The Original Test Bed:

Understanding the 52 reactors at the INL site

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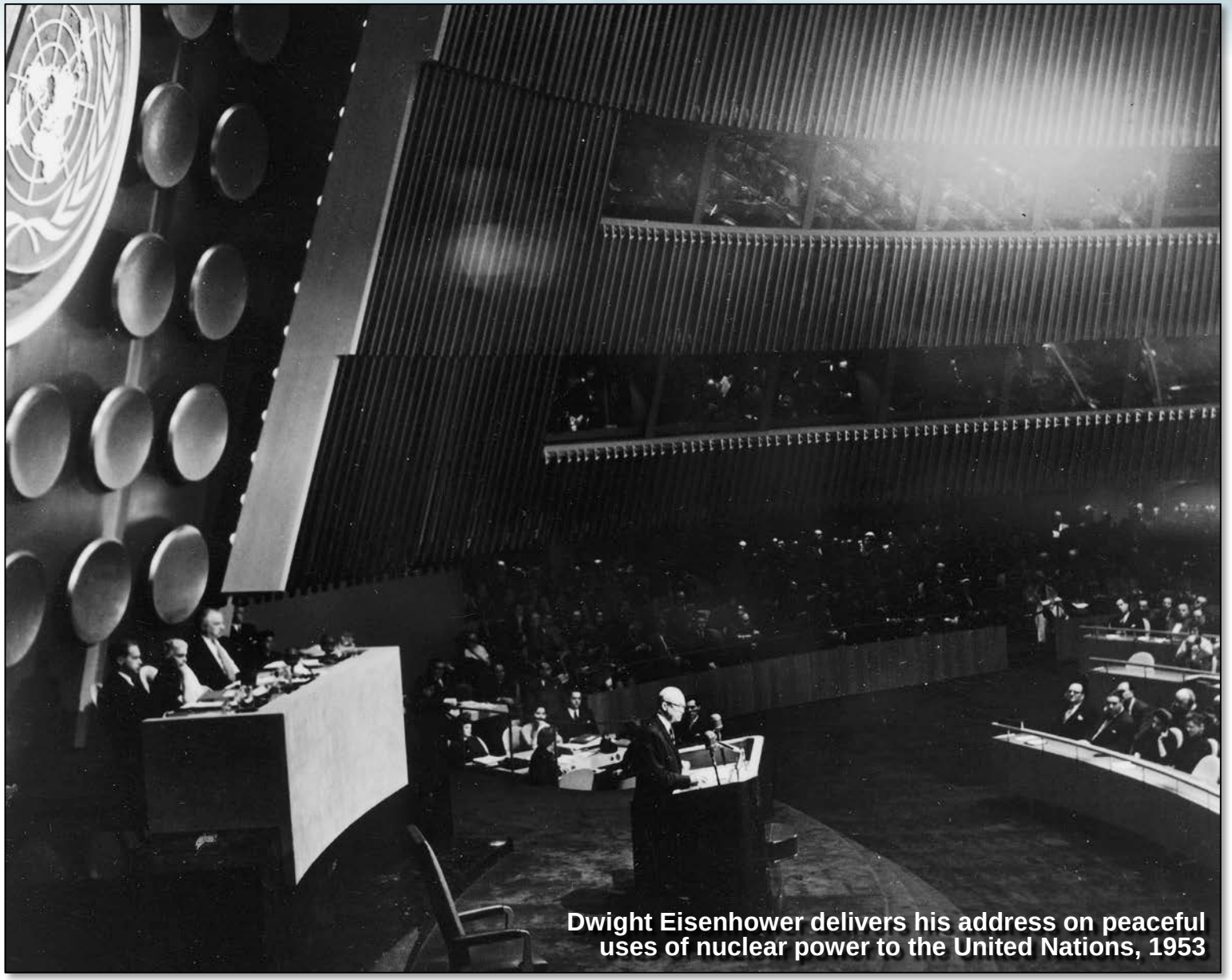
July 13, 2017

Atoms for Peace

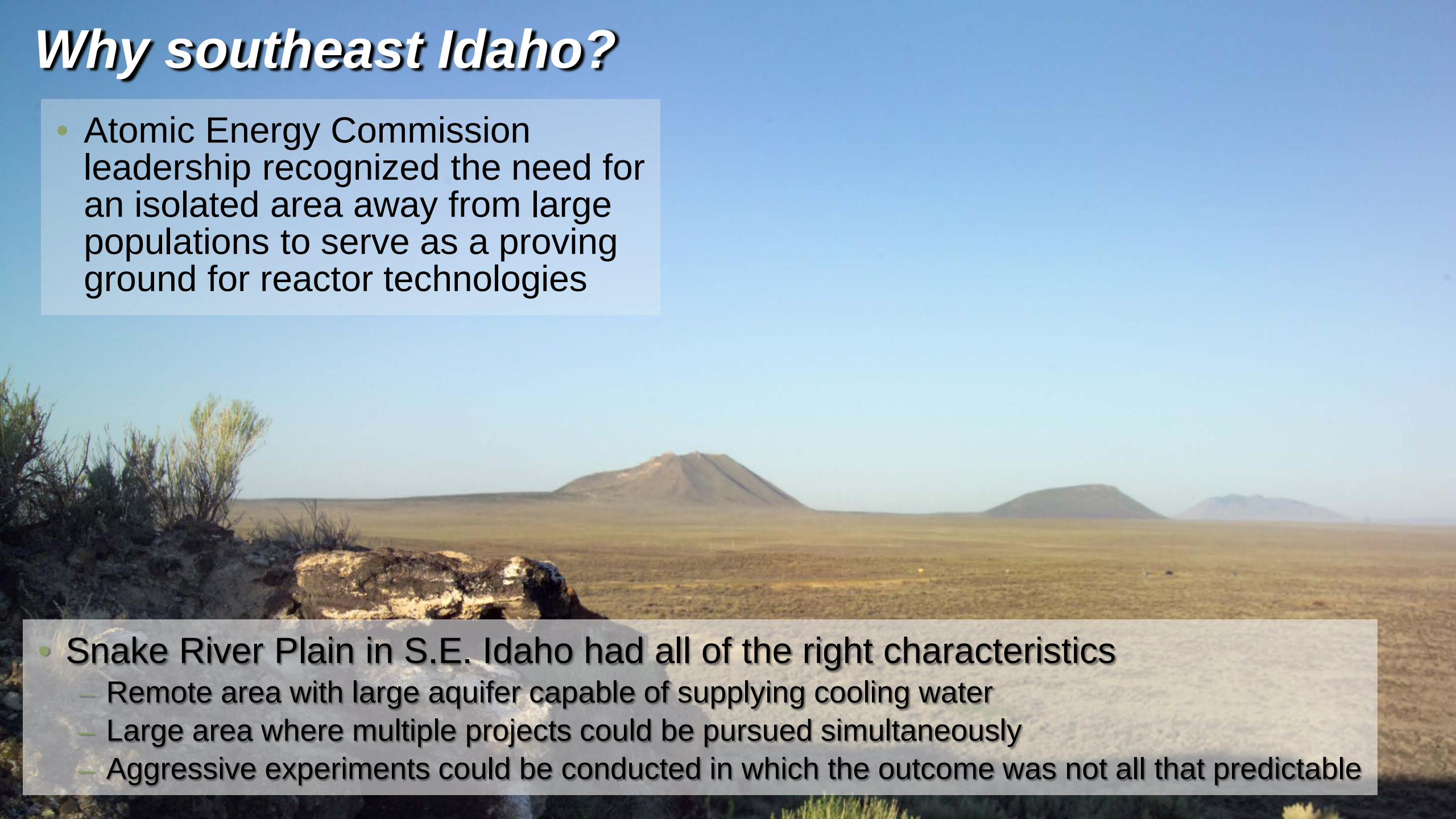
- Post-World War II, the U.S. began looking for ways to demonstrate peaceful uses of nuclear power



Dwight Eisenhower delivers his address on peaceful uses of nuclear power to the United Nations, 1953

Why southeast Idaho?

- Atomic Energy Commission leadership recognized the need for an isolated area away from large populations to serve as a proving ground for reactor technologies



- Snake River Plain in S.E. Idaho had all of the right characteristics
  - Remote area with large aquifer capable of supplying cooling water
  - Large area where multiple projects could be pursued simultaneously
  - Aggressive experiments could be conducted in which the outcome was not all that predictable

Previous uses – WWII and later

- Navy gunnery range
- Ordnance testing and storage
- B-24 bombing range

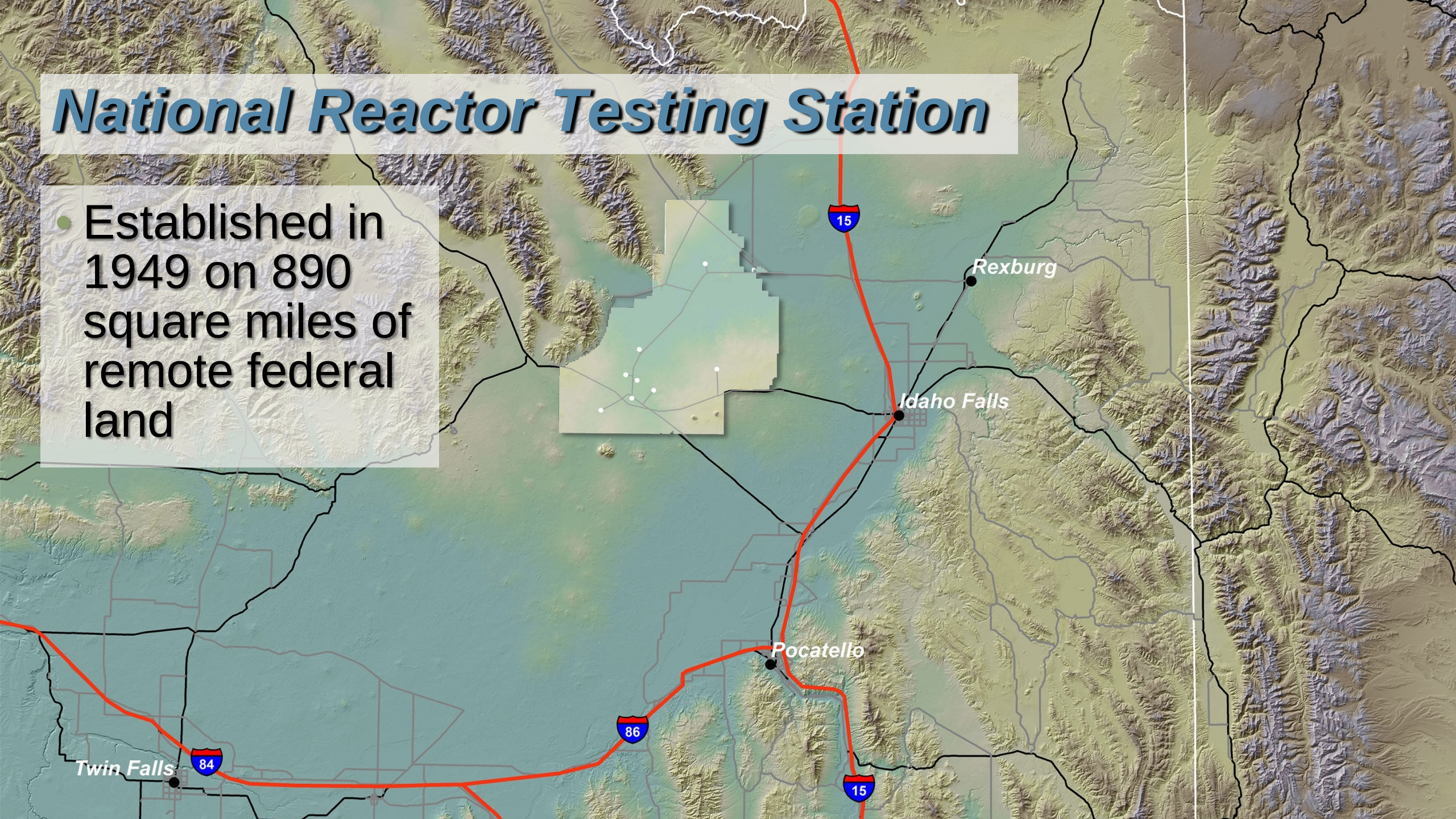
Test-firing 16-inch relined battleship guns toward the Big Southern Butte

August 1945 conventional explosives test – 250,000 lbs. of TNT

Ordnance and gun loading/unloading facilities at what is now INL's Central Facilities Area

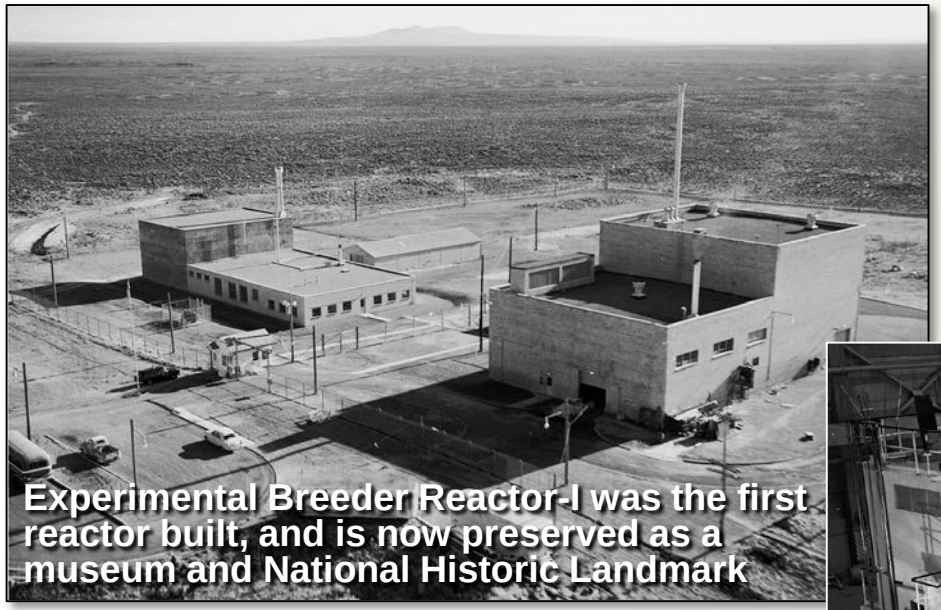
National Reactor Testing Station

- Established in 1949 on 890 square miles of remote federal land

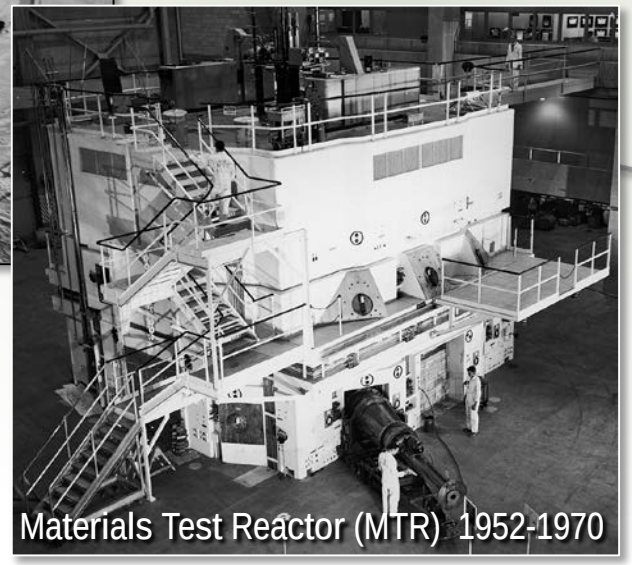


Reactor construction begins

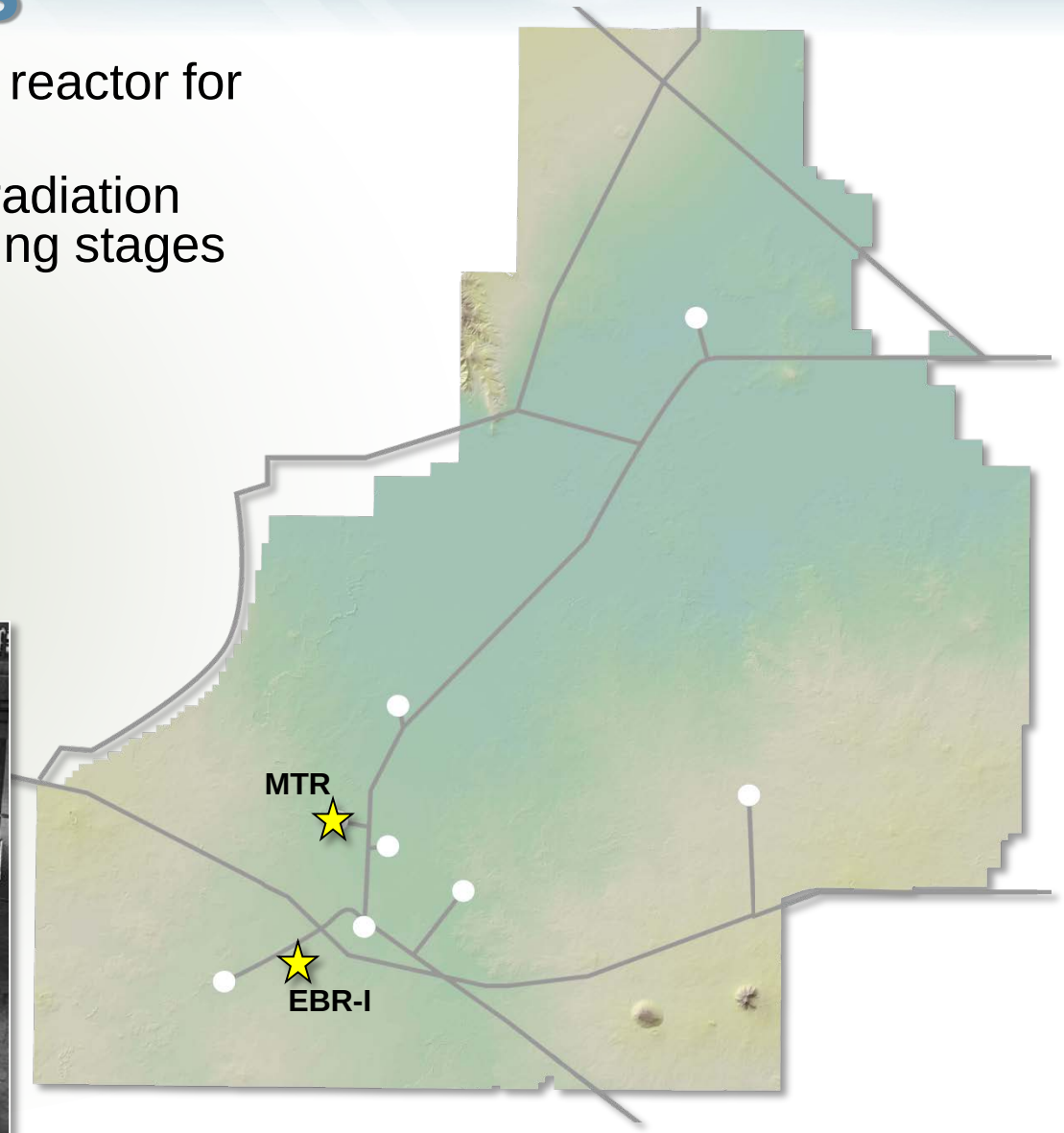
- Argonne's Experimental Breeder Reactor-I was the first reactor for the nation's new test bed
- Materials Test Reactor followed soon after to provide irradiation testing of fuels and materials for other reactors in planning stages



Experimental Breeder Reactor-I was the first reactor built, and is now preserved as a museum and National Historic Landmark



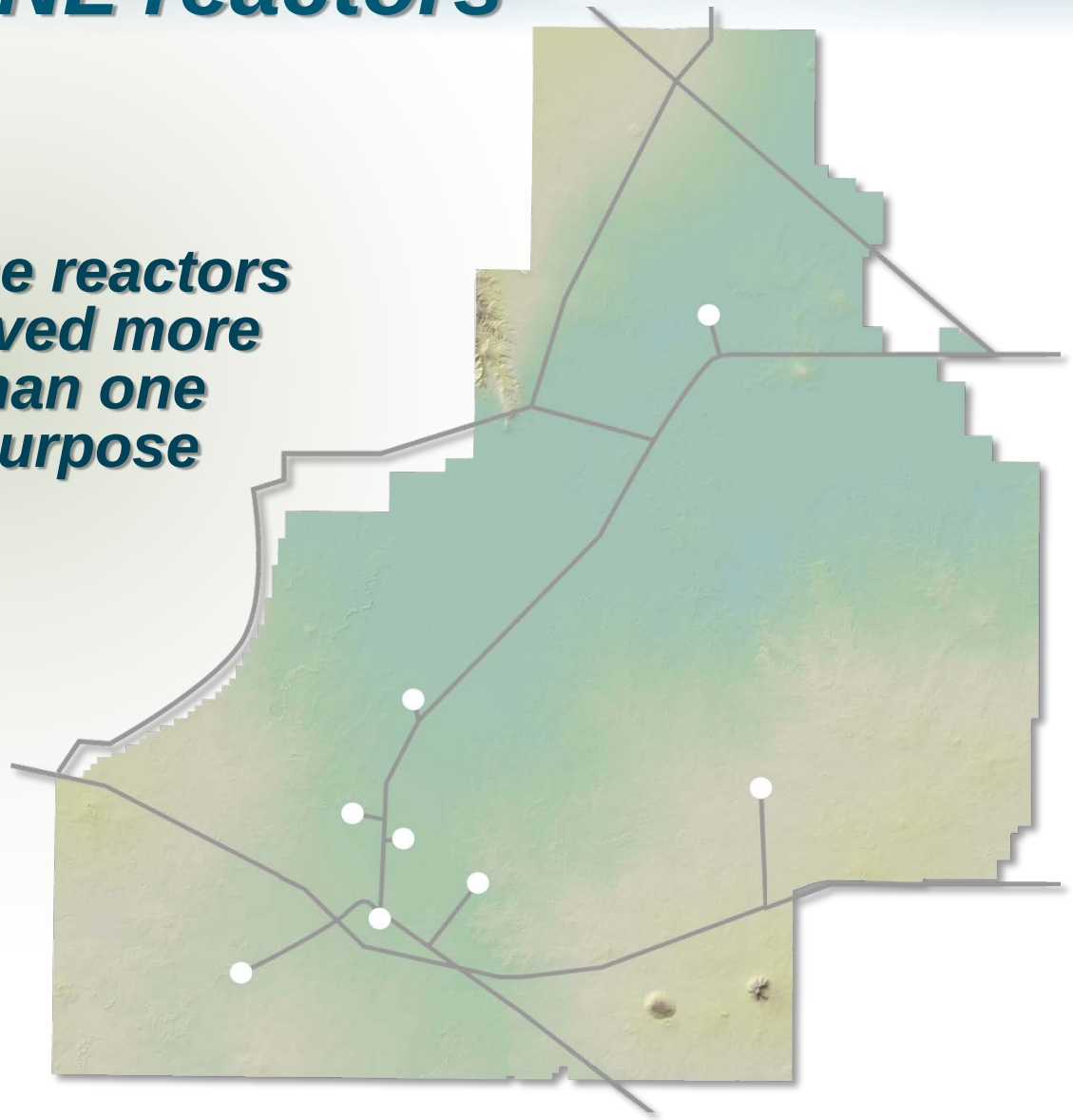
Materials Test Reactor (MTR) 1952-1970



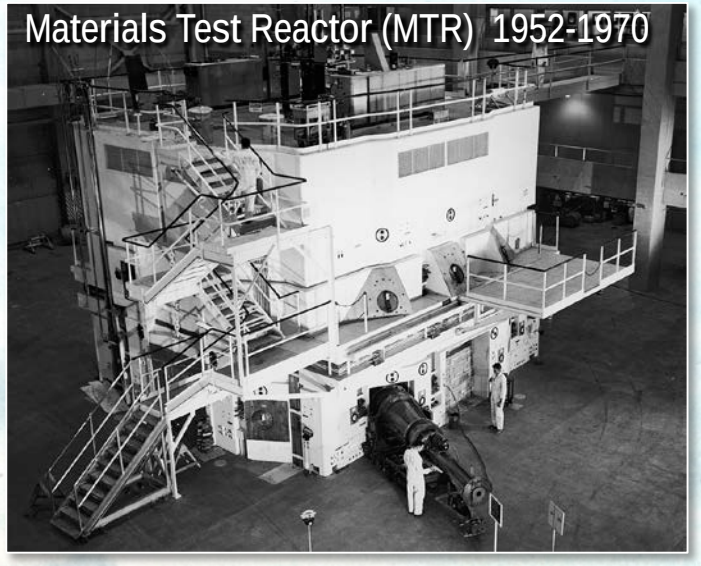
A functional classification of INL reactors

- Safety testing
- Marine propulsion
- Fuels and materials testing
- Demonstration
- Air and Space
- Military
- Focused experiments
- Support for larger reactors

Some reactors served more than one purpose



Reactors for Testing Fuels and Materials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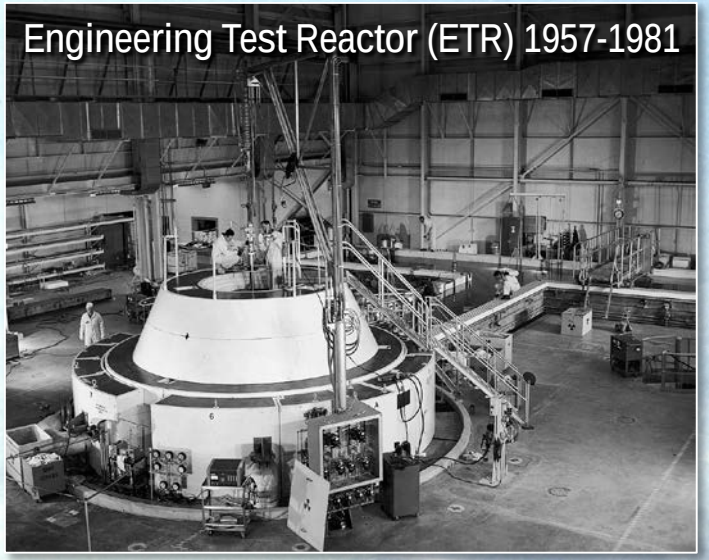
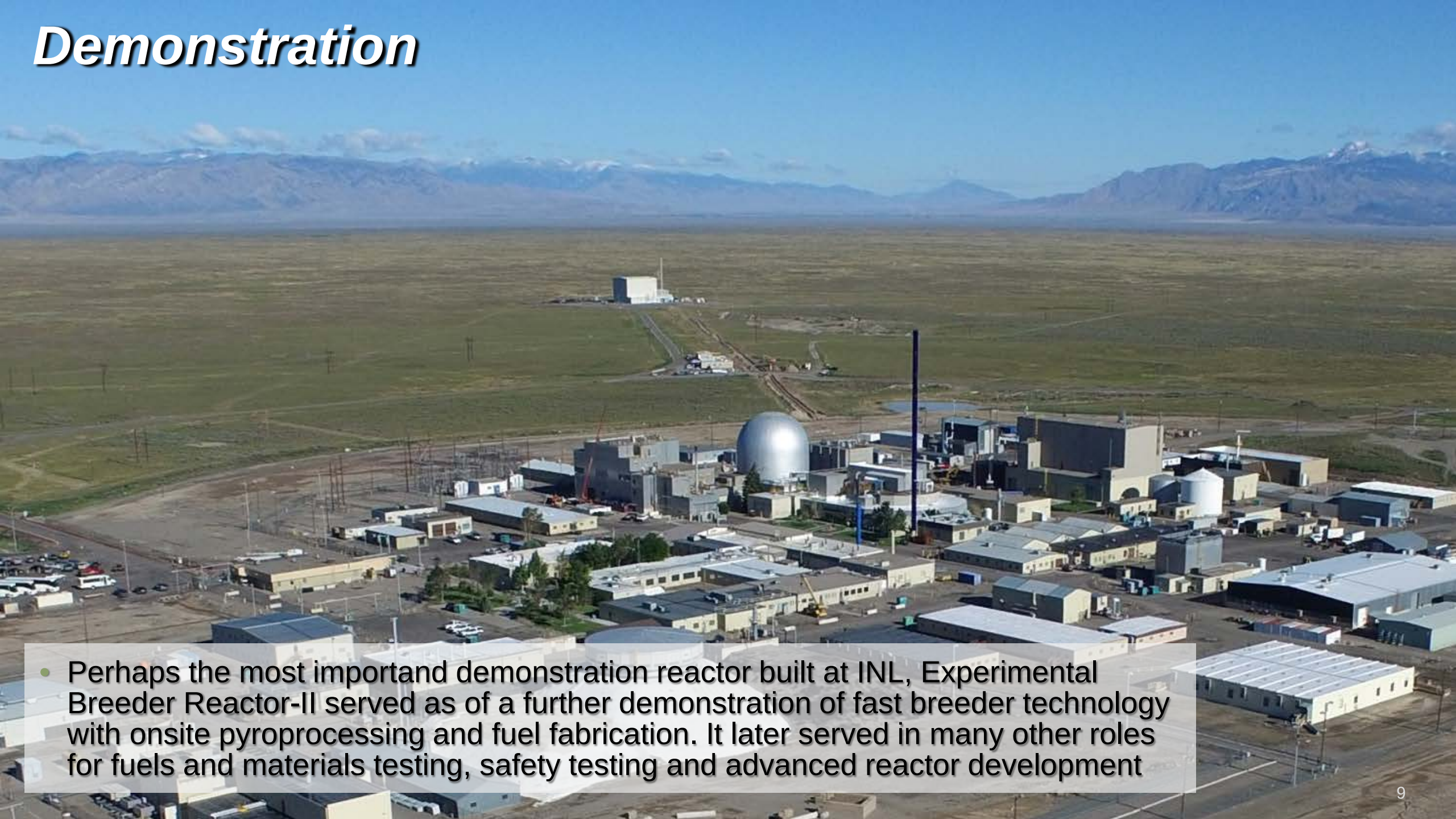

Engineering Test Reactor (ETR) 1957-1981

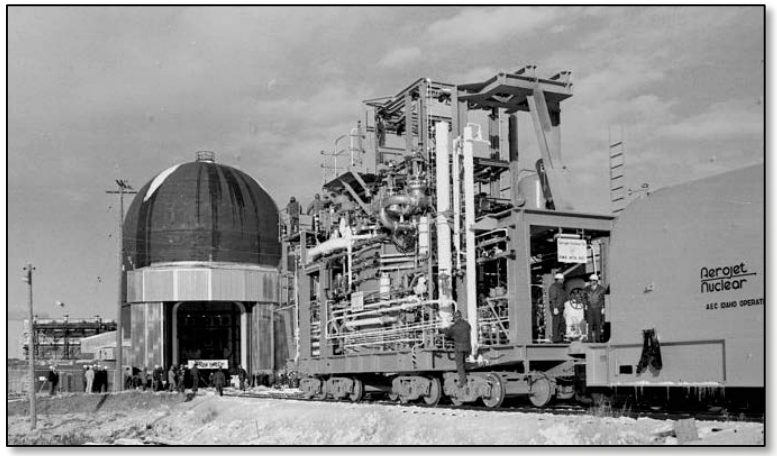

Advanced Test Reactor (ATR) 1967-present

Demonstration

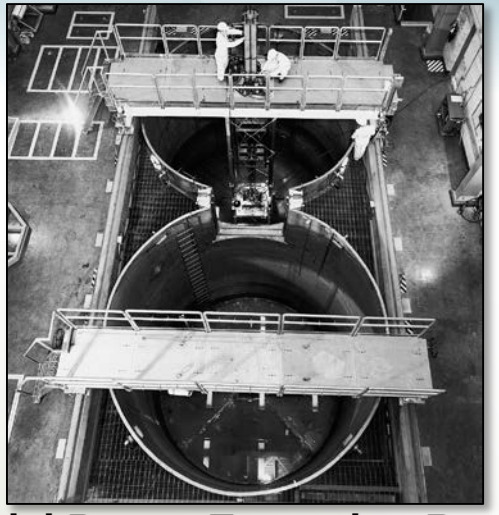


- Perhaps the most importand demonstration reactor built at INL, Experimental Breeder Reactor-II served as of a further demonstration of fast breeder technology with onsite pyroprocessing and fuel fabrication. It later served in many other roles for fuels and materials testing, safety testing and advanced reactor development

Safety Testing, Including Transients

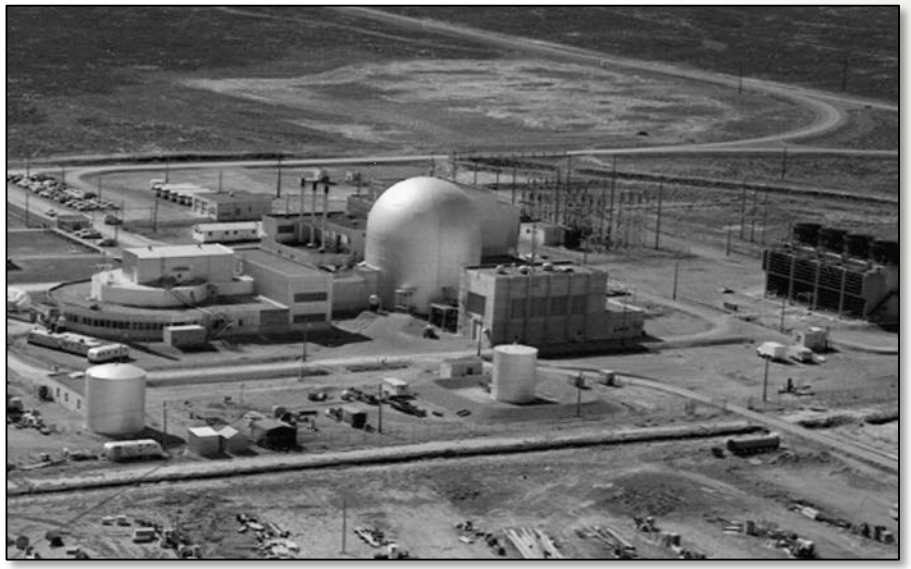


Loss Of Fluid Test Facility (LOFT)



Special Power Excursion Reactor Tests I though IV (SPERT)

Power Burst Facility (PBF)



Experimental Breeder Reactor-II (EBR-II)

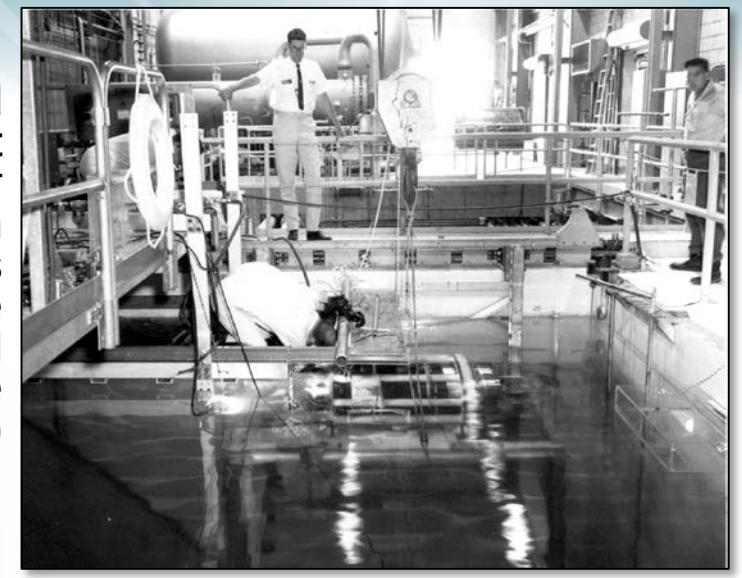
Boiling Water Reactor Experiments I-V (BORAX)

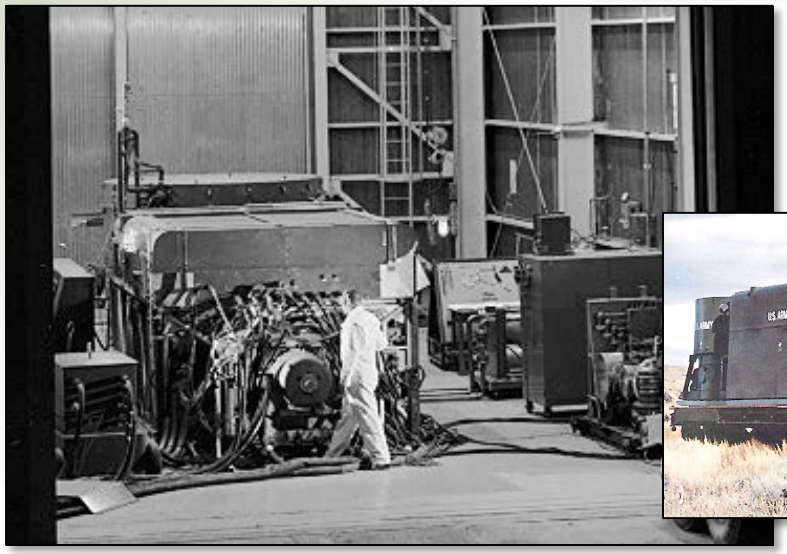
Transient Reactor Test Facility (TREAT)

Military

In 1961, an accident at the Army's **Stationary Low-Power Reactor (SL-1)** killed 3 men and destroyed the facility

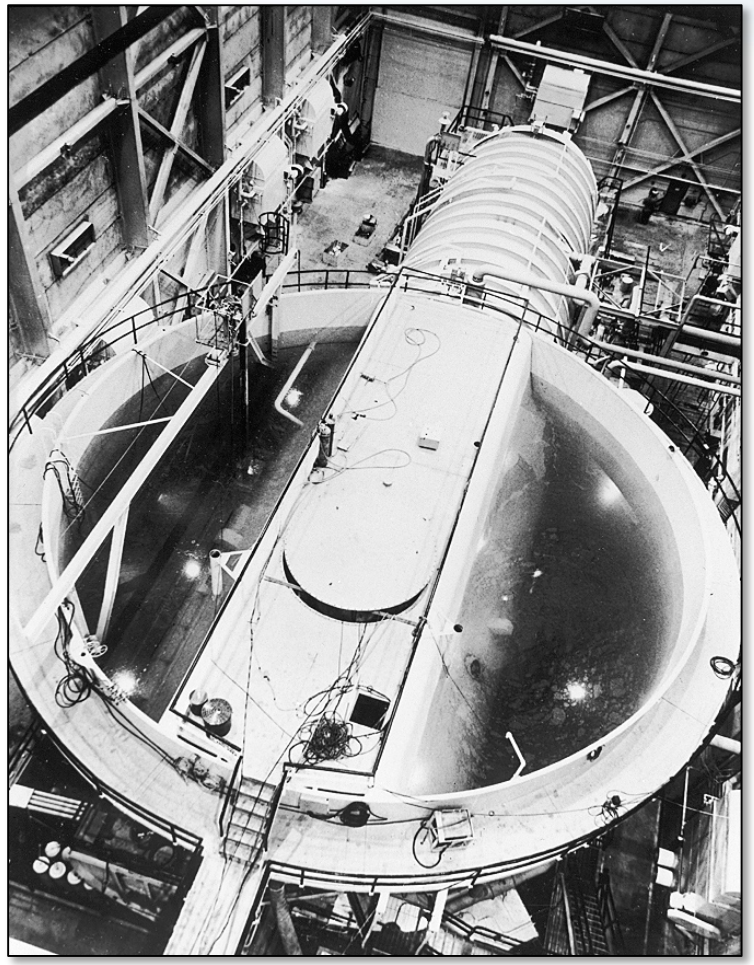
The **Gas Cooled Reactor Experiment (GCRE)** was a water moderated, nitrogen cooled reactor that was the first phase in the Army's intended development of a mobile NPP (1960-1961)



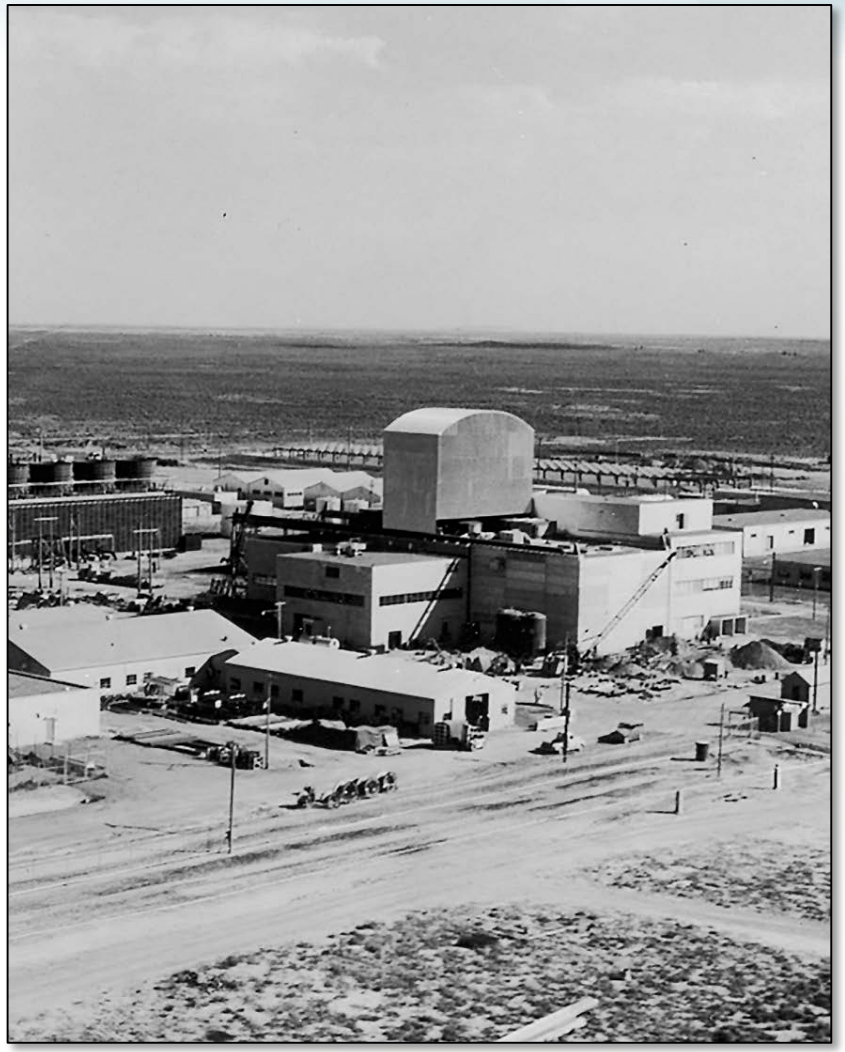


The **Mobile Low-Power Reactor No. 1 (ML-1)** designed to be transported in < 40t modules by cargo planes or low-bed trailers. ML-1 operated for 664 hours between 1961 and 1964

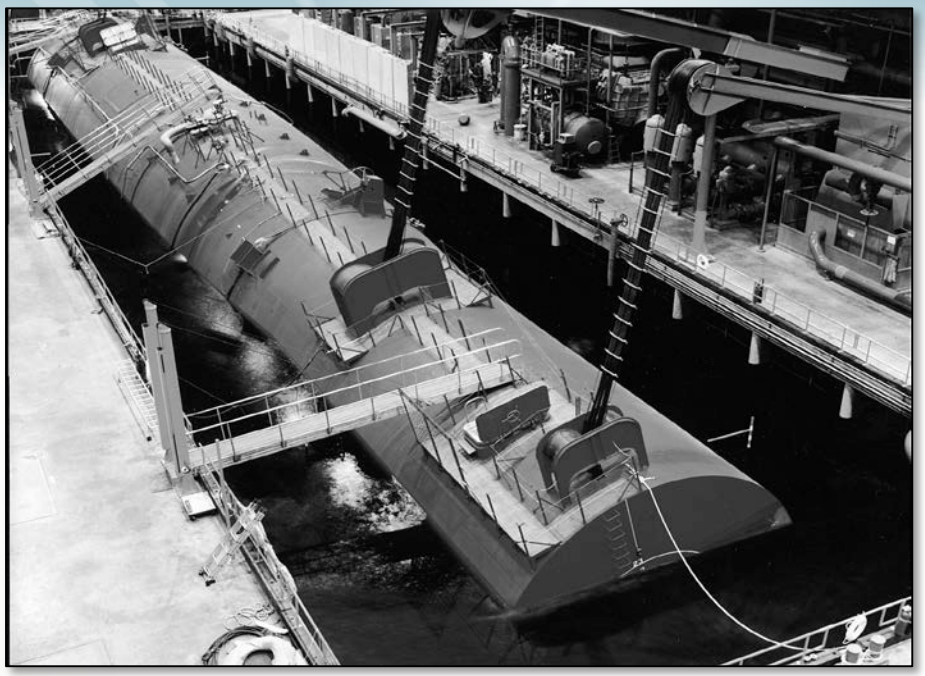
Marine Propulsion



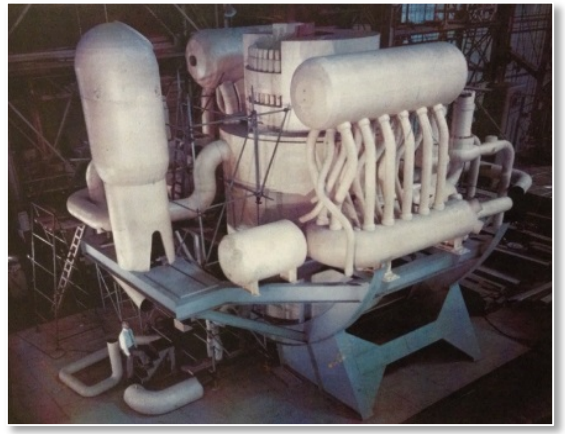
S1W
aka Submarine Thermal Reactor (STR)



A1W
Aircraft carrier prototype reactor



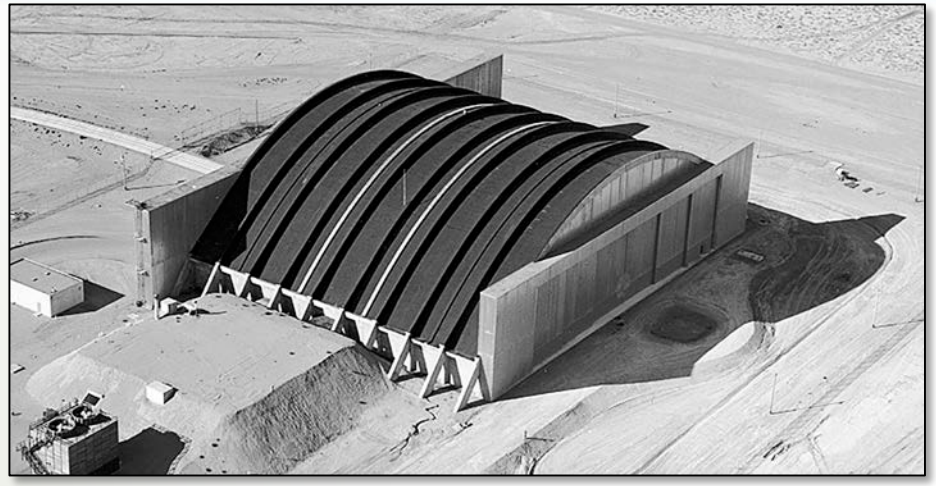
S5G



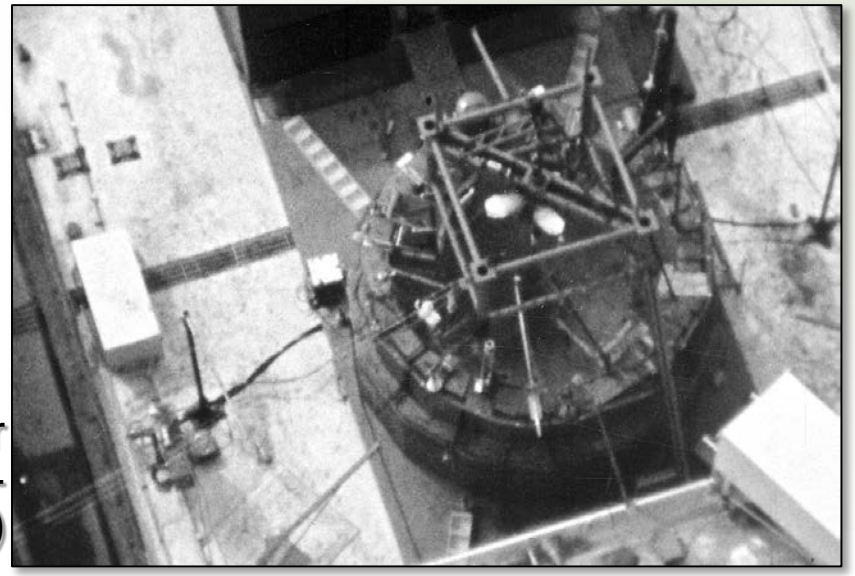
High Temperature Marine Propulsion Reactor 630A (civil)

Air and Space Propulsion

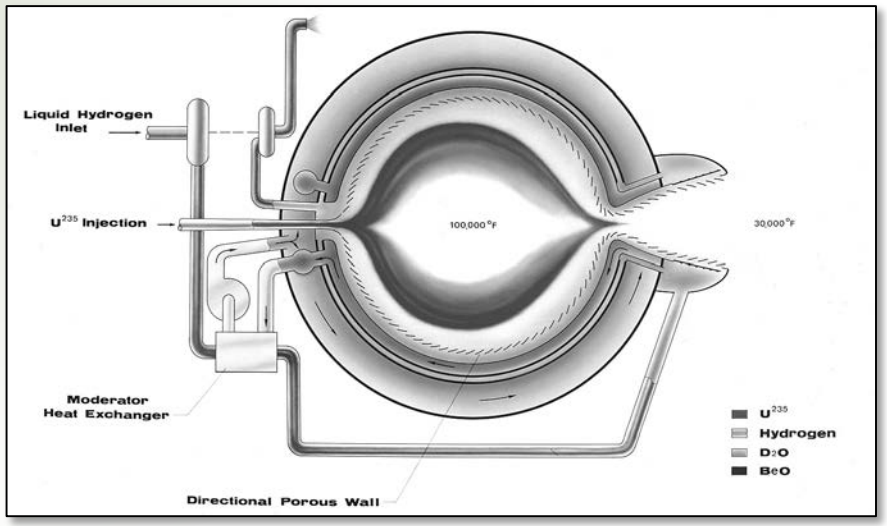
Aircraft Nuclear Propulsion Heat Transfer Reactor Experiments HTRE-2 and -3 on display at historic EBR-1 site



Shielded aircraft hanger built for ANP now used as an advanced armor manufacturing center



Systems for Nuclear Auxiliary Power - SNAP-10A (1964-1966)



Spherical Cavity Reactor Critical Experiment 1972-73

Focused Experiments

Peter Collins examining ZPPR-16

Major Facilities/Experiments

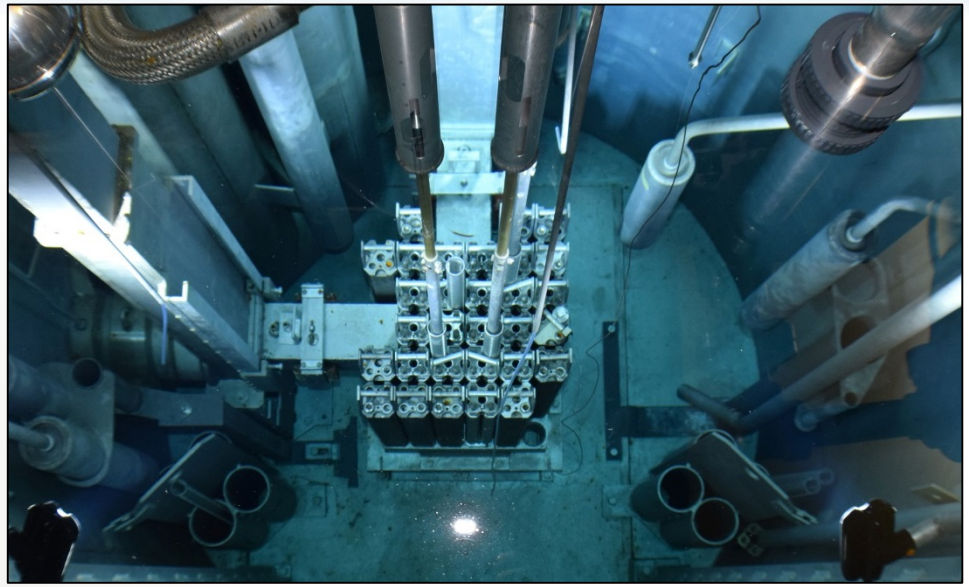
- ZPPR (1969-1992)
  - 20 full scale fast reactors ranging in design size from 100 kWe to 1200 MWe
  - **ZPR-3 (1955-1970)**
  - **BORAX (Boiling water reactor experiment) 1953-1964**
    - Proved the viability of the BWR concept
    - Powered City of Arco in 1955

Miscellaneous Facilities

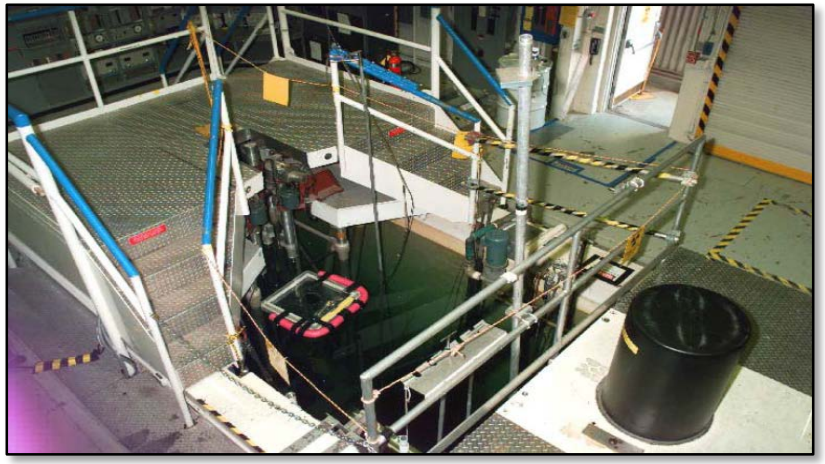
- **Experimental Organic Cooled Reactor**
- **Hot Critical Experiment 1958-61**
- **Nuclear Effects Reactor 1968-70**
- **Organic Moderated Reactor 1957-63**

Little reactors supporting bigger facilities

- **Support for irradiation facilities**
  - Advanced Reactivity Measurement Facility (ARMF) 1960-74
  - Coupled Fast Reactor Measurement Facility (CFRMF) 1968-91
  - Critical Experiment Tank (1958-61)
  - Engineering Test Reactor Critical Facility (ETRC) 1957-82
- **Advanced Test Reactor Critical Facility (ATRC) 1964-present**
- **Neutron Radiography Reactor (NRAD) 1978-present**
  - 250kW TRIGA provides analog and digital neutron radiography and tomography on irradiated samples, and rapid-turnaround irradiation of samples
- **Shield Test Pool Facility (SUSIE)**
- **Reactivity Measurement Facility (RMF)**
- **Thermal Reactor Idaho Test Station (THRITS)**
- **Argonne Fast Source Reactor (AFSR)**



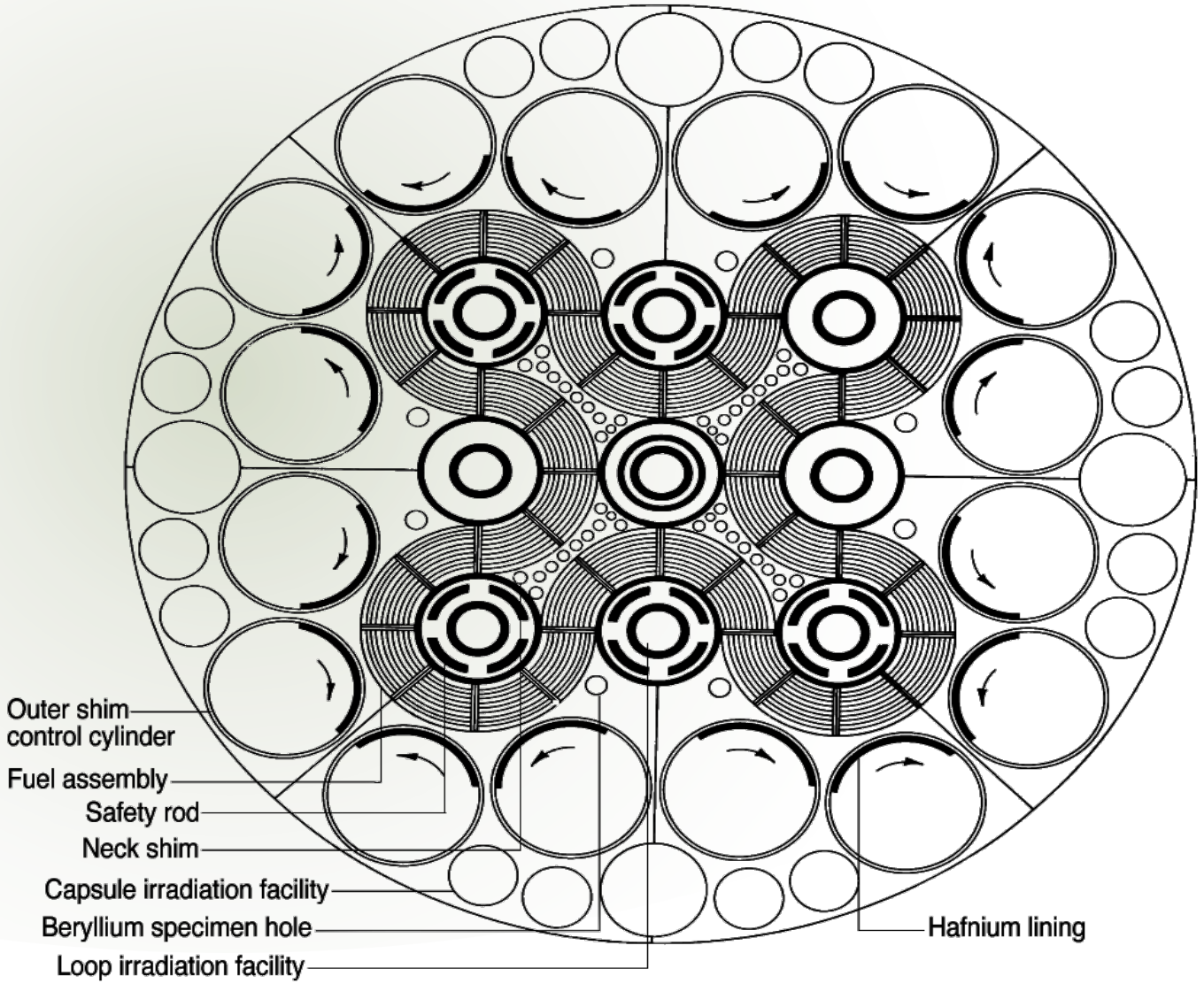
NRAD



ARMF and CFRMF

Notable Innovation and Impact

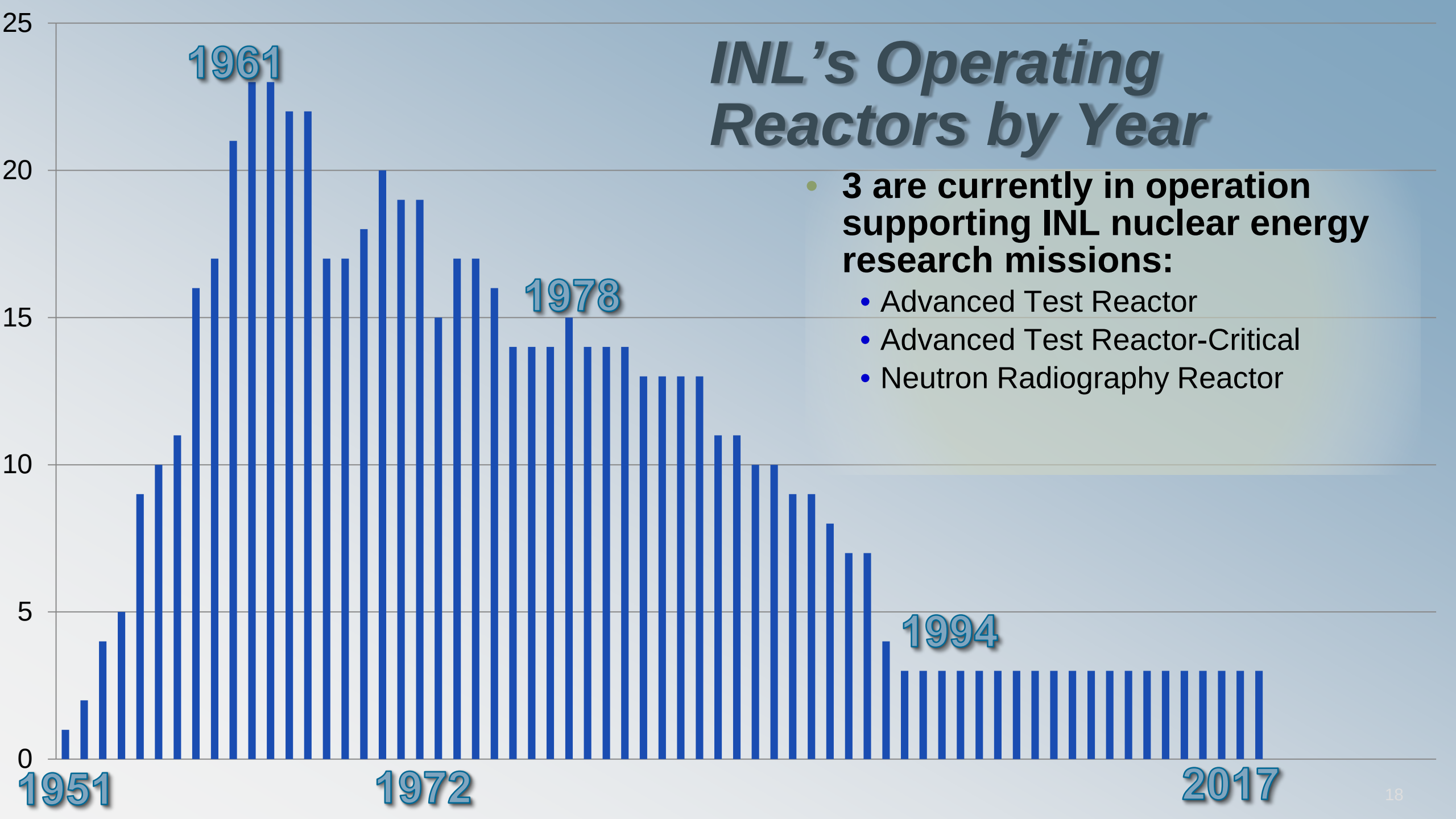
- Enabling commercialization of PWRs, some two thirds of the world's nuclear plants
- Enabling BWRs, another 20%
- Enabling nuclear propulsion
- Very high flux test reactors
- Inherent safety
- Integral Fast Reactor (IFR)
- Safety licensing basis
- Advanced fuel development
- First nuclear electricity
- Methods for gathering nuclear data
- Decommissioning



Some Perspective on INL's Reactors

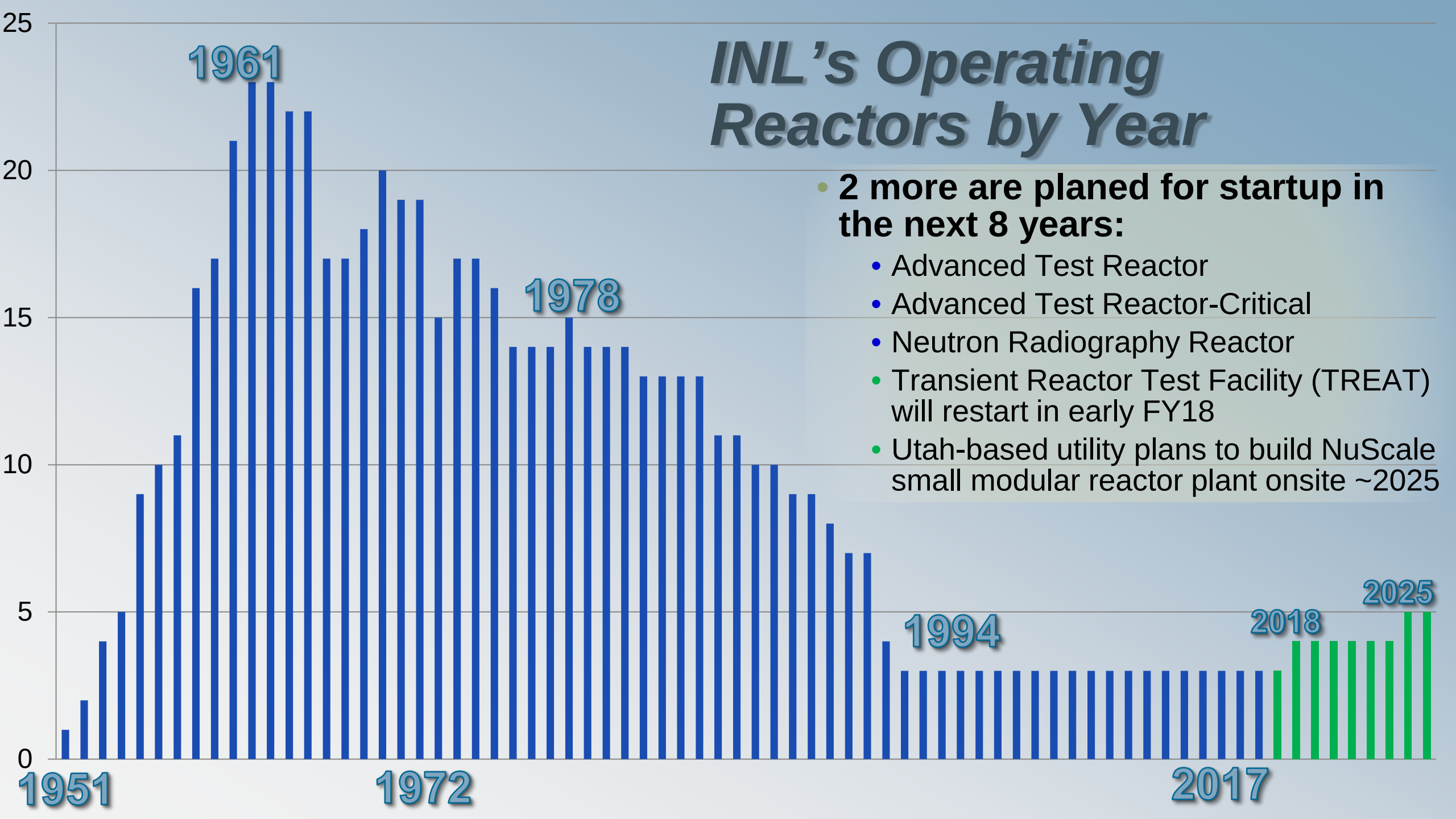
- During the 1950's and 60's, the test reactors were supporting concepts that were being industrialized in the AEC's power reactor demonstration program, including pressurized water, boiling water, sodium, gas and organic cooled reactors built at utility sites around the country.
- In 1955, five new reactors started up on the INL site, a 100% increase.
- In 1994, three of the remaining 7 operating reactors shut down, a 43% decrease.
- In spite of the demise of the aircraft program and the SL-1 accident in 1961, the number of operating reactors peaked at 23 in 1961 and 1962.
- The last major reactor to start up was LOFT in 1973.
- Most reactors were not designed for long lifetimes –just to provide quick test data.
- On the other hand, ATR's components are replaceable, so there is no defined lifetime.

INL's Operating Reactors by Year



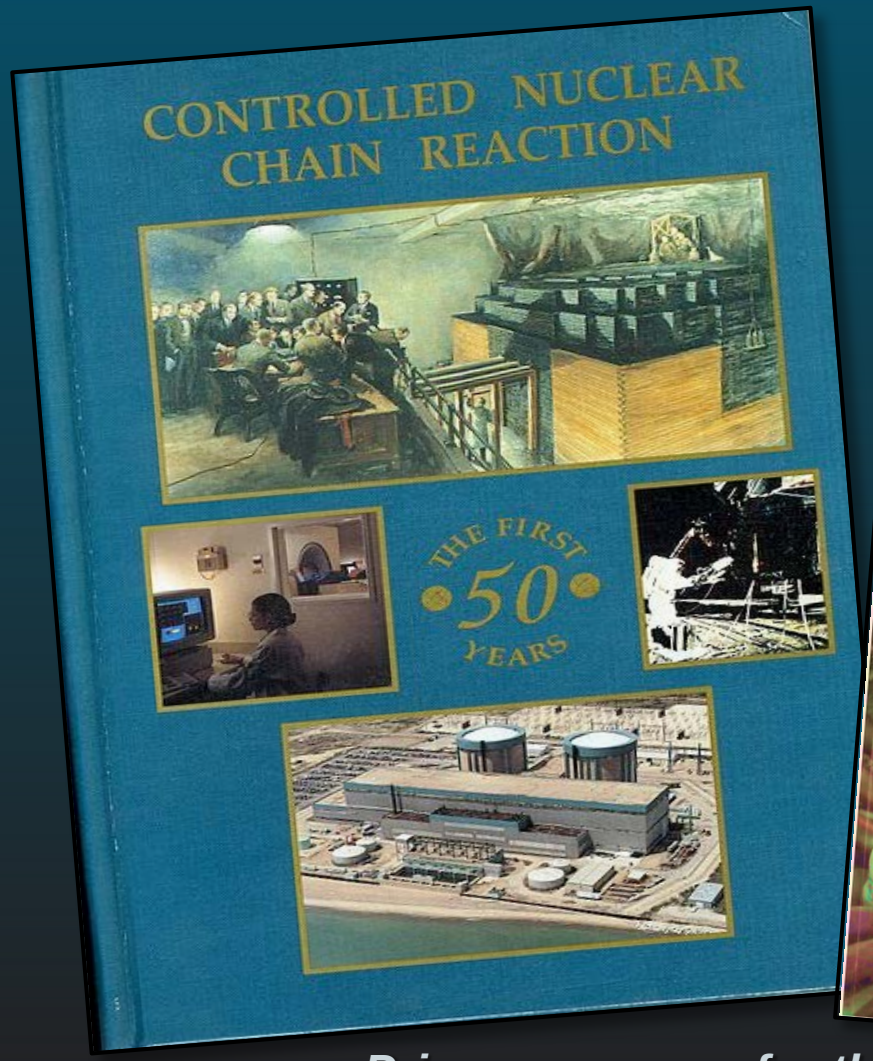
- **3 are currently in operation supporting INL nuclear energy research missions:**
  - Advanced Test Reactor
  - Advanced Test Reactor-Critical
  - Neutron Radiography Reactor

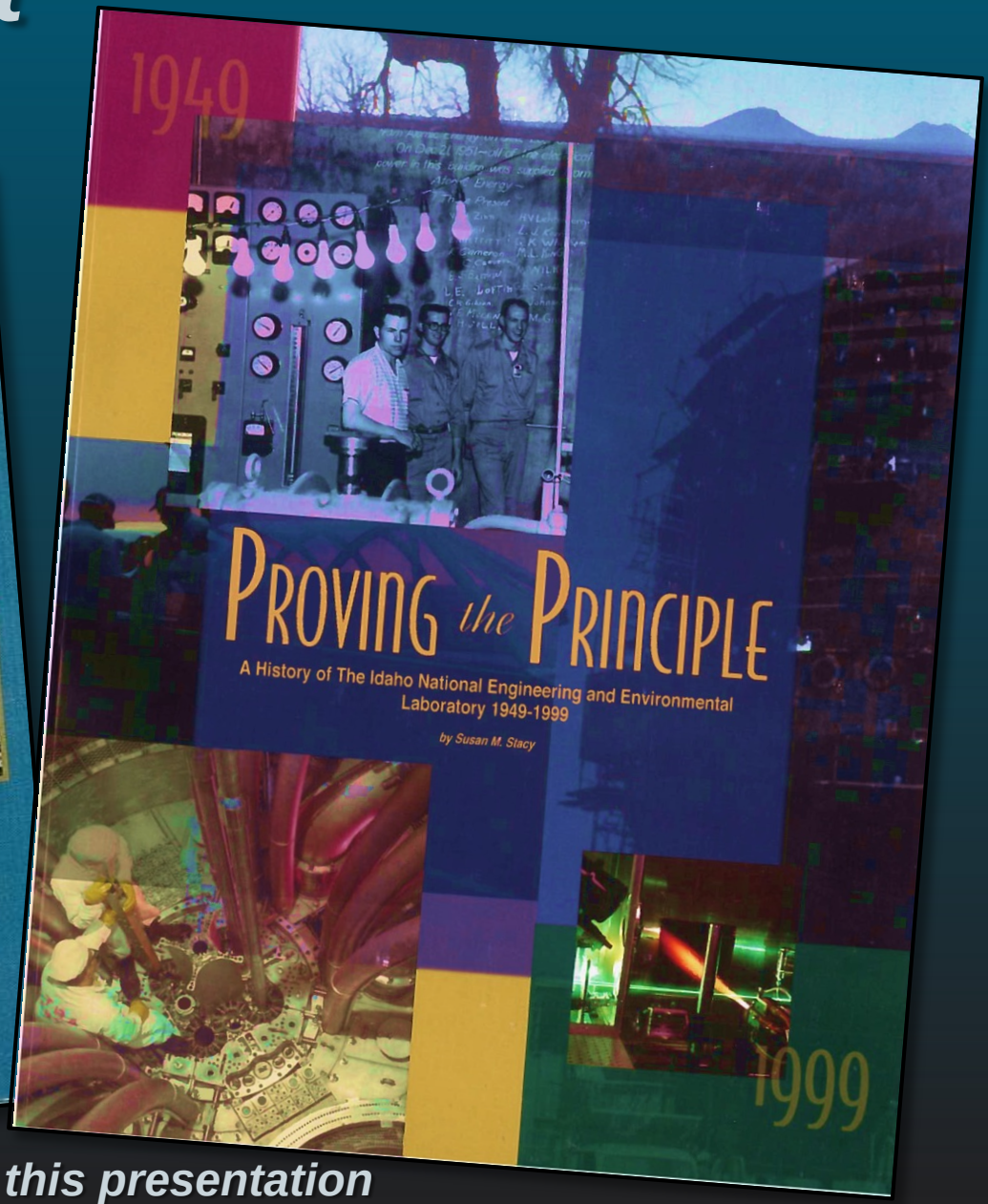
INL's Operating Reactors by Year



- **2 more are planed for startup in the next 8 years:**
  - Advanced Test Reactor
  - Advanced Test Reactor-Critical
  - Neutron Radiography Reactor
  - Transient Reactor Test Facility (TREAT) will restart in early FY18
  - Utah-based utility plans to build NuScale small modular reactor plant onsite ~2025

Understanding the Context and the Details

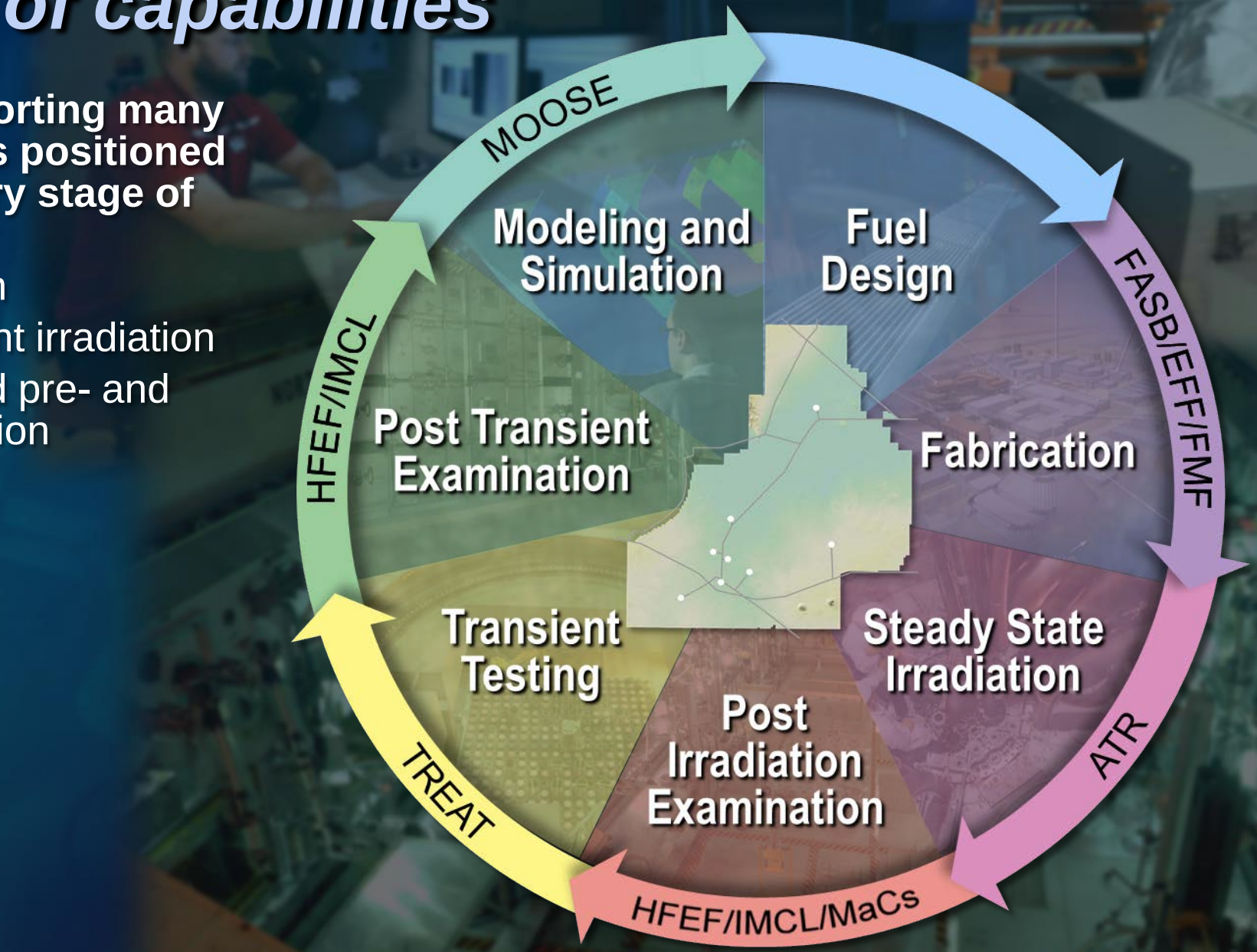




Primary sources for this presentation

Unmatched suite of capabilities

- **R&D infrastructure for supporting many of these reactor projects has positioned INL with capabilities for every stage of the nuclear R&D cycle**
  - Advanced fuel fabrication
  - Steady-state and transient irradiation
  - Traditional and advanced pre- and post-irradiation examination
  - Modeling & Simulation
  - Fuel & reactor design



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