Enclosure 1

Changes to PSAR Section 3.1

(Non-Proprietary)

CHAPTER 3 DESIGN OF STRUCTURES, SYSTEMS, AND COMPONENTS

3.1 INTRODUCTION

This chapter identifies and describes the principal architectural and engineering design criteria for the structures, systems, and components (SSC) that are required to ensure reactor facility safety and protection of the public. The primary safety feature of the Hermes design is the unique combination of TRISO fuel and Flibe reactor coolant. Other safety-related systems support maintaining the fuel and coolant configuration within acceptable limits. These SSCs include the safety-related portion of the Reactor Building structure, the reactor vessel and internals, the reactor control and shutdown system, and the decay heat removal system.

3.1.1 Design Criteria

Kairos Power is pursuing a construction permit and subsequent operating license for the Hermes reactor under 10 CFR 50. The NRC regulations in Title 10 to the CFR have been evaluated for applicability to this facility and the results are contained in the "Regulatory Analysis for the Kairos Power Fluoride Salt-Cooled, High Temperature Reactor" topical report (Reference 1). The design related regulations that that are addressed by this preliminary safety evaluation report (PSAR) are summarized in Table 3.1-1 and addressed throughout this safety analysis report. In addition, this topical report identified regulations for which exemption were needed. These exemptions are identified in this safety analysis report in their applicable sections and are summarized in Table 3.1-2.

Kairos Power has also developed a set of principal design criteria (PDC) applicable for the KP-FHR technology which has been reviewed and approved by the NRC in "Principal Design Criteria for the Kairos Power Fluoride Salt-Cooled High Temperature Reactor" (Reference 2). The application of these criteria to the SSCs of the test reactor are shown in Table 3.1-~~2~~3. The site contains only one reactor, with no SSCs shared with another reactor unit, which satisfies PDC 5. Specific details regarding how the other PDC are met by the design are described in the individual sections throughout this safety analysis report and summarized in Table 3.1-3.

Note that several of the PDCs in KP-TR-003 contain the terms "safety significant," "anticipated operational occurrences," and "accidents." These terms are not applicable to the Hermes reactor and are not used in this safety analysis report, which represents a departure from the approved topical report. These terms are relevant to power reactors, which use frequency to bin postulated events. In the non-power reactor licensing framework, "Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors" (NUREG-1537), the postulated events in the design basis are treated the same, regardless of frequency. Consistent with 10 CFR 50.2 (as modified – See Section 1.2.3), SSCs that are relied upon to mitigate the postulated events are classified as safety-related and a significance determination is not made in this framework. There are only two SSC classifications used in this safety analysis report for the Hermes reactor: safety-related and non-safety related. PDCs 1, 2, 3, 4, 5, 13, 14, 15, 16, 17, 18, 20, 28, 30, 31, 32, 33, 34, 44, 61, 71, 73, 75, and ~~77~~ 76 use the term "safety significant." For these PDCs, the term "safety significant" is replaced in this safety analysis report with "safety-related." Additionally, PDCs 10, 13, 15, 17, 20, 26, 29, 34, 60, 64, and 73 use the term "Anticipated Operational Occurrences." Since there is no distinction between AOOs and accidents in the non-power reactor licensing framework (NUREG-1537), the AOO terminology (including language that differentiates between AOOs and accidents) is replaced by "postulated events" in this safety analysis report for the Hermes reactor. PDCs 2, 4, 5, 13, 16, 17, 19, 20, 22, 26, 28, 31, 35, 37, 44, 46, 61, 64, 73, and 75 use the

term “accidents,” and in these instances “accident” is replaced with “postulated events” in this safety analysis report.

Note that an exemption to the 10 CFR 50.2 definition of safety-related is discussed in Section 1.2.3 with respect to the replacement of the words: “integrity of the reactor coolant pressure boundary” with “integrity of the portions of the reactor coolant boundary relied upon to maintain coolant level above the active core.” This is a departure from the proposed exemption described in Reference 1. However, as discussed above, the term “safety-significant” does not apply to Hermes. For Hermes, the safety-related portions of the reactor coolant boundary for the reactor are limited to portions of the reactor vessel (see Section 4.3). Failures of other SSCs containing reactor coolant (e.g., pipe breaks within the reactor coolant boundary) do not result in unacceptable consequences as described in Section 13.1.3. A failure of the reactor vessel is a beyond the design basis event as the vessel is designed against such failure consistent with PDC 14. Thus, the makeup inventory of reactor coolant to the reactor vessel is not relied on to mitigate the consequences of a postulated event and the requirements of PDC 33 have been addressed.

3.1.2 NRC Guidance Documents

The NRC guidance documents considered in the design of the reactor are identified within this safety analysis report and are listed in Table 3.1-4. The sections cited in this table describe the extent of usage of these guidance documents. Note that Division 1 regulatory guides are not applicable to non-power test reactors and are not included in this table. In some cases, portions of the Division 1 regulatory guides were utilized and are identified in sections throughout this safety analysis report. Codes and standards used in the design of the reactor structures, systems, and components that contain radioactivity are provided in Section 3.6. Other codes and standards are also identified throughout the report.

3.1.3 References

1. Kairos Power, LLC, “Regulatory Analysis for the Kairos Power Salt-Cooled, High Temperature Reactor,” KP-TR-004-P, Revision 3. August 2020.
2. Kairos Power, LLC, “Principal Design Criteria for the Kairos Power Fluoride Salt-Cooled, High Temperature Reactor,” KP-TR-003-P-A~~.~~, Revision 1. July 2019.