



**UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS  
WASHINGTON, DC 20555 - 0001**

MEMORANDUM TO: David Petti, Lead  
Kairos Power Licensing Subcommittee  
Advisory Committee on Reactor Safeguards

FROM: Thomas Roberts, Member  
Advisory Committee on Reactor Safeguards

SUBJECT: INPUT FOR ACRS REVIEW OF KAIROS NON-POWER REACTOR  
HERMES 2 CONSTRUCTION PERMIT APPLICATION – DRAFT  
SAFETY EVALUATION FOR CHAPTERS 7, “INSTRUMENTATION  
AND CONTROL SYSTEMS” AND 8, “ELECTRIC POWER  
SYSTEMS”

In response to the Subcommittee’s request, I have reviewed the NRC staff’s draft safety evaluations (SEs) with no open items, and the associated sections of the applicant’s Preliminary Safety Analysis Report (PSAR), for Chapter 7, “Instrumentation and Control Systems,” Revision 1, and Chapter 8, “Electric Power Systems,” Revision 1. The following is my recommended course of action concerning further review of these chapters and the staff’s associated safety evaluations.

### **Background**

Chapters 7 and 8 of the SE document the staff’s review of the Kairos Power, LLC (Kairos), Hermes 2 construction permit application for the preliminary design of the Hermes 2 non-power test reactor structures, systems, and components (SSCs) as presented in Chapters 7, “Instrumentation and Control Systems,” and 8, “Electric Power Systems,” of the Hermes 2 PSAR, Revision 1. The Hermes 2 construction permit (CP) application purpose is to upgrade the original Hermes design to include a two-reactor architecture and a power generation system.

### **SE Summary**

The staff SE evaluated and documented discussions of the Hermes 2 instrumentation and control (I&C) and electric power systems described in the PSAR, with special attention to changes that are being made from the Hermes design. For the I&C system, addition of the power generation system requires a new intermediate heat transfer control system and power generation control system. For the electric power system, significant changes include addition of a turbine-generator (TG), with the ability to power reactor auxiliary loads using the plant TG in addition to the Hermes capability to use external power.

Areas of review for these sections included I&C plant control system (PCS), reactor protection system, main control room (MCR), remote onsite shutdown panel (ROSP), display information, and sensors, and the normal and backup electric power systems. Within these review areas, the staff concluded that the information provided in the PSAR supports approval of the requested CP.

### **Discussion**

Chapters 7 and 8 do not clearly describe how the two reactors, along with a shared TG system, will be controlled. While this information may be deferred until the operating license (OL) application, the following potential issues are highlighted at this time:

1. The PSAR does not state whether separate reactor operators are intended for the two units. During the Kairos subcommittee meeting on May 16, 2024, the applicant stated that they plan to have separate reactor operators for each unit, and that the operator workstations will be designed with the flexibility to use the supervisor workstation as a backup to each individual reactor workstation. Further work will develop the concept of operations to ensure the supervisor can properly maintain their supervisory function in this case.
2. The PSAR does not assess the potential for a loss of alternating current (AC) power to both units when using the plant TG to provide electrical power. In this case, a loss of the plant TG could lead to a loss of AC power to components such as the primary and intermediate salt pumps. Control system actions that are intended to control power level, such as runbacks of these salt pumps as described in PSAR section 7.2.3, would not be possible. Plant response (e.g., likelihood of complete loss of AC and consequence of loss of pump runback functionality) and operator actions to accommodate this dual reactor event are not defined.

Two other concerns from this chapter that should be tracked for resolution are as follows:

1. The I&C system architecture diagram (Figure 7.1-1) shows: (a) a single “supervisory controller” between redundant signal pathways that connect the PCS to the main control room, implying the potential for single failures to cause loss of all indication and control capability from the main control room; and (b) the potential for unrestricted external access to the plant control system via an ethernet connection from the “Kairos Power Plant Displays and Control Center.” These are largely unchanged from the Hermes 1 PSAR. The ACRS (C. Brown) memo on Chapter 7 of the original Hermes PSAR, dated April 27, 2023, identified issues related to these aspects of the I&C system. These issues were not addressed in the Hermes 2 PSAR and hence remain open.
2. Chapter 8 does not state how long the uninterruptable power supplies (UPSs) are required to operate following loss of electrical power to the plant. The electrical configuration diagram (Figure 8.1-1) in the Hermes 1 PSAR included notes indicating a 72-hr capability for most UPSs. The reference to a 72-hr capability was deleted in the equivalent figure in the Hermes 2 PSAR. During our subcommittee meeting on May 16, 2024, the applicant stated the 72-hr capability would be maintained and the purpose of the drawing change was to move the timing requirement to a different document. It is suggested that specific discussion of UPS duration be added to Chapter 8.

### **Recommendation**

Staff evaluate the above discussion and track for resolution during review of the OL application.

### **References**

1. Kairos Power LLC, "Submittal of the Preliminary Safety Analysis Report for the Kairos Power Fluoride Salt-Cooled, High Temperature Non-Power Reactor, Revision 1 and the Postulated Event Analysis Methodology Technical Report, Revision 1," May 23, 2024 (Agencywide Documents Access and Management System (ADAMS) No. ML24144A090).
2. USNRC, "Hermes 2 Advance SE Transmittals to ACRS," 2024 (ML24179A149).
3. USNRC, ACRS memorandum from C. Brown, "Input for ACRS Review of Kairos Non-Power Reactor Hermes Construction Permit Application – Draft Safety Evaluation for Chapter 7, 'Instrumentation and Control Systems'," April 27, 2023 (ML23117A016).

SUBJECT: INPUT FOR ACRS REVIEW OF KAIROS NON-POWER REACTOR HERMES 2 CONSTRUCTION PERMIT APPLICATION – DRAFT SAFETY EVALUATION FOR CHAPTERS 7, “INSTRUMENTATION AND CONTROL SYSTEMS” AND 8, “ELECTRIC POWER SYSTEMS”

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