Irradiation Testing of Candidate Accident Tolerant Fuels for LWRs

Designated as the ATF-1 Test Series, preliminary irradiation of Accident Tolerant Fuel concepts will be performed as a series of drop-in capsule tests to be irradiated in the Advanced Test Reactor at Idaho National Laboratory.

The safe, reliable, and economic operation of the nation's nuclear power reactor fleet has always been a top priority for the United States' nuclear industry. Continual improvement of technology, including advanced materials and nuclear fuels, remains central to the industry's success. One of the missions of the U.S. Department of Energy's (DOE) Office of Nuclear Energy (NE) is to develop nuclear fuels and claddings with enhanced accident tolerance for use in the current fleet of commercial light water reactors (LWRs) or in reactor concepts with design certifications (GEN-III+). A companion information sheet, *Enhanced Accident Tolerant Fuels for Light Water Reactors,* provides additional detail on the overall goals for Accident Tolerant Fuel (ATF) development for LWRs.

The ATF program is in the early phases of research and development, supporting the investigation of a number of technologies that may improve fuel system response and behavior in accident conditions. DOE is sponsoring multiple teams to develop ATF concepts within national laboratories, universities, and the nuclear industry. These concepts offer both evolutionary and revolutionary changes to the current nuclear fuel system. The laboratory research team is simultaneously developing a set of technical evaluation metrics to support downselection of ATF concepts.

The overall ATF development goal is to demonstrate performance by inserting a lead fuel rod (LFR) or lead fuel assembly (LFA) into a commercial power reactor by 2022 with deployment in the U.S. LWR fleet to follow within 20 years. As a step toward this goal, an irradiation test series has been defined to assess the performance of proposed ATF concepts. The test plan progresses from feasibility experiments under normal operating conditions to integral demonstrations under accident conditions to support the LFR/LFA program and eventual qualification of an ATF concept. Data generated by this test program will be used to establish the feasibility of certain aspects of proposed ATF concepts, as well as provide information to support screening among concepts.

ATF-1 Test Series: Drop-In Capsules

Designated as the ATF-1 Test Series, preliminary irradiation of ATF concepts will be performed as a series of drop-in capsule tests to be irradiated in the Advanced Test Reactor (ATR) operated by Idaho National Laboratory (INL). These experiments will investigate the performance of a variety of proposed ATF concepts under normal LWR operating conditions.

The ATF-1 capsules are filled with an inert gas and are designed to isolate fuel rodlets from the ATR primary coolant during irradiation. Hence, the test rodlet cladding will not be in contact with water coolant during irradiation. This test series is intended to investigate the irradiation behavior of new fuels and their interaction with the cladding. Resultant data on fuel behavior and fuel-cladding interaction will inform down-selection to one or more promising concepts prior to subsequent irradiation tests.

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ATF-1 will commence with the insertion of several ATF concepts supported by development teams that are led by Oak Ridge National Laboratory (ORNL), Westinghouse Electric Company, AREVA, and General Electric (GE) Global Research. Additional concepts under development by Los Alamos National Laboratory, the Electric Power Research Institute, ORNL, Westinghouse and GE will be ready for insertion in FY15. ATF capsules will be removed from ATR for post-irradiation examination at various burnup levels, ranging from 10 to 80 GWd/MTU (240 to 1300 effective fuel power days), to build a performance database.

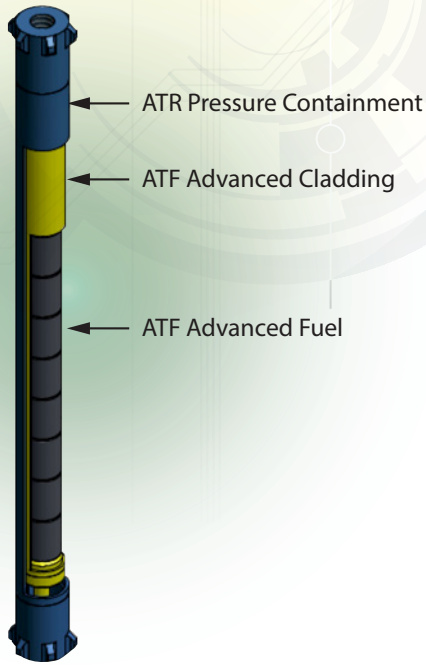
ATF-2 Test Series: ATR PWR Loop

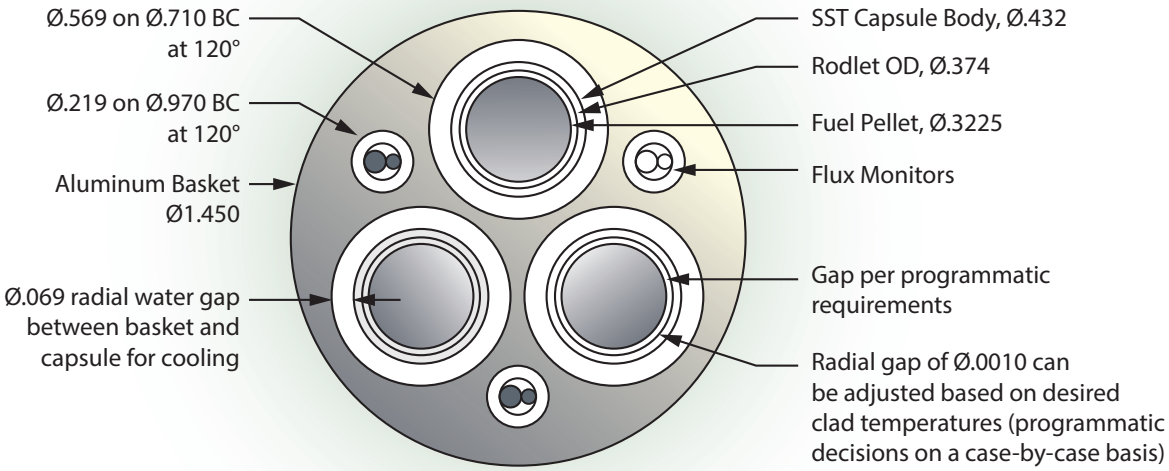
The ATF-2 series will further test the most promising concept(s) from ATF-1 in the INL ATR pressurized water loop. In an ATR loop, experimental fuel rods will be in direct contact with high-pressure water coolant with active chemistry control to mimic the conditions of pressurized water reactor (PWR) primary coolant. In addition to continuing the investigation of fuel behavior and fuel-cladding interaction begun in ATF-1, ATF-2 will include cladding-coolant interaction. ATF-2 will be the most prototypic irradiation test possible in the ATR to assess the performance of ATF concepts under normal PWR operating conditions.

ATF-3 and -4: Transient Testing

The most promising concept(s) will proceed to transient testing at the INL Transient Reactor Test (TREAT) facility for the ATF-3 test series. In TREAT, experimental ATF rods will be subjected to reactivity-initiated accident (RIA) scenarios to investigate their integral performance under this class of accident conditions. It is anticipated that this phase of testing will begin with fresh (unirradiated) fuel rods to assess performance under a beginning-of-life scenario and progress to testing of irradiated fuel rods at multiple burnup levels obtained from the ATF-1 and ATF-2 test series.

The logical final phase of the irradiation test program is to subject a subset of LFRs from commercial reactor irradiation to transient testing in TREAT. As in the ATF-3 test series, it is anticipated that this phase of testing will begin with fresh (unirradiated) fuel rods, fabricated by the same vendor and process as used for the LFRs, to assess performance under a beginning-of-life scenario and progress to irradiated LFR segments at multiple burnup levels.





Cross-section of existing ATR basket assembly to be adapted for ATF-1; multiple capsules will be stacked in each radial capsule position (dimensions in inches)

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14-50188 • INL/MIS-14-32363