



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

February 08, 2022

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

SUBJECT: SAFETY EVALUATION OF THE KAIROS POWER LLC TOPICAL REPORT
KP-TR-012-P, REVISION 1, "KP-FHR MECHANISTIC SOURCE TERM
METHODOLOGY"

Dear Chairman Rempe:

By letter dated December 20, 2021 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML21342A179), 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-012-P, Revision 1, "KP-FHR Mechanistic Source Term Methodology." The NRC staff appreciates the ACRS' review, and its conclusions and recommendations listed below:

1. The topical report presents the methodology used by Kairos to calculate the mechanistic source term of fission products, activation products, and corrosion products produced in the Kairos Power fluoride salt-cooled high temperature reactor (KP-FHR) core. The approach is consistent with existing high-level regulatory guidance on source terms for advanced reactors.
2. Staff review of an application that employs this methodology will need to ensure that the assumptions on the number of failed pebbles as well as the experimental limitations related to tritium behavior in the molten salt coolant for the KP-FHR (Flibe¹) and diffusion and trapping effects in graphitic components are adequately considered in conservative safety analyses and relevant sensitivity studies.
3. The staff SE does not require experimental validation of vaporization of fission products from Flibe. This has an important effect on the overall source term, and experimental validation data are needed to confirm the approach used by the applicant. The SE should be changed to address this concern.

¹ Flibe is a mixture of lithium fluoride (LiF) and beryllium fluoride (BeF₂), with a nominal chemical composition of 2LiF:BeF₂.

Regarding Recommendation 1, the NRC staff appreciates that the ACRS agrees with the NRC staff's position that the methodology used by Kairos for the mechanistic source term is consistent with existing regulatory guidance for advanced reactors.

Regarding Recommendation 2, the NRC staff notes that the ACRS' discussion of tritium behavior points out specific topics that the NRC staff should ensure are covered in the subsequent review of an application for a KP-FHR. For example, the ACRS points out several considerations, including the different heat treatment of the various carbon-based materials, which can affect the amount of tritium retained in those materials through traps. The NRC staff agrees that modeling the concentration of fission products in the matrix relative to the trap concentration is an important consideration in the determination of tritium retention and the subsequent effect on radionuclide release; therefore, validation of these diffusion and trapping models by the applicant using the methodology, is necessary. The ACRS also notes that experience with pebble bed reactor operation shows that pebbles are broken during operation, and that applicants using the report will need to justify the assumption on the number of pebbles being damaged. The NRC staff agrees that the number of damaged pebbles is an important consideration in the implementation of the methodology. In any application which uses an approved topical report methodology, the NRC staff will assess the applicability of the topical report to the application, including assumptions in the approved methodology.

The staff's SE also includes limitations and conditions on the use of the topical report that concern issues addressed in ACRS' Recommendation 2. Specifically, SE limitations and conditions 6 and 10, ensure that the applicant is to provide information related to modeling of tritium behavior in the Flibe and graphite. The NRC staff appreciates the technical issues pointed out in the ACRS letter, which will aid the NRC staff in future reviews of an application which implements the topical report methodology.

The NRC staff considered ACRS Recommendation 3 and agrees that vaporization of fission products from Flibe is important to the overall source term and that experimental data are needed to confirm modeling of radionuclide vaporization. The NRC staff are engaging with the applicant (ADAMS Accession No. ML22033A483) to ensure that the approach used by the applicant is confirmed with experimental data. The NRC staff will also address this in its final safety evaluation of the topical report.

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The NRC staff appreciates the ACRS' review. The NRC staff plans to issue the SE report in early spring 2022 and looks forward to future interactions with the ACRS regarding Kairos licensing topical reports or applications.

Sincerely,

Robert M.
Taylor

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Andrea D. Veil, Director
Office of Nuclear Reactor Regulation

Project No. 99902069

cc: Chairman Hanson
Commissioner Baran
Commissioner Wright
SECY

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METHODOLOGY" DATED: FEBRUARY 08, 2022

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