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Advanced Reactor Experiments for Sodium Fast Reactor Fuels (ARES) Project: Transient Irradiation Experiments for Metallic and MOX Fuels

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Advanced Reactor Experiments for Sodium Fast Reactor Fuels (ARES) is a joint project between the U.S. Idaho National Laboratory (INL) and the Japanese Atomic Energy Agency (JAEA) to investigate the transient fuel performance of metallic and MOX fuels. The project has the specific goals of experimentally evaluating the transient failure modes of high burnup metallic and MOX fuels, guided by advanced modeling and simulation (M&S) tools, but also to support development and validation of M&S tools. The recent availability of the Transient Reactor Test (TREAT) facility provides the opportunity to renew in-pile evaluation of advanced fuel designs. Sodium Fast Reactor (SFR) experiments leverage a rich inventory of fuels irradiated in EBR-II and FFTF, currently residing at INL, and still supporting research programs at the INL. As part of the ARES project, a heat-sink capsule with liquid metal specimen bond has been designed and M&S is being used to develop the detailed experimental conditions for the planned experiments. A series of fresh fuel commissioning tests is planned in TREAT for 2021. These tests will evaluate the performance of the hardware and instrumentation to measure temperature response, fuel elongation, and fuel failure. The four irradiated fuel tests are planned for fully intact, high-burnup pins (2x metallic pins and 2x MOX pins), which achieved nearly ~13 at% burnup in EBR-II, to be irradiated in TREAT in 2022. Test instrumentation will include optical-fiber-based distributed temperature sensors, thermocouples, acoustic emission detectors, a capsule pressure sensor, self-powered neutron detectors (SPND) as well as the refurbished TREAT fuel motion monitoring system (hodoscope). Fresh fuel tests will incorporate additional advanced diagnostics including optical-fiber-coupled pyrometry and fuel elongation sensors. The experiments will benefit from advanced pre- and post-transient examination capabilities available at INL and actively used for similar examinations. Long-term test development underway includes a full circulating sodium loop and the ability to refabricate fuel specimens. This paper will present more detailed description of the planned test design, matrix, and conditions with an emphasis on modeling guiding experiment design.

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