Resumption of Transient Testing Program

TREAT Startup Update

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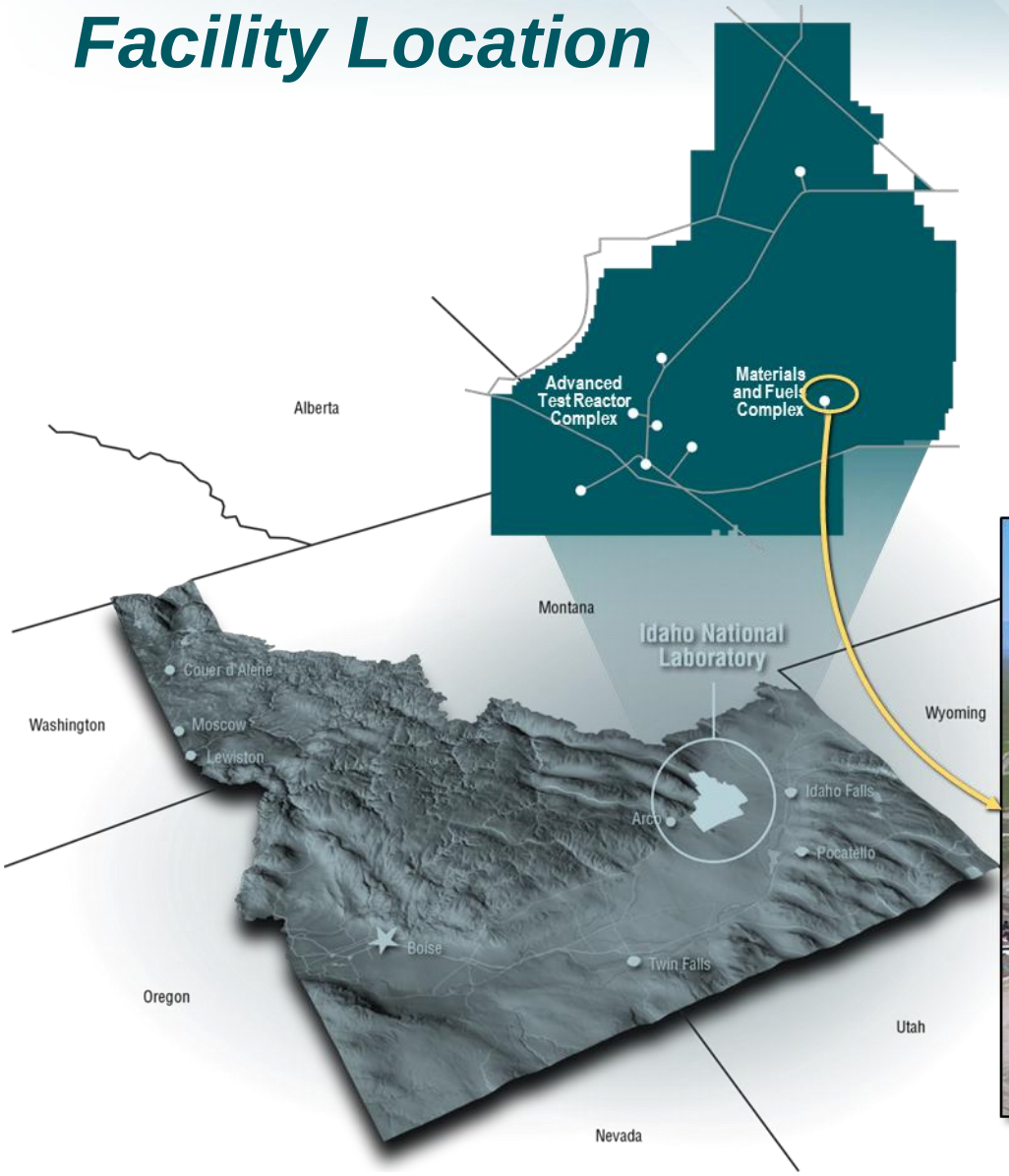
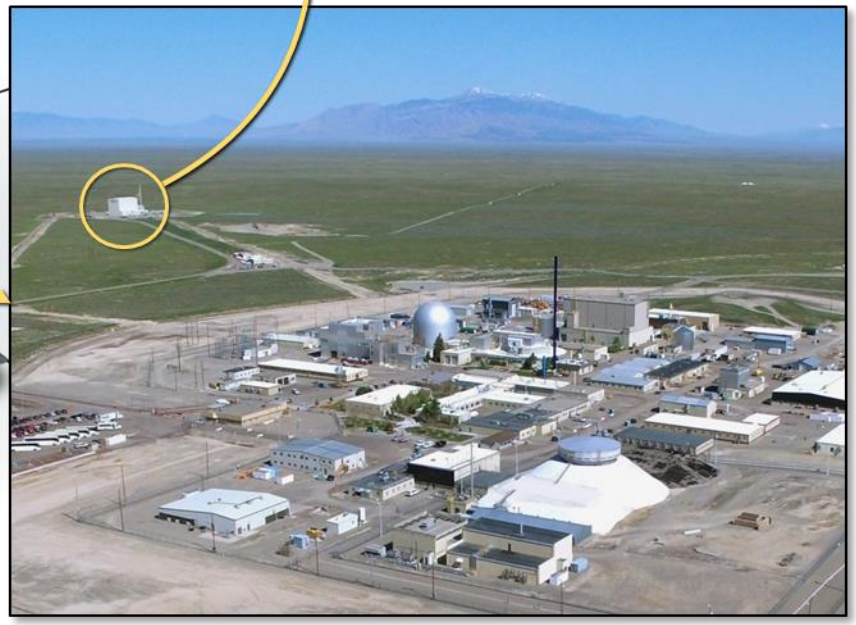
www.inl.gov

Idaho National Laboratory

Facility Location



TREAT

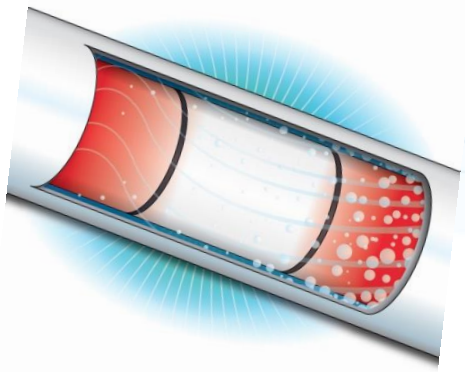


Materials and Fuels Complex

Nuclear Fuels Development Requires Transient Testing for Design Development and Qualification

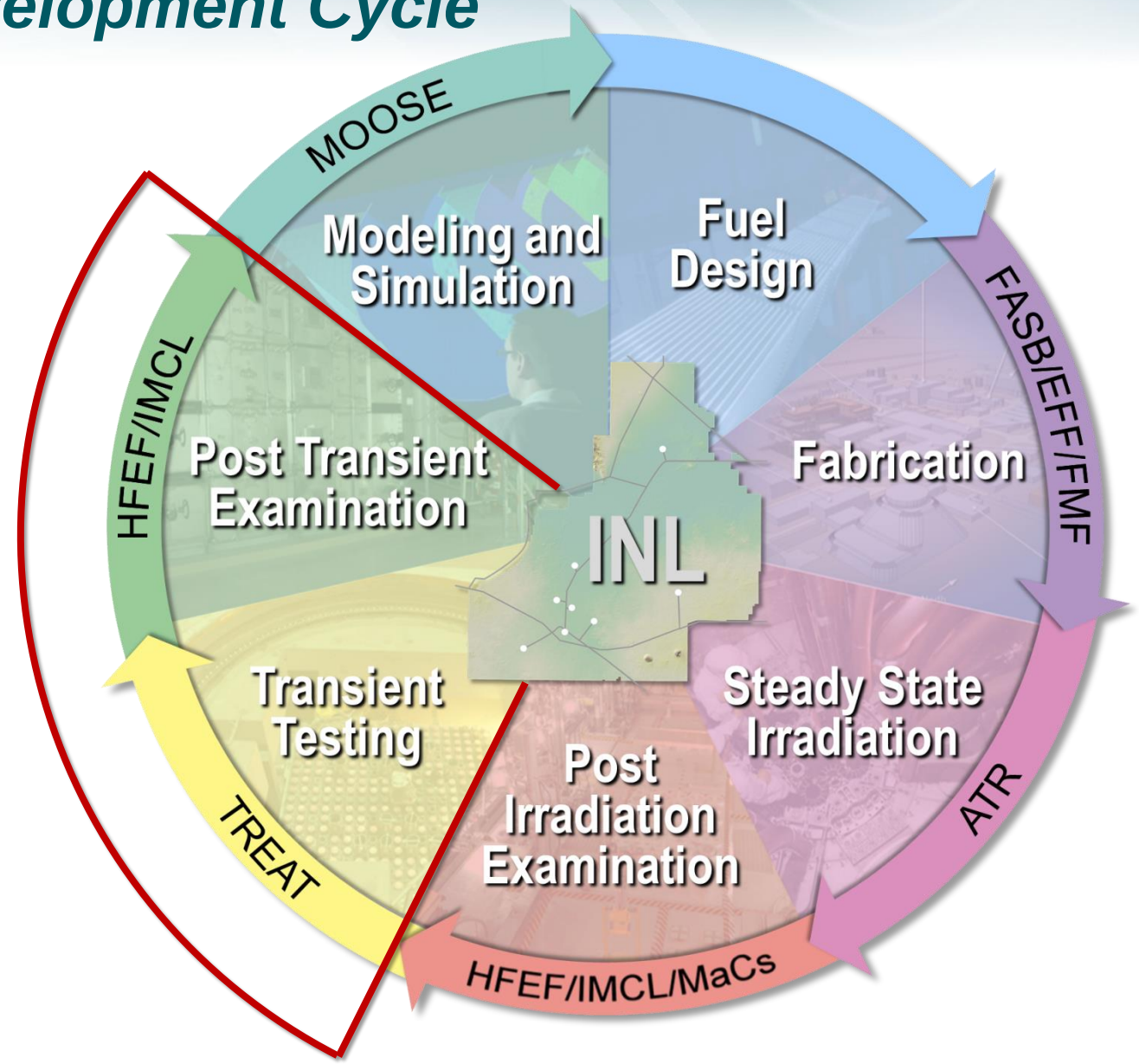
Nuclear fuel tends to fracture during use or when exposed to a power burst, it is important for the fuel to retain reasonable structural integrity

During a transient test, fuel is exposed to a power to cooling mismatch, driving the fuel to high temperatures



Transient testing fuel and crash testing cars have a lot in common: **Design and test for high safety standards**

Fuel Development Cycle



TREAT Reactor

- Designed to conduct transient testing of fuels and structural materials.
- Operated from 1959 to 1994.
- Reactor has performed 6604 reactor startups, 2884 transient irradiations.
- Major refurbishment completed in the late 1980's, and upgraded reactor ran from 1989 to 1994.
- Reactor remained fully fueled during standby from 1994 to now, plant left in excellent condition with all required surveillance and maintenance activities performed.

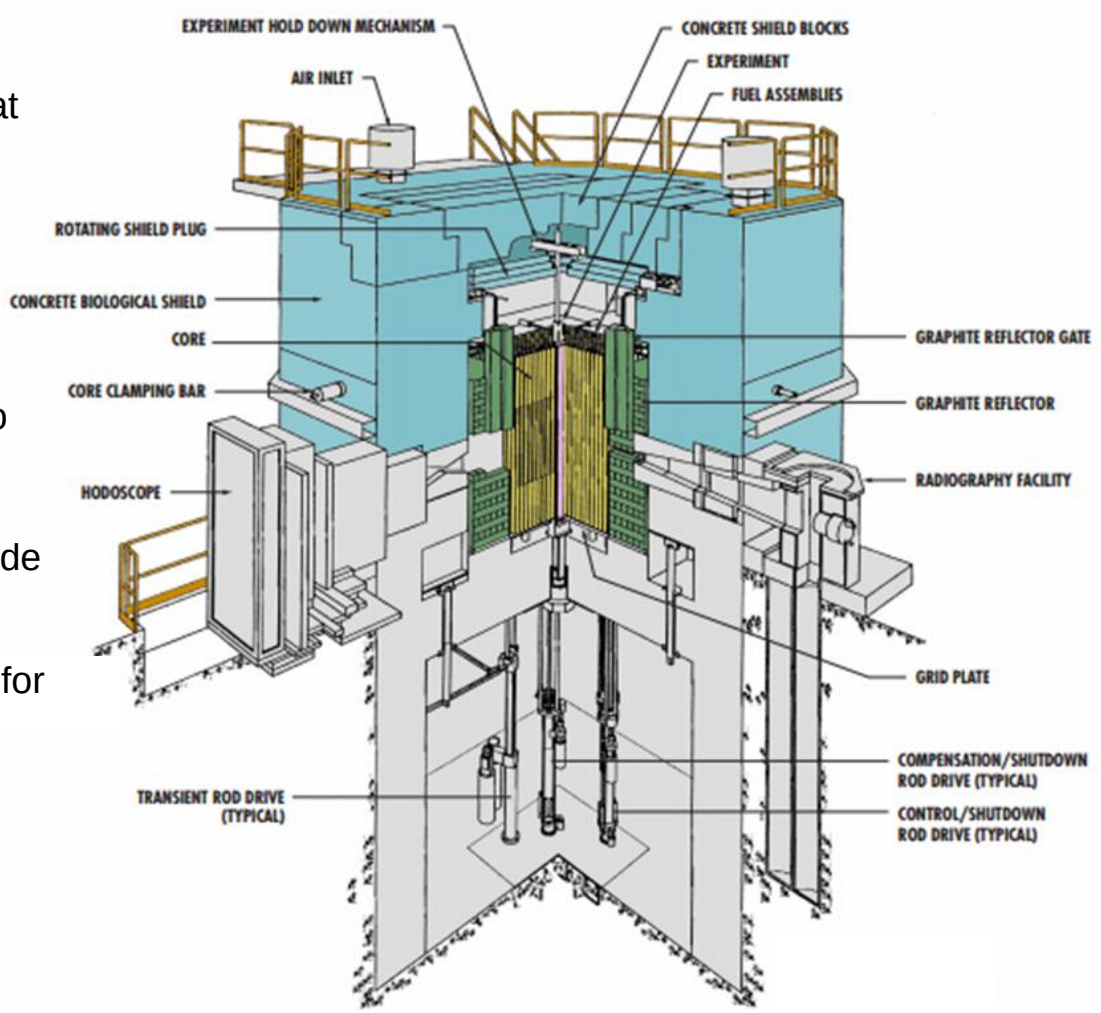
South View of the Reactor

Top of the Reactor

- Over 20 GW Peak Transient Power (120 kW Steady-state power).
- Core: 4 ft. high x roughly 6 ft. dia.; surrounded by 2 ft. graphite reflector.
- Fuel: 19 x 19 array (approximately 360 fuel elements) of 4 in. X 4 in. fuel and reflector assemblies.
- LEU conversion work initiated.

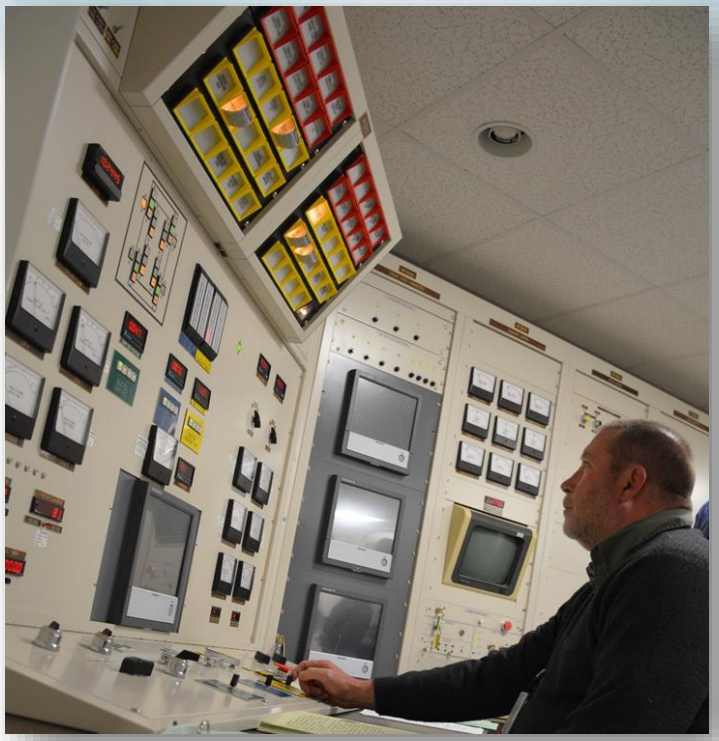
TREAT Configuration and Unique Features

- No decay heat mitigation actions required
  - Negligible decay heat
  - Low fission product inventory
  - No emergency cooling or residual heat removal required
  - No emergency power required
- Self-limiting
  - Near instantaneous large negative temperature coefficient – safely shuts the reactor down, inherently safe
  - Reactor Trip System is not required to prevent fuel damage
- Reactivity Control and Operation
  - Prompt critical operation – normal mode
  - Air cooling system has a non-safety-related function – operated during steady-state operations or to prepare for next transient
  - Three independent Control Rod Drive types
  - Transients performed from remote Control Room
  - Self-contained experiments



RTTP Recap and Highlights

- Managed as a reactor being returned to service following an extended outage.
- Relied on operations and maintenance history and experienced operating personnel.
- Required activities completed for restart include:
  - Systematic approach used to return facility systems and equipment to service.
  - Procedures and processes revised to current standards.
  - Hired and trained full operating staff.
  - Thoroughly tested and exercised all equipment and systems supporting reactor operations.
- Extremely good safety record with no significant injuries.
- Resumption of Transient Testing Program (RTTP) was completed August 31, 2017, more than twelve months ahead of the baseline schedule of September 2018 and for about $20M less than the baseline cost estimate of $75M.
- On November 14, 2017 the Reactor critical operations resumed after over two decades of standby.



TREAT Restart Timeline

2011: Mission need approved for transient testing

2014: **In February** NEPA process completed and FONSI approved, TREAT selected as the reactor to perform transient testing

2014: **After February** initiated assembling restart team, initiated infrastructure items such as facility cleanout, roof replacement, initiated system walkdowns

2015: Revised and implemented SAR and TS to allow control rod and in core activities, DOE RA performed, system testing initiated, facility repairs and refurbishment under way

2016: Poisoned core and validated, replaced Transient Rod shock absorbers, completed plant significant modifications, initiated integrated plant simulated operations

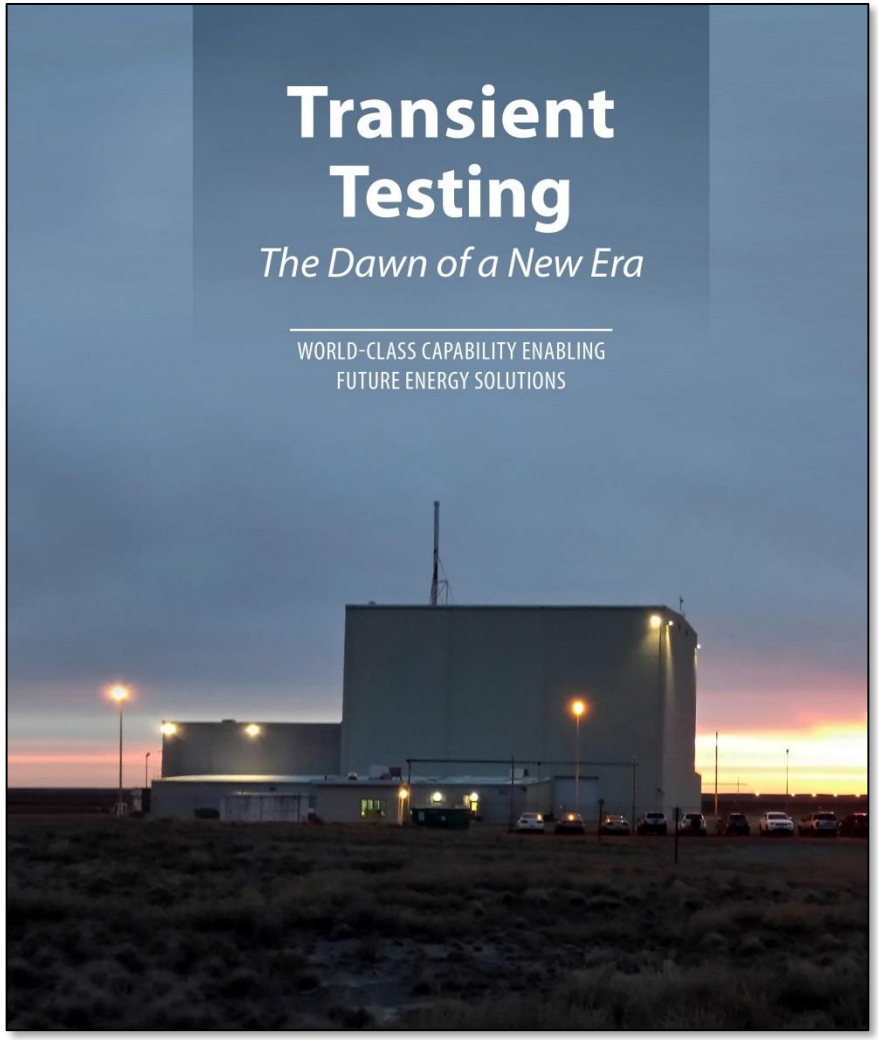
2017: Completed all personnel, plant, and process preparations, initiated and completed review processes, low power testing initiated

2018: *Physics testing, completion of restart plan, initiate experimental operations ~ March 2018*

Equipment Readiness Journey

Future of TREAT Operations

- The Reactor will continue to be operated through 2017 at low power for startup testing.
- Experiments and testing of new cutting edge instruments is expected to commence in calendar year 2018.
- There is great interest in use of TREAT, anticipated customers and research are under development
- Dan Wachs is giving a Transient Testing experiment presentation later in the meeting.



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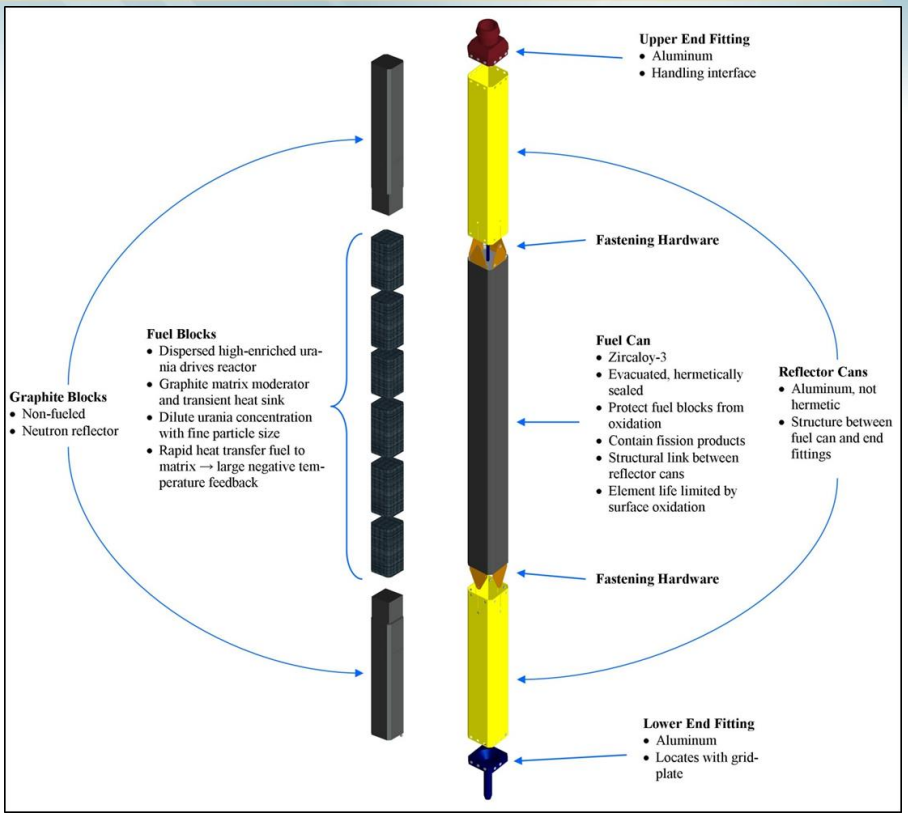
Fuel Assembly

- Standard Fuel Assembly
  - Central uranium oxide-bearing Fuel Section
  - Upper and lower Graphite Reflector Sections
- Fuel Section
  - Standard is 4 feet long, contains six 8 inch long fuel blocks, specialized use less fuel
  - 1 part HE UO_2 to 10,000 parts carbon/graphite
  - 37g HE UO_2 per fuel element
  - Clad in Zr-3, under vacuum
- Carbon and Graphite Urania Fuel
  - High heat-absorption capability provides heat sink for transient heat without cooling dependence.
  - Homogeneity of fuel and moderator provides near instantaneous large, negative temperature coefficient.
  - Excellent thermal shock resistance sustain high rates of heat input during transient operation.
  - Less than 0.3% burnup on existing fuel, indicating remaining fuel life well in excess of the 40 year programmatic projected need.
- Graphite Reflector Sections
  - 2 feet long each



Fuel Configurations