Kairos Power

KP-NRC-2212-003

December 19, 2022

Docket No. 50-7513

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

Subject: Kairos Power LLC
Transmittal of Changes to Preliminary Safety Analysis Report Chapter 6 and Response to NRC Question on DHRS Testing

References:

1. Letter, Kairos Power LLC to Document Control Desk, "Submittal of the Preliminary Safety Analysis Report for the Kairos Power Fluoride Salt-Cooled, High Temperature Non-Power Reactor (Hermes), Revision 1," September 29, 2022 (ML22272A594)
2. Audit Plan, Nuclear Regulatory Commission, "Kairos Power, LLC – Plan for a General Audit of The Hermes Constructure Permit Application," February 10, 2022 (ML22039A336)
3. Letter, Kairos Power LLC to Document Control Desk, "Transmittal of Response to NRC Question on DHRS Testing from PSAR Section 6.3 Audit on Hermes Preliminary Safety Analysis Report," September 1, 2022 (ML22244A236)

In September 2022, Kairos Power submitted Revision 1 of the Preliminary Safety Analysis Report (PSAR) (Reference 1) as part of the Construction Permit Application (CPA) for the Hermes non-power reactor. This letter transmits changes to the pages of the PSAR to address NRC feedback received on Chapter 6 in the General Audit (Reference 2). Changes to the pages of the PSAR are provided in Enclosure 1. Kairos Power requests NRC review of these changes as part of the continued review of the Hermes CPA.

Additionally, on September 1, 2022, Kairos Power submitted a response to an NRC question on DHRS testing (Reference 3). The NRC asked a follow-up question on additional DHRS performance phenomena as part of the General Audit. In addition to the phenomena listed in the Kairos Power response, the design verification process will also evaluate phenomena associated with material and mechanical performance of the DHRS during startup of the system including:

- thermal shock effects on material properties,
- flow-induced vibration effects on DHRS components, and
- metal fatigue effects due to stress and thermal cycling.

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

I declare under penalty of perjury that the foregoing is true and correct.
Executed on December 19, 2022

Sincerely,

Peter Hastings, PE
Vice President, Regulatory Affairs and Quality

Enclosures: Changes to PSAR Chapter 6

xc (w/enclosure):

William Jessup, Chief, NRR Advanced Reactor Licensing Branch
Benjamin Beasley, Project Manager, NRR Advanced Reactor Licensing Branch
Edward Helvenston, Project Manager, NRR Advanced Reactor Licensing Branch
Samuel Cuadrado de Jesus, Project Manager, NRR Advanced Reactor Licensing Branch
Matthew Hiser, Project Manager, NRR Advanced Reactor Licensing Branch

**Enclosure 1**
**Changes to PSAR Chapter 6**
**(Non-Proprietary)**

preclude a safety-related SSC from performing its safety function. Design features addressing differential displacement are discussed in Section 3.5. The reactor building also provides civil structural support for the DHRS and protection of safety-related components from external hazards such as wind, tornadoes, floods, and wind-induced missile events. The DHRS design requirements for seismic and other natural hazards demonstrate conformance with the requirements in PDC 2.

The DHRS is designed and located to minimize the probability and effect of fires and explosions by the use of low combustible materials and physical separation. These design features, in conjunction with the fire protection plan described in Section 9.4, provide assurance that the DHRS demonstrate conformance with the requirements in PDC 3.

The DHRS is designed with materials that will withstand the radiation environment of the reactor cavity and environmental temperatures up to ~~800~~750°C to ensure the DHRS is capable of performing its safety function under conditions associated with normal operation, maintenance, testing, and postulated events. The DHRS is designed against equipment failures that could result from Flibe spills. Pipe whip and other similar dynamic failures are avoided by the low-pressure design of the DHRS and the use of restraints. Each component of the DHRS is designed such that failure of one component does not cascade and cause failures of nearby safety systems, including other DHRS components. These design considerations demonstrate conformance with the requirements in PDC 4.

Natural circulation in the reactor core transfers decay heat from the fuel to the reactor vessel shell when normal cooling is not available, as described in Section 4.6.3. Thermal-hydraulic calculations demonstrate that the DHRS is capable of passively removing a sufficient amount of decay heat from the reactor vessel without reliance on electric power for up to 7 days as needed to mitigate postulated events, such that the reactor vessel temperature remains below its design limit and is decreasing. In addition, fuel temperatures remain below their design limits. The DHRS is designed with sufficient redundancy, leak detection capability, and isolation to ensure the safety function can be performed assuming a single failure. The system includes four independent loops and maintains the ability to perform its function with the loss of a single loop. Isolation of the four water storage tanks from one another ensures that damage at one tank location does not result in a total loss of DHRS inventory. The thimbles, separators, and thimble feedwater and steam-return piping are all contained within the leak barrier. The leak barrier provides leak detection capability and ensures that a failure of the primary DHRS pressure boundary does not prevent the system from performing its heat removal function. These DHRS design features, along with the natural circulation characteristics of the reactor core, demonstrate conformance with the requirements in PDC 34 and PDC 35.

The DHRS design includes the capability for online monitoring of leaks to monitor for system integrity and to ensure that DHRS inventory remains sufficient to perform the safety-related heat removal function. The water level in the storage tanks is also capable of being monitored to ensure that sufficient inventory is present at the onset of a postulated event to provide sufficient cooling capacity. The DHRS is also sufficiently accessible to perform inspections for system integrity. These features satisfy PDC 36.

When the reactor is above threshold power, the DHRS is an “always on” operating condition which provides an ongoing demonstration of system availability. The transition from normal to postulated event operation can also be functionally tested. These features demonstrate conformance with the requirements in PDC 37.

**Table 6.3-3: Thimble Parameters**

| Parameter | Value |
|---|---|
| Material | Stainless Steel |
| Design pressure (psig) | 30 |
| Design temperature (°C~~F~~) | 750~~1500~~ |
| Number per steam separator | 6 |
| Length (in) | 144 |
| Thimble wall outer diameter (in) | 2.875 |