NRIC National Reactor Innovation Center

National Reactor Innovation Center

GAIN Industry Day

November 2025

nric.inl.gov

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National Reactor Innovation Center
Idaho National Laboratory

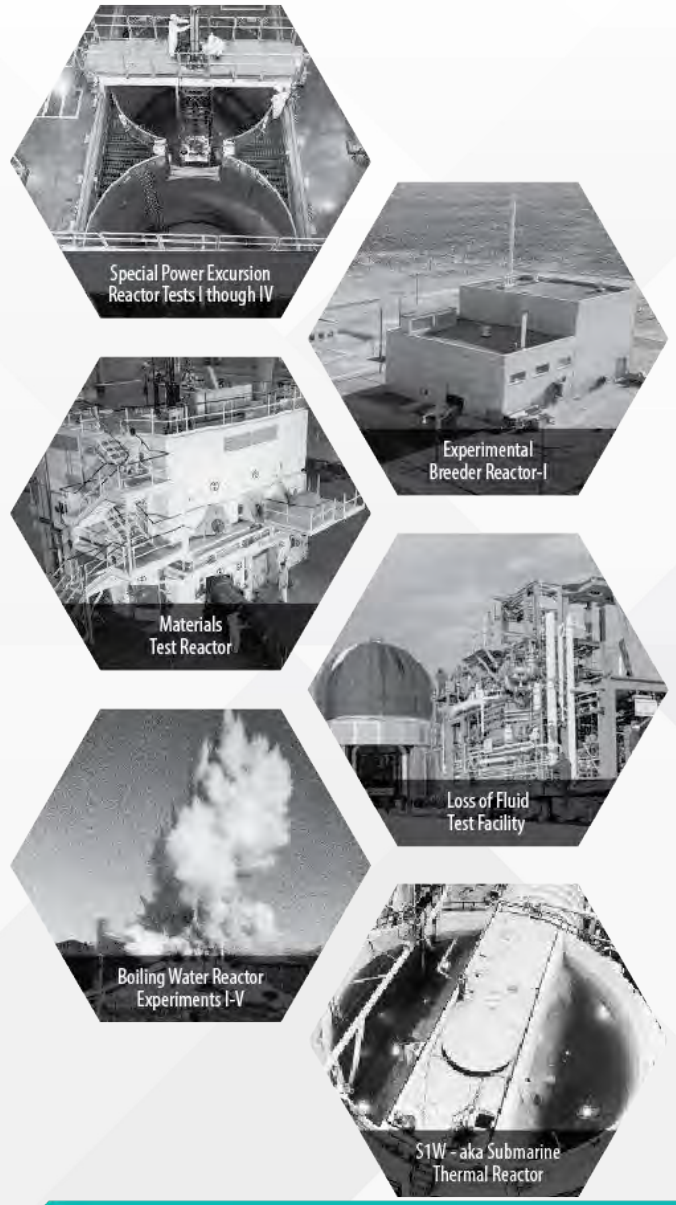
MIS-25-85437

Our Heritage: *The National Reactor Testing Station drove nuclear innovation in the U.S. and around the world*

1st

- Nuclear power plant
- U.S. city to be powered by nuclear energy
- Submarine reactor tested; training of nearly 40,000 reactor operators until mid-1990s
- 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



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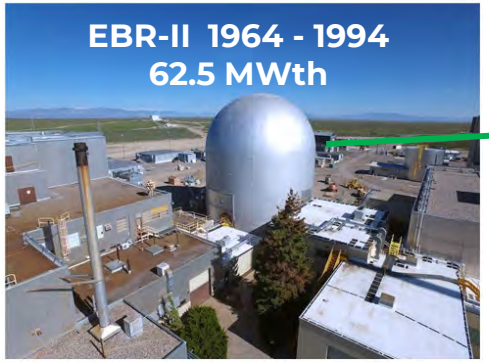
NRIC Enables Advanced Nuclear Technology Tests & Demonstrations

- DOE program launched in October 2019
- Authorized by the Nuclear Energy Innovation Capabilities Act (NEICA)
  - DOE-Office of Nuclear Energy; INL Nuclear Science & Tech
- Partner with industry to bridge the gap between research and commercial deployment
- Leverage national lab expertise and infrastructure

Portfolio Built to Empower Innovators

- **Advancing Reactor Testing**
  - Advanced Reactor Test Beds
  - Experimental Facilities
  - Virtual Test Bed
- **Addressing Costs & Markets**
  - Advanced Construction
  - Digital Engineering for Nuclear
  - Maritime Applications

NRIC Advanced Reactor Testbeds

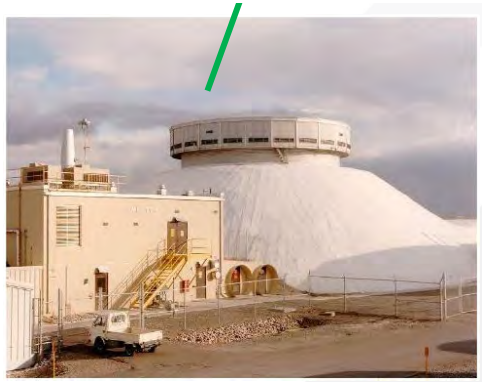


Demonstration of Microreactor Experiments (DOME)

- DOME is the repurposed EBR-II structure
- Designed for Advanced Microreactors up to 20MW_{th}
- Designed for High-Assay Low-Enriched Uranium (HALEU) fuels < 20% enrichment
- Accommodates ISO 668 High-Cube Shipping Containers up to 40ft long.
- 480V / 400Amp electrical Service
- ≈ 78 ft diameter floor space with an 80ft ceiling
- 300kWth of environmental cooling expandable to 500KW_{th}

Materials & Fuels Complex at INL

ZPPR 1969 to 1990
Transuranic and fuel inspection repackaging and experiments



Laboratory for Operations and Testing in the US (LOTUS)

- LOTUS is the repurposed ZPPR structure
- Designed for >20% enriched fuels
- Cell Heat Removal – (2) redundant HVAC packages – 50kWth
- Reactor Heat Removal – Design only – Min: 25KW_{th}; Max: 500 kW_{th}
- In Cell Equipment Power
  - Normal – 480VAC, 450A, 3 phase
  - Auxiliary – 208VAC, 160A, 3 phase
- Cell Provides Radiological Confinement
- Cell Geometry – 30ft usable inner diameter; 16ft 11in (bottom of crane hook); Recessed pit area
- Entry Tunnel – 13ft x 13ft
- Polar Crane Capacity – 5 tons

NRIC-DOME Test Bed

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2024

2025

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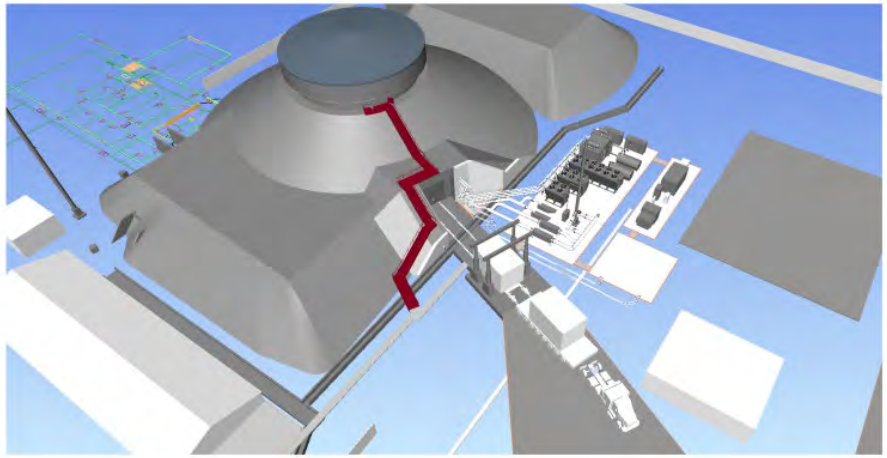
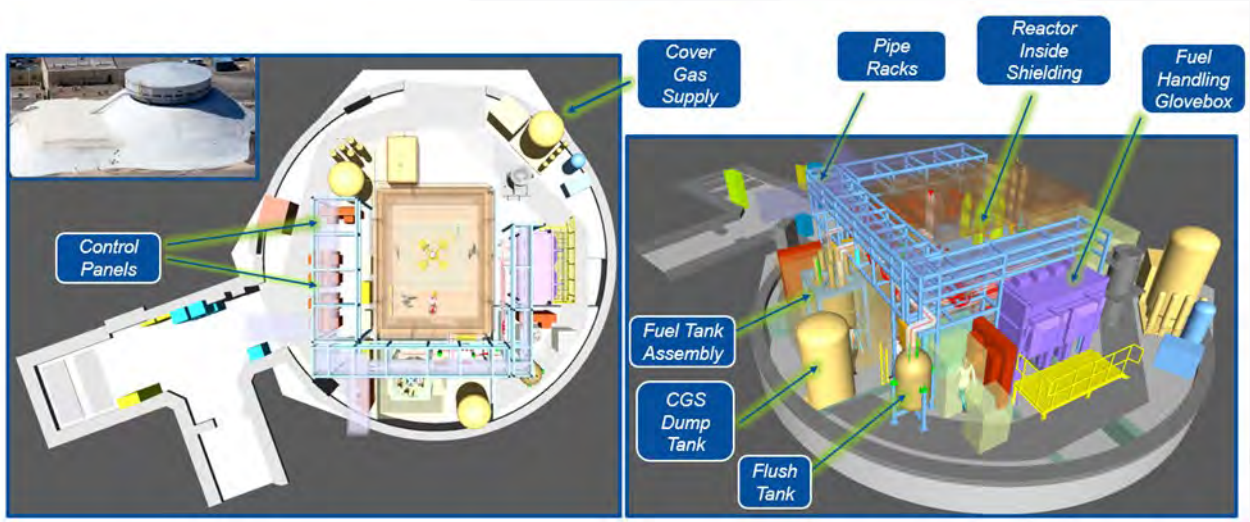
NRIC-LOTUS Test Bed

NRIC-LOTUS Testbed



LOTUS Conceptual Design Model



Molten Chloride Reactor Experiment integrated into LOTUS

- Line-item project: CD-1 Approved June 2023
- Completed Final Design: Sept 2024
- Complete Construction: FY27/28
- First User: Molten Chloride Reactor Experiment

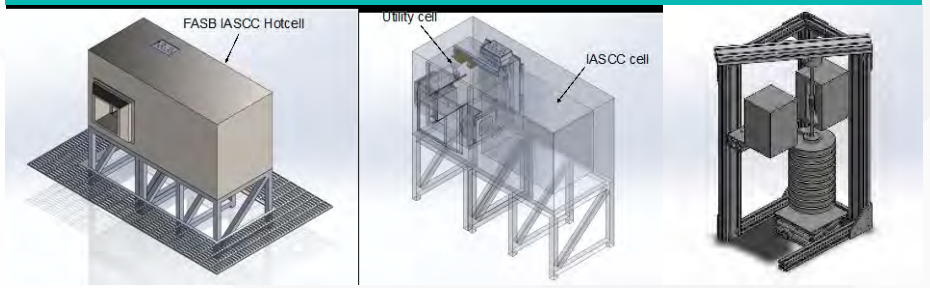
Molten Chloride Reactor Experiment

- Southern Company & Terra Power
- Funded through DOE Advanced Reactor Demonstration Program Risk Reduction
- Reactor Install: FY 28

NRIC Experimental Infrastructure

Helium Component Test Facility [*2022*]

In-HotCell Thermal Creep Frame [*2025*]

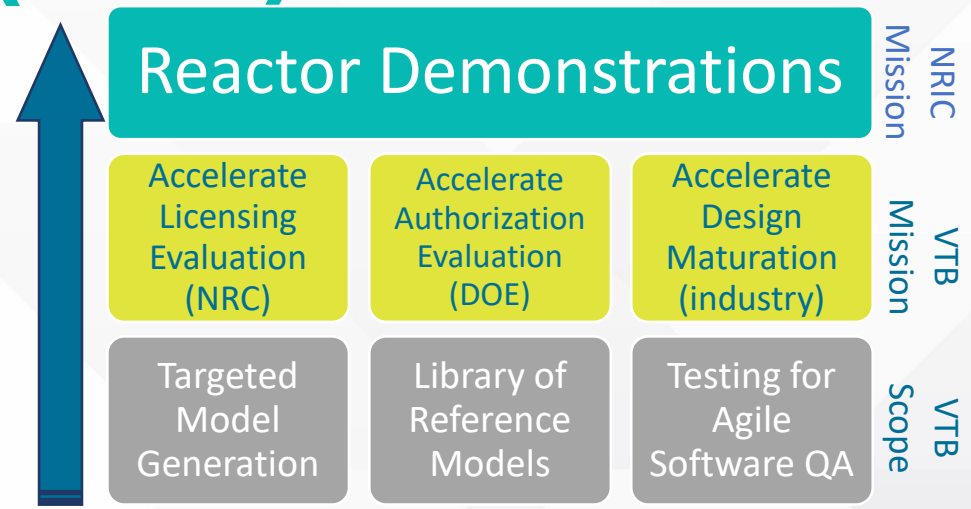


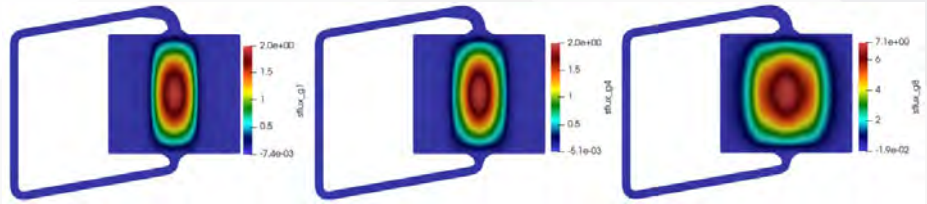
Molten Salt Thermophysical Examination Capabilities (MSTEC) [*2025*]

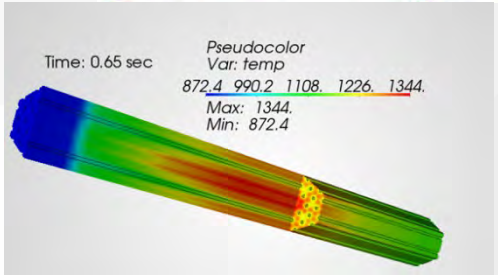
Mechanisms Engineering Test Lab (METL) [Operating since 2018]

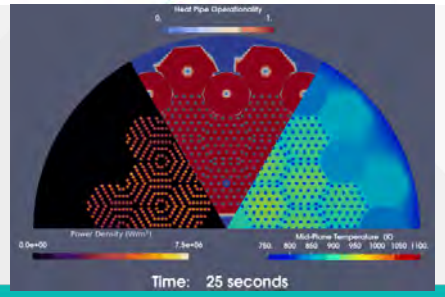
NRIC – Virtual Test Bed (VTB)

- Central location for reactor developers/stakeholders to access and leverage state-of-the art ModSim models of advanced reactors to evaluate performance and safety
- Cross-laboratory and cross-program collaboration between NRIC and DOE Nuclear Energy Advanced Modeling and Simulation (NEAMS) program
- Repository/library of simulations for. Sodium, lead, micro and molten salt reactors (continuously tested)
- Currently hosting 47 distinct models with 15 NEAMS codes
- Averaging 250+ visits/month









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Advanced Construction Technologies

Demonstrate Technologies

- Reduce cost of new SMR builds by 10%+
- Compress construction schedule by as much as 25%
- Reduce required site work & improve overall quality of structure
- Support long-term structure monitoring

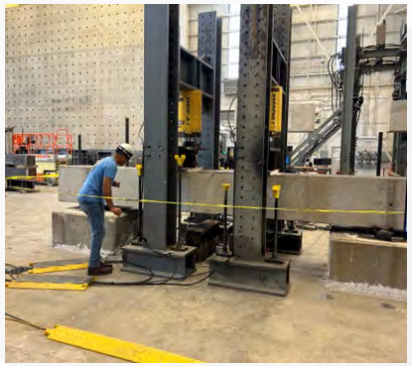
Phase One Recent Accomplishments

- Purdue DPSC testing complete & successful 11/18/24
- 10 CFR 851 determination received from DOE HQ GC 11/15/24

Optional Phase Two

- Demonstrate 60-degree pie shape containment walling system
- Inner and outer walls, base mat integration, multi-story
- Deploy digital twin plus sensor technology for monitoring
- NDE Execution and Deployment
- NRC Engagement & Decommissioning

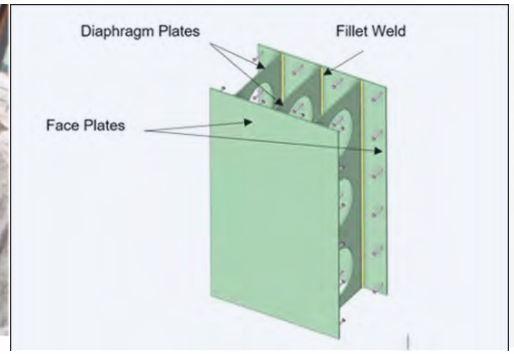
Testing DPSC samples at Purdue



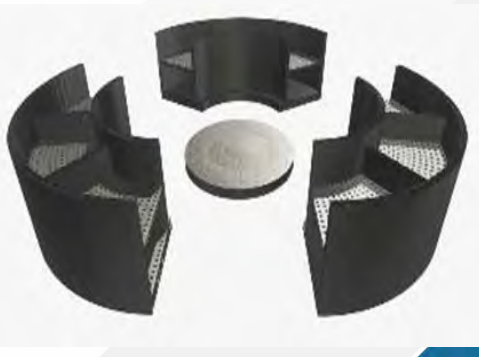
Team – General Electric Vernova

EPRI, Black & Veatch, Purdue, UNCC, Aecon, and Tennessee Valley Authority

Vertical Shaft Excavation

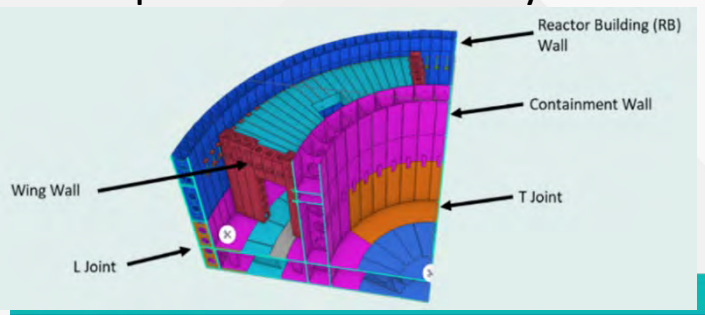


Diaphragm Plate Steel Composite (DPSC)



Modular Wall Concept

Proposed Phase II containment system



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Evaluating Maritime Applications NRIC & American Bureau of Shipping (ABS)

Maritime Nuclear Application Group

- Collaboration with ABS and Morgan & Lewis Law Firm
- Research Hub and Resource Center
- 175 members representing 80+ companies
- Gap assessment of testing capabilities for maritime nuclear applications
- Future work to examine 3S+L for maritime applications and develop MACCS codes to assess environmental impacts caused by sabotage or acts of terrorism

ABS iFOA Award

- Business cases and demo pathway (Task 1)
- Configuration models of advanced reactors integrated with maritime applications (Task 2)
- DOE Testing Readiness Report (Task 3)
- Upcoming: Overcoming Challenges to Nuclear-Maritime Demonstrations (Task 4)

*MNAG is a **research hub** and **resource center** that brings together experts from the maritime and nuclear energy sectors to facilitate the demonstration of advanced nuclear technologies for a range of marine applications.*

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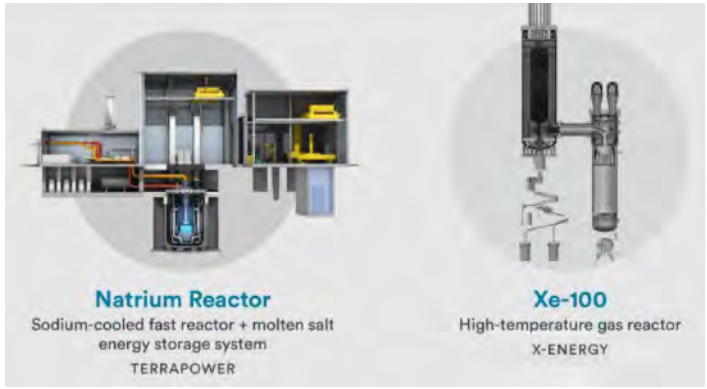
Supporting Advanced Reactor Projects at INL

ARDP

- INL scope range
  - Modeling & Simulation
  - Irradiation & PIE
  - Fuel design & fabrication
- NRIC/INL Coordinator
- Coordination meeting/monthly
- NRIC Digital Engineering and project management tools

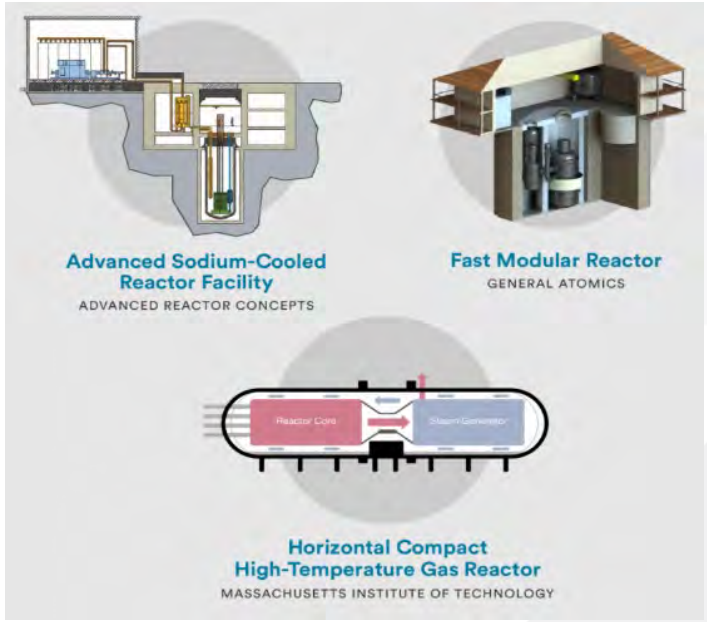
Demonstration



Natrium Reactor
Sodium-cooled fast reactor + molten salt energy storage system
TERRAPOWER

Xe-100
High-temperature gas reactor
X-ENERGY

Concept Development

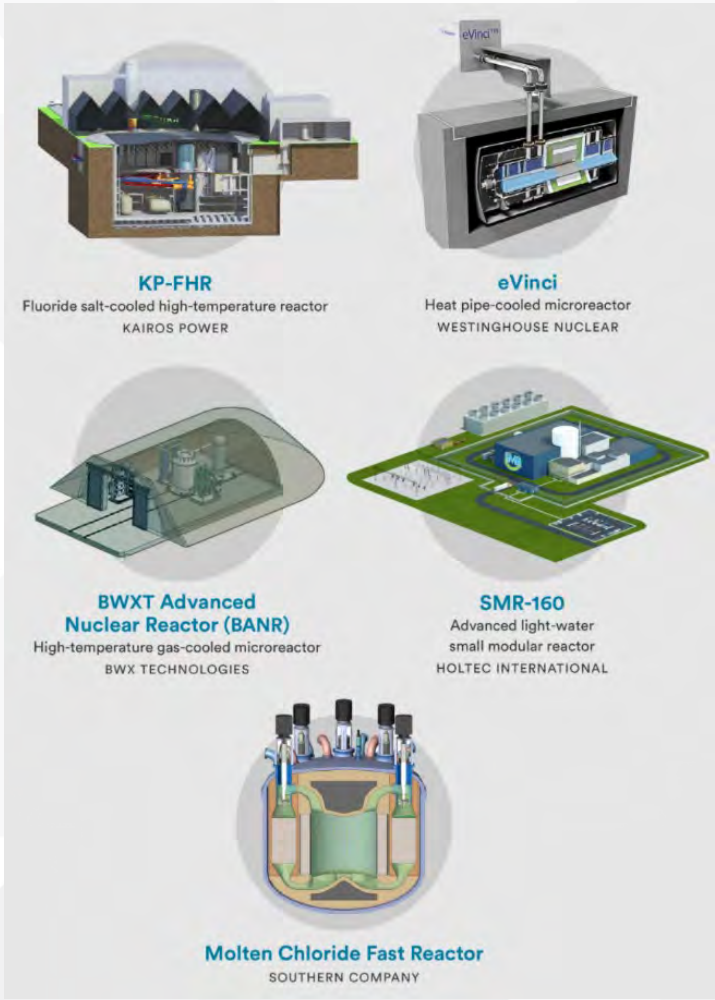


Advanced Sodium-Cooled Reactor Facility
ADVANCED REACTOR CONCEPTS

Fast Modular Reactor
GENERAL ATOMICS

Horizontal Compact High-Temperature Gas Reactor
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Risk Reduction



KP-FHR
Fluoride salt-cooled high-temperature reactor
KAIROS POWER

eVinci
Heat pipe-cooled microreactor
WESTINGHOUSE NUCLEAR

BWXT Advanced Nuclear Reactor (BANR)
High-temperature gas-cooled microreactor
BWX TECHNOLOGIES

SMR-160
Advanced light-water small modular reactor
HOLTEC INTERNATIONAL

Molten Chloride Fast Reactor
SOUTHERN COMPANY

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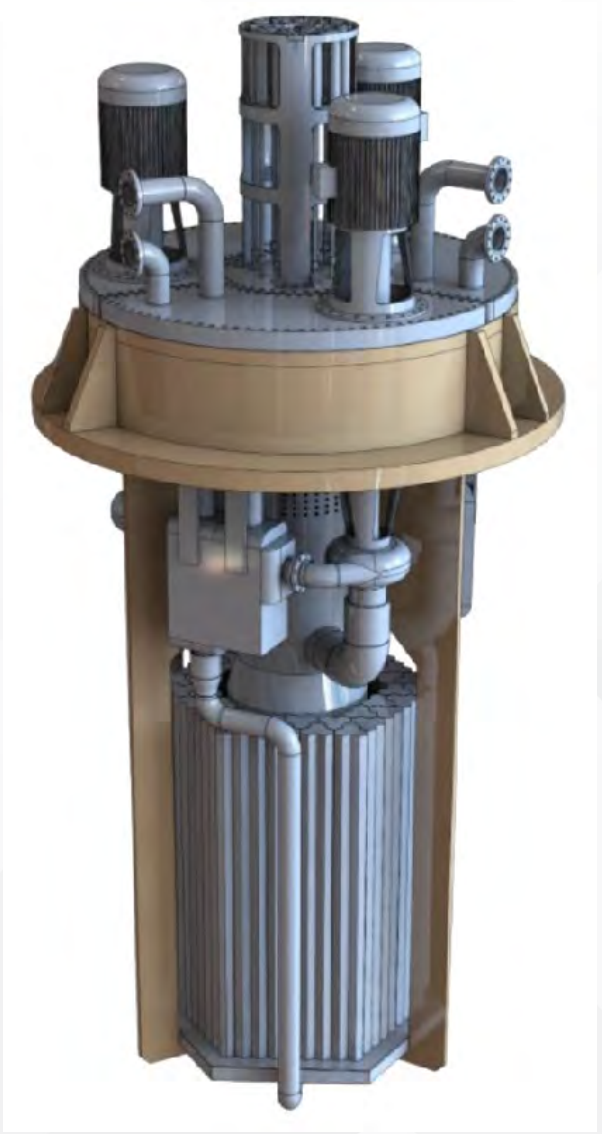
Oklo Aurora Reactor

- Oklo is a publicly traded company developing sodium-cooled fast reactors based on proven technologies developed at INL (e.g., EBR-I, EBR-II)
- Aurora Reactor
  - Site use agreement in place
  - 75 Mwe maximum output
  - DOE Authorized
- DOE competitively awarded Oklo with 5 MT of HALEU material recovered from EBR-II driver fuel
  - Fuel fab facility to be constructed at INL
    - DOE authorized
    - CSDR approved by DOE

Aalo-X Reactor

- Aalo Atomics
  - Land lease with DOE signed
  - Planned as DOE authorized test
- Aalo-X Reactor
  - Liquid Metal Reactor, Sodium Cooled Thermal Reactor
  - UO2 fuel pins
  - 20 MWth
- 5% enriched (LEU+)
- Other Transaction Agreement (OTA) signed



NRIC Launch Pad

Launch Pad as a continuation of advanced nuclear deployment on DOE land

- 1000+ acres at INL set aside for multiple nuclear developers
- Reactors, fuel fabrication, recycling, etc.
- Logical step in scaling to pure commercial deployments
- RFI has revealed need for end users

*AI Image, not representative of final product

Accelerating advanced reactor demonstration and deployment

Front End Engineering and Experiment Design (FEEED)

ANTARES-R1
Antares | TEST REACTOR

Selected for DOME Testing

eVINCI NTR
Westinghouse | TEST REACTOR

KALEIDOS
Radiant | TEST REACTOR

MARVEL
DOE | TEST REACTOR

HERMES 2
Kairos | SMR

Xe-100
X-energy & Dow | SMR

NATRIUM
TerraPower & GE | SMR

MCRE
Southern Co. & TerraPower | EXPERIMENT

PROJECT PELE
DoD & BWXT | MICRO

AURORA
Oklo | MICRO

2026

2027

2028

2029

2030

SMR-300
HOLTEC | SMR

LOTUS
NRIC | TEST BED

MSR-100
Natura Resource | SMR

DOME
NRIC | TEST BED

Aalo-X
Aalo | MICRO

Natura MSR-1
Natura Resources & Abilene Christian University | TEST REACTOR

HERMES
Kairos | TEST REACTOR

U.S. DEPARTMENT of ENERGY

Selected for Reactor Pilot Program
Aalo, Antares, Atomic Alchemy, Deep Fission, Last Energy, Oklo, Natura Resources, Radiant, Terrestrial Energy, and Valar Atomics

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12/9/2025

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