



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

February 8, 2023

Joy L. Rempe, Chairman
Advisory Committee on Reactor Safeguards
U.S. Nuclear Regulatory Commission
Washington, DC 20555

SUBJECT: STAFF RESPONSE TO ADVISORY COMMITTEE ON REACTOR SAFEGUARDS LETTER ON SAFETY EVALUATION OF THE KAIROS TOPICAL REPORT KP-TR-011, REVISION 2, "FUEL QUALIFICATION METHODOLOGY FOR THE KAIROS POWER FLUORIDE SALT-COOLED HIGH TEMPERATURE REACTOR (KP-FHR)"

Dear Chairman Rempe,

In your letter dated December 20, 2022 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML22340A628), the Advisory Committee on Reactor Safeguards (ACRS) reported on its review of the U.S. Nuclear Regulatory Commission (NRC) staff's safety evaluation (SE) of the Kairos Power LLC (Kairos Power) Topical Report KP-TR-011, Revision 2, "Fuel Qualification Methodology for the Kairos Power Fluoride Salt-Cooled High Temperature Reactor (KP-FHR)." The NRC staff appreciates the ACRS review and recommendations. In consideration of the observations and recommendations by the ACRS, the NRC staff is revising the SE.

The ACRS letter contained the following recommendations:

1. The topical report and the associated SE should acknowledge two concerns that affect assurance of Tri-structural Isotropic (TRISO) particle silicon carbide (SiC) layer integrity and radionuclide retention in the Kairos FHR designs:
 - a. Material compatibility between the Flibe molten salt with impurities (e.g., Fe, Cr, Ni) and the fuel pebble containing TRISO particles, and
 - b. Irradiation performance of the Kairos fuel pebbles fabricated at production-scale prior to Hermes operation.
2. The SE should explicitly consider the value of Hermes as a prototype. The results of Hermes operation and the associated fuel surveillance plans should be considered as a compensatory measure to address Recommendation 1.
3. The SE should explicitly acknowledge how the flexibility provided by the Atomic Energy Act for test reactors factored into the finding for acceptability of the fuel qualification methodology for Hermes.

4. After these items are addressed, the SE should be issued.

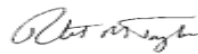
The ACRS observed that experience in other TRISO test programs showed transition metal interaction with the SiC layer of the TRISO particle. The NRC staff appreciates the ACRS observation of this TRISO behavior and Recommendation 1a. The NRC staff will add a condition to the SE requiring applications for KP-FHR power reactors to include information demonstrating that TRISO particle failures due to chemical attack during expected reactor conditions from impurities (e.g., Fe, Cr, or Ni) in the molten salt coolant are precluded or can be demonstrated to be insignificant.

The ACRS also observed that irradiation testing of production samples of the Hermes fuel pebbles is not planned. The ACRS noted that the Kairos Power fuel pebbles have a unique design with a low-density graphite core surrounded by an annular fuel region which has a relatively high packing fraction of TRISO particles. Regarding Recommendation 1b and considering Recommendation 2, the NRC staff agrees that the Hermes test reactor is serving as a prototype and the test reactor operation will provide information on the irradiation performance of fuel pebbles from the production process. The NRC staff will revise the SE to describe this aspect of the Hermes' role in irradiation testing of production pebbles.

As mentioned in Recommendation 3, the ACRS noted that the Atomic Energy Act directs the Commission to impose only such minimum amount of regulation on test reactors as needed to fulfill the Commission's obligations. The NRC staff's SE revision on surveillance of pebble irradiation performance in Hermes will also note that licensing requirements are different between the non-power test and the commercial electric power versions of a KP-FHR.

The NRC staff agrees with the ACRS observation that the Hermes test reactor will provide valuable insight on the potential synergistic effects of irradiation with other reactor operating conditions which are not explicitly addressed by the Kairos Power fuel qualification plans. The NRC staff appreciates the ACRS's review and agrees with its recommendations. The NRC staff plans to revise and issue the final SE in February 2023 and looks forward to future interactions with the ACRS on Kairos Power licensing activities.

Sincerely,



Taylor, Robert signing on behalf
of Veil, Andrea
on 02/08/23

Andrea D. Veil, Director
Office of Nuclear Reactor Regulation

Project No. 99902069

cc: Chairman Hanson
Commissioner Baran
Commissioner Wright
Commissioner Caputo
Commissioner Crowell
SECY

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