ATR Experiment Program

Frances M. Marshall
Manager, ATR Experiment Program

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Idaho National Laboratory

Presentation Outline

- ATR Description Summary
- Experiment Configurations and Capabilities
- Current Research
- Proposed Research
- Planned Enhancements
- Summary

ATR Description

Reactor Type

Pressurized, light-water moderated and cooled; beryllium reflector
250 MWt design

Reactor Vessel

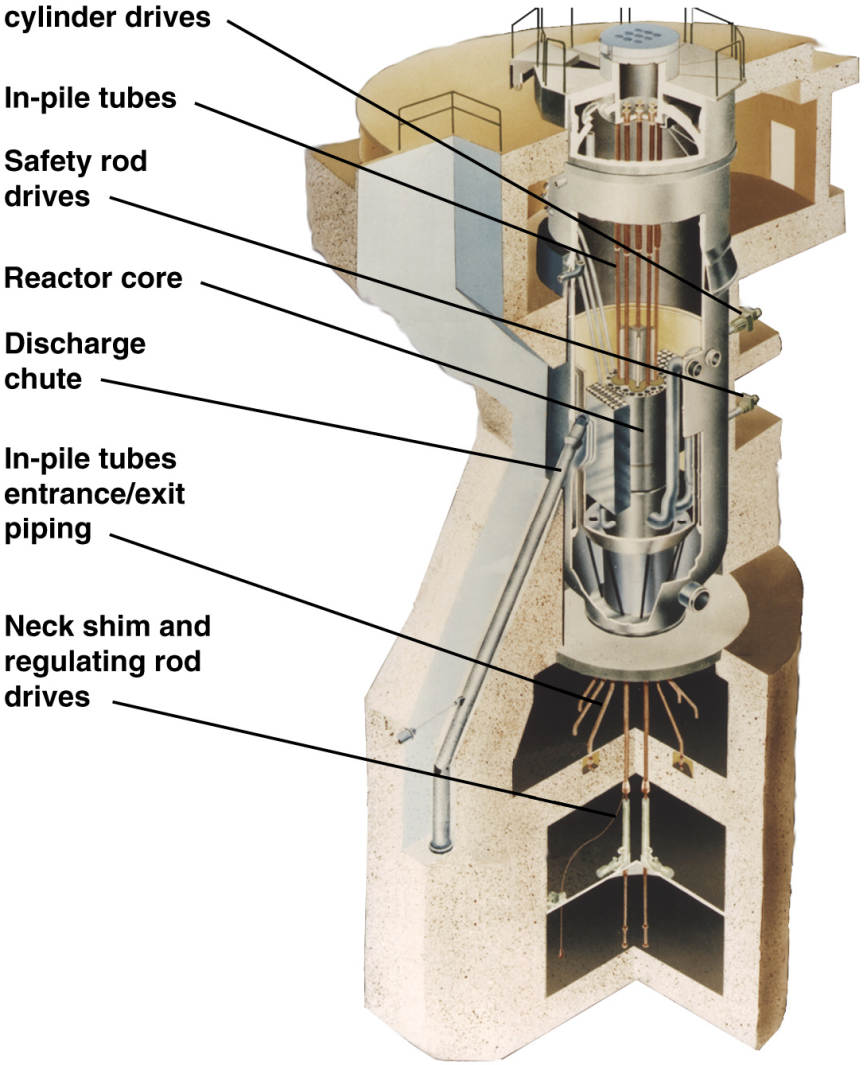
12 ft (3.65 m) diameter cylinder,
36 ft (10.67 m) high stainless steel

Maximum Flux, at 250 MW

1 x 10^{15} n/cm^2-sec thermal
5 x 10^{14} n/cm^2-sec fast

Reactor Core

Fuel length – 48” (122 cm)
U-Al plates – 19/assembly

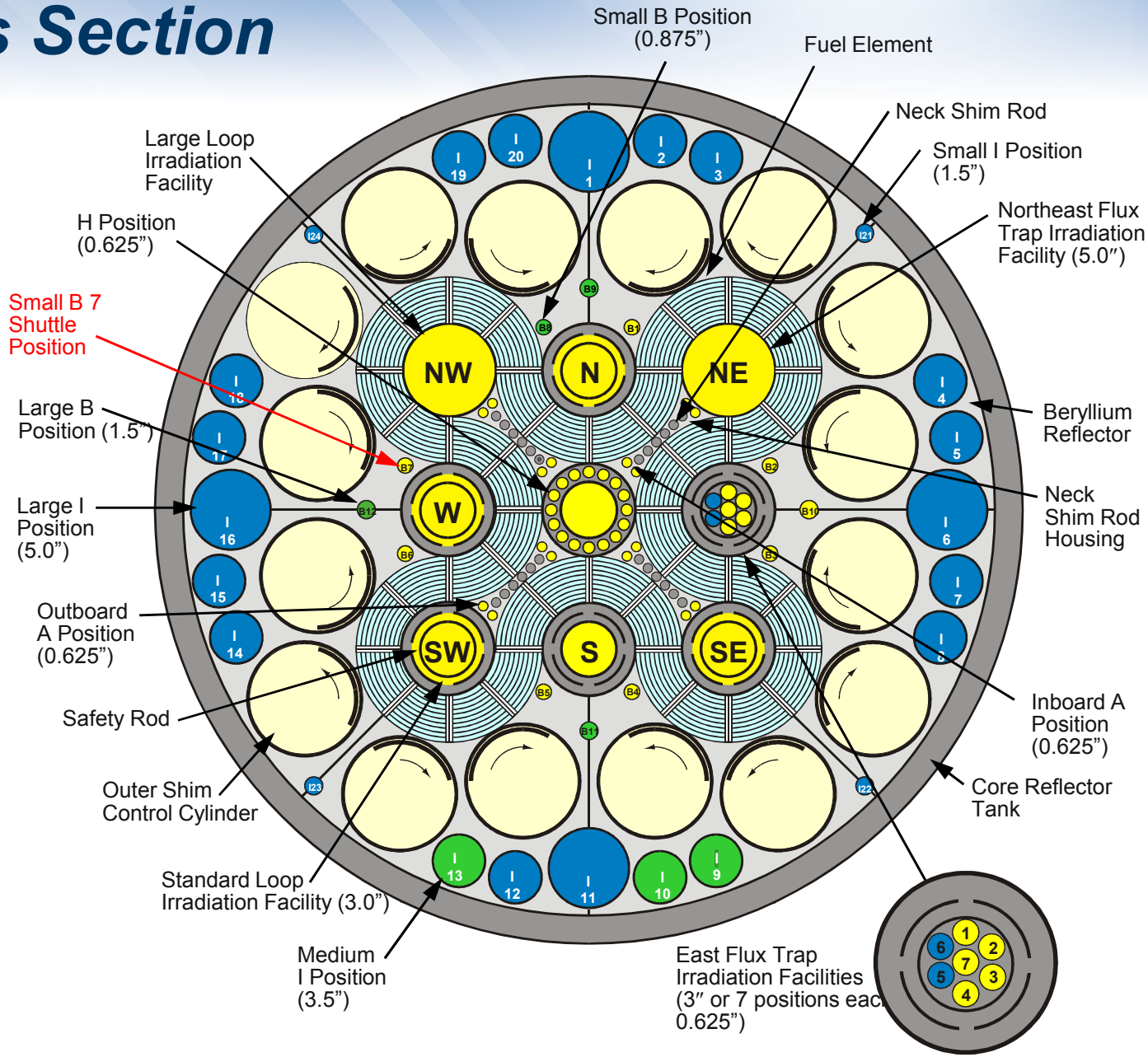


ATR Core Cross Section

77 irradiation positions

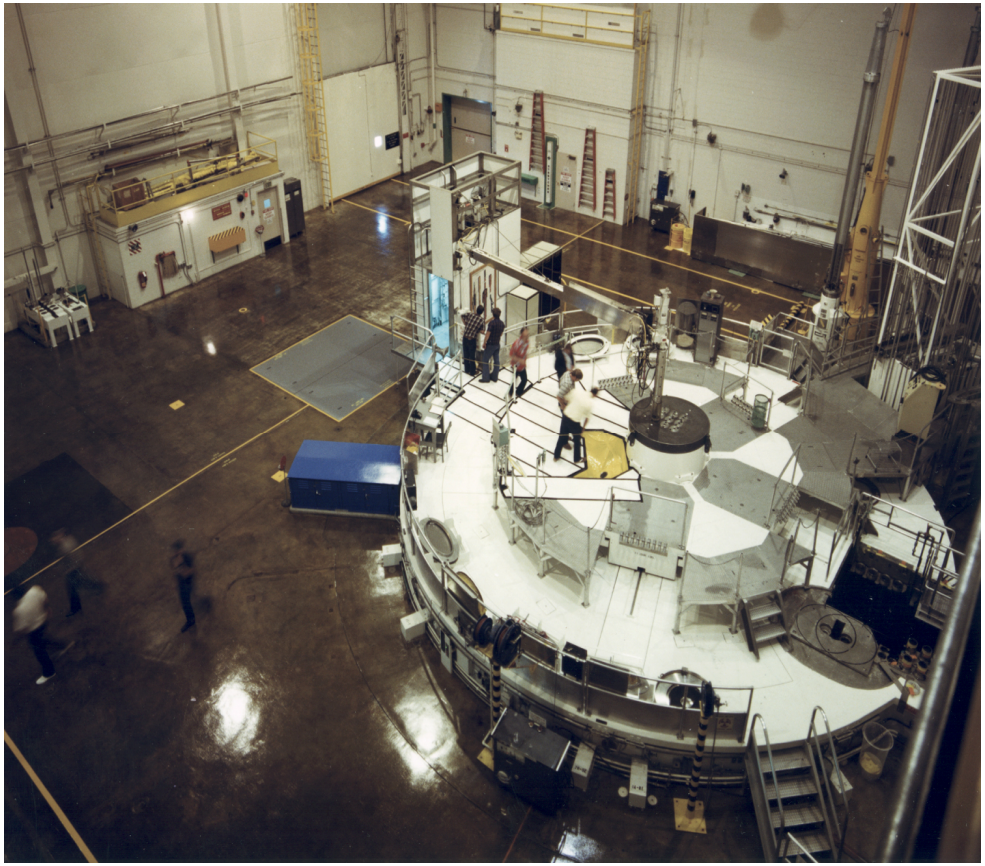
- 4 flux traps
- 5 in-pile tubes
- 68 in reflector

Currently in use
Planned future use (within 18 months)
Currently unplanned for 2010



ATR Operational Schedule

- Operating Cycles
  - Standard operating cycle is 6 to 8 weeks
  - Occasionally short high power cycles of 2 weeks
  - Standard reactor outages are 1 or 2 weeks
  - Operations for approximately 250 days per year
- Core Internals Changeout (CIC), every 7 to 10 years
- ATR Critical Facility – used for reactivity measurements

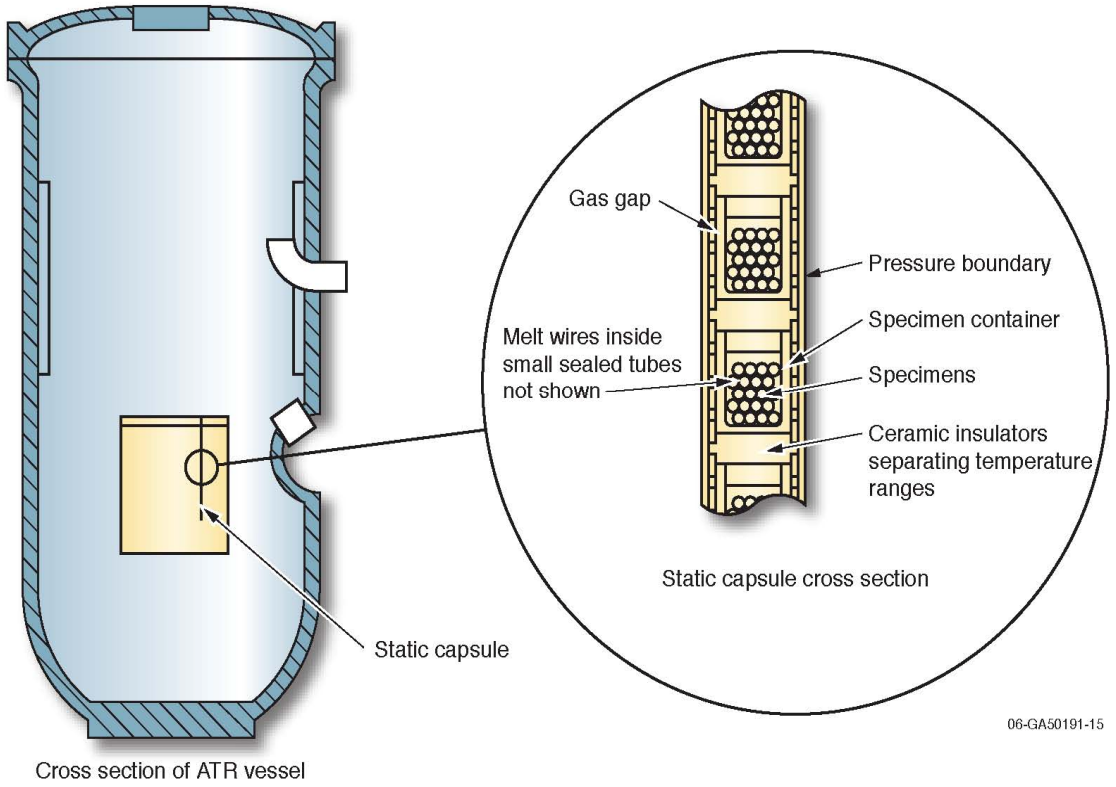


Irradiation Environments

- Inert gas - temperature control selections
  - Insulator gas
    - Argon – good temperature range but activation issue
    - Neon – less temperature range but very limited activation - fission gas monitoring
- Non-inert gas
  - Utilize different temperature control gases
  - Utilize second gas boundary and specific cover gas
- Thermal Bonding – liquid metal
  - Reduced temperature gradients in specimens
  - Smaller gas gaps necessary to achieve desired temperatures
- Pressurized water
  - Chemistry control
  - Flow
    - Loop
    - Stagnant – water capsule facility
    - Test reactor primary coolant system

Simple Static Capsule Experiments

- Passive instrumentation (flux wires, melt wires)
- Enclosed in sealed tube, or fuel plates
- Temperature target controlled by varying gas mixture in conduction gap and with material selection
- Lengths up to 48”; diameter 0.5” – 5.0”
- Co-60, AFCI, NSUF, RERTR

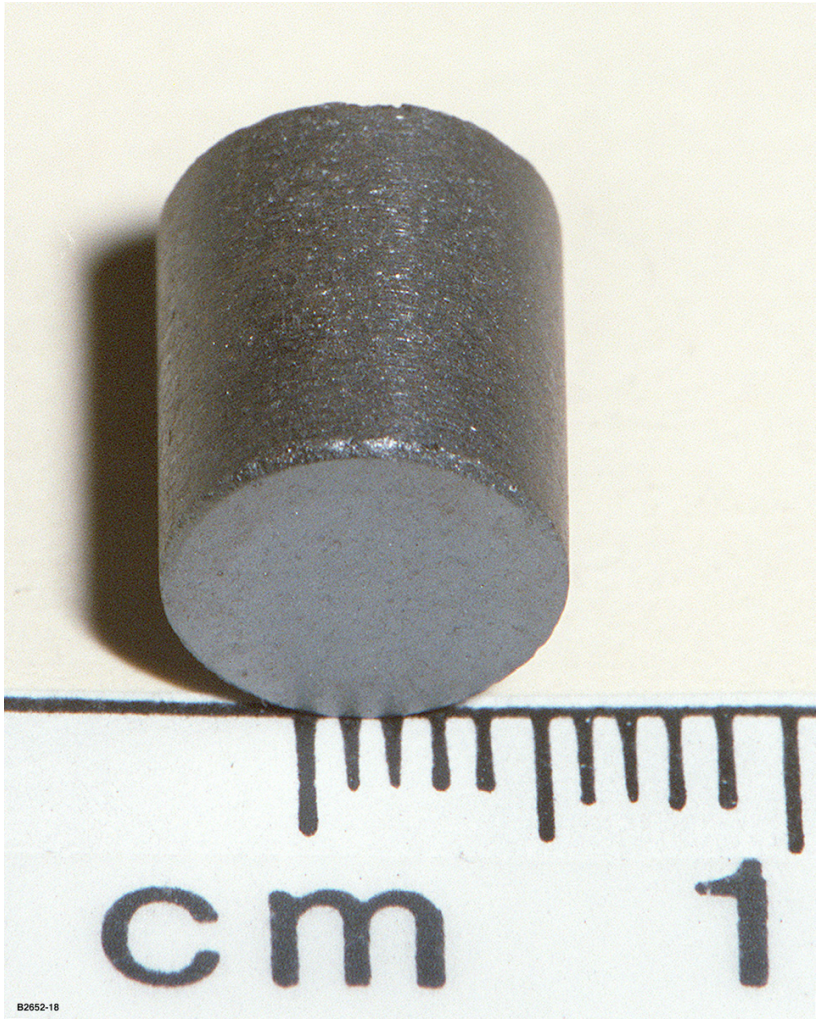


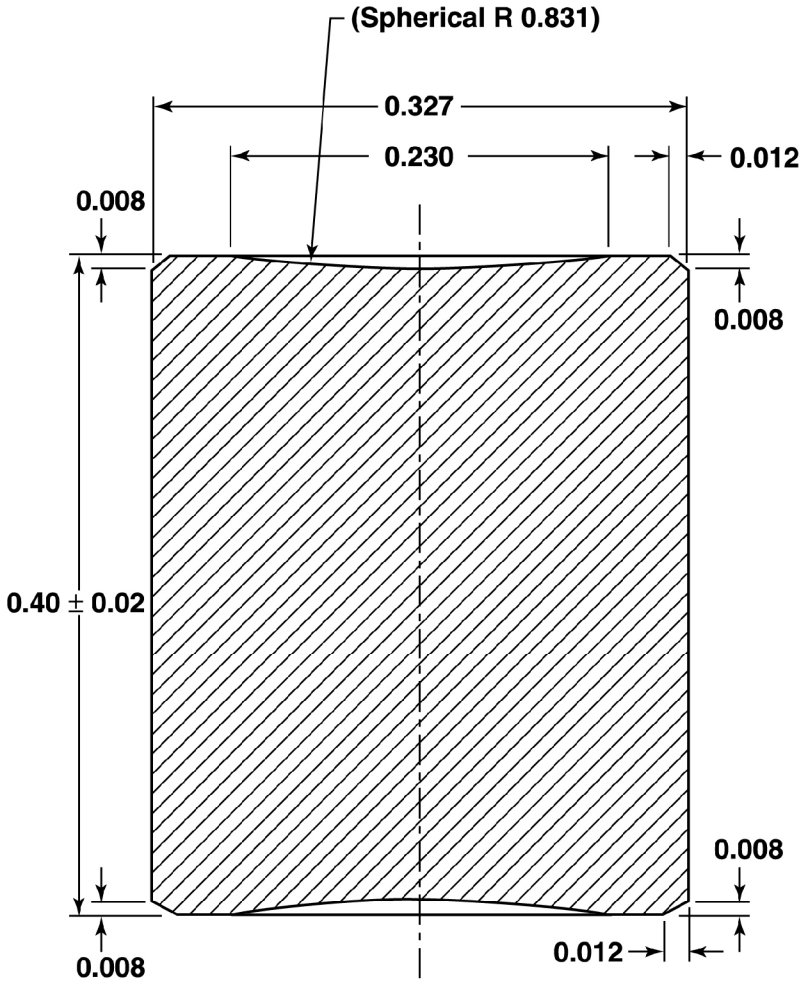
Mixed Oxide (MOX) Fuel Irradiation

Purpose of the experiment was to obtain Mixed Oxide Fuel (MOX) fuel and cladding irradiation performance data on fuel pins made with weapons grade plutonium.

- PWR temperature at surface of fuel pin cladding
- Linear heat rate requirements
  - 6 KW/ft minimum
  - 10 KW/ft maximum
- Fuel burn-up levels
  - 8 GWd/t minimum
  - 50 GWd/t maximum
- Maintain orientation of irradiation basket in relation to ATR core center
- Maintain orientation of fuel pins relative to ATR core center

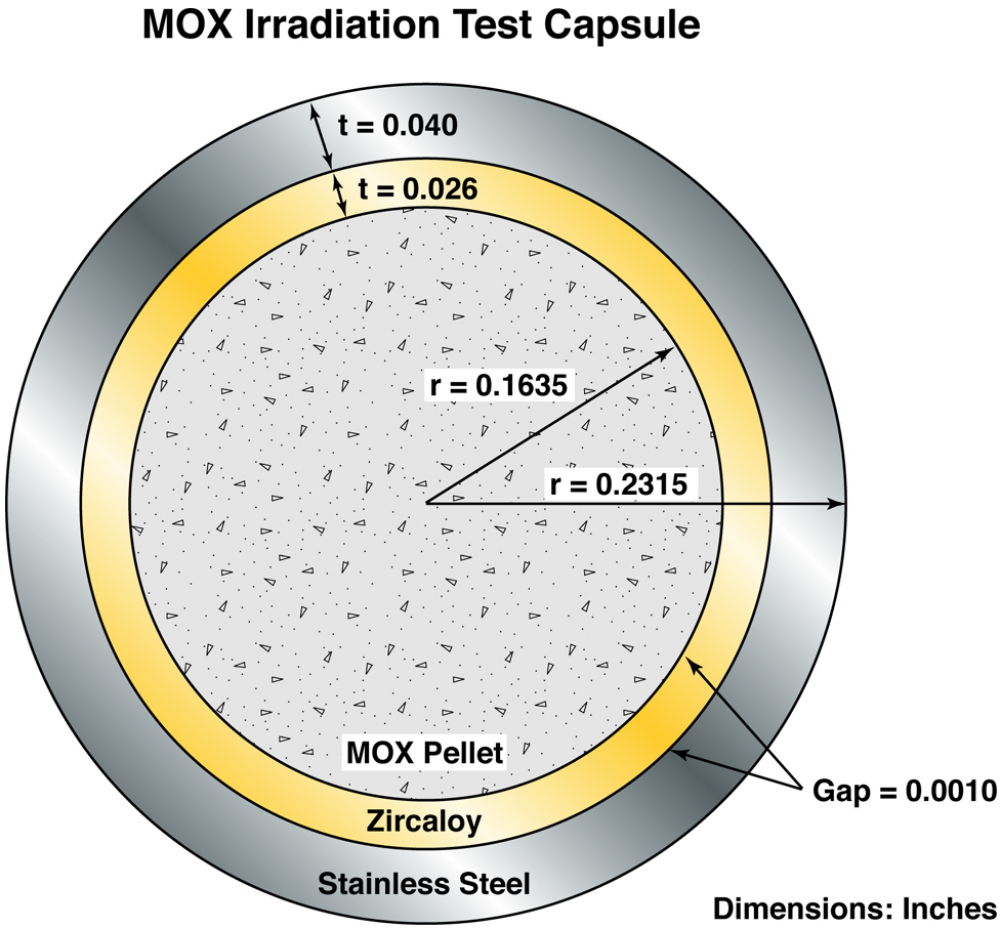
MOX Test Fuel Pellets





Test Fuel Employed Typical PWR Pellet Dimensions with Normal Dish and Chamfer

MOX Fuel Capsule Cross Section

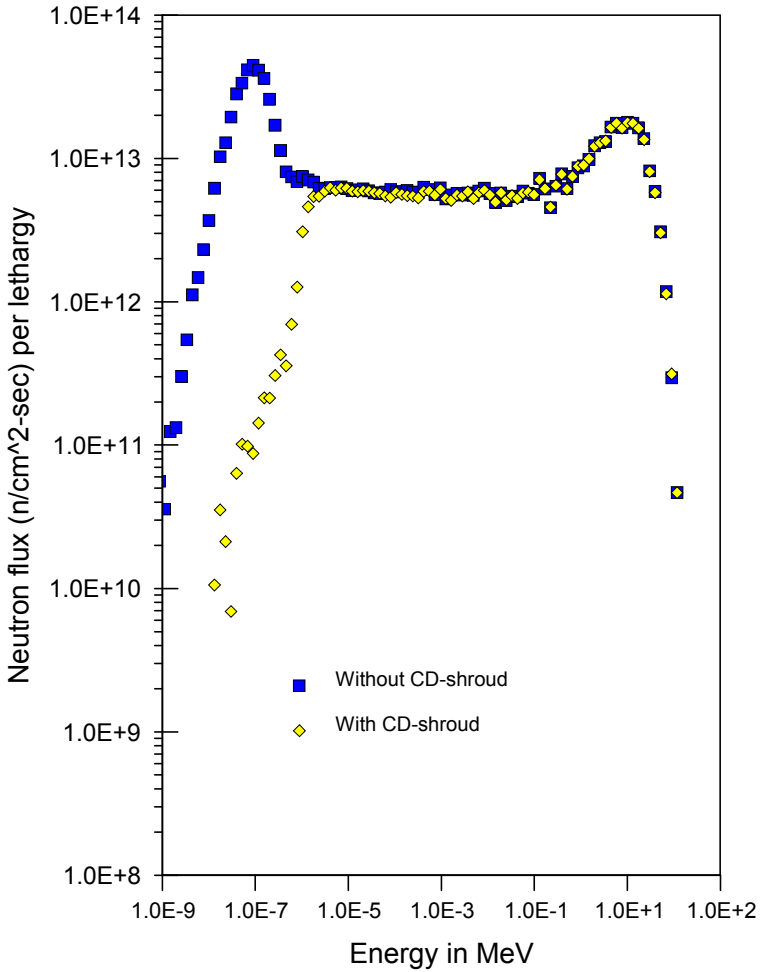


- Capsule designed to ASME Section III Class 1 requirements
- Small (0.001”) insulating gas gap between fuel pin and capsule provided desired temperatures
- Zircaloy fuel pin outer surface protected from
  - Corrosion
  - Hydrogen pickup (hydrides)

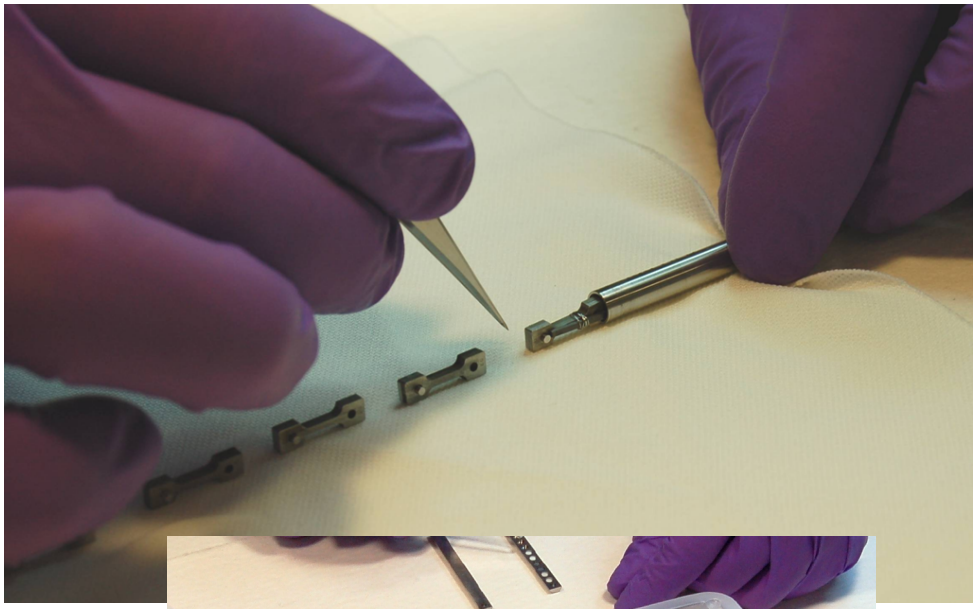
AFCI Flux Spectra with Cadmium Sleeved Basket

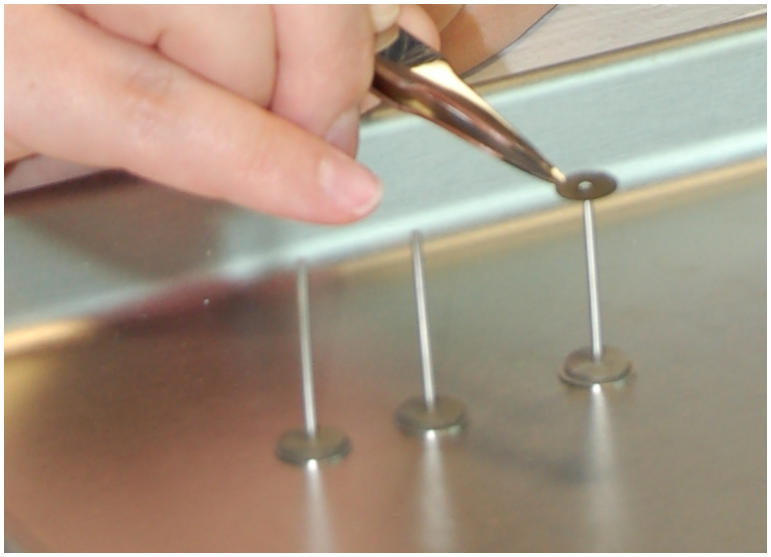
- Hard Spectrum Achieved in ATR by Use Of .045 inch Thick Cadmium
- > 97% of Thermal Flux is Removed

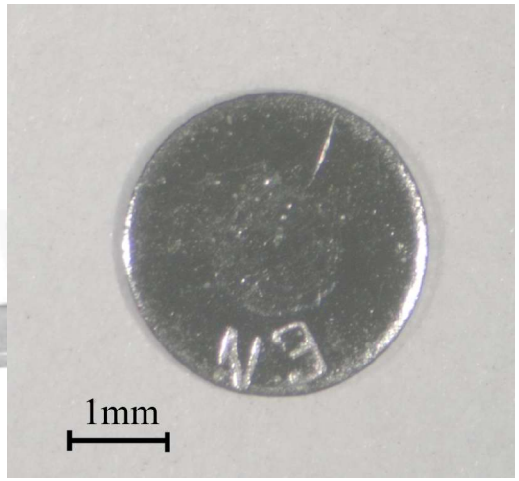
	Thermal neutron flux (E < 0.625 eV) n/cm^2-sec	Fast neutron flux (E > 1.0 MeV) n/cm^2-sec
With CD-shroud	8.46E+12	9.31E+13
Without CD-shroud	3.71E+14	9.39E+13
Ratio	2.28%	99.14%
Note: the flux tallies are normalized to a E-lobe power of 22 MW.		



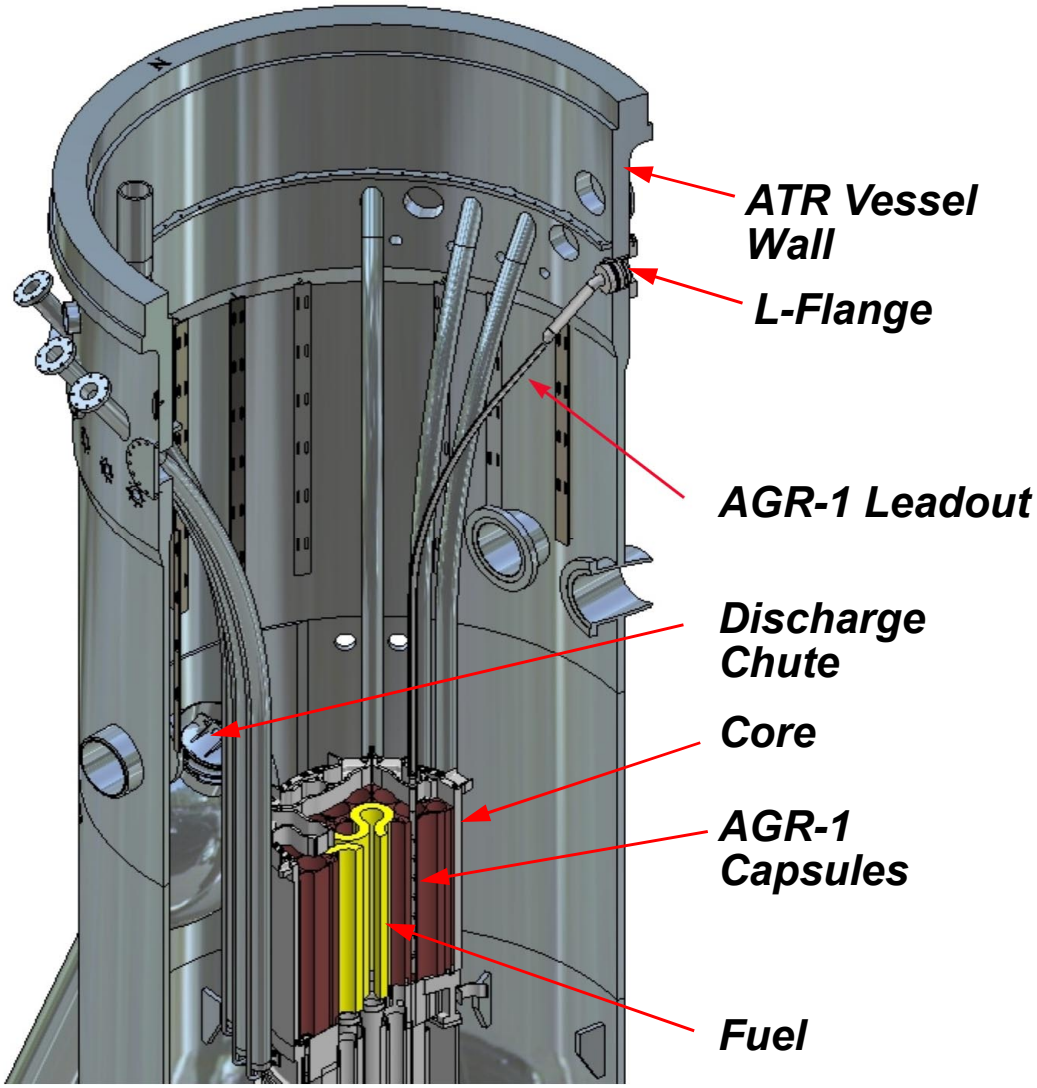
NSUF Experiment Fabrication – Sample Loading







Instrumented Lead Experiments



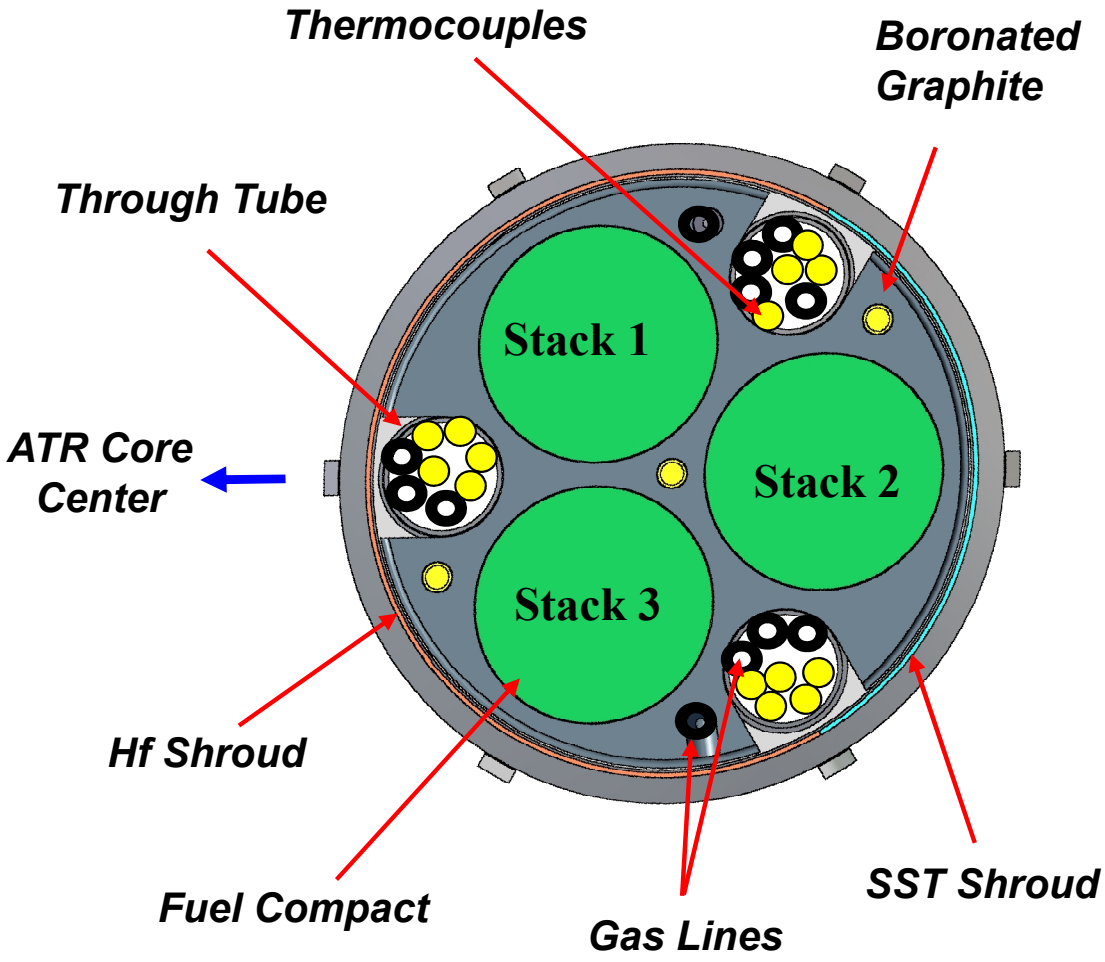
- On-line experiment measurements
- Temperature control range 250-1200°C, within +/- 5°C
- Monitoring of temperature control exhaust gases for experiment performance (e.g., fission products, leaking materials, etc.)
- Specialized gas environments (oxidized, inert, etc.)
- AGR, AGC, TTP

AGR Fuel Program

- Objective - support development of next generation Very High Temperature Reactors - near term for the Next Generation Nuclear Plant
  - Provide irradiation performance data to support fuel process development
  - Support development & validation of fuel performance & fission product transport models and codes
  - Provide irradiated fuel & materials for post irradiation examination & safety testing
- Purposes of AGR-1 Experiment are:
  - Shakedown of test design prior to fuel qualification tests
  - Irradiate early fuel from laboratory scale processes
- TRISO-coated, Uranium Oxycarbide (UCO)
- Low Enriched Uranium (LEU), <20% enrichment

AGR-1 Capsule Design Features

- Fuel Stacks
  - 3 fuel compacts/level
  - 4 levels/capsule
  - Total of 12 fuel compacts/capsule
  - Surrounded by nuclear grade graphite
- Through Tubes
  - Provide pathway for gas lines & TC's between capsules
  - Maintain temperature control gas jacket

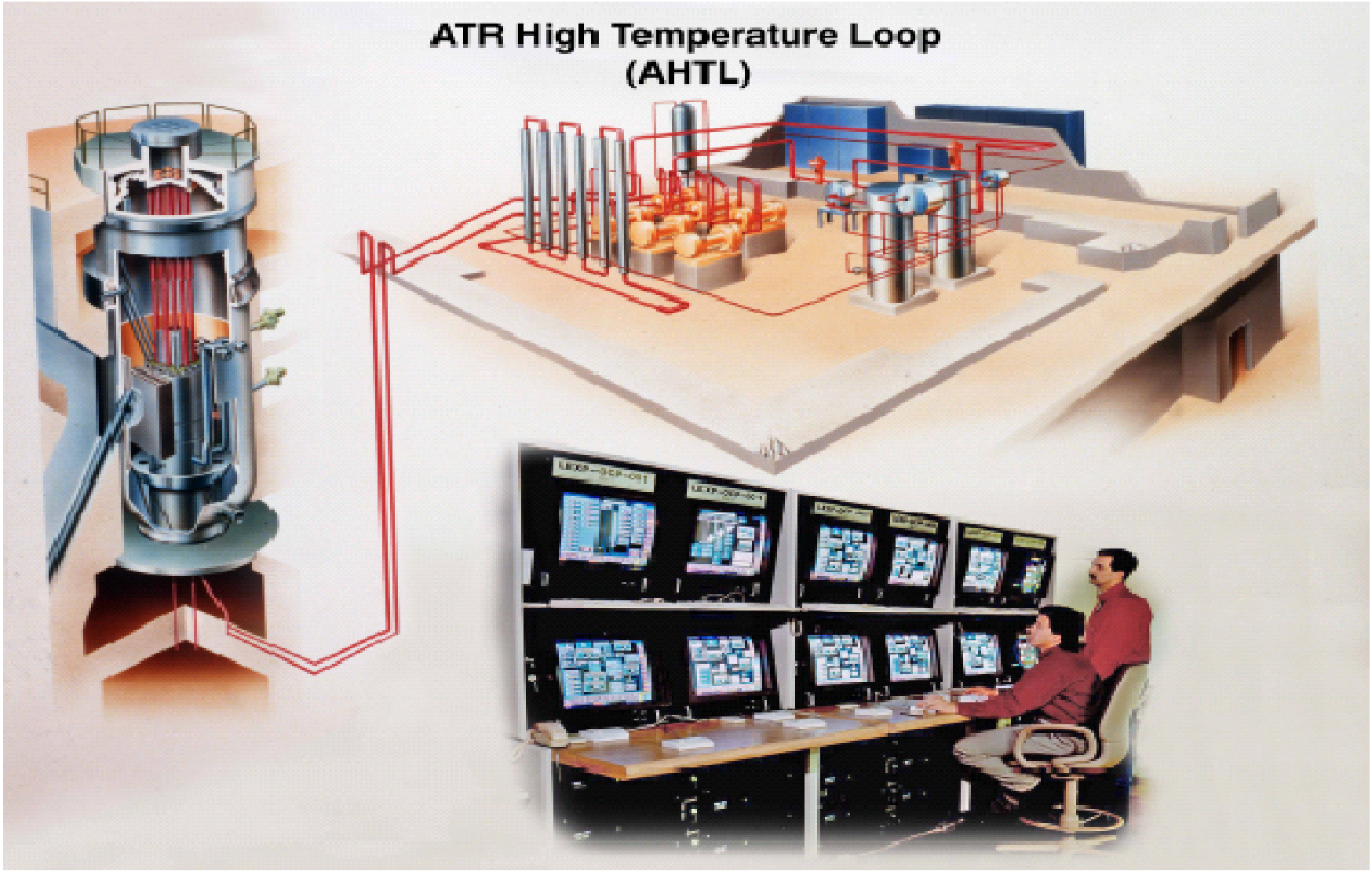


AGR-1 Capsule Cross Section

Pressurized Water Loop Tests

- Five Flux Trap Positions Currently have Pressurized Water In-pile Loop Tests (1 large diameter, 4 small diameter)
- Separate from ATR Primary Coolant System - can meet current PWR operating conditions (2235 psig, 650F)
  - Temperature
  - Pressure
  - Flow
  - Chemistry control systems
  - Transient testing capabilities (cycle/seconds)
- Potentially feasible to simulate boiling water reactor void conditions

ATR Standard Loop Layout



Current ATR Irradiation Projects

- Naval Reactors Materials
- Advanced Fuel Cycle Initiative (AFCI)
- NGNP, Particle Fuel and Graphite
- University NSUF Materials
- Tritium Barrier Material
- RERTR Fuel
- Cobalt-60
- Zirconium

Proposed Irradiation Tests

- Isotopes, Industrial and Medical Applications
- Light Water Reactor (LWR) Material in PWR Loop - Cladding, Fuel, Control Rod Material
- Simulation of BWR Conditions for LWR and New Reactors
- Advanced Fuels for Fuel Cycle and New Reactor Research
- Optical Fibers for Instruments
- Zircaloy Material for LWR Applications
- Material Tests for International Research on Aging and New Reactor Designs

Expressions of Interest in Irradiation Tests

- Beryllium Samples (Research Reactor Reflector Applications)
- Treated Stainless Steel
- Control Blade Material, Commercial LWR Applications
- Instrument Tests for Reactor Measurement and Test Parameters
- New Reactor Fuel Elements
- Aqueous Reactor Structural Material

NSUF Experiments in Process

- University Pilot Project – University of Wisconsin (UW), capsule
- 2008 Peer Reviewed Experiments Awarded, In Reactor
  - University of Florida (UF), capsule
  - North Carolina State University (NCSU), capsule
  - University of Illinois (UI), capsule
  - University of California, Santa Barbara (UCSB), capsule
  - Colorado School of Mines (CSM), irradiation in MITR
- 2009 Peer Reviewed Experiments Awarded
  - UCSB, instrumented lead
  - Utah State University, capsule
  - UW, PIE only
  - Massachusetts Institute of Technology (MIT), irradiation in MIT Reactor
  - Drexel University, capsule
  - Idaho State University, ATR Critical Facility

Irradiation Capability Enhancements

- Test Train Assembly Facility – Completed in Summer 2009
- Instrumentation Development
  - Continue on temperature measurement capabilities
  - Beginning investigations on in-experiment creep rigs
  - In cooperation with INL LDRD program
- PWR Loop Test Readiness Project - Prepare Systems to Install Experiments and Handle Irradiated Experiments
  - Initial systems (assembly) completed in 2010
  - Irradiated experiment handling systems completed in 2011
- Laboratory Initiative to Establish Irradiated Experiment Shipping

Summary

- Continued growth in DOE programs (NGNP, AFCI, RERTR, TMIST, NSUF)
- Increase in ATR Interest from Other Sources
  - Isotopes
  - LWR industry
  - Private companies
  - Foreign organizations, government and private
- Continue to Invest in Capability Enhancements and Personnel Skills
- DOE Commitment for Long Term Utilization of ATR