Status of Transient Testing Capabilities in the United States

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GAIN Workshop on Fuel Safety Research
May 1-5, 2017, Idaho Falls, ID
Fuel Safety Research

- **Objective:**
  Conduct the experimental activities required to help the industry describe how fuel systems respond to relevant transients (both operational and off-normal)
History of Transient Testing at the INL

• Since its inception as the US Nuclear Reactor Testing Station (NRTS) in the 1950’s, researchers at the INL have been conducting experimental programs to establish the limits of nuclear system performance.

• These studies were critical to establishing the fuel safety criteria required to develop, design, and deploy nuclear technologies that form the basis of today’s nuclear energy industry.

• A similar effort is required to realize the advanced nuclear technologies of tomorrow’s nuclear energy industry.
History of Transient Testing in Idaho

- **1950**: Special Power Excursion Reactor
- **1960**: SPERT
- **1970**: Transient Reactor Test Facility
- **1980**: Loss of Fluid Test Facility
- **1990**: Power Burst Facility
- **2000**: Operational Standby
- **2010**: Planned restart
- **2020**: TREAT

Timeline events include:
- 1950: Special Power Excursion Reactor
- 1960: SPERT
- 1970: Transient Reactor Test Facility
- 1980: Loss of Fluid Test Facility
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- 2020: TREAT
Scientific Instruments for Fuel Safety Research

Nuclear Transient

Sample Environment

Instruments

Research on Fuel System Samples

Real-time Monitoring

Irradiation Test Vehicles

TREAT

Note: a thermal transient is applied by a furnace in out-of-pile testing to simulate the nuclear transient
Nuclear Transient

- TREAT’s unique design delivers the nuclear environment required to meet fuel safety research needs
  - 19 GW Peak Transient Power (with 100 kW Steady-state power option)
  - Core: \(~1.2 \text{ m high x 2 m. dia}\) 19 x 19 array of 10 x 10-cm. fuel and reflector assemblies
  - Instantaneous, large negative temperature coefficient (self protecting driver core)

- Resumption of Operations
  - ‘Mission Need Statement for Resumption of Transient Testing’ issued by DOE in January 2010
  - TREAT Selected as ‘preferred option’ in February 2014 and restart activities were initiated at the beginning of FY15
  - Commitment to restart by the end of 2018 (to support the Accident Tolerant Fuels Program)
  - First operations anticipated in November this year
**TREAT Transients**

**Pulsing**
- NSRR
- PBF
- CABRI
- LWR
- TREAT Pulse with He-3 Shutdown System
- TREAT Clipped Pulse using Control Rods
- TREAT Natural Pulse

**Continuous Power**
(e.g. ‘Flattop’)

**Power Ramps**
- 50% Overpower, 1.7 %/s Ramp

**Complex Transients**

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absorbing rods such that the reactor can support a transient such as an
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- Received during performance of a typical M-series heat balance (M7) used to determine test pin
- Power couple.
Sample Environment

- The irradiation test vehicle used in TREAT are cartridge type devices operated independently of the reactor.
- These devices deliver the experiment specific thermal-hydraulic environment. Systems can be developed to deliver a wide range of conditions
  - Prototypic pressure/temperature/flow for LWR, SFR, LFR, GR or MSR applications
  - Specialized or simplified environments for separate effects studies

MARCH Vehicle for Separate Effects Studies

Sodium Loop for Prototypic Fuel Performance Tests
Instrumentation

- Pre- and Post-Test Examination
  - Traditional PIE
  - Modern 3D neutron tomography

- In-situ Instrumentation
  - High speed, specialized instrumentation to monitor temperature, pressure, deformation, etc.
  - Fast Neutron Hodoscope for real-time fuel motion monitoring

3D Reconstruction of 7-pin TREAT Test

TREAT Fast Neutron Hodoscope
More than just TREAT ...

- Additional capabilities are available at the DOE hot cell facilities and Material Test Reactors. See the latest during the poster session.
Summary

- Fuel Safety Research plays a crucial role in maintaining and developing nuclear energy technology.

- The TREAT facility is being reactivated by the US DOE to serve as a cornerstone scientific instrument in this field. Optimal development of this instrument will require engagement with the nuclear technology community to prioritize development in several key areas including:
  - Transient capability
  - Sample environment
  - Instrumentation

- This instrument will be integrated with existing out-of-pile fuel safety research infrastructure to provide the nuclear industry with a comprehensive domestic capability.