EXPERIMENTAL CAPABILITIES OF THE TRANSIENT REACTOR TEST (TREAT) FACILITY*

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The TREAT facility was designed and built in the 1950s to provide a transient reactor for conducting safety experiments on reactor fuels. Throughout its almost 40-year history, it has proven to be a safe, reliable, and versatile facility, compiling a distinguished record of successful experiments. Several major improvements to the facility have been made, including an expansion of the building and of equipment handling capability, and enlargement of the access hole above the core, rearrangement of the reactor's control rods to provide more-uniform flux profiles, installation of improved reactor computer-control systems, a feedback system that safely allows real-time changes in power transients depending upon events occurring in the experiment, and several upgrades in the fast neutron hodoscope for improved experiment-fuel-motion diagnostics. The original TREAT fuel is still in use, however, since it appears to have no degradation from its many years of service.

The TREAT reactor core consists of a 19 x 19 array of 10-cm-square fuel assemblies of highly-enriched uranium-oxide dispersed through a graphite and carbon matrix. The active fuel height is 122 cm. The reactor fuel assemblies are easily removable to accommodate test vehicles or other experiment equipment of a variety of sizes and shapes. In addition, the shielding blocks above and
around the core can be removed or reconfigured as needed to permit lateral access to the core for experiment purposes. Limited accessibility to the core is available also from the bottom.

The TREAT reactor is capable of generating a wide variety of power-transient shapes. The Automatic Reactor Control System (ARCS) provides for open and closed-loop computer control to achieve, respectively, transients which (a) are initiated by a step insertion of reactivity and are terminated when a predetermined reactor period, power, energy release, or time interval has been realized or (b) follow a predetermined time and power or period profile and are terminated when a predetermined experiment parameter, reactor parameter, or time interval has been realized.

The TREAT fast-neutron hodoscope is, for most reactor safety tests, a key diagnostic instrument. By collimating and detecting fission neutrons emitted by experiment fuel samples, the hodoscope provides time and spatial resolution of fuel motion during transients and in-place measurement of fuel distribution before and after an experiment.

Most experiments in TREAT are performed on irradiated fuels. Irradiated fuel samples are loaded into the experiment capsule or loop in a large hot cell facility, called the Hot Fuel Examination Facility (HFEF), which is also located on the ANL-West site. Posttest, the fuel-bearing experiment hardware is returned to HFEF for disassembly, examination, and/or preparation for shipment to another hot cell facility. The HFEF facility includes an argon-atmosphere cell 21-m long by 9-m wide by 7.6-m high which was designed for non-destructive and destructive evaluation of fuels and materials including plutonium-bearing fuels. An adjacent air-atmosphere hot cell is used for remote assembly of previously-irradiated fuel elements into TREAT test vehicles. The Alpha-Gamma Hot Cell Facility (AGHCF) located at ANL-East is a nitrogen-atmosphere hot cell equipped for detailed
evaluation of irradiated fuels and materials. Specialized capability includes microstructural characterization using metallographic and ceramographic techniques, electron microprobe analysis, and scanning electron microscope-energy dispersive spectroscopy.

Numerous types of experiment assemblies (vehicles) have been designed and used in TREAT experiments through the years. Some assemblies contained single pins in a gas environment. Other assemblies were built to perform series of tests in which flowing coolant was required. These coolant "loops" typically are of two designs: one design is a "package" loop that fits entirely within a shielded handling cask and is inserted and removed from the reactor as a single package. In the other type of loop, much of the loop hardware (for example, pump, pressure tanks, heater, heat exchanger) is located outside the reactor and is hydraulically connected to the fueled, in-reactor assembly. Both package and ex-core sodium-coolant loops and an ex-core steam loop have been used for reactor safety testing in TREAT -- the Mark-series, R-series, and STEP loops, respectively.

International interest in higher-burnup utilization of oxide fuel and incorporation of plutonium-bearing mixed-oxide (MOX) fuel in light-water-cooled commercial reactors (LWRs), coupled with ambiguity of results of recent in-reactor safety tests on LWR reactivity-initiated accidents (RIAs), have led to a need for performing experiments that provide prototypic RIA conditions. With a pressurized water loop, now in the conceptual design phase, TREAT appears to be particularly well suited for providing such prototypic conditions. Recent calculations indicate that the reactor, with the water loop installed, is capable of simulating RIA accidents that have power bursts with full-width-at-half-maximum (FWHM) ranging from 66 msec to several seconds. For example, with a 66-ms FWHM pulse, 300 cal/gm peak energy can be deposited in 4.95%-enriched fuel pin that had been irradiated to 80 GWD/MTU. In addition, several concepts designed to provide significantly-
narrower RIA pulses appear feasible.

The high-pressure, circulating water loop being designed for TREAT will be capable of providing water temperature and pressure typical of that on a pressurized water reactor (PWR) type of LWR. It will be of the ex-core design, with most of the equipment located atop the TREAT reactor. A U-shaped zircaloy extension (in-pile assembly) into the reactor core region will contain the test fuel rods (up to three PWR rods or two BWR rods). Experiment fuel will be installed into, and removed from, the in-pile portion of the loop at HFEF. The main, ex-reactor portion, of the loop will remain in place from test to test. Its fundamental components are water holding tanks, pump, water heater, and cesium filter/trap. Instrumentation in the test fuel region and elsewhere in the loop will measure temperatures, flow rates, pressures, and other parameters of interest. Modification of the loop concept would allow testing of CANDU reactor fuel elements.

TREAT has not only a distinguished history of producing significant safety experiment results but also a future expected to last well into the 21st century. It provides a safe, reliable, versatile, and economical facility for testing of high-burnup LWR elements, CANDU reactor elements, and innovative fuel element designs for reactors of the future. It is anticipated that the utilization of TREAT will continue to provide significant data supporting safe nuclear power generation to meet the world's growing need for clean production of electricity.