



# National Reactor Innovation Center (NRIC) Chobani

February 2024

*Changing the World's Energy Future*

Bradley John Tomer



*INL is a U.S. Department of Energy National Laboratory operated by Battelle Energy Alliance, LLC*

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**Bradley John Tomer**

**February 2024**

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**<http://www.inl.gov>**

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NRIC

National Reactor  
Innovation Center

# National Reactor Innovation Center (NRIC)

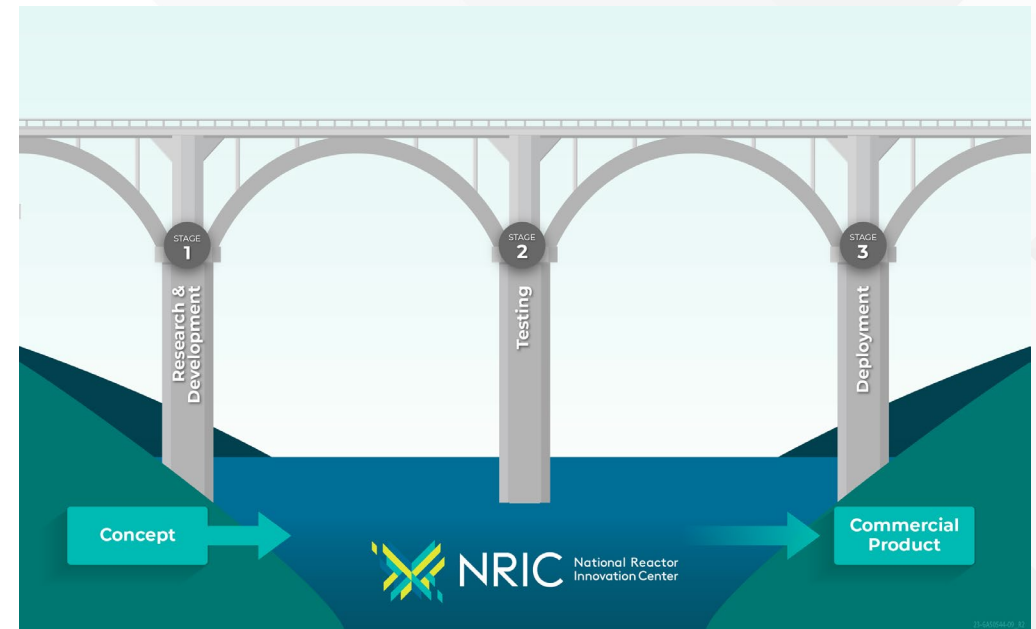
Jack Britt – NRIC Department Manager  
Jack.Britt@inl.gov

02/07/2024

# NRIC is a DOE-NE center, launched in FY2020

*NRIC Accelerates Nuclear Reactor Demonstrations*

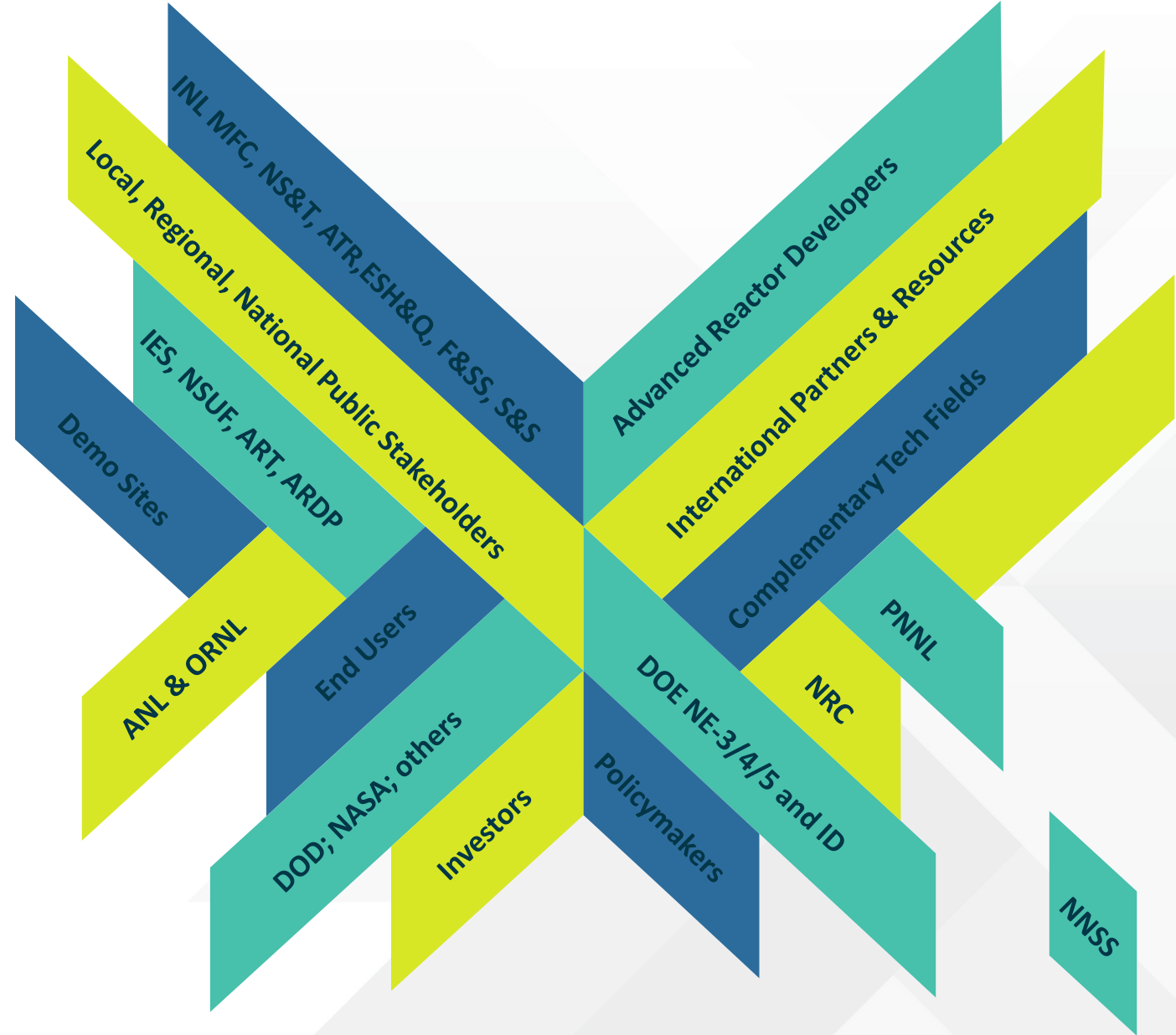
- Authorized by the Nuclear Energy Innovation Capabilities Act (NEICA)
- Partner with industry to bridge the gap between research and commercial deployment
- Leverage national lab expertise and infrastructure
- Manage demonstrations to success



# Collaborative Approach

NRIC is  
partnering  
regionally and  
nationally to  
support  
demonstrations

LANL

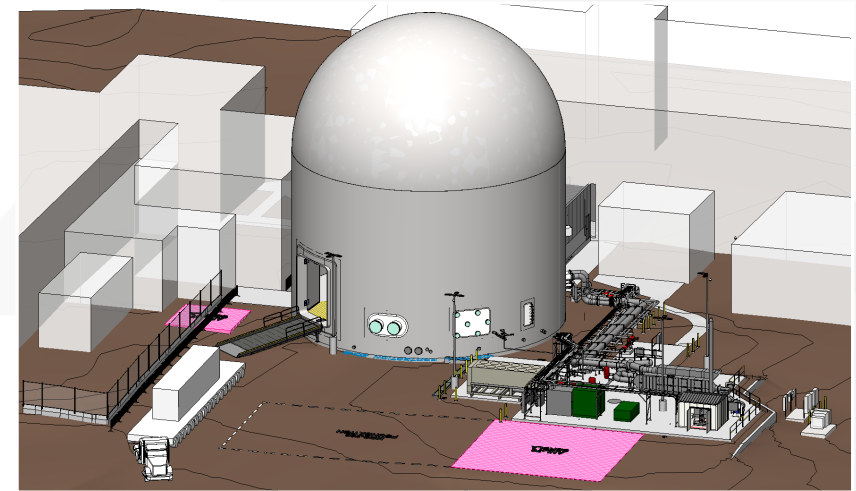
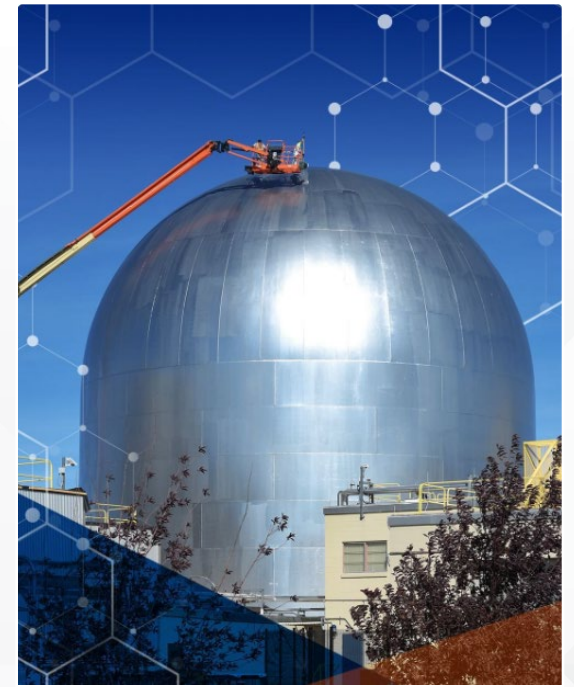
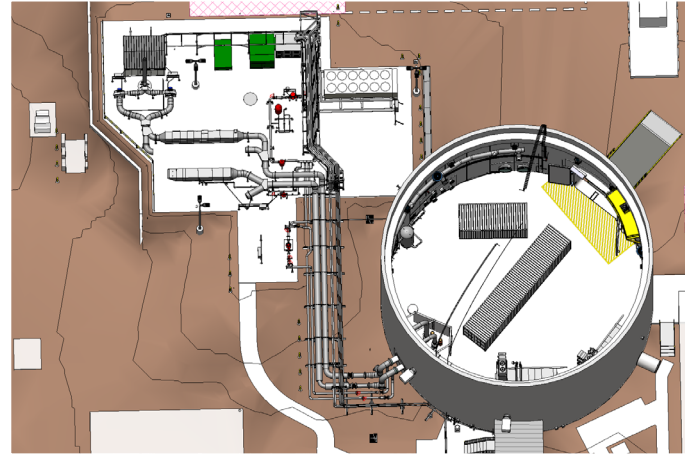
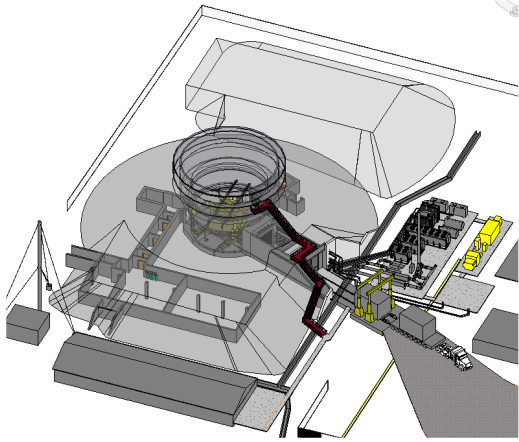


# Portfolio Designed to Empower Innovators



- Building foundation for testing
  - Advanced Reactor Test Beds
  - Experimental Facilities
  - Virtual Test Bed
- Addressing Costs & Markets
  - Advanced Construction Technologies
  - Digital Engineering for Nuclear
  - Maritime Applications

# NRIC Demonstration Test Beds





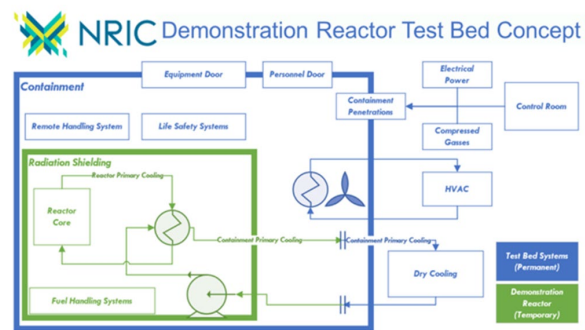
# NRIC Testbed Strategy

## NRIC-DOME Testbed

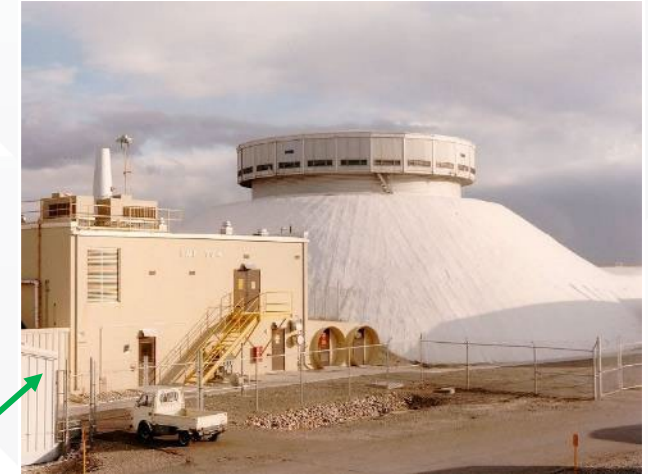


- EBR-II Operated from 1964 to 1994
  - 62.5 MW thermal
- Repurposing EBR-II as NRIC-DOME
  - $<20\text{MW}_{\text{th}}$   $<20\%$  enriched fuels
  - Final design complete
  - Construction begins 2023
  - First user expected 2026

Materials & Fuels Complex at INL



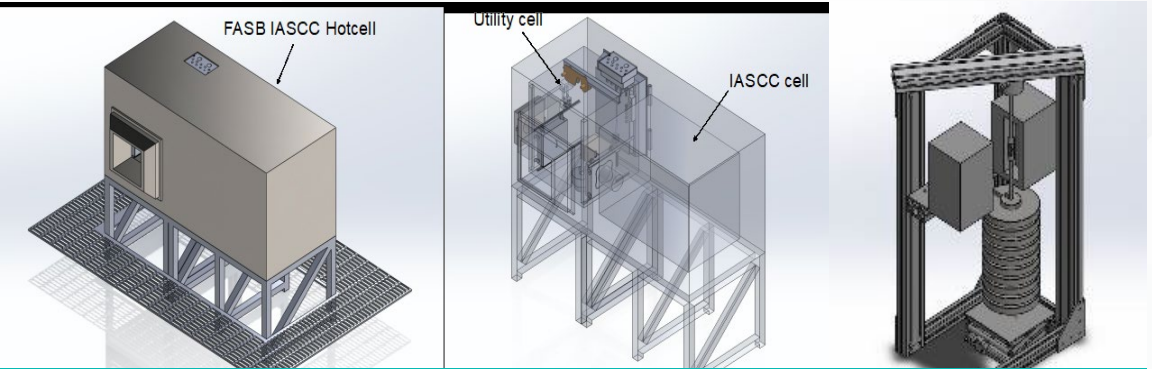
## NRIC-LOTUS Testbed



- ZPPR Operated from 1969 to 1990
  - Used for transuranic and enriched-uranium material inspection/repackaging and experiments
- Repurposing ZPPR Cell as NRIC-LOTUS Testbed
  - Small KWth reactors
  - $>20\%$  enriched fuels
  - Conceptual design phase complete
  - Preliminary/Final Design Initiated
  - First user expected 2027/2028

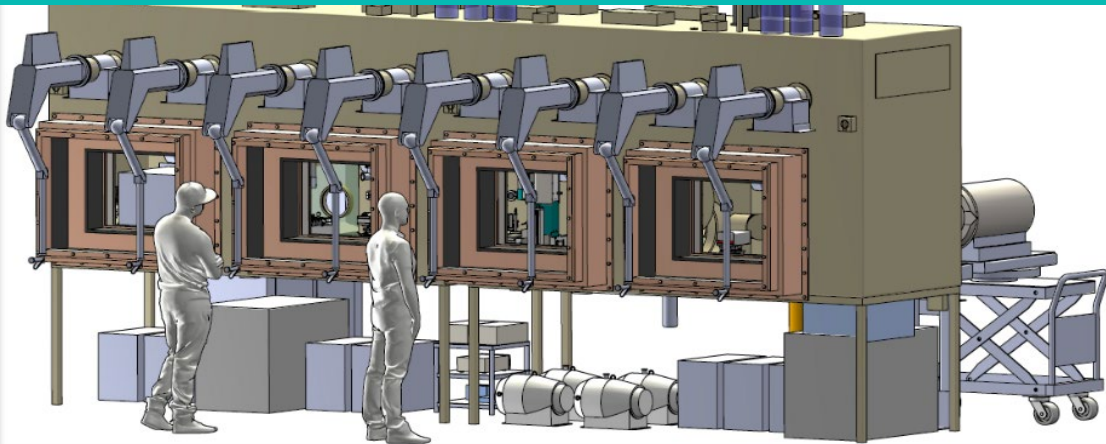
# NRIC Experimental Infrastructure

Helium Component Test Facility [2022]



In-HotCell Thermal Creep Frame [2025]

Molten Salt Thermophysical Examination Capabilities (MSTEC) [2025]



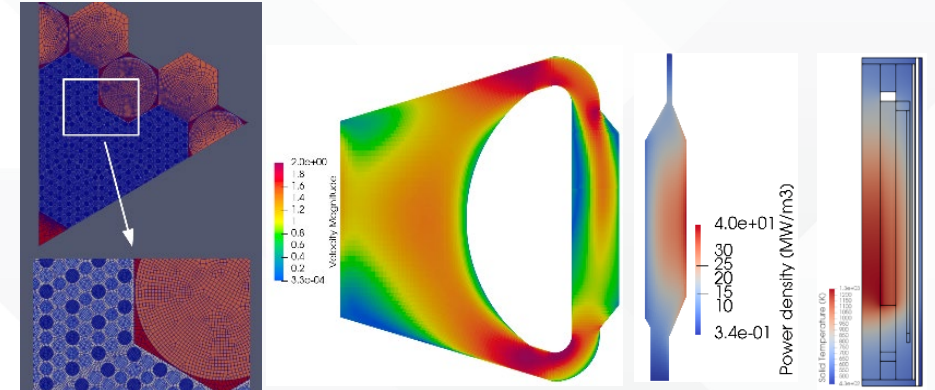
Mechanisms Engineering Test Lab (METL) [Operating]





# NRIC - Virtual Test Bed

- Central location for reactor developers/stakeholders to access/leverage state-of-the-art ModSim reactor models to evaluate performance and safety of their advanced reactors
- Cross-laboratory collaboration between NRIC and Nuclear Energy Advanced Modeling and Simulation (NEAMS) programs
- Repository/Library of NEAMS models of advanced reactors: sodium, microreactors, gas, molten salt, fluoride high-temperature reactors
- Currently hosting 30+ distinct advanced reactor models, with 7 NEAMS codes showcased... More coming soon!
- Averaging 200+ users/month since we started tracking in April 2023 (NRC/Industry/Academia)



Example models and results in the VTB repo



Announcement of Tech Talk on VTB

**VTB Link:** [https://mooseframework.inl.gov/virtual\\_test\\_bed](https://mooseframework.inl.gov/virtual_test_bed)

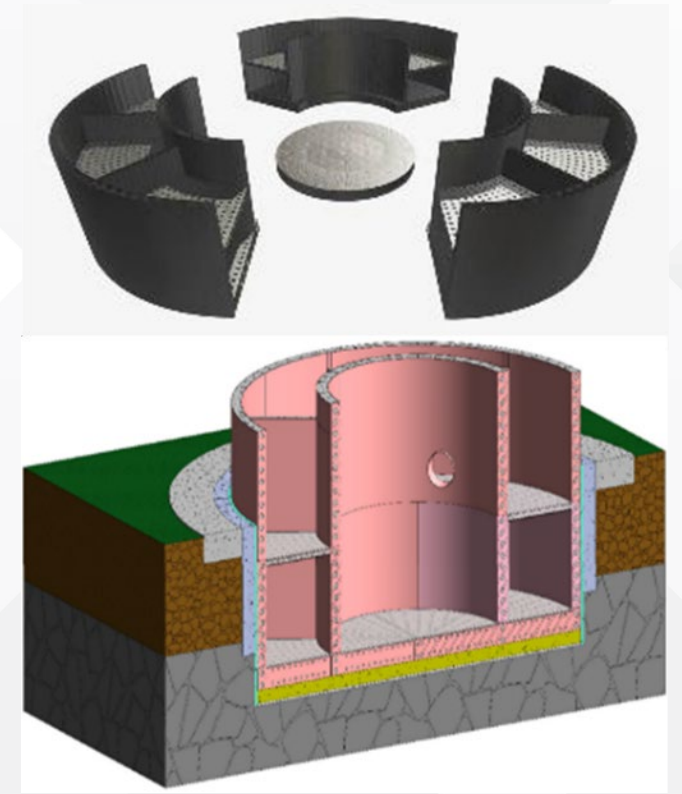
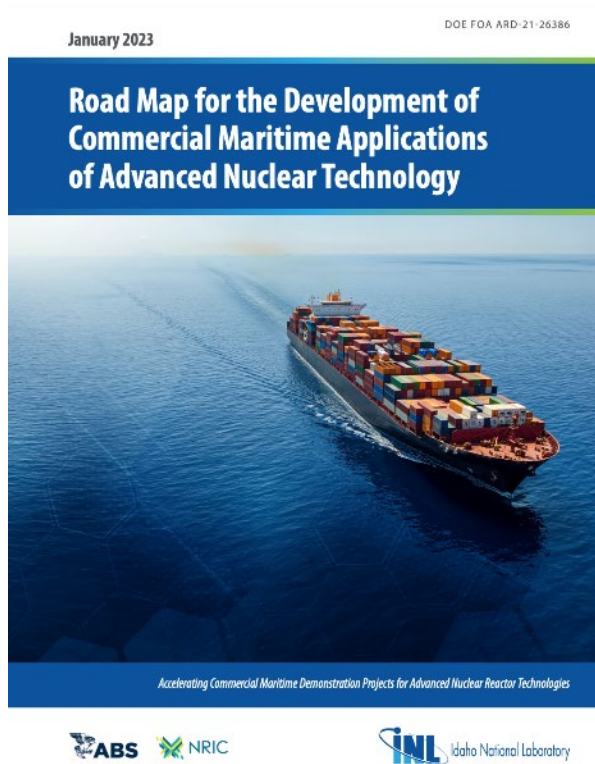
**ANS Special Session Link:**

<https://www.ans.org/meetings/wm2021/session/view-874/>

**NRIC Tech Talk Link:** [https://nric.inl.gov/nric-tech-talks-modeling\\_simulation/](https://nric.inl.gov/nric-tech-talks-modeling_simulation/)

# Addressing Cost and Markets

- Demonstration/Deployment Opportunities (Maritime)
- Advanced Construction Technologies
- Digital Engineering & Knowledge Sharing/Lessons Learned



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

## Maritime Nuclear Application Group

- Collaboration with ABS and Morgan & Lewis Law Firm to establish a forum for the maritime and nuclear energy sectors to demonstrate advanced nuclear technologies
- Identifies domestic and international legal and regulatory hurdles, catalogs and share relevant information resources, and collaborates with global stakeholders
- 100+ members representing 40+ domestic/international companies from nuclear, shipping, and oil/gas industries including:
  - Westinghouse, NuScale, BWXT, NEI, Shell, NRC, US Coast Guard, etc.
- Conducting assessment of experimental and testing gaps to fill

## Industry FOA Award 2022 - ABS Accelerating Commercial Maritime Demonstration Projects for Advanced Nuclear Reactor Technologies System

- Develop roadmap for maritime application test/demonstration projects
- Reconcile maritime and nuclear licensing and conduct a regulatory gap analysis
- Develop business cases & 2050 market potential for nuclear-marine applications

## Road Map for the Development of Commercial Maritime Applications of Advanced Nuclear Technology



Accelerating Commercial Maritime Demonstration Projects for Advanced Nuclear Reactor Technologies



- IAEA Symposium – Deployment Of Floating Nuclear Power plants –Nov
- CORE POWER - DC – Oct





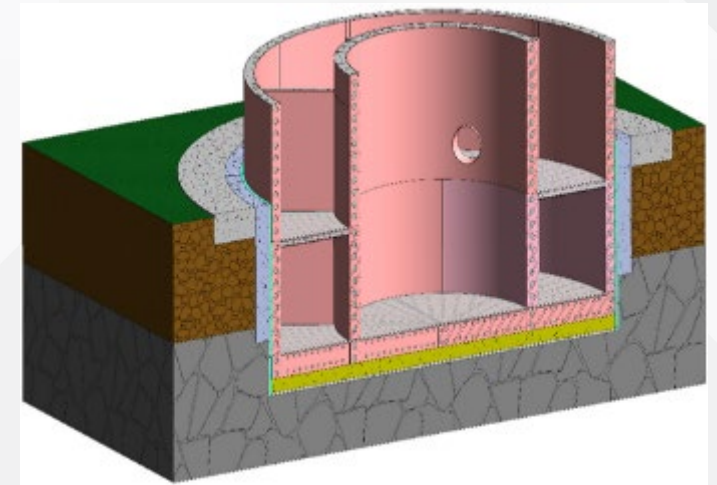
# Advanced Construction Technology Initiative (ACTI)

- **Purpose -**

- Demonstrate advanced construction technologies/processes that can significantly improve economics and schedule duration of nuclear build projects for SMRs
- Enable commercial deployment by 2030
  - Partner with industry to learn by doing
  - Collaborate with Nuclear Regulatory Commissions

- **General Electric Hitachi Nuclear**

- Technology Areas:
  - Vertical shaft excavation techniques
  - Steel Bricks™- Steel Concrete Composite Modules
  - Advanced monitoring & digital twin technology
- Two Phase Project:
  - Phase I: Prototype and test Steel Bricks™, optimize design of demonstration
    - Started Jan 2022 with ~ DOE-NE 70% and GEH Team 30% cost share
  - Phase 2: Scaled demo unit construction, testing and decommissioning
    - 2 or 3 years, subject to availability of funds and successful Phase I



Steel Bricks is a trademark of Modular Walling Systems Holdings Limited (MWS)

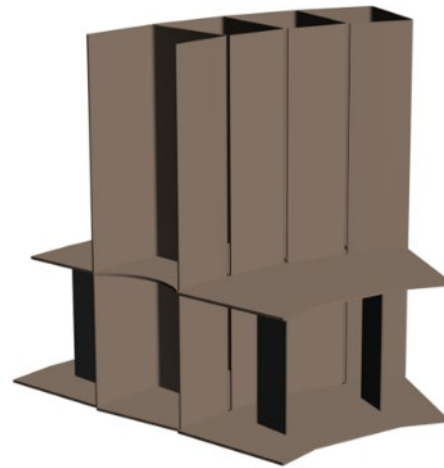
# Steel Brick™ Concept

Next generation Steel Concrete Composite modules, for Seismic Category 1 structures installed in a radial configuration

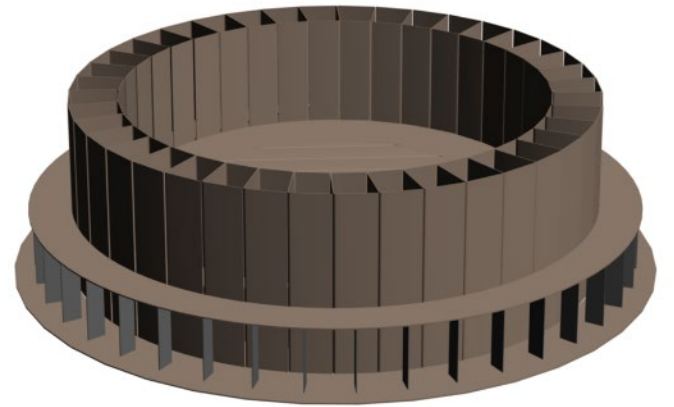


Steel Brick™ Fabricated at Shop

*Concurrent wall fab and excavation  
Reduced schedule duration*



Steel Brick™ Modules  
Shipped to site



Assembled in field, outside of  
pit, lowered into pit

*Reduced onsite work  
Improved quality  
Less rework*



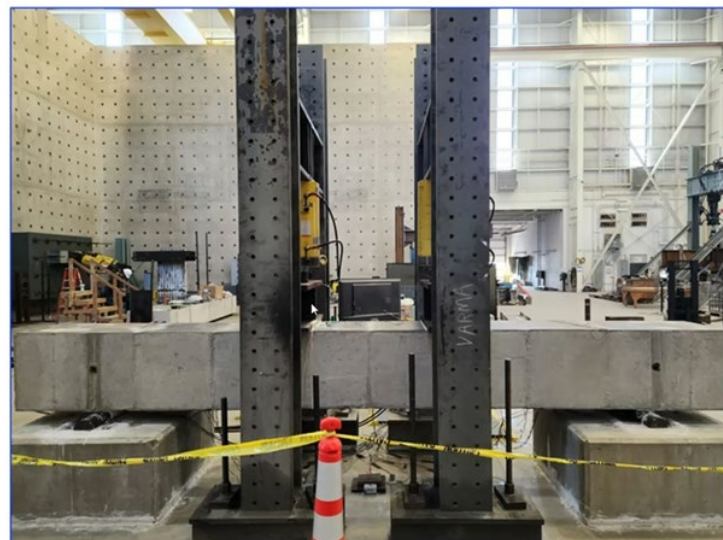
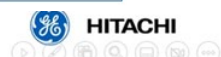
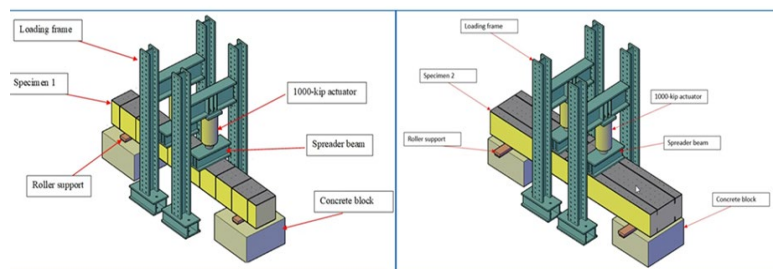


Steel Brick™ prototypes arrive at Purdue from Cauntion Engineering, filled with Concrete and imperfections for Stress and NDE Testing

Picture of East Side of Test Setup



Test Setup and Specimen Drawings



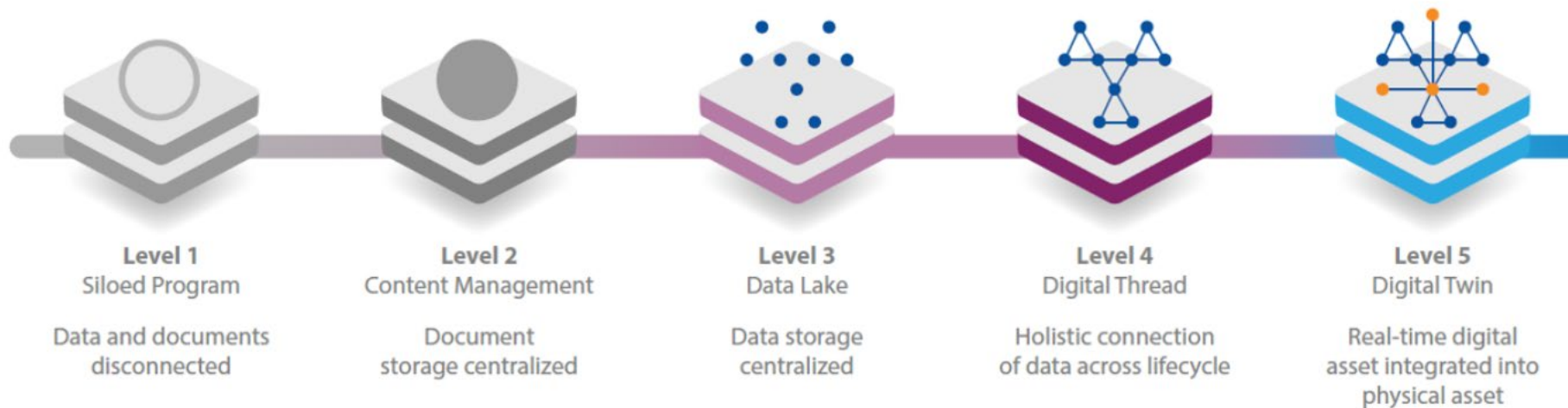
Disclosure, Use, or Reproduction without the Express Consent of GEH or BEA is Prohibited.





# NRIC Systems/Digital Engineering Overview

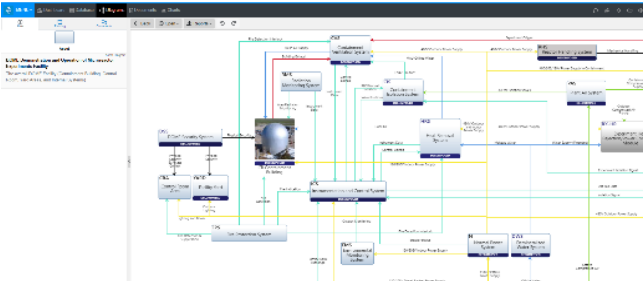
- Holistic approach to the design of a complex system:
  - Design using models/data instead of documents
  - Integration of data across models to realize significant risk reduction on project cost and schedule
  - Applying state-of-the art Model Based Systems Engineering Tools from requirements engineering through design, construction, and operations
  - NRIC-DEN (Digital Engineering for Nuclear) sharing this tool set architecture with industry partners and others to facilitate cost reductions and improve advanced reactor deployment



Will combine DOME model with reactor model to facilitate virtual fit up and testing

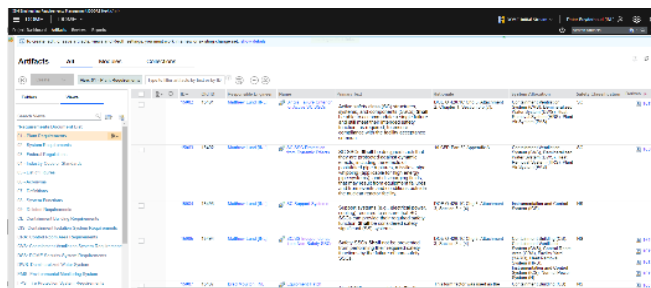


## Systems Engineering



IBM Rational

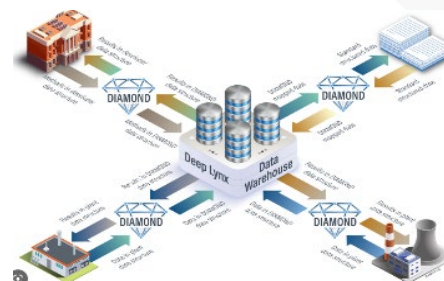
## Requirements Engineering



Pull any data from one system and push to other systems – Single Source of Truth



## Product Lifecycle Management



## Data Warehouse: Deep Lynx

**PROCORE**

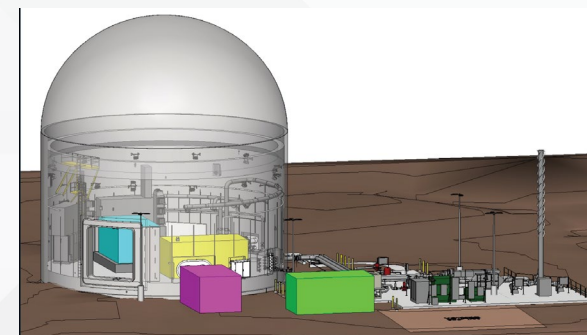
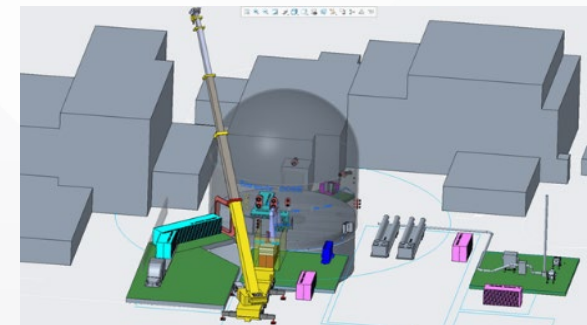
Construction Management



INL Asset Suite



## 3D CAD Digital Twin



## 3D BIM Digital Twin

FY23: Deployed Windchill, integrated P6 schedule system, & deployed engineering V&V tool

FY24: Complete upgrade to DOME digital twin to include component information (informational digital twin)



**NRIC**

National Reactor Innovation Center



# Engagement

- Tools
  - Web/Social, Flyover, Mapping, Videos
- Best practices development
  - University of Michigan, FPTZ
- University grants for social science efforts

Menu

Choose a site: All

**Legend**

Site #9

Site #10

Adjust Camera Height

0:41 / 1:08

**NRIC** National Reactor Innovation Center  
Demonstration Resource Network

**Search by Map**  
Zoom to the facility of interest then select it to view the details.

OR

**Filter by Capability**

- ☐ Chemical and Molecular Science (emerging)
- ☐ Chemical Engineering
- ☐ Condensed Matter Physics and Materials Science (emerging)
- ☐ Cyber and Information Sciences
- ☐ Demonstration Test Bed (existing building)
- ☐ Environmental Subsurface Science
- ☐ Fuel Development and Fabrication
- ☐ Large-scale User Facilities / R&D Facilities / Advanced Instrumentation
- ☐ Mechanical Design and Engineering
- ☐ Nuclear and Radiochemistry
- ☐ Nuclear Engineering
- ☐ Power Systems and Electrical Engineering
- ☐ Systems Engineering and Integration

Clear Filter

**Filtered Results**

- ATR Test Train Assembly Facility (TTAF) (TRA-1620)
- CITRIC Communications Research Facility (CBF-413)
- CITRIC Wireless Comm. Support Building (CBF-623)
- Center for Advanced Energy Studies (CAES) (IF-665)
- Collaborative Computing Center (IF-692)
- EBR-II Reactor Plant Building (MFC-767)

About this Site

Earthstar Geographics

0 6 mi

**Experimental Breeder Reactor II Dome (EBR-II)**  
• Microreactor Demonstrations

**Fuel and Applied Science Building (FASB)**  
**Fuel Conditioning Facility (FCF)**

**NRIC** The former home of the EBR-II reactor is one place we plan to host microreactor demonstrations.

1:42 / 3:33

**NRIC** National Reactor Innovation Center

Who We Are Who We Work With How We Work U.S. Nuclear Energy Leadership Newsroom Resources

## Communities

The planning and construction of advanced nuclear power plants requires collaboration between Communities, Innovators, and the U.S. National Laboratory System. NRIC provides a platform for these groups to work with each other by communicating common visions and accomplishing shared goals.

Communities that host nuclear power technology are its most trusted stewards. Constructing new plants requires identifying

# Siting Tool for Advanced Nuclear Development - STAND

Provides a systematic way based on user siting preferences and priorities related to socioeconomic, proximity, and safety factors to:



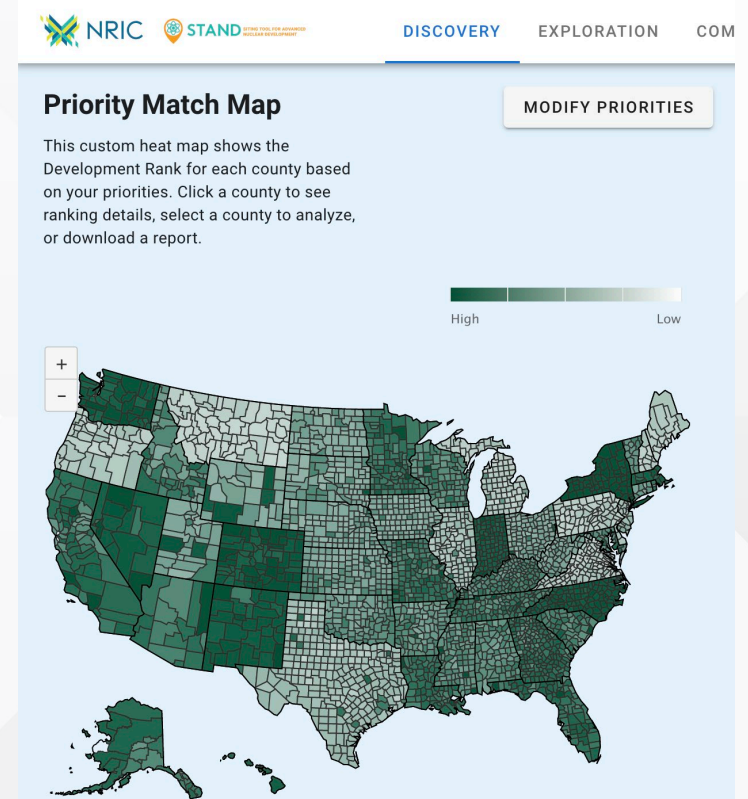
**Discover** areas that may be a good fit



**Explore** areas to identify specific sites



**Compare** sites to identify an optimal option



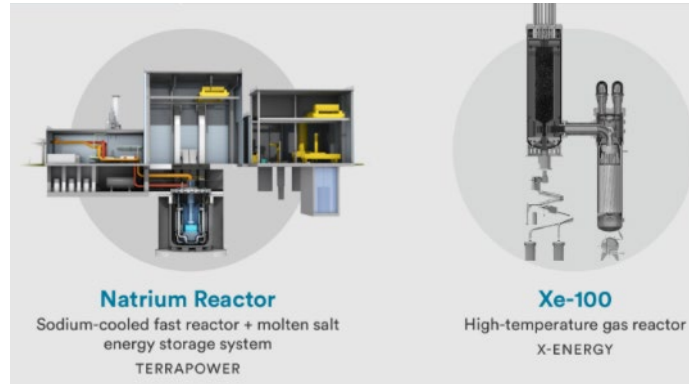
Launched at January 26<sup>th</sup> Tech Talk  
<https://nric.inl.gov/nric-tech-talks-stand-tool/>



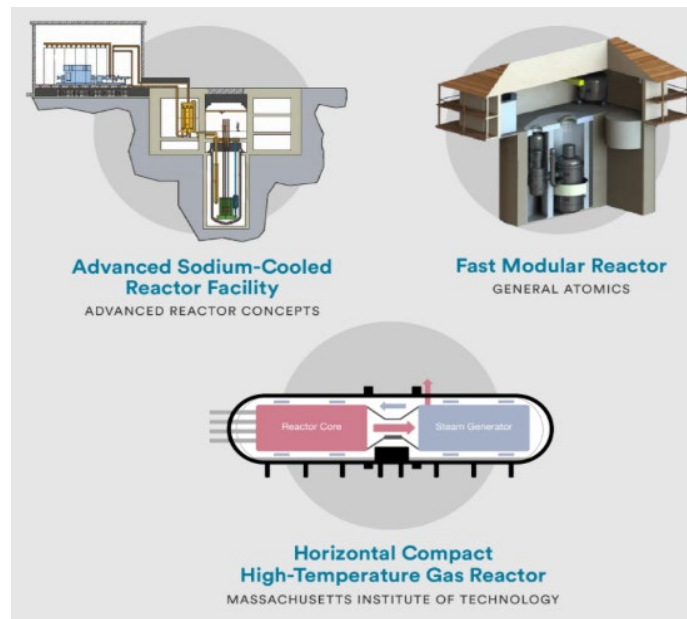
# INL Participation in ARDP Projects

- 9 projects supported
- Scope range
  - Modeling & Simulation
  - Irradiation & PIE
  - Fuel design & fabrication
- NRIC/INL Coordinator
- NRIC Deployed Digital Engineering and project management tools

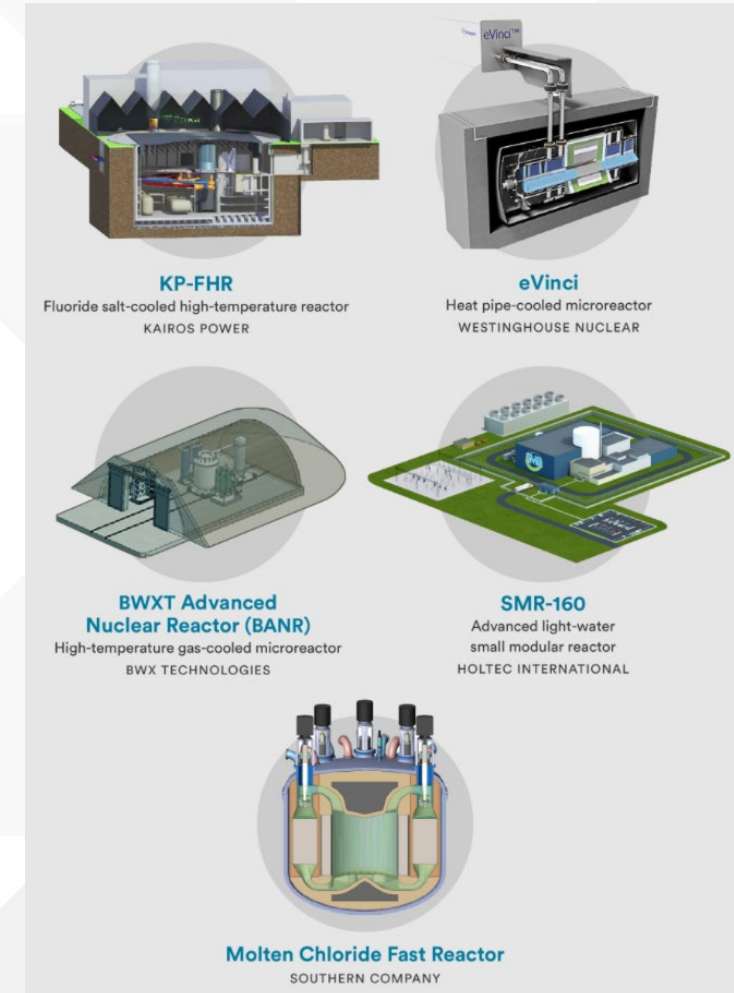
## Demonstration



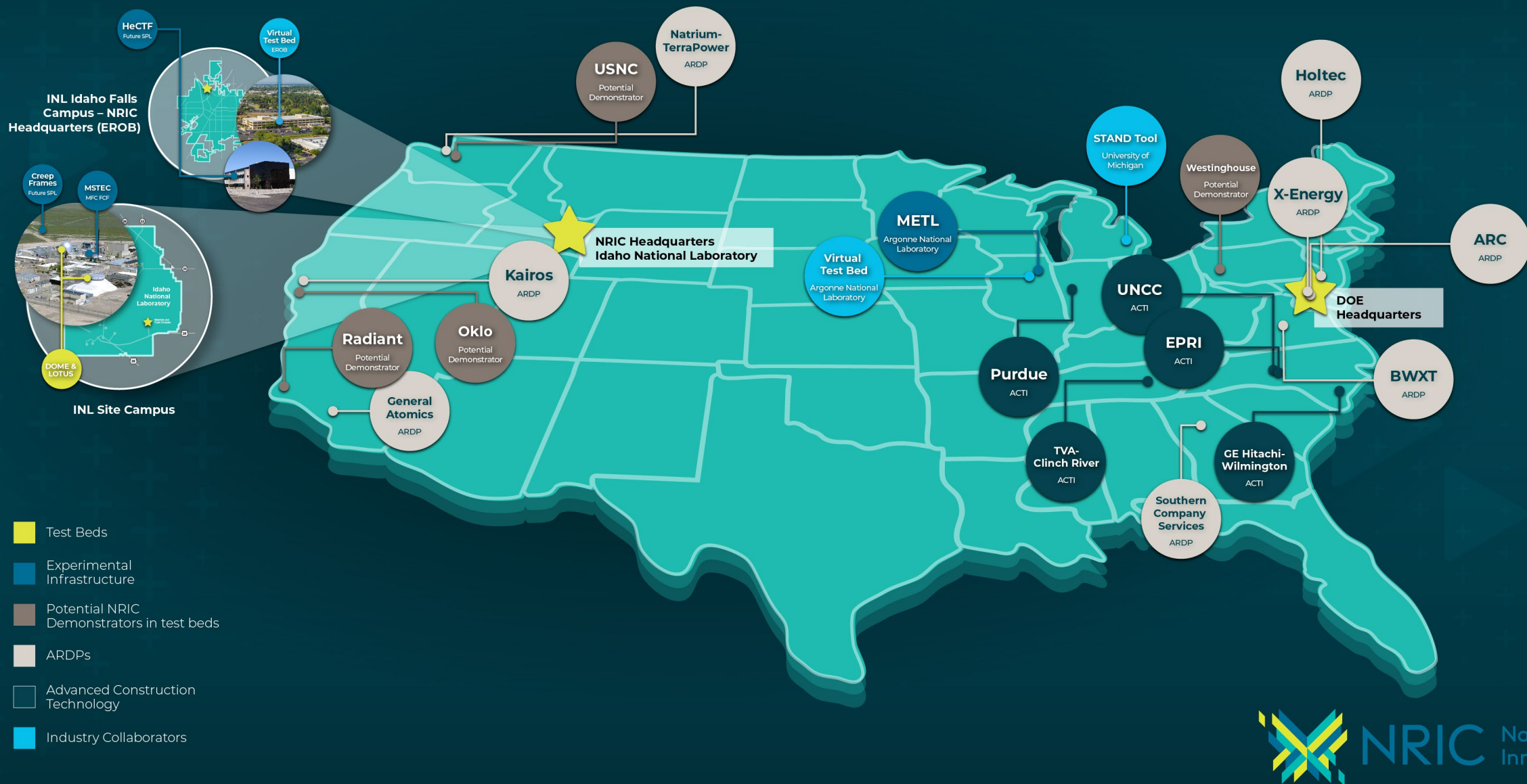
## Concept Development



## Risk Reduction



# NRIC National Footprint



# Thank you! Questions?



**NRIC** National Reactor  
Innovation Center

5/21/2024

[www.nric.inl.gov](http://www.nric.inl.gov)