Enclosure 1
Changes to PSAR Chapters 4 and 5
(Non-Proprietary)

Heavy load considerations are addressed in Section 9.8.4, Cranes and Rigging. These features demonstrate compliance with PDC 4.

Core cooling is maintained through the design of the reactor vessel and the reactor vessel internals. As described in Section 4.3.1.2, the vessel and vessel internals define the coolant flow path. To preclude degradation to the vessel due to corrosion of the stainless steel, the reflector blocks and the vessel are "baked" (i.e., heated uniformly) to remove residual moisture prior to coming into contact with coolant. The reflectors, which act as a heat sink in the core, are spaced to prevent the formation of tensile and bending stresses and accommodate thermal expansion and hydraulic forces during normal operation and postulated events. The gaps between the graphite blocks support coolant flow to the reflector thus maintaining a coolable core geometry and precluding reflector degradation by overheating. Maintaining a coolable core geometry and adequate coolant flow through the core ensures the vessel wall temperature is below design limits which prevent vessel failure. Dynamic behavior of the reactor, its support, and its internals are analyzed and designed to ensure vessel integrity and core geometry are maintained in a design basis earthquake to a degree sufficient to ensure passive heat removal. The vessel, as part of the reactor coolant boundary, ensures the containment of radionuclides by ensuring the coolant is confined and the TRISO particles in the fuel pebbles are protected from damage. These features demonstrate conformance to PDC 10.

To demonstrate compliance with PDC 14, the reactor vessel is fabricated, erected, and tested so as to have an extremely low probability of leakage, rapidly propagating failure, and gross rupture. The reactor vessel materials and weld metal will be qualified for use as described in Kairos Power topical report "Metallic Materials Qualification for the Kairos Power Fluoride Salt-Cooled High-Temperature Reactor," KP-TR-013-P (Reference 3). The 316H SS of the reactor vessel as fabricated and tested in accordance with Reference 1 standards has a high fracture toughness at reactor operating conditions, thus reducing the likelihood of crack propagation. The design of the reactor vessel and vessel internals support a 10-year operating lifetime. This is accomplished by operating the reactor vessel within the as-designed operational and transient condition stresses and by monitoring for changes (e.g., irradiation and thermally induced degradation, corrosion, creep) to the reactor vessel during in-service inspection and testing. The RVSS-reactor vessel bottom head interface is designed to allow access for weld inspections. The reactor vessel top head supports in-service inspection of attachments and penetrations.

The reactor vessel shell and bottom head maintain a coolant pathway for cooling the reactor core and ensure submergence of fuel pebbles in the core. The reactor vessel is fabricated, erected, and tested in accordance with Reference 1 as a Class A component to account for thermal and physical stresses during normal operation and postulated events. The vessel is fabricated from 316H SS base metal and ER16-8-2 weld metal using a gas tungsten arc welding process. Reference 1 provides for weldment stress rupture factors up to a temperature of 650°C for ER16-8-2 weld metal with 316H base metal. Testing provides stress rupture factors up to 816°C for weld material with 316H base metal (Reference 3). The plant control system will detect leakage from the reactor vessel ~~and~~ with catch basins, as described in Section 4.7, that are used to detect leaks in nearby coolant-carrying systems. These features demonstrate compliance with PDC 30.

Reactor vessel stress rupture factors are determined up to 816°C to encompass transient conditions. The stress rupture factors are determined by a creep-rupture test on the vessel base material with weld metal under the gas tungsten arc welding process. The vessel precludes material creep, fatigue, thermal, mechanical, and hydraulic stresses. The leak tight design of the reactor vessel head minimizes air ingress into the cover gas and precludes corrosion of the internals. The high temperature, high carbon grade 316H SS of the core barrel and reflector support structure have high creep strength and are resistant to radiation damage, corrosion mechanisms, thermal aging, yielding, and excessive neutron absorption.

5.1.3 System Evaluation

The design of the nonsafety-related PHTS is such that a failure of components of the PHTS does not affect the performance of safety-related SSCs due to a design basis earthquake. In addition to protective barriers, the PHTS pipe connections to the reactor vessel nozzles have sufficiently small wall thickness, such that if loaded beyond elastic limits, inelastic response occurs in the PHTS piping which is nonsafety-related. These features, along with the seismic design described in Section 3.5, demonstrate conformance with the requirements in PDC 2 for the PHTS.

While the PHTS is a closed system, there are conceivable scenarios that may result in the release of radioactive effluents. The fuel design locates the fuel particles near the periphery of the fuel pebble, enhancing the ability of the fuel to transfer heat to the coolant. The thermal hydraulic analysis of the core (see Section 4.6) ensures that adequate coolant flow is maintained to ensure that SARRDLs, as discussed in Section 6.2, are not exceeded. These features demonstrate conformance with the requirements in PDC 10.

The design of the reactor coolant, in part, ensures that power oscillations cannot result in conditions exceeding SARRDLs. The reactor is kept near ambient pressure and the reactor coolant in the PHTS does not experience two phase flow. The coolant has a high thermal inertia making the reactor resilient to thermal-hydraulic instability events. These features, in part, demonstrate conformance with the requirements in PDC 12.

The functional containment is described in Section 6.2. The design relies primarily on the multiple barriers within the TRISO fuel particles to ensure that the radiological dose at the exclusion area boundary as a consequence of postulated events meets regulatory limits. However, the reactor coolant also serves as a distinct physical barrier for fuel submerged in Flibe by providing retention of fission products that escape the fuel. The design of the reactor coolant composition provides, in part, a means to control the accidental release of radioactive materials during normal reactor operation and postulated events (PDC 60), and supports, in part, demonstration of the functional containment aspects. The design aspects of the reactor coolant are discussed in Reference 5.1.5-1. The Flibe also accumulates radionuclides from fission products, and transmutation products from the Flibe and Flibe impurities. The retention properties of the Flibe are credited in the safety analysis as a barrier to release of radionuclides accumulated in the coolant, and radionuclide concentration is limited by technical specifications. The transport of radionuclides through Flibe is based on thermodynamic data that will be justified in the application for an Operating License. These features demonstrate conformance with the requirements in PDC 16.

The fouling and plugging of the reactor coolant flow path through the vessel as a result of a reduction in coolant purity is not expected. However, the temperature of the reactor coolant in the downcomer and core can be monitored to determine decrease in heat removal capability that could occur as a result of fouling or plugging of passages. This demonstrates conformance with PDC 70.

The design of the PHTS controls the release of radioactive materials in gaseous and liquid effluents in the event the PHTS working fluid is inadvertently released to the atmosphere via leaks in the piping system. The PHTS SSCs that are part of the reactor coolant boundary are designed to the ASME B31.3 Code (for the piping) and Section VIII (for the PHX) such that leaks are unlikely. Means are provided for detecting and, to the extent practical, identifying the location of the source of reactor coolant leakage in the PHTS SSCs. A postulated event in the PHTS would be a PHX tube failure. This event would cause Flibe to leak into the intermediate coolant, as the Flibe is maintained at a higher pressure than the intermediate coolant and would result in a spread of contamination to the PHRS. Such an event would