INL TRANSIENT REACTOR RESTART PROGRESS

John D. Bumgardner
Transient Testing Director
Idaho National Laboratory, Idaho Falls, ID 83415
john.bumgardner@inl.gov

ABSTRACT

Final preparations for restart of the TREAT are under way. The TREAT reactor was used from 1959 to 1994 to conduct more than 2,800 nuclear fuel transient tests, and was placed in standby in 1994. The plant was extensively upgraded shortly before it was placed in standby. The reactor systems and infrastructure were renewed as required, procedures and configuration management documents have been updated, and a qualified operating organization put in place.

The United States Department of Energy authorized operations of the Transient Reactor Test (TREAT) facility on August 31st, 2017. This authorization completed the reactor restart program, more than twelve months ahead of the baseline schedule and approximately $20 million less than the baseline cost estimate.

A controlled approach to restart of the TREAT reactor is being implemented with actual startup anticipated by early 2018. Following reactor performance evaluation and physics testing the experimental programs will be initiated.

Keywords: **TREAT, Transient Test Reactor, INL**

1. TRANSIENT TESTING SIMULATES ACCIDENT CONDITIONS

Transient tests expose nuclear fuel systems to a wide range of carefully controlled dynamic conditions, simulating events, up to and including extreme scenarios that can induce fuel and material system failure, with capability to monitor the fuel response in real time. After the experiment is completed, the fuel or material is analyzed to determine the effects of the radiation. Transient test results are critical for development and validation of robust fuel designs and the fuel safety criteria that define their operational envelope.

Transient testing is required for essentially all nuclear fuel design and qualification efforts to learn how nuclear fuel will respond during accidents involving transient overpower and/or under cooling events. For example, nuclear fuel may fragment when exposed to higher than normal power or temperature. This fragmentation can cause unacceptable post-accident performance. Transient testing is also needed to validate performance models for nuclear fuel and materials.

These models, when validated, will dramatically shorten the development and qualification life cycle for nuclear fuels, supporting rapid development of low emissions, and reliable nuclear power generation.

The TREAT reactor was used from 1959 to 1994 to conduct more than 2,800 nuclear fuel transient tests, and was placed in standby in 1994. Nearly all transient testing capability was lost in the United States when the Idaho National Laboratory (INL) Transient Reactor Test (TREAT) facility was placed in standby in 1994. The U.S. Department of Energy evaluated how to provide the required transient testing capability currently and, following completion of the National Environmental Policy Act process, they selected the Transient Reactor Test (TREAT) facility to resume transient testing. TREAT is located at Idaho National Laboratory (INL).

TREAT's test region is flexible and can accommodate devices ranging from simple capsules for separate effects studies through complex recirculating loops capable of simulating operating environments, and accident conditions including a multistage loss-of-coolant-accident (LOCA) simulation. The unique open core layout also enables unrivaled access to the test region for real-time monitoring of the experiment during the test. TREAT is capable of transients in excess of 20 GW.

2. TREAT RESTART PROGRESS

The TREAT restart used an approach similar to recovery from an extended reactor outage, with a focus on time-related factors such as age-related degradation and updated operational, engineering and regulatory standards. The program relied on a high-level, multi-year integrated schedule that guided major program activities from initial program planning to successful demonstration of readiness to restart the TREAT reactor.

The plant was extensively upgraded shortly before it was placed in standby. Present day assessments revealed that a sound infrastructure remains at the plant; thorough testing has proven that all major reactor plant systems are fully functional to support operations; the previous procedures, drawings, and other documentation were preserved and updated to current standards; a strong team was hired to support both restart efforts and transition into operations which included some personnel who were involved in historical operations. The following sections provide restart highlights.

2.1 Fuel Evaluations

The fuel was evaluated and found acceptable for reactor operation. The TREAT fuel was placed in service since 1959. Since that time, ~30% of the analyzed use has been experienced, with ~70% of the analyzed life remaining before the fission product source term requires reevaluation for continued operations. Core burnup is approximately 0.3%, and there is an associated low fission product buildup and radioactivity. It is expected the fuel will last for the scheduled lifetime of the reactor.

FIGURE 1. TREAT Fuel Assembly Lift and Inspection

The physical evaluation of the fuel involved lifting fuel assemblies from the core, and performing a visual evaluation as shown in the photo above. One fuel element was found to have a clad anomaly and was taken out of service, and minor foreign material issues were identified and resolved.

2.2 Systems Status

Extensive system readiness activities ensured proper functioning of all TREAT systems to support reactor operations. The TREAT systems have been evaluated in detail, corrective and preventative maintenance performed, and functional testing complete. No reactor systems required major change or modification.

A few noteworthy actions taken include changes to the control areas fire protection systems, primarily to improve fire detection and change out of the HALON gaseous fire protection system to an environmentally friendly equivalent.

The shock dampeners in the bottom of the control/shutdown and compensating/shutdown control rod actuators required replacement due to leaking seals. To replace the dampeners, it was necessary to fully remove and reinstall all of the control/shutdown and compensating/shutdown control rods and actuators. Figure 2 shows a picture of the control rods in the subpile room and replacement removal activity.

FIGURE 2. TREAT Subpile room showing the control rod actuators and replacement activity

The automatic reactor control system (ARCS) is a fully digital control system that has been restored and returned to service. The software was recovered and full simulation testing has ensured the system is ready to support reactor operations. Figure 3 shows the ARCS (blue cabinet on the right) with maintenance activities being conducted.

FIGURE 3. ARCS startup and functional testing

All remaining plant systems have had the evaluations and integrated functional testing completed.

2.3 Documented Safety Analysis

The TREAT Safety Analysis Report (SAR) was updated to current standards and subsequently approved by the Department of Energy regulator. The SAR is in the Nuclear Regulatory Commission (NRC) Regulatory Guide 1.70 format, the approved safe harbor for DOE reactors.

2.4 Procedures

The procedures required for restart of operations have been writtten, approved, and released for use. Historical documents have proven to be of great value, and were the starting point for the updated procedures.

2.5 Personnel and Training

Staffing levels are adequate for reactor restart and subsequent reactor operations and all required training has been completed. The plant was used in a simulation mode for training exercises as shown in Figure 4.

FIGURE 4. TREAT control room simulated operations

2.6 Experiment Capability

The infrastructure for preparation and conduct of experiments is being updated, and progress has been made with the design and fabrication of new test vehicles with modern instrumentation. Upon successful restart, the first experimental objectives will be primarily related to the current generation of Light Water Reactors, including development of accident tolerant fuel. Experiments are also being developed for fast reactors, and multiple other customers.

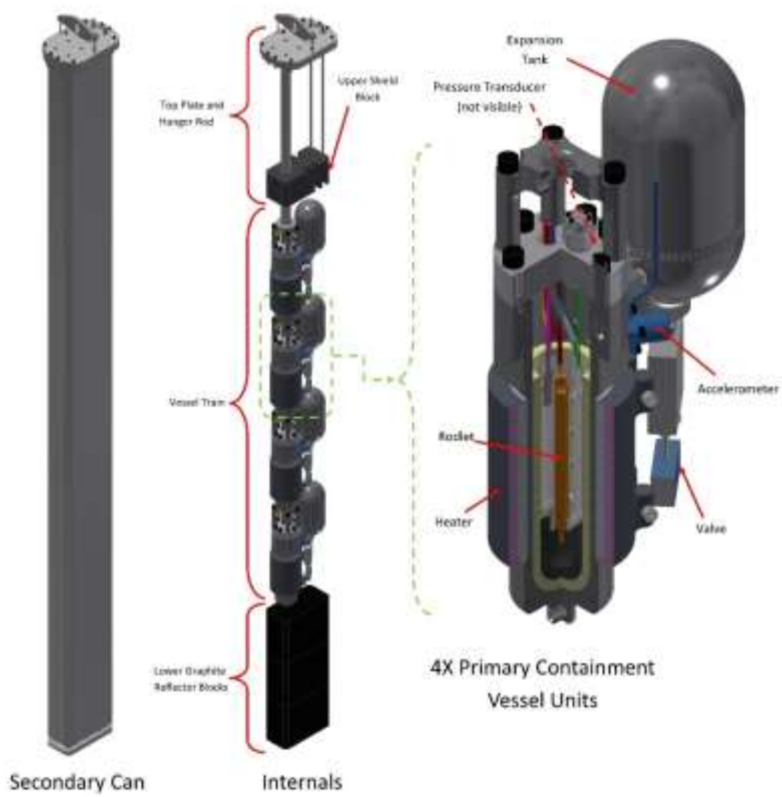

FIGURE 5. Multi - Static Environment Rodlet Transient Test Apparatus (SERTTA)

3. CONCLUSION

All activities required for TREAT restart have been completed more than a year ahead of schedule and approximately $20 million less than the baseline cost estimate. TREAT plant reactor fuel and equipment are acceptable for reactor operations. The updated safety basis is in place, and procedures, training and general plant maintenance and restoration efforts are complete. Experiment capability preparations are in progress. The Department of Energy has approved reactor startup which is anticipated by early 2018.