CHAIR PETTI: It was curies per --

MS. HART: I think so. Does Kairos have that information and would like to provide it?

MR. GARDNER: It is in the PSAR, in the non-proprietary version of the PSAR. I don't recall it at the moment, but it's in large curies.

CHAIR PETTI: Okay. Good. My other question is on the whole thing -- okay, the liquid effluents. I know there is no liquid waste as well. Somebody gets contaminated in the plant, and you've got to scram down. What do you do with that water?

It's now contaminated. I mean, is the plan to collect any water and solidify it? Is that the -- I mean, eventually, hopefully, you know, in a waterborne plant that would go, you know, off effluent treatment, et cetera, et cetera.

MS. HART: So they do describe collection of liquid wastes and packaging of that. I don't know that they've made a final determination --

CHAIR PETTI: But it may --

MS. HART: -- what they would --

CHAIR PETTI: -- solidify it. That would make -- that would make sense to me.

MS. HART: Correct.

MEMBER MARCH-LEUBA: Yeah. But the most source will be washing clothes. You will have overalls that are -- clothes that are contaminated, and you are not going to throw them all --

MEMBER HALNON: Right. I know that --

MEMBER MARCH-LEUBA: -- that is possible.

MEMBER HALNON: -- when we had to take water from TMI recently, we just dropped it off and disposed of it, big tanker truck. So, I mean, there's

MEMBER MARCH-LEUBA: Yeah. That's so not -- equal waste.

MEMBER HALNON: Part 61, yeah. There's options to be able to --

MS. HART: And of course they do commit to all of the waste regulations and shipping regulations and whatever is necessary for that.

In looking at their screening calculation, we did look at the actual output from the XOQ/DOQ modules, so we were able to verify their description of it that they have in the PSAR.

And we had several questions about the information in the PSAR, but we were able to have discussions with them about why they made those choices, like for the stack elevations. We did this in concert with the environmental review, so both the environmental reviewers and the safety reviewers looked at the information on the screening calculation, because it was used in both areas of review.

Next slide, please.

So for the remainder of topics in PSAR Section 11.1, radiation protection, we did not need additional information. In the audit, we did find that the PSAR describes the applicable regulatory requirements and guidance and provides preliminary information on the programs, practices, and design features, and that Kairos' commitments provide reasonable assurance that the Hermes design will comply with applicable requirements.

Next slide, please.

So now to move on to PSAR Section 11.2, the radioactive waste management. Staff did audit one topic area, the radioactive waste handling systems and controls. And this was, as I described before, just got done talking about we did look at the preliminary effluent calculation.

The PSAR describes the applicable regulatory requirements, preliminary design criteria and guidance, and provides preliminary design information on the systems that we have used for radioactive waste handling. And those PDCs are PDCs 2, 60, and 63. And we did find that Kairos' commitments provide reasonable assurance that the Hermes design will comply with the applicable requirements.

I did also want to note that in addition to the information in the PSAR we did take some information from the environmental report on fly storage to help us make this determination.

Next slide, please.

There should be one more slide. There we go.

So in total for Chapter 11, the staff did find that preliminary information and design criteria for these radiation protection and waste management programs and provisions meet the applicable acceptance criteria in the NUREG-1537, and the provide reasonable assurance the final design will conform to the design bases and meet the applicable regulatory requirements and provides an acceptable basis for the development of the radiation protection programs and radioactive waste management.

And there is reasonable assurance that Kairos will comply with the regulations in 10 CFR Part 20 during facility operation, and, therefore, the staff concludes the information in Chapter 11 is sufficient to support issuance of construction permit.

Are there any questions?

MEMBER HALNON: Yeah. Michelle, did you in looking at 1537 Part 2, and I -- I go back on this a lot, that it's an old, you know, 20-plus-year, 25 years old, did you see any areas that you were concerned about in the operating license of -- for the operating license, if it would not be adequate review criteria for you?

MS. HART: I --

MEMBER HALNON: I mean, this is a first-of-a-kind and type of reactor, and it wasn't anticipated back in 1997 when issued.

MS. HART: Right. So we have heard the concerns, and we have some similar concerns about, you know, the treatment of tritium and how it's going to be handled and how worker protection will be handled for that. I mean, I think a lot of it is to be determined when we get the actual final design detail.

MEMBER HALNON: Okay. So keep your eyes open, keep your ears --

MS. HART: Yeah.

MEMBER HALNON: -- open type of thing.

MS. HART: Yeah. I'm very interested in the analysis and all of that.

MEMBER HALNON: So this will be strict -- it's not on 1537.

MS. HART: No. I was not planning to do that, assuming I would be --

MEMBER HALNON: Okay.

MS. HART: -- the reviewer.

CHAIR PETTI: So just something -- I did find the number. It's 62,500 curies per year.

MS. HART: It's several curies.

CHAIR PETTI: That's 6.2 grams per year

being released, so it is a significant number. It would be interesting to know what the CANDUs release. I used to know these numbers, but I've forgotten them.

The other question I had was I had asked the staff for an answer to a question, reminding me of one in the previous meeting. I'm used to, you know, in other reactor systems that deal with tritium, it comes through the heat exchanger. There's a secondary side, sometimes water, and there's a leak. And that tritium and that water has to meet the drinking water standard.

You know, in the DOE facilities they are doing interesting things with tritium. There is a water pathway. There is also an airborne pathway, but most of the issues are the waterborne pathway.

When you do it all like this and put it all airborne, does the fact that it could end up in the -- in the drinking water, is that considered in the whole chain of calculations?

MS. HART: So I will say, you know, the guidance that we have -- of course, it was for power reactors. It's Reg Guide 1.109 that talks about how you do these effluent calculations. It does consider airborne effluents separately from waterborne effluent.

And there is not right now -- I'm not aware of any capability in the codes to actually do that conversion from the airborne into the water and then transport it further. We don't have a direct regulatory requirement that they meet the drinking water standard, like --

CHAIR PETTI: Because they don't --

MS. HART: -- 10 CFR Part 20 --

CHAIR PETTI: -- have a liquid pathway, right?

MS. HART: Right.

CHAIR PETTI: Basically.

MS. HART: And Part 20 doesn't refer directly to the drinking water standards. Of course, any applicant is required to comply with any applicable regulation that applies to them, whether it's NRC or not.

MEMBER MARCH-LEUBA: Yeah. My guess, whatever gets into the air, it will be -- in chemical form will be HDO?

CHAIR PETTI: HTO, yeah. And eventually it gets --

MEMBER MARCH-LEUBA: HDO?

CHAIR PETTI: -- it will get into --

MEMBER MARCH-LEUBA: I mean, will most

likely be absorbed by the gas around the plant.

CHAIR PETTI: Correct. Correct.

MEMBER MARCH-LEUBA: And, I mean, soil

CHAIR PETTI: So the fusion program was very, very worried about this back in the -- before I was involved with the program -- '80s. They did experiments to look at dispersion, and they had codes, really complicated dose codes, that modeled all pathways.

It was really quite sophisticated, because of the public sensitivity of tritium, which as we know is -- is well in excess of the regulations I guess is a fair way to put it.

MS. HART: So Part 20 does have an environmental release level that is related to the ALARA requirement in, what is it, 10 CFR 11.01(d). And so there are those in the Appendix B to Part 20. There are concentration criteria, and that's at the release point.

It would -- if you took in that amount of tritium for the entire year, there is both an air and a water concentration. That would result in 50 millirem.

CHAIR PETTI: Okay. So that's still pretty reasonable.

MS. HART: Yeah. And then there's an additional constraint in 20.11.01(e) that would require them from all pathways, all sources, to be less than 10 millirem per year in their design. So if they used that ALARA constraint to help them with their design, it would reduce that even further.

MEMBER MARCH-LEUBA: I don't think the problem is safety of the public, but somebody is going to start sampling the Clinch River water a mile downstream. And if you start being able to detect it

CHAIR PETTI: Look what's going on at this plant in Minnesota.

MEMBER MARCH-LEUBA: Yeah.

CHAIR PETTI: Right? I mean, Brookhaven. It shut down that reactor for numbers way, way below drinking water standards. It's just -- you know, it's a disproportionate --

MEMBER MARCH-LEUBA: The Clinch River, by that location, is a big fault. And if you dilute two grams in a year, you are going to see it. But you may be able to detect it, so that's --

CHAIR PETTI: Okay.

MEMBER MARCH-LEUBA: Kairos, do be careful and don't -- don't leak as much as you -- as you are assuming in your --

CHAIR PETTI: I mean, the problem is, you know, in a high temperature system, once it goes past that heat exchange, it's gone. Even if you had a second basis --

MEMBER MARCH-LEUBA: I'm more worried about, if the plant is going to be in the old K25 enrichment facility, and when you walk into K25, you have to wear suits everywhere or you are picking up tech-99 everywhere you touch.

I'm wonder if, Kairos, you have to wear the same thing because you're picking tritium from every place you touch.

MEMBER HALNON: When you talk to tritium in groundwater versus drinking water, there is a -- there is a huge difference. So be careful. Drinking water well at 20,000 I guess picocuries, that's huge. But you'll hear values coming out of these plants of 30, 40, 50,0000. That's groundwater. That's not drinking water. So you've got to be careful on doing that. The deposition of tritium HDO, whatever, in the ground, you would have to have unbelievable amount to affect the drinking water.

MEMBER MARCH-LEUBA: There are no wells out there. There's so much surface water that you don't need to pick --

MEMBER HALNON: The surface water is not drinking water. So, anyway, I just wanted to make that distinction. It's a real --

MEMBER MARCH-LEUBA: It's not a safety issue.

MEMBER HALNON: No. But it is definitely a public relations issue.

MEMBER MARCH-LEUBA: Yes.

MEMBER HALNON: Which we are finding now at the operating reactors.

MS. HART: Any questions?

MR. SCHULTZ: Michelle, this is -- this is Steve Schultz.

MS. HART: Yes.

MR. SCHULTZ: You mentioned in the audit you reviewed the dose calculations at the side boundary, specifically for tritium. Did -- what did that entail in terms of your review? You didn't do any -- any qualifying calculations yourself. They were using some NRC-related codes.

So you reviewed input, output. Is that the extent of the -- of the review?

MS. HART: Yes. We did not do any kind of scoping or confirmatory calculations. They did use the NRC dose 3 code, GASPAR, and XOQ/DOQ. We did see the output file from that run that they did. And so and we were able to ask them questions about it as well.

MR. SCHULTZ: Okay. Thank you.

CHAIR PETTI: Okay. If there are no more questions, let's bring the memo up.

(Whereupon, the above-entitled matter went off the record at 2:22 p.m. and resumed at 2:23 p.m.)

CHAIR PETTI: So we are back on the record for public comment. Anyone has a comment from the public, please state your name and your comment.

Okay. Not hearing any, now we're off the record. Thank you.

(Whereupon, the above-entitled matter went off the record at 2:23 p.m.)

Enclosure 1
Presentation Slides for the April 4, 2023
ACRS Kairos Power Subcommittee Meeting
(Non-Proprietary)

Hermes PSAR Chapter 5 Heat Transport System

NICOLAS ZWEIBAUM – DIRECTOR, SALT SYSTEMS DESIGN

ACRS KAIROS POWER SUBCOMMITTEE MEETING

APRIL 4, 2023

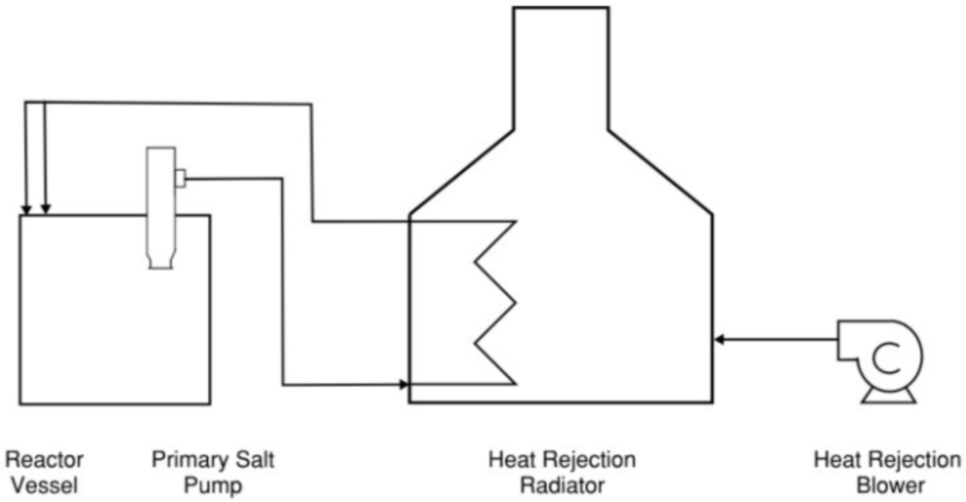
5.1 Primary Heat Transport System: Description

- The PHTS is responsible for transporting heat from the reactor to the ultimate heat sink (environmental air) during power operation and during normal shutdown
- The PHTS operates near atmospheric pressure and does not provide a safety-related heat removal function
    - No driving force for energetic releases during a pipe break
- The PHTS is a non-safety-related system

Parameter	Value
Thermal duty	35 MWth
Number of HRRs	1
Number of hot legs	1
Number of cold legs	2
Primary loop line size	8-12 in nominal pipe size
HRR inlet coolant temperature	600-650°C
HRR outlet coolant temperature	550°C
Nominal flow rate	210 kg/s
PHTS design pressure	525 kPa(g)

5.1 Primary Heat Transport System: Description (cont.)

- Primary Loop Piping
  - Transports reactor coolant between Reactor Vessel and Heat Rejection Radiator
  - Not a safety-related portion of the reactor coolant boundary
- Primary Salt Pump (PSP)
  - Variable speed, cartridge style pump located on the Reactor Vessel head
  - Inlet extends downwards through the Reactor Coolant free surface
  - Hot leg anti-siphon function performed by geometric features of the PSP's downward-facing inlet
  - No safety-related function for the PSP but safety-related trip to maintain Reactor Coolant inventory level
- Heat Rejection Subsystem (HRS)
  - Provides for heat transfer from the Reactor Coolant to the ultimate heat sink (environmental air)
  - Consists of a Heat Rejection Radiator, Heat Rejection Blower, and associated ducting and thermal management
  - No safety-related function for the HRS but safety-related blower trip upon tube failure minimizes forced air ingress
- Primary Loop Thermal Management
  - Provides non-nuclear heating and insulation to the PHTS as needed for various operations
  - No safety-related function



5.1 Primary Heat Transport System: Reactor Coolant

- Flibe ($2LiF-BeF_2$) – Liquid Fluoride Salt Coolant
- Negative temperature coefficient of reactivity
- Secondary barrier to fission product release
- Thermophysical properties
  - Topical report approved by NRC, "Reactor Coolant for the Kairos Power Fluoride Salt-Cooled High Temperature Reactor" (KP-TR-005)
  - High heat capacity provides large thermal inertia for transients

5.1 Primary Heat Transport System: Design Basis

- The PHTS SSCs that are a part of the reactor coolant boundary will be designed to ASME B31.3 and BPVC Section VIII codes and standards
- Failure of the non-safety-related PHTS components during seismic events does not affect the performance of nearby safety-related SSCs (PDC 2)
- Adequate coolant flow is maintained to assure SARRDLs will not be exceeded under any condition of normal operation (PDC 10)
- The PHTS is designed with features that ensure power oscillations cannot result in conditions exceeding SARRDLs (PDC 12)
- The reactor coolant provides control of the release of radioactive materials during normal operations and postulated events through the accumulation of radionuclides (PDCs 16, 60)
- The PSP casing is designed with geometric features to prevent reactor coolant from being siphoned below the pump casing inlet elevation to maintain reactor coolant inventory in the event of a break in an external portion of the PHTS (PDC 33)
- The PHTS is designed with features that support maintaining reactor coolant inventory and maintaining reactor coolant purity by limiting air ingress (PDCs 33, 70)
- The PHTS will be designed according to 10 CFR 20.1406, to the extent practicable, to minimize contamination and support eventual decommissioning

Hermes PSAR Chapter 7 Instrumentation and Controls Systems

ANTHONIE CILLIERS – DIRECTOR, I&C AND ELECTRICAL

ACRS KAIROS POWER SUBCOMMITTEE MEETING

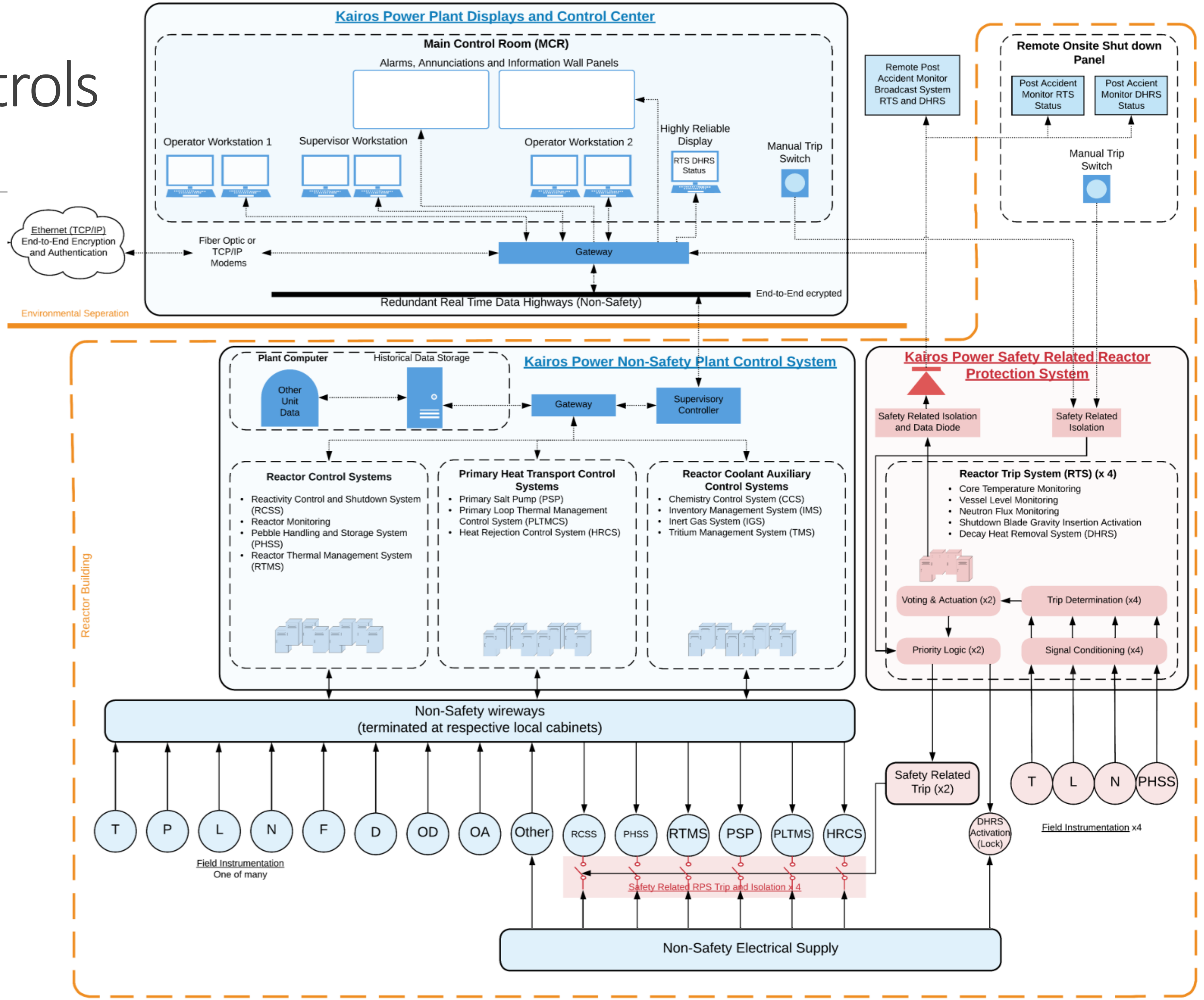
APRIL 4, 2023

7.1 Instrumentation & Controls Systems: Overview

The Instrumentation and Controls (I&C) Systems include:

- The Reactor Protection System (RPS) is a safety-related system that provides protection for reactor operations by initiating signals to mitigate the consequences of postulated events and ensure safe shutdown.
- The Plant Control System (PCS) is a non-safety related system responsible for controlling plant parameters during normal operations and providing data to the Main Control Room control consoles.
- The Main Control Room (MCR) provides a means for operators to monitor the behavior of the plant and control performance of the plant. The Remote Onsite Shutdown Panel (ROSP) provides a separate means to shut down the plant and to monitor plant parameters in response to postulated event conditions.
- Sensors are used to provide information about plant parameters as inputs to the PCS and RPS. Sensors that provide input to the RPS are safety-related. The PCS receives inputs from non-safety-related sensors, as well as safety-related sensors through safety-related isolation device.

Instrumentation & Controls Systems Architecture



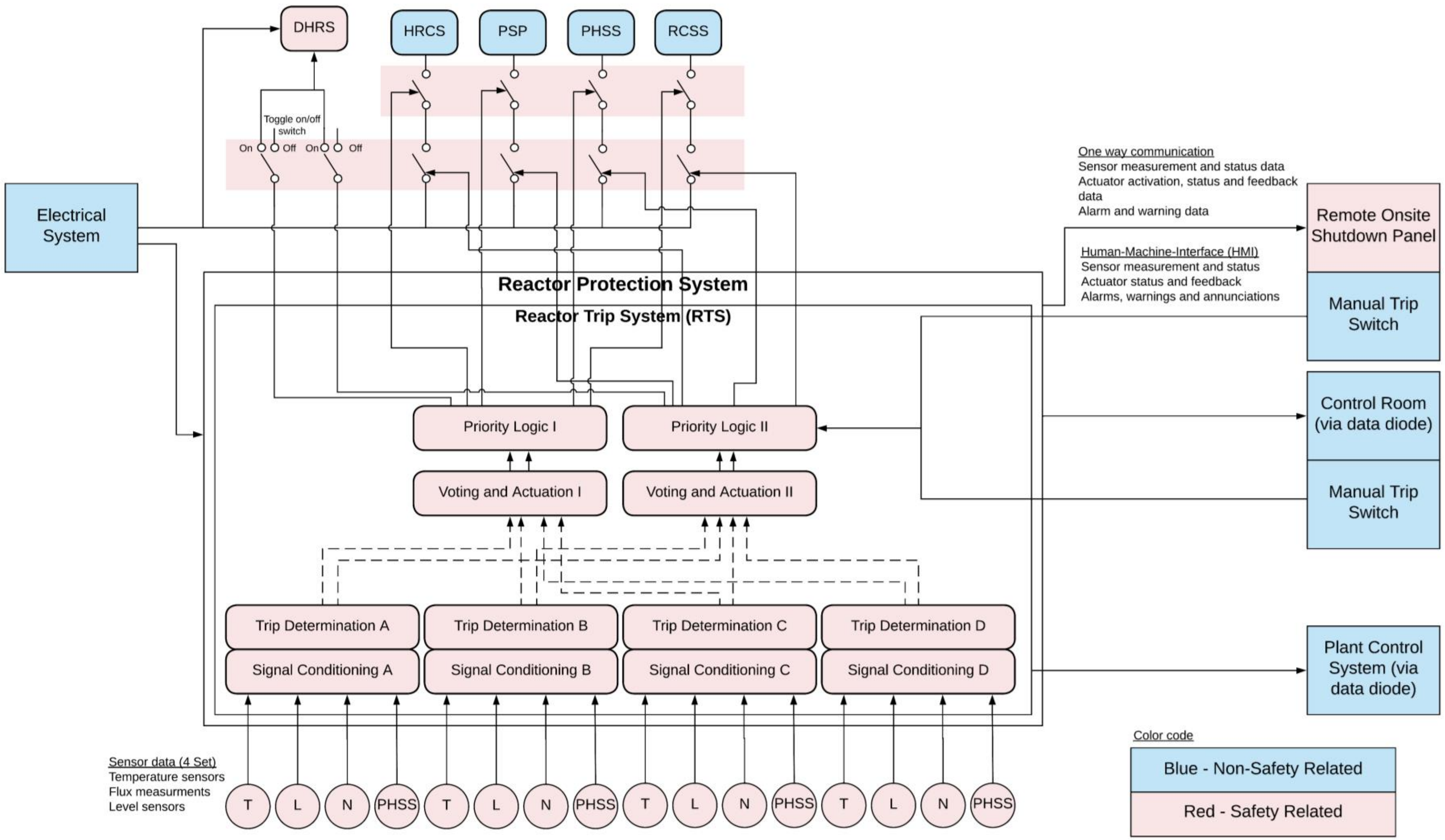
7.2 Plant Control System

- The PCS implements its monitoring and control functions through a series of subsystems:
  - The Reactor Control System performs functions associated with reactivity control and power level adjustments, monitoring of core neutronics, pebble handling and storage, and monitoring and controlling temperature in the reactor.
  - The Reactor Coolant Auxiliary Control System performs functions associated with chemistry control, inventory management system control, inert gas system control, and tritium management system monitoring and control.
  - The Primary Heat Transport Control System performs functions associated with control of the flow rate through the Primary Heat Transport System (PHTS), PHTS thermal management, control of the heat rejection system, and primary loop draining, filling, and piping monitoring.
- The PCS receives inputs from non-safety-related sensor inputs, as well as safety-related sensor inputs. The PCS is electronically and functionally isolated from the safety-related RPS using a safety-related isolation device.
- The PCS generates control outputs based on sensor inputs and setpoints provided by the control system. The setpoints are adjusted automatically based on plant operating mode, or in some cases by operators via the main control room consoles. Plant Operators do not directly control PCS outputs.

7.3 Reactor Protection System

- The RPS is the safety-related system credited with tripping the reactor and initiating protective functions upon receipt of signals in response to out-of-normal plant conditions. There are three possible sources that can cause the RPS to actuate:
  - Process variables reach or exceed specified setpoints as measured by safety-related RPS sensors that monitor core temperature, reactor coolant level, neutron flux, and the condition of the PHSS extraction line
  - Manual initiation from the main control room or remote onsite shutdown panel
  - Loss of plant electrical power (with a time delay)
- Three protective functions result from RPS actuation:
  - Actuate the RCSS to insert control and shutdown elements into the reactor core
  - Inhibit actions from the PCS so that it does not interfere with the functioning of the RPS, including RCSS element withdrawal, stopping the primary salt pump and heat rejection blower, stopping the pebble handling and storage system, and preventing the actuation of the reactor thermal management system
  - Ensure the actuation of the Decay Heat Removal System
- The RPS is built on a logic-based platform that utilizes discrete components and field programmable gate array technology
- The RPS is isolated from non-safety related I&C Systems using safety-related isolation hardware

Reactor Protection System Trip Logic Schematic



7.4 Main Control Room and Remote Onsite Shutdown Panel

- The MCR contains equipment related to normal operation of the plant including:
  - Operator and supervisor workstation terminals, which provide alarm, annunciation, personnel and equipment interlocks, and process information from the PCS and RPS
  - A manual trip switch that propagates through a gateway and safety-related isolation to allow operators to initiate a plant trip
  - Central alarm panel for the fire protection system to monitor status of fire protection equipment in the Reactor Building and controlling the ventilation and extinguishing systems related for fire response
- The Remote Onsite Shutdown Panel (ROSP) provides a human/system interface for plant staff to monitor indications from the RPS including the operating status of the reactor trip system and the decay heat removal system in the event the MCR becomes inaccessible or uninhabitable. The ROSP features one-way (read only) communication with the RPS and the ability to initiate a manual trip signal that actuates the RPS.

Instrumentation and Controls Systems: Design Basis

- The RPS and safety-related sensors are designed using relevant industry codes and standards such as IEEE 603-2018 and the quality assurance program (PDC 1)
- The RPS and safety-related sensors are designed to withstand and be able to perform their safety-related functions during adverse natural phenomena (PDC 2)
- The RPS and safety-related sensors are designed and located to minimize the probability and effects of fires and explosions (PDC 3)
- The RPS is designed for the environmental conditions associated with normal operation, maintenance, testing and postulated events (PDC 4)
- The RPS provides reactor trip and decay heat removal actuations that ensure radionuclide release design limits are not exceeded during normal operations, as a result of postulated events, and upon reactor trip actuation, including in the event of a single failure of the reactivity control system (PDCs 10, 20, 25)
- The RPS, PCS, and safety-related sensors are designed to monitor plant parameters over the anticipated ranges of normal operation and postulated event conditions (PDC 13)
- The design of the MCR (1) allows actions to be taken to operate the reactor under normal operating and postulated event conditions, (2) provides radiation protection allowing access and occupancy during postulated event conditions without personnel receiving radiation exposures in excess of 5 rem TEDE for the duration of the event, and (3) maintains habitability, allowing access and occupancy during normal operations and postulated event conditions. The ROSP is located outside of the MCR and (1) provides the capability to promptly shutdown the reactor and monitor the unit during shutdown and (2) provides capability for subsequent safe shutdown of the reactor through use of suitable procedures (PDC 19)

Instrumentation and Controls Systems: Design Basis

- The RPS and safety-related sensors are designed with sufficient redundancy and independence to assure no single failure results in a loss of protection function (PDC 21)
- The results of natural phenomena, and of normal operating, maintenance, testing, and postulated event conditions do not result in loss of protection function of the RPS or safety-related sensors (PDC 22)
- The RPS fails to a safe state upon loss of electrical power or detection of adverse environmental conditions (PDC 23)
- The RPS and safety-related sensors are functionally independent from the non-safety related control systems (PDC 24)
- The RPS setpoints are designed to limit the potential amount and rate of reactivity to ensure sufficient protection from postulated events involving reactivity transients (PDC 28)
- RPS and safety-related sensors are designed to be redundant to assure there is a high probability of accomplishing the safety-related functions of the RPS in postulated events (PDC 29)

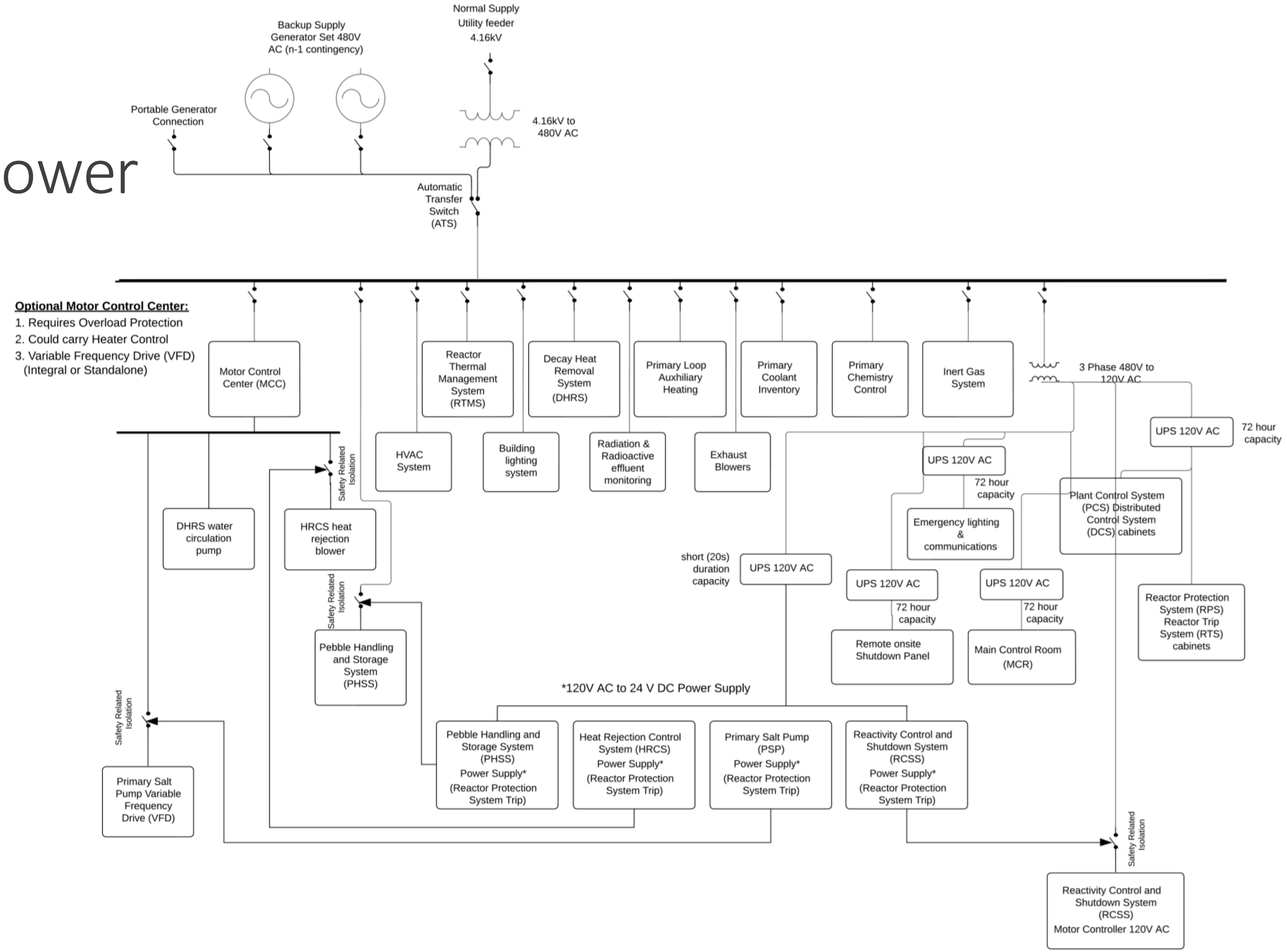
Hermes PSAR 8 Electrical Design

ANTHONIE CILLIERS – DIRECTOR, I&C

ACRS KAIROS POWER SUBCOMMITTEE MEETING

APRIL 4, 2023

8.1 Electrical Power System



8.2 Normal Power System

- The normal power system does not perform any safety-related functions and is not credited for the mitigation of postulated events
- AC power is distributed to the plant electrical loads during startup and shutdown, normal operation, and off-normal conditions
- DC power supply is limited to I&C functions that require 24VDC for operations
- The passive design features do not rely on electrical power for safety-related SSCs to perform their safety functions during postulated events (PDCs 17, 18)
- The normal power system is designed so that differential displacements do not preclude a safety-related SSC from performing its safety function (PDC 2)
- The normal power system is designed in accordance with National Fire Protection Association (NFPA) 70, “National Electrical Code”

8.3 Backup Power System

- The backup power system (BPS) does not perform any safety-related functions and is not credited for the mitigation of postulated events
- The BPS provides AC electrical power to essential loads when normal power is not available
- The BPS includes:
  - Backup generators
    - Automatically start in the event of offsite power
    - One redundant generator by design
  - Uninterruptible power supplies (UPS)
    - Highly reliable and continuous AC electrical supply
  - Electrical equipment to connect the backup generators to the low voltage AC electrical power distribution
  - Plug-in connection for a portable 480 VAC generator

8.3 Backup Power System: Design Basis

- To ensure fail-to-safety in the event of a complete loss of AC electrical power, the reactivity control and shutdown system (RCSS) and the primary salt pump (PSP) relays require 24 VDC to remain closed
  - On a loss of power, the RCSS relay opens, and the shutdown elements drop into the reactor by gravity
  - On a loss of power, the PSP relays open to prevent inadvertent pump and blower restart on power restoration
- On activation of the decay heat removal system, the reactor protection system will remove 24 VDC from the activation circuit relay to prevent inadvertent shut down of the DHRS by operator error
- Equipment for monitoring reactor status will be supplied by UPS until the normal power supply or backup generators are restored
- The passive design features do not rely on electrical power for safety-related SSCs to perform their safety functions during postulated events (PDCs 17, 18)
- The BPS is designed so that differential displacements do not preclude a safety-related SSC from performing its safety function (PDC 2)
- The BPS is designed in accordance with National Fire Protection Association (NFPA) 70, "National Electrical Code"

Hermes PSAR 11 Radiation Protection and Waste Management

AUSTIN CLARK - ENGINEER III, LICENSING

ANDREW LINGENFELTER - LEAD ENGINEER, ENGINEERING INTEGRATION

ACRS KAIROS POWER SUBCOMMITTEE MEETING

APRIL 4, 2023

11 Radiation Protection and Waste Management

- This chapter defines the elements of the radiation protection program and the radioactive waste management program and systems
  - Radiation Protection
    - Includes identification of radiation sources, description of radiation protection program, description of ALARA program, radiation monitoring and surveying, radiation exposure control and dosimetry, contamination control, and environmental monitoring program
  - Radioactive Waste Management
    - Includes a description of the radioactive waste management program, and a description of radioactive waste handling systems and controls, design bases, and disposal of radioactive waste
- For the PSAR, these programs are described at the commitment level. The PSAR commits to provide additional details at the operating license application stage, consistent with 10 CFR 50.34(b).

11.1 Radiation Protection

- Radiation Sources
  - Sources of radiation that present a potential hazard to workers and the public include fission products, decay products, fuel, and neutron activation products, including tritium
- Radiation Protection Program
  - The radiation protection program implemented for Hermes will comply with the regulatory requirements in 10 CFR 19 and 10 CFR 20, and will be developed, documented, and implemented commensurate with the scope and extent of licensed activities for a test reactor facility
  - Program content and implementation will be reviewed periodically
- ALARA Program
  - A program to ensure occupational doses and doses to members of the public are as low as is reasonably achievable will be implemented as required by 10 CFR 20.1101
  - The ALARA program will be consistent with the guidance in Regulatory Guide 8.10 and the program description will be provided with the application for the operating license
- Radiation Monitoring and Surveying
  - Conducted as required by 10 CFR 20 to detect releases of radioactive material from facility equipment and operations
  - Operational environmental monitoring is controlled by a radiological environmental monitoring program (REMP)

11.1 Radiation Protection

- Radiation Exposure Control and Dosimetry
  - Facility effluents are monitored for radioactivity during normal operations and postulated events
  - Structures, systems, and components are designed to limit uncontrolled liquid or gaseous effluent releases to work areas or the environment
  - A screening analysis of radioactive emissions from the facility employed:
    - the NRC's XOQDOQ and GASPAR II codes for dispersion and dose model calculations respectively
    - site-specific, validated meteorological data covering a 5-year period of record
    - a bounding tritium emissions rate set equal to the first-year tritium generation rate
  - Total body effective dose equivalents from gaseous effluents were calculated for the plant site boundary, the location of the maximally exposed individual (MEI) in an unrestricted area, and an analytical nearest resident
    - All modeled doses are below the limits specified in 10 CFR 20

11.1 Radiation Protection

- Contamination Control
  - SSCs with the potential to contain/handle radiological materials include design considerations to limit leakage and control the spread of contamination and to facilitate eventual decommissioning consistent with the requirements in with 10 CFR 20.1406
- Environmental Monitoring
  - Radiation monitoring and surveys of radiation levels in unrestricted areas and radioactive materials in effluents will be conducted as required by 10 CFR 20.1302
  - An operational radiation effluent monitoring program (REMP) will be implemented considering the guidance in RG 4.1, Rev 2 and NUREG-1301
  - A description of the program will be provided with the application for an operating license
  - The REMP will be implemented coincident with start of operation
    - The existing site is already well characterized by Department of Energy to establish a baseline prior to Hermes operation

11.2 Radioactive Waste Management - Description

- Radioactive waste management systems (RWMSs) are provided in the Hermes design for the collection, packaging, storing, and dispositioning of low-level liquid and solid radioactive waste (LLRW)
- RWMSs functions include:
  - Decontamination capability for components and materials
  - Vents and drains for the collection of liquid radioactive wastes
  - Liquid radioactive waste handling
  - Solid radioactive waste handling

11.2 Radioactive Waste Management – Design Bases

- The RWMSs are not credited to perform any safety-related functions
- The design bases for the RWMSs include:
  - The RWMSs are designed so that seismic-induced failure does not impact the safety related SSCs (PDC 2)
  - The RWMSs are designed such that releases of radioactive materials to the environment do not exceed the limits of 10 CFR 20 (PDC 60)
  - The RWMSs are equipped with a radiation monitoring system to monitor effluent radiation levels (PDC 63)
  - The RWMSs are designed, to the extent practicable, to minimize contamination of the facility and the environment and facilitate eventual decommissioning consistent with 10 CFR 20.1406
- Additional system description information will be provided with the application for an Operating License, consistent with 10 CFR 50.34(b)

11.2 Radioactive Waste Management - Program

- Low-level radioactive waste (including all solid and some liquid radioactive waste) is expected to be packaged and disposed using a licensed and qualified LLRW disposal vendor
- Gaseous radioactive effluents are filtered as practicable and monitored prior to release
- Radioactive waste will be managed as prescribed by the radioactive waste management plan
- Additional description of the radioactive waste management program will be provided with the application for an Operating License, consistent with 10 CFR 50.34(b)

NRC Staff Review for PSAR Chapters 5, 7, 8, and 11

Briefing for the Advisory Committee on Reactor Safeguards

April 4, 2023

Office of Nuclear Reactor Regulation

Agenda

- PSAR Chapter 5, “Primary Heat Transport System”
- PSAR Chapter 7, “Instrumentation and Control Systems” (I&C)
- PSAR Chapter 8, “Electrical Power Systems”
- PSAR Chapter 11, “Radiation Protection and Radioactive Waste Management”
- Common Agenda for Each Chapter
  - Overview of PSAR Chapter and Principal Design Criteria (PDC)
  - Referenced topical reports (if applicable)
  - Staff technical evaluation
  - Findings and Conclusions

Common Regulatory Basis

- 10 CFR 50.34(a), “Preliminary safety analysis report.”
- 10 CFR 50.35, “Issuance of construction permits.”
- 10 CFR 50.40, “Common standards.”

- **Guidance:** NUREG-1537, “Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors,” Part 2, “Standard Review Plan and Acceptance Criteria.”

NRC Staff Review for PSAR Chapter 5 Primary Heat Transport System

Briefing for the Advisory Committee on Reactor Safeguards

April 4, 2023

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

PSAR Chapter 5 Primary Heat Transport System (PHTS) Overview

- Non-safety related system
- Includes primary salt pump, heat rejection subsystem, and associated piping
  - Circulates reactor coolant through the core and the heat rejection subsystem
- Transports heat from reactor core to ultimate heat sink
- Manages thermal changes and provides normal residual heat removal
- Provides for in-service inspection, maintenance, and replacement activities

Chapter 5 Principal Design Criteria

- PDC 2 – “Design bases for protection against natural phenomena”
- PDC 10 – “Reactor design”
- PDC 12 – “Suppression of reactor power oscillations”
- PDC 16 – “Containment design”
- PDC 33 – “Reactor coolant inventory maintenance”
- PDC 60 – “Control of releases of radioactive materials to the environment”
- PDC 70 – “Reactor coolant purity control”

Referenced Topical Reports

- KP-TR-003-NP-A, Revision 1, “Principal Design Criteria for the Kairos Power Fluoride Salt-Cooled, High Temperature Reactor”
- KP-TR-005-NP-A, Revision 1, “Reactor Coolant for the Kairos Power Fluoride-Salt Cooled High Temperature Reactor”
- KP-TR-012-NP-A, Revision 1, “Mechanistic Source Term Methodology for the Kairos Power Fluoride Salt-Cooled High-Temperature Reactor”
- KP-TR-013-NP, Revision 4, “Metallic Materials Qualification for the Kairos Power Fluoride Salt-Cooled High-Temperature Reactor,”
- KP-TR-014-NP, Revision 4, “Graphite Material Qualification for the Kairos Power Fluoride Salt-Cooled High-Temperature Reactor”

Staff Evaluation – PDC 2

PDC 2, "Design bases for protection against natural phenomena"

- PHTS piping and supports are designed in accordance with ASME B31.3.
- The primary heat exchanger is designed in accordance with ASME Boiler and Pressure Vessel Code (BPVC) Section VIII standards.
- The design of the non safety-related PHTS SSCs is such that a failure of PHTS SSCs would not affect the performance of safety-related SSCs due to a design basis earthquake.

The staff finds the preliminary design of the PHTS is consistent with PDC 2.

Staff Evaluation – PDC 10

- PDC 10 requires the core be designed to ensure specified acceptable system radionuclide release design limits (SARRDLs) are not exceeded
- The NRC staff finds the preliminary information on the PHTS design is consistent with PDC 10
  - Coolant composition and properties of Flibe in KP-TR-005-NP-A
  - Chemistry control system can maintain composition
  - Proposed technical specification to maintain reactor coolant within allowable limits to maintain Flibe properties
  - Reactor coolant is resistant to thermal hydraulic instabilities
  - Sections 4.3 and 4.6 of staff SE evaluate thermal hydraulics
  - Section 6.3 of staff SE evaluates heat removal when the normal PHTS heat removal path is unavailable

Staff Evaluation – PDC 12

- PDC 12 requires the core be designed to ensure power oscillations that result in conditions exceeding SARRDLs are not possible or can be reliably detected and suppressed

- The NRC staff finds the preliminary information on the PHTS design is consistent with PDC 12
  - PHTS can limit and suppress inlet temperature and mass flow rate oscillations, limit entrained gas in the coolant, and maintain coolant specifications
  - Reactor coolant is resistant to thermal hydraulic instabilities
  - Section 4.5 of staff SE evaluates nuclear design
  - Chapter 7 of staff SE evaluates instrumentation and controls

Staff Evaluation – PDCs 16 and 60

- PDC definitions
  - PDC 16 requires a functional containment to control the release of radioactivity to the environment
  - PDC 60 requires the plant design to control the release of radioactive materials, including during postulated events
- PSAR Section 5.1.3 describes the ability of Flibe to retain fission products that may escape the fuel
  - Flibe credited in safety analyses as a radionuclide barrier
- The NRC staff finds that the preliminary information is consistent with PDCs 16 and 60 because:
  - Flibe's ability to retain radionuclides as evaluated in KP-TR-012-NP-A, Revision 1
  - A proposed TS Limiting Condition for Operation to limit circulating activity, which supports the assumptions in KP-TR-012-NP-A, Revision 1

Staff Evaluation – PDC 33

PDC 33 – “Reactor coolant inventory maintenance”

- Anti-siphon features to limit loss of reactor coolant if there is a break in the PHTS cold leg.
- Reactor coolant inventory is maintained by anti-siphon design features on the hot and cold legs.
- The design’s ability to remove residual heat following a failure in the PHTS is consistent with the guidance given in NUREG-1537.
- The staff finds that the preliminary information of the PHTS design is consistent with PDC 33.

Staff Evaluation – PDC 70

- PDC 70 requires systems to maintain reactor coolant purity including chemical attack, fouling/plugging, radionuclide concentrations, and air/moisture ingress
- PSAR Section 5.1.3 and RAI responses describe how the PHTS is designed to withstand and/or mitigate fouling, air ingress, chemical attack, and manage radionuclide concentrations
- The NRC staff finds the preliminary information is consistent with PDC 70 because
  - Coolant purity control and temperature monitoring to detect fouling or plugging of passages
  - Ability of Flibe to retain radionuclides, circulating activity limits, and ability to remove radionuclides from Flibe
  - Material qualification topical reports assess chemical attack in Flibe and the chemistry control system (CCS) can purify the coolant as well
  - PHTS designed to limit forced air ingress, remain within bounds of qualification testing for air ingress, and availability of compensatory measures

U.S.NRC
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Protecting People and the Environment

Testing and Inspection

- PSAR states design of PHTS allows for inspection, maintenance, and replacement activities

- PSAR states any testing and inspection of PHTS will be submitted with the OL application
  - Staff will review these programs at that time

Technical Findings and Regulatory Conclusion

- NRC staff finds the preliminary design information is consistent with the applicable criteria in NUREG-1537 and the applicable PDC

- The staff concludes information in Hermes PSAR Section 5 is sufficient for the issuance of a CP in accordance with 10 CFR 50.35 and 50.40 and further information can be reasonably left for the OL application

Questions?

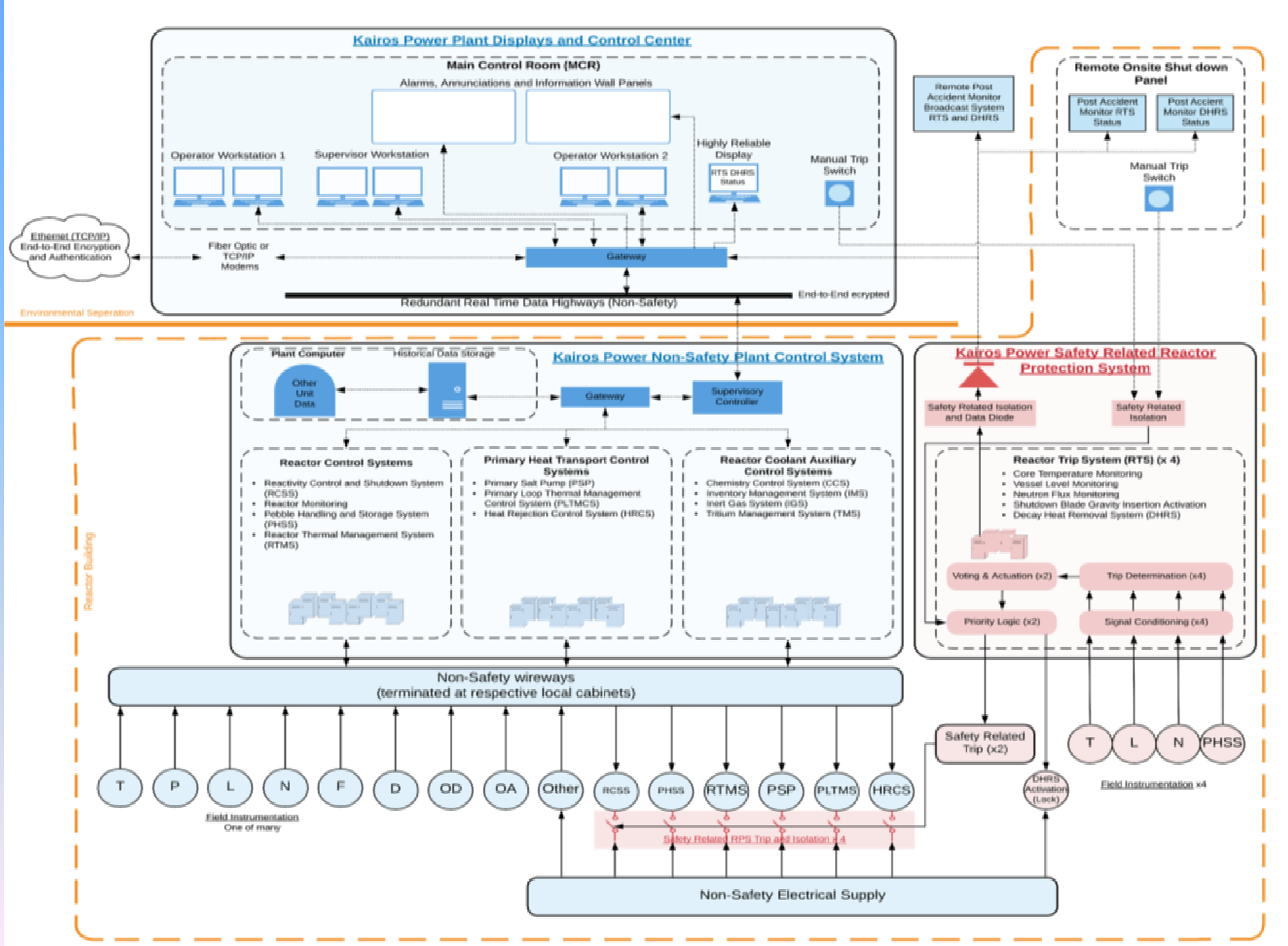
NRC Staff Review for PSAR Chapter 7 Instrumentation and Control Systems

Briefing for the Advisory Committee on Reactor Safeguards

April 4, 2023

By the Division of Engineering and External Hazards,
Office of Nuclear Reactor Regulation

PSAR Chapter 7, I&C Architecture



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Chapter 7 Principal Design Criteria

- PDC 1 – “Quality standards and records”
- PDC 2 – “Design bases for protection against natural phenomena”
- PDC 3 – “Fire Protection”
- PDC 4 – “Environmental and dynamic effects design bases”
- PDC 10 – “Reactor design”
- PDC 13 – “Instrumentation and control”
- PDC 15 – “Reactor coolant system design”
- PDC 19 – “Control room”
- PDC 20 – “Protection system functions”
- PDC 21 – “Protection system reliability and testability”
- PDC 22 – “Protection system independence”
- PDC 23 – “Protection system failure modes”
- PDC 24 – “Separation of protection and control systems”
- PDC 25 – “Protection system requirements for reactivity control malfunctions”
- PDC 28 – “Reactivity limits”
- PDC 29 – “Protection against anticipated operation occurrences”

Staff Evaluation – Plant Control System

- Architecture
- Communications
- Codes and Standards
- Technical Specifications
- Logic, Display, and Alarms
- Failure Modes

Staff Evaluation – Reactor Protection System

- Architecture
- Protective Functions
- Communications
- Codes and Standards
- Logic and Schematics
- Trip Functions
- Accident Mitigation
- Safety Settings
- Response Time
- Technical Specifications
- I&C Platform
- Single Failure

Staff Evaluation – Main Control Room and Remote Onsite Shutdown Panel

- Architecture
- Communications
- Codes and Standards
- Controls, Displays, and Alarms
- Technical Specifications

Staff Evaluation – Sensors

- Architecture
- Codes and Standards
- Sensors

Technical Findings and Regulatory Conclusions

Kairos has described the proposed facility design criteria for the I&C systems, including, but not limited to, the PDC, and has identified the major features or components incorporated therein for the protection of the health and safety of the public.

Further technical or design information as may be required to complete the safety analysis of the I&C systems can reasonably be left for later consideration in the FSAR.

The staff concludes the information in Hermes PSAR Chapter 7 is sufficient and meets the applicable guidance and regulatory requirements identified in this section for the issuance of a construction permit in accordance with 10 CFR 50.35 and further information can be reasonably left for the OL application.

Questions?

NRC Staff Review for PSAR Chapter 8 Electrical Power Systems

Briefing for the Advisory Committee on Reactor Safeguards

April 4, 2023

By the Division of Engineering and External Hazards,
Office of Nuclear Reactor Regulation

PSAR Chapter 8 Electrical Power Systems Overview

- Non-Class 1E normal power system
- Non-Class 1E backup power system

- Principal design criteria (PDC):
  - PDC 17 – “Electric power systems”
  - PDC 18 – “Inspection and testing of electric power systems”

Staff Evaluation – Normal Power System

- Provides alternating current (AC) and direct current (DC) electrical power by an offsite power source

- Designed in accordance with National Fire Protection Association (NFPA) 70, “National Electrical Code 2020”

- During an audit, the applicant confirmed that no electrical systems were required for performing any safety-related function for safe shutdown of the plant or to keep the plant in the safe shutdown condition

Staff Evaluation – Normal Power System

- The normal power system is not credited for postulated events or safe shutdown, is classified as non-Class 1E or non-safety, and no technical specifications for the normal power system are required

- Based on exceptions to PDCs noted in Section 3.1.1 of PSAR, PDCs 17 and 18 are not applicable since
    - there are no safety-related/Class 1E power systems required to perform any safety-related functions
    - Normal power system (non-Class 1E) is available for non-safety functions not credited for design basis events (e.g., for certain UPS loads)

Staff Evaluation – Backup Power System

- Provides AC electrical power to the essential facility loads when the normal AC power supply is not available
- Includes backup generators and uninterruptible power supplies (UPS), as well as electrical equipment and circuits used to interconnect the backup generators to the low voltage AC electrical power distribution
- Plug-in connection available for use with a portable 480 VAC generator to provide power to essential loads in the event the backup generators are unavailable
- Designed according to NFPA 70, National Electric Code 2020

Staff Evaluation – Backup Power System

- The PSAR addressed the classification and design attributes of the Backup Power System
- The Backup Power System does not perform any safety-related functions, is not credited for the mitigation of postulated events, and is not credited with performing safe shutdown functions.
- Based on exceptions to PDCs noted in Section 3.1.1 of PSAR, PDCs 17 and 18 are not applicable since
  - there are no safety-related/Class 1E power systems required to perform any safety-related functions
  - Backup Power System (non-Class 1E) is available for non-safety functions not credited for design basis events, (e.g., for certain UPS loads)

Technical Findings and Regulatory Conclusion

- The staff finds that PDCs 17 and 18 are not applicable, since there are no Class 1E electrical power systems and non-Class 1E electrical power systems are available for non-safety functions not credited for DBE

- Staff finds that the design of the Hermes normal power system and backup power system are sufficient and meet the applicable regulatory requirements and guidance 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 OL application

Questions?

NRC Staff Review for PSAR Chapter 11 Radiation Protection and Radioactive Waste Management

Briefing for the Advisory Committee on Reactor Safeguards

April 4, 2023

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

Overview of PSAR Chapter 11

- Radiation protection and radioactive waste management
  - Preliminary information on design and programs
  - Commitments to develop more detailed information in the OL application

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Overview of PSAR Section 11.1 "Radiation Protection"

- Radiation sources
- Radiation protection program and ALARA program
- Radiation monitoring and surveying
- Radiation exposure control and dosimetry
- Contamination control
- Environmental monitoring

Overview of PSAR Section 11.2 "Radioactive Waste Management"

- Radioactive waste management program
- Radioactive waste handling systems and controls
- Release of radioactive waste

Staff Evaluation – Radiation Sources

- Staff audit confirmed that Kairos developed preliminary isotopic values for fuel and Flibe radiation sources for use in preliminary shielding design
- Staff audit of conservative screening analysis of gaseous tritium emissions described in PSAR Section 11.1.5 noted:
  - Conservative assumption for tritium effluent release rate equal to the generation rate
    - Does not account for retention in the reactor
  - Release rate for other gaseous radionuclides taken from the Clinch River ESP Environmental Report
    - Reasonable assumption for a preliminary analysis considering relative power levels and design differences
  - Liquid effluent release direct to the environment was not modeled; not expected based on preliminary design

Staff Evaluation – Radiation Protection

- Remainder of topics in PSAR Section 11.1
  - Did not need additional information in audit
  - PSAR describes the applicable regulatory requirements and guidance, and provides preliminary information on programs, practices, or design features
  - Kairos's commitments provide reasonable assurance that the Hermes design will comply with applicable requirements

Staff Evaluation – Radioactive Waste Handling Systems and Controls

- Preliminary effluent calculation in PSAR Section 11.1
- PSAR describes the applicable regulatory requirements, PDCs, and guidance and provides preliminary design information
  - PDC 2, “Design bases for protection against natural phenomena”
  - PDC 60, “Control of releases of radioactive materials to the environment”
  - PDC 63, “Monitoring of fuel and waste storage”
- Kairos’s commitments provide reasonable assurance that the Hermes design will comply with applicable requirements

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Staff Evaluation – Radioactive Waste Management

- Remainder of topics in PSAR Section 11.2
  - Did not need additional information in audit
  - PSAR describes applicable regulatory requirements and guidance and provides preliminary information on programs, practices, or design features
  - Kairos's commitments provide reasonable assurance that the Hermes design will comply with applicable requirements

Technical Findings and Regulatory Conclusion

- Staff finds that preliminary information and design criteria of the radiation protection and waste management programs and provisions
  - meets applicable acceptance criteria in NUREG-1537, Part 2
  - provides reasonable assurance that the final design will confirm to the design bases
  - meets applicable regulatory requirements
  - provides an acceptable basis for the development of the radiation protection programs and radioactive waste management, and there is reasonable assurance that Kairos will comply with the regulations in 10 CFR Part 20 during facility operation
- The staff concludes the information in Hermes PSAR Chapter 11 is sufficient and meets the applicable guidance and regulatory requirements identified for the issuance of a construction permit in accordance with 10 CFR 50.35 and further information can be reasonably left for the OL application