National Reactor Innovation Center Overview

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www.inl.gov

Idaho National Laboratory

Idaho National Laboratory's origin is the National Reactor Testing Station (NRTS)

1949 — National Reactor Testing Station

1974 — INEL (Idaho National Engineering Laboratory)

Energy Mission – Reactor Science, Safety and Sustainability Solutions

1997 — INEEL (Idaho National Engineering and Environmental Laboratory)

Environmental Management Mission

2005 — INL (Idaho National Laboratory)

INEEL & ANL-W combined to create the new Idaho National Laboratory

- Nuclear Energy
- National and Homeland Security
- Energy and Environment

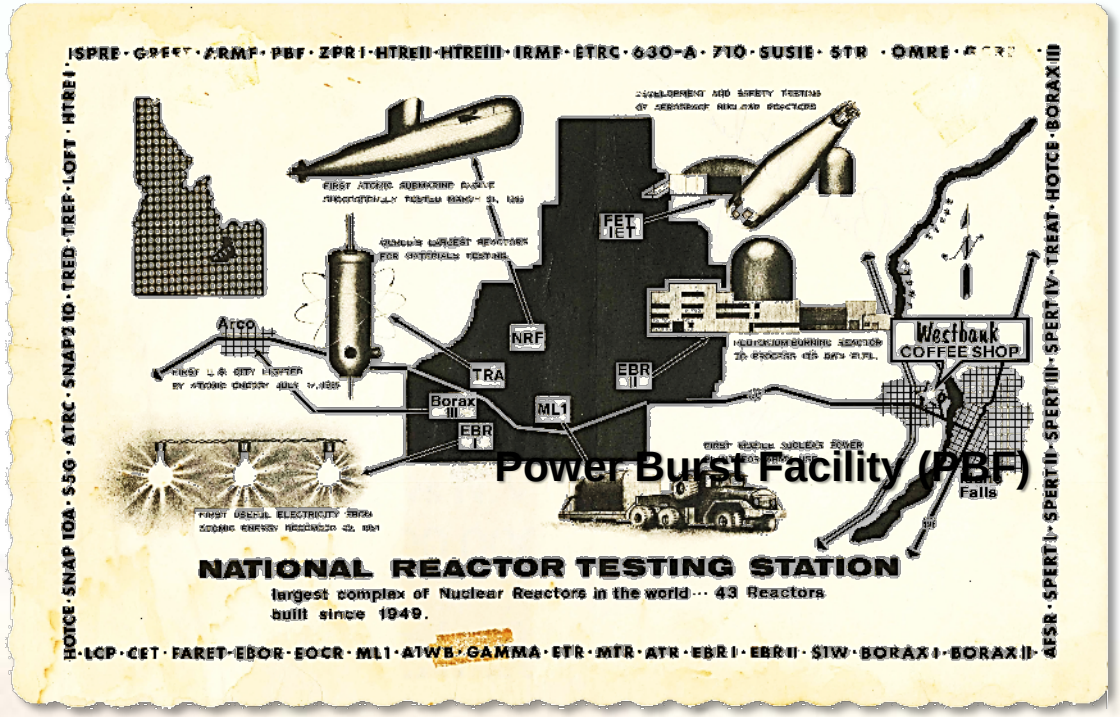
Argonne NATIONAL LABORATORY

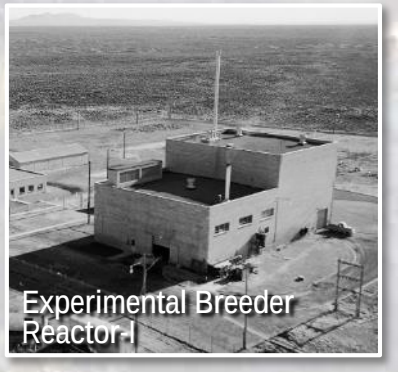
2019

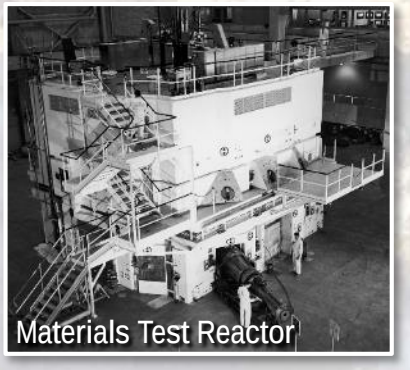
- Advancing Nuclear Energy
- Securing & Modernizing Critical Infrastructure
- Enabling Clean Energy Systems

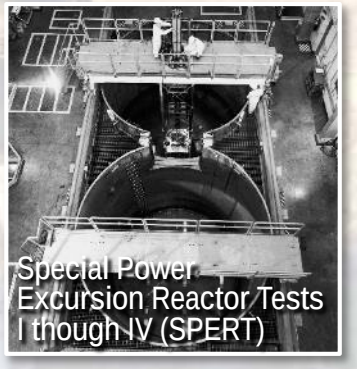
National Reactor Testing Station provided capabilities that drove nuclear innovation in the U.S. and around the world

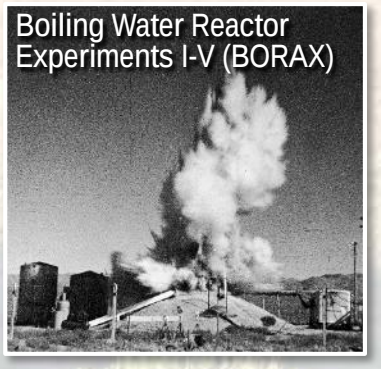
- ✓ First nuclear power plant
- ✓ First U.S. city to be powered by nuclear energy
- ✓ First submarine reactor tested
- ✓ First mobile nuclear power plant for the army
- ✓ Demonstration of self sustaining fuel cycle
- ✓ Basis for LWR reactor safety
- ✓ Aircraft and aerospace reactor testing
- ✓ Materials testing reactors



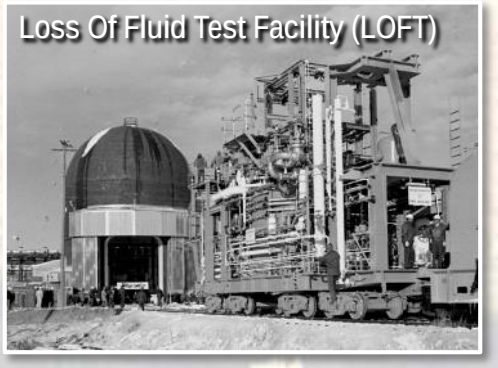

Experimental Breeder Reactor-I


Materials Test Reactor


Special Power Excursion Reactor Tests I though IV (SPERT)

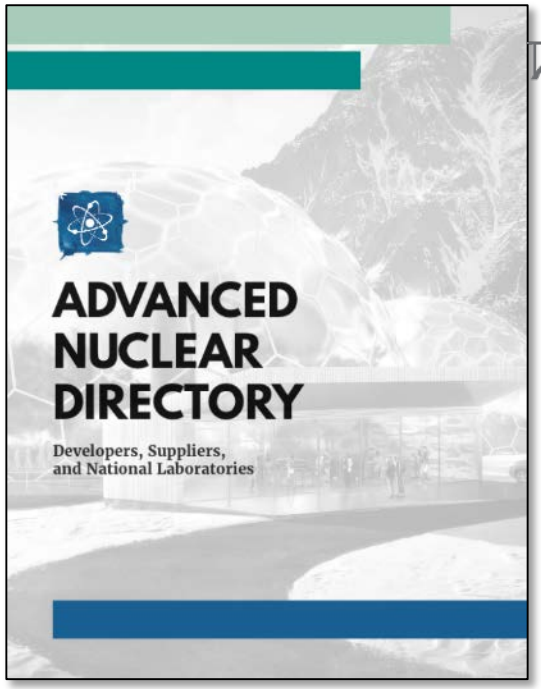

Boiling Water Reactor Experiments I-V (BORAX)


S1W (aka Submarine Thermal Reactor (STR)


Loss Of Fluid Test Facility (LOFT)

Renewed interest in clean energy in general, and advanced nuclear in particular, has driven the need for a new NRTS

- **Facilities and capabilities to develop, test, and demonstrate promising advanced reactor concepts to enable commercialization and deployment, domestically and beyond.**



GAIN
Gateway for Accelerated Innovation in Nuclear

framatome

OKLO

HolosGen™

BATTERY
Local Modular Energy

STARCORE NUCLEAR

TerraPower

Xe

TOSHIBA
Micro Nuclear

HOLTEC INTERNATIONAL

Westinghouse

Kairos Power

US ULTRA SAFE NUCLEAR

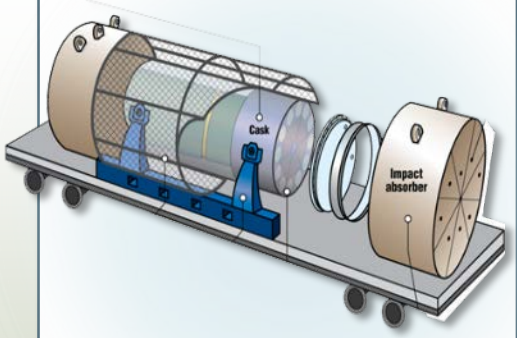
HITACHI

Creating the next-generation National Reactor Testing Station:

Advanced Reactor Pipeline Vision at Idaho National Laboratory

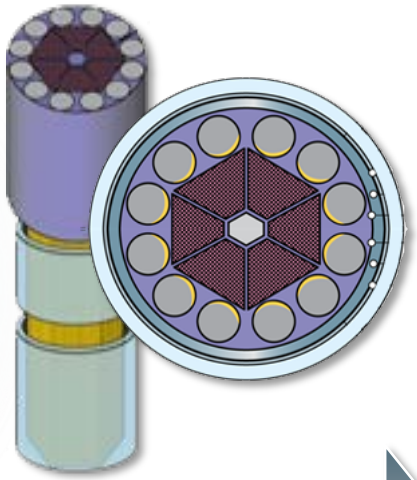
Demonstrate first <10MW micro-reactor by early 2020s

- Resolve key advanced reactor issues
- Open new markets for nuclear energy
- Provide a 'win' to build positive momentum



Commercial micro-reactors deployed

- Support deployment of micro-reactors for key remote site power and process heat customers

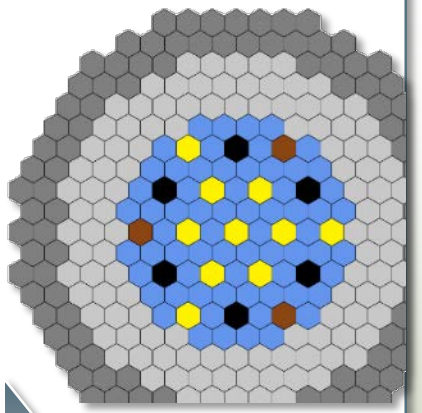


SMR operating by 2026

- Enable deployment through siting and technical support
- Joint Use Modular Plant leased for federal RDD&D

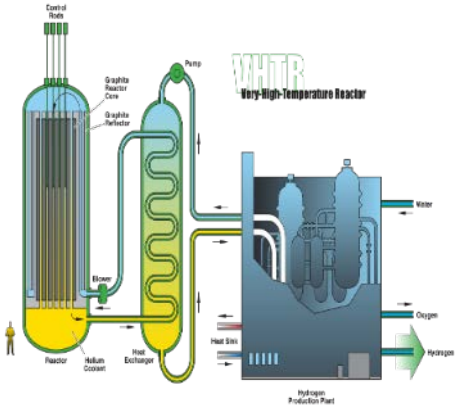
Versatile Test Reactor (VTR) operating by 2026

- Re-establish leadership in fast-spectrum testing and fuel development capability
- Supported by micro-reactor demonstration
- Support non-LWR advanced reactor demonstration



Non-LWR Advanced Demonstration Reactor by 2030

- Demonstrate non-LWR technology replacement of U.S. baseload clean power capacity



2021 → 2025 → 2026 → 2028 → 2030

Congress has responded by authorizing the National Reactor Innovation Center (NRIC)

- Authorized by the bipartisan Nuclear Energy Innovation Capabilities Act of 2017 and signed into law in September 2018, The National Reactor Innovation Center is intended to:
  - Enable testing and demonstration of reactor concepts to be proposed and funded, in whole or in part, by the private sector.
  - Enable physical validation of advanced nuclear reactor concepts.
  - Resolve technical uncertainty and increase practical knowledge relevant to safety, resilience, security, and functionality of advanced nuclear reactor concepts.
  - General research and development to improve nascent technologies.

115TH CONGRESS
2D SESSION

S. 97

AN ACT

To enable civilian research and development of advanced nuclear energy technologies by private and public institutions, to expand theoretical and practical knowledge of nuclear physics, chemistry, and materials science, and for other purposes.

"SEC. 958. ENABLING NUCLEAR ENERGY INNOVATION.

"(a) NATIONAL REACTOR INNOVATION CENTER.—There is authorized a program to enable the testing and demonstration of reactor concepts to be proposed and funded, in whole or in part, by the private sector.

NRIC will provide capabilities to accelerate technology readiness from Proof-of-Concept through Proof-of-Operations

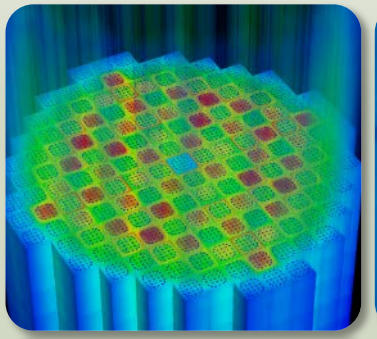
1 2 3 | 4 5 | 6 7 8 9

Proof-of-Concept	*Proof-of-Performance*	*Proof-of-Operations*
R&D to Address Technical Feasibility – Materials and fuels – Validated predictive modeling and simulation capabilities – Experimental capabilities	**Establish Performance of Nuclear Technologies** – Validation data – Irradiation and transient testing – Irradiated materials characterization	**Demonstration Platform to Address Economic/Operational Feasibility** – Sites for demonstration – Licensing support – Integrated energy systems support

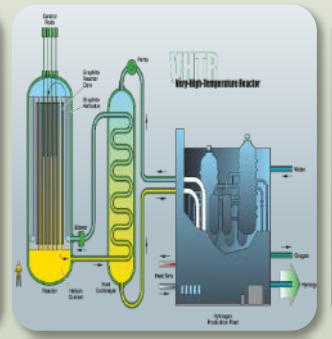
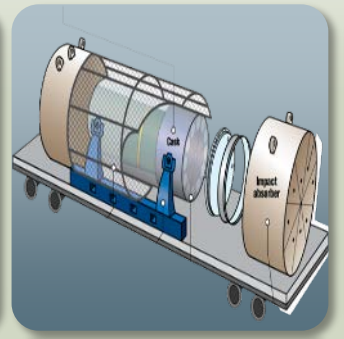
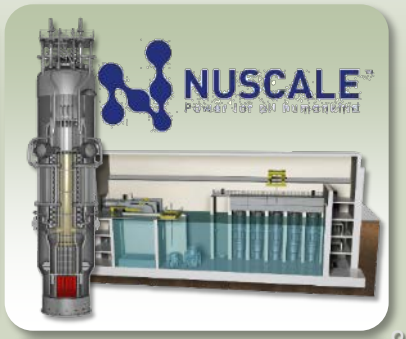
NRIC is the next-generation National Reactor Testing Station

INL is working with DOE to establish NRIC

- INL's thermal test reactor (ATR) and a proposed fast spectrum (VTR) are important for NRIC
- Transient test reactor (TREAT)
- Laboratory and engineering-scale fuels fabrication (MFC)
- Advanced irradiated materials characterization capabilities (IMCL)
- First-of-a-kind Small Modular Reactor - UAMPS/NuScale and Joint Use Modular Plant (JUMP)
- Micro and advanced reactor demonstrations
- Nuclear fuel cycle research and materials recovery (MFC)
- Integrated energy systems demonstrations
- Microgrid research and testing
- Cybersecurity for nuclear energy systems
- Nuclear energy advanced scientific computing (Collaborative Computing Center)
- Partnerships to leverage capabilities, resources, and expertise outside of INL

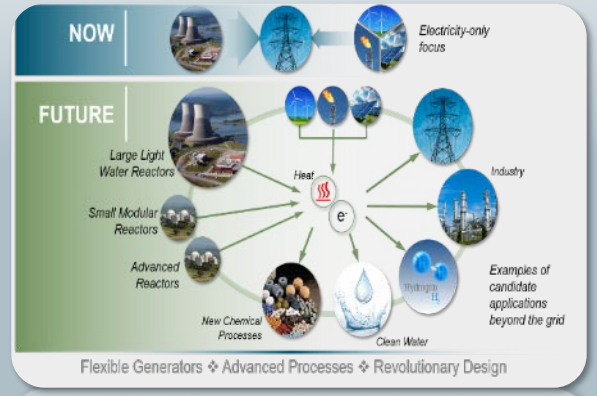


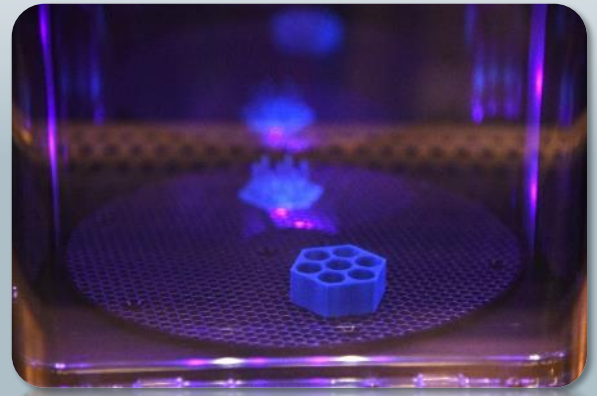


NRIC will provide capabilities essential to develop and demonstrate new reactor technologies

- Site with proven record of nuclear facility operations
- Existing buildings and green field sites for reactor demonstrations
- Engineering-scale fuel fabrication and advanced manufacturing capabilities
- Utility connections, integrated energy systems testing
- World-class nuclear RD&D experimental facilities and capabilities to support development
- Common site characterization, controlled emergency planning zone
- NRC-licensing and DOE-authorization for facilities, as appropriate

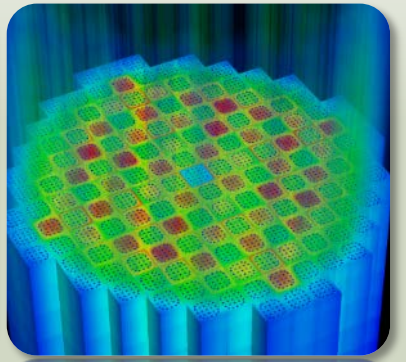




Examples of Recent Activities to Enable NRIC Success

- EBR-II reactor building (dome) secured from demolition for future research and development
- An Environmental Assessment for EBR-II HALEU completed to support recovery of an important resource to enable advanced reactor demonstrations
- INL is working with other labs on Versatile Test Reactor (VTR) program to establish a new fast-spectrum test reactor
- Site seismic evaluation initiated
- Memorandum of Understanding established between UAMPS, DOE, and Battelle Energy Alliance to support NuScale benefits for INL through power purchase agreements and R&D through JUMP
- Engagement with numerous reactor concept developers to provide unique INL capabilities to support near-term demonstrations
- Collaborative Computing Center (C3) under construction and on-schedule



Questions?

Image credit: Third Way and Gensler

Nuclear Energy Innovation Capabilities Act (NEICA) directs DOE to submit report to Congress defining key aspects of NRIC

- INL is supporting DOE to develop the report, which will be submitted to the appropriate Congressional committees, assessing the capabilities of the Department to authorize, host, and oversee experimental advanced nuclear reactors. The report will address:
  - DOE safety review and oversight, including options to leverage expertise from the Commission and the National Laboratories;
  - Options to regulate privately proposed and funded experimental rectors hosted by the Department;
  - Potential sites capability of hosting privately funded experimental advanced reactors.
  - Efficacy of the available contractual mechanisms for private-public partnerships (CRADAs, SPP, ACTs, etc.);
  - Federal government liability with respect to the disposal of low-level radioactive waste, spent nuclear fuel, or high-level radioactive waste;
  - Impact on aggregate U.S. inventory of low-level radioactive waste, spent nuclear fuel, or high-level radioactive waste;
  - Potential cost structures relating to physical security, decommissioning, liability, and other long-term project costs; and
  - Other challenges or considerations identified by the Secretary.