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Cc: Beasley, Benjamin; Cuadrado de Jesus, Samuel; Schmidt, Jeffrey
Subject: NRC Questions for February 9 Public Meeting
Date: Thursday, February 3, 2022 4:58:00 PM

Hello Darrell, Drew, Marty,

In advance of the public meeting scheduled for next Wednesday, February 9, please see below for a list of preliminary questions the NRC staff has prepared for Kairos related to the Hermes PSAR, to facilitate preparation for and discussion at the meeting. We will add this e-mail with the questions to public ADAMS. If any questions ahead of the meeting, please let Ben, Sam, or I know.

Thanks, Ed

1. PSAR Section 3.1.1 states "[t]he application of these criteria [PDC] to the SSCs of the test reactor are shown in Table 3.1-2." PSAR Table 3.1-2, "Regulations Requiring Exemptions for the Hermes Reactor" does not appear to address PDCs. Was PSAR Table 3.1-3 meant to be referenced in this sentence? If not, please clarify how PSAR Table 3.1-2 applies the criteria to the SSCs of the test reactor.
2. The middle of third paragraph in PSAR Section 3.1.1 lists a number of PDCs, including PDC 77. However, PDC 77 is not listed in topical report KP-TR-003 nor PSAR Table 3.1-3. Should this be PDC 76?
3. Topical report KP-TR-003 uses the term "safety-significant" in the context of licensing using the Licensing Modernization Project (LMP) program. The LMP program is not being used in the Hermes construction permit application. In PSAR Section 3.1.1, Kairos identifies a number of PDCs for which it states it only considers "safety-related" structures, systems, and components (SSCs) to be within the meaning of "safety significant" as used in the PDCs. Does the definition of "safety-related" as used in the PSAR only consider structures, systems, and components (SSCs) which satisfy the definition of safety-related SSCs in 10 CFR 50.2, "Definitions," or is it broader, to include SSCs that are risk significant or used for defense-in-depth? Of the PDCs not listed in PSAR Section 3.1.1 as being satisfied by safety-related SSCs only, are there any PDCs satisfied solely by non-safety SSCs, and would these PDCs still be considered safety significant consistent with topical report KP-TR-003?
4. Is there some reason why the term "postulated events" is used instead of "postulated accidents" (consistent with NUREG-1537), to describe the types of accidents analyzed in the PSAR (Chapter 13)?
5. Reference 2 listed in PSAR Section 3.1.3 identifies the Kairos Power, LLC, topical report KP-TR-003-P-A, "Principal Design Criteria for the Kairos Power Fluoride Salt-Cooled High Temperature Reactor," as dated July 2019. However, the safety evaluation that was issued by the NRC staff for this topical report was not issued until May 20, 2020 (ADAMS Accession No. ML20111A118), and the "-A" version was published after the safety evaluation issuance. Should this reference be to KP-TR-003-P, Revision 1?
6. The PSAR Section 3.6 and Chapter 4 design information related to the reactor vessel system and reactor vessel support system does not include information related to the cycles (i.e., temperature and/or mechanical loading cycles) that are assumed in the design. Also, the load combinations to be used for the different ASME Code design load levels (i.e., A, B, C, and D) are not identified in the PSAR. To make the requisite NUREG-1537, Part 2, Section 3.5, "Systems and Components," findings, the staff

needs to understand the loads being assumed for the different ASME Code design levels and how the loads are combined (e.g., straight addition or square root sum of the squares (SRSS)), along with the assumptions used to evaluate cyclic fatigue (start-ups, shutdowns, trips, transient assumptions, etc.).

7. PSAR Section 4.7 mentions a reactor vessel connector, which is shown on the bottom portion of PSAR Figure 4.7-1. The figure shows the reactor vessel connector as a bolt. Is this a bolt with a nut on the bottom? How many vessel connectors are there? Does this reactor vessel connector fit through holes in the reactor vessel bottom plate to provide lateral and vertical restraint for the reactor vessel?
8. Is the information in PSAR Table 4.1-1 the normal or nominal operating parameters, or is it the design parameters, for the reactor vessel and associated systems?
9. PSAR Section 4.2.2 indicates PDC 2 applies to the design of the Reactor Control and Shutdown System (RCSS), and that to address PDC 2 seismic considerations, a one-time test to assess control element insertion capability will be conducted prior to initial reactor operation. Is this test done out-of-pile or during initial reactor startup testing? If a one-time, out-of-pile test, what will be the basis for this test being conservative (e.g., a geometric maximum deflection)?
10. Related to the discussion of PDC 4 in PSAR Section 4.2.2.3, what would be the effect on the neutron absorbing material in the control elements if it came in contact with the coolant? LWR operation experience has demonstrated that stainless steel clad, B_4C control rods have failed, and absorber material unexpectedly dissolved in the coolant. Is there a plan for testing the potential interaction of B_4C and Flibe? If not, what is the basis for not testing?
11. Related to the discussion of PDC 4 in PSAR Section 4.2.2.3, what are the stress limits used for the SS 316H material used for the control and shutdown elements? Are these from the ASME Code?
12. In the discussion of PDC 4 in PSAR Section 4.2.2.3, the shutdown and drive mechanisms are said to be analyzed to meet ASME Section III Division **5** loads due to operational stepping, reactor trip, stuck element, fatigue, and shipping and handling. Have seismic loads also been considered?
13. The discussion of PDC 4 in PSAR Section 4.2.2.3 states control and shutdown elements are tested to ensure that wear during element movement is acceptable. Will this test program be performed out-of-pile before initial reactor operation? What are the wear acceptance criteria (e.g., two-thirds of cladding thickness)?
14. PSAR Section 4.3 states “The anti-siphon feature also limits the loss of reactor coolant inventory from inside the reactor vessel in case of a [primary heat transport system (PHTS)] breach.” Describe the anti-siphon feature that limits the loss of vessel inventory in the event of a break in the PHTS. Could a leak in the piping connected to the defueling chute or the pebble insertion line establish a siphon and result in a loss of coolant within the core?
15. How are pebbles kept from entering the suction of the primary salt pump and being impacted by the impeller?
16. PSAR Figure 4.3-2 shows the primary salt pump as a penetration in the reactor vessel top head design. Is this penetration for the discharge piping of the salt pump, the actual housing for the salt pump, or something different? Please provide more information so that we may obtain a complete understanding of this penetration.
17. PSAR Chapter 14 describes a limiting condition for operation (LCO) technical specification (specifically, LCO 3.4, Engineering Safety Features – Reactor Vessel Integrity) that will be developed for the Hermes operating license to provide a limit on the reactor vessel system temperature. However, PSAR Chapter 7 does not appear to include a description of a temperature monitoring device to determine compliance with this LCO. Will this device be an input to the reactor protection system or an indicating alarm to the operators to take action should the temperature exceed a

certain value? How many channels will be available? Will this LCO be based on the coolant temperature sensor or vessel temperature sensors?

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