Enclosure 1
Changes to PSAR Chapter 4
(Non-Proprietary)

Condition 1, the shutdown and control elements provide a means to ensure that SARRDLs are not exceeded, and that safe shutdown is achieved and maintained during normal operation. Condition 1 is met assuming the highest worth shutdown or control element is fully withdrawn. In compliance with Condition 2 of PDC 26, the control elements by themselves provide the capability to control reactivity changes during planned normal power changes such that the SARRDLs are not exceeded. The control elements provide a means that is independent and diverse from the shutdown elements because they are located in different locations, receive different signals to trip, and each of them have two independent and diverse release mechanisms. In compliance with Condition 3 of PDC 26, the shutdown and control elements provide a means of inserting reactivity at a sufficient rate and amount, to ensure that the capability to cool the core is maintained and a means for shutting down the reactor and maintaining it at safe shutdown following a postulated event. Condition 3 is met assuming that the most reactive control or shutdown element is fully withdrawn. In compliance with Condition 4 of PDC 26, the shutdown and control elements provide a means for maintaining the reactor shutdown to allow for interventions such as fuel loading, inspection, and repair. Compliance with PDC 26 is summarized in Table 4.5-6.

Nuclear Stability

The inherent nuclear characteristics of the reactor are such that uncontrolled power oscillations are not possible. The reactor is small in size and is neutronically connected due to the long diffusion length of neutrons in the core. As a result, the reactor is inherently stable with regard to both axial and radial power oscillations. In compliance with PDC 12, the reactor is not susceptible to nuclear instability.

4.5.3.2 Nuclear Design Analysis Inputs to Other Sections

Vessel Irradiation

The fast neutron fluence received by the reactor vessel from the reactor core and pebble insertion and extraction lines is attenuated by the core barrel, the reflector, and by the reactor coolant. Fluence and depletion calculations are performed to confirm that the vessel is not adversely affected by this neutron fluence. The methodology for calculating best estimate vessel fluence and ~~helium production~~associated transmutation products is described in Reference 1. These calculated values are evaluated using conservative uncertainties.

The calculation of associated dpa on the vessel uses the fluence as input. The preliminary best estimate dpa plus uncertainty is within 30% of the low-level irradiation value discussed in Reference 2.

Nuclear Transient Analysis

Values for neutron generation time and delayed neutron fraction are shown during startup and equilibrium operation in Table 4.5-7. In addition, conservative values for power distribution, reactivity coefficients, and shutdown margin are provided for the initial conditions for each of the postulated reactivity transient events analyzed in Chapter 13.

The most credible inadvertent insertion of excess reactivity does not disturb the core and does not adversely impact the capability to cool the core in accordance with PDC 28 as described in Chapter 13.

4.5.4 Core Design Limits

4.5.4.1 Nuclear Core Design Limits

The reactor core design is performed such that the design parameters during normal operation are within the fuel qualification envelope described in Section 4.2.1 for peak particle power, burnup, peak fluence, and peak fuel temperature.

4.5.4.2 Testing and Monitoring

Neutron flux and burnup are monitored during operation to ensure that the core is performing within design.

The following core nuclear design parameters are anticipated to be included in the technical specifications:

- Shutdown Margin
- Coolant Outlet Temperature
- Moderator pebble to fuel pebble ratio

There will also be a technical specification controlling the fuel enrichment to less than 20 wt% U-235. The technical specifications are described in Chapter 14.

4.5.5 References

1. Kairos Power LLC, “KP-FHR Core Design and Analysis Methodology,” KP-TR-017-P, September 2021.
2. Kairos Power, LLC, “Metallic Materials Qualification for the Kairos Power Fluoride Salt-Cooled High-Temperature Reactor,” KP-TR-013-P, Revision 3.