

Annular fuel pebble test program for the FHR

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Kairos Power is developing an innovative Fluoride-salt-cooled High-temperature Reactor (FHR) combining two advanced reactor technologies, using molten salt coolant and spherical ‘pebble’ fuel elements embedded with TRISO particles. The pebble fuel element has a novel annular design with a low-density carbon inner core surrounded by a fuel region shell containing TRISO particles and an exterior fuel free outer carbon shell. While extensive experience has been gained on fabrication and the irradiation performance of TRISO fuel particles through the DOE AGR program, the use of TRISO particles in combination with the annular pebble design will benefit from a test program supporting its use in a commercial FHR. The fuel test program involves three efforts consisting of laboratory testing, irradiation testing, and a fuel surveillance program in the commercial reactor. The laboratory tests include mechanical, tribology, buoyancy, and corrosion tests to demonstrate that the fuel element meets design requirements. The irradiation test is performed in a test reactor using a temperature-controlled capsule with online measurement of sweep gas activity. Irradiation test data and PIE will be used to measure fission product release fractions and establish failure proportions or equivalent for heavy metal contamination, manufacturing defects, and in-service failure frequency. The final part of the program is fuel surveillance during early operations in the FHR. The reactor cover gas will be monitored for activity indicating particle failures and fuel pebbles will be inspected using non-destructive and destructive methods. This data will be used to confirm the technical bases of a mechanistic source term model. The combination of these efforts will demonstrate FHR safety permitting full commercial operations of the demonstration plant.