

U.S. DEPARTMENT OF  
**ENERGY**

*Office of*  
**NUCLEAR ENERGY**

# **Office of Nuclear Reactors (NE-5) Overview**

**FY2025 CINR Webinar**

**May 9, 2024**

# **Office of Reactor Sustainability (NE-51) Overview**

**Alison Hahn, Acting Director**

**FY2025 CINR Webinar**

**May 9, 2024**

NE-5

## Office of Nuclear Reactors

### Reactor Sustainability

#### Light Water Reactor Sustainability

- LWR modernization and optimization
- Hydrogen production demonstrations

#### Advanced Reactor Safeguards and Security

#### Integrated Energy Systems

### Advanced Reactors

#### Advanced Reactor Technologies

- Advanced non-LWRs R&D
  - Gas-cooled/TRISO
  - Molten Salt cooled/fueled
  - Fast metal cooled
- Advanced structural materials
- Microreactor R&D
- ARC-20 Projects

#### Advanced Reactor Demonstration Program

- National Reactor Innovation Center
- Risk Reduction Projects
- Regulatory framework and technical support

# Light Water Reactor Sustainability Program Overview

**LWRS Mission:** Enable long term operation of the existing commercial nuclear power fleet.

**Focus:** Originally material issues related to SLR applications, recent shift toward improving economic competitiveness

## Plant Modernization

- Modernize technology by replacing existing I&C technologies with digital systems
- Leverage digitalization to modernize business model

## Flexible Plant Operation and Generation

- Maximize revenue by producing new economic products and integrating energy storage
- Decarbonize industrial processes and support the grid as variable resources increase

## Risk Informed System Analysis

- Applies quantitative methods to optimize safety, reliability, and economics
- Coupling probabilistic risk assessment and systems margin quantification to achieve accurate modeling and representation of safety margins

## Materials Research

- Understand and predict long-term behavior of materials
- Including detecting, characterizing, and mitigating aging degradation

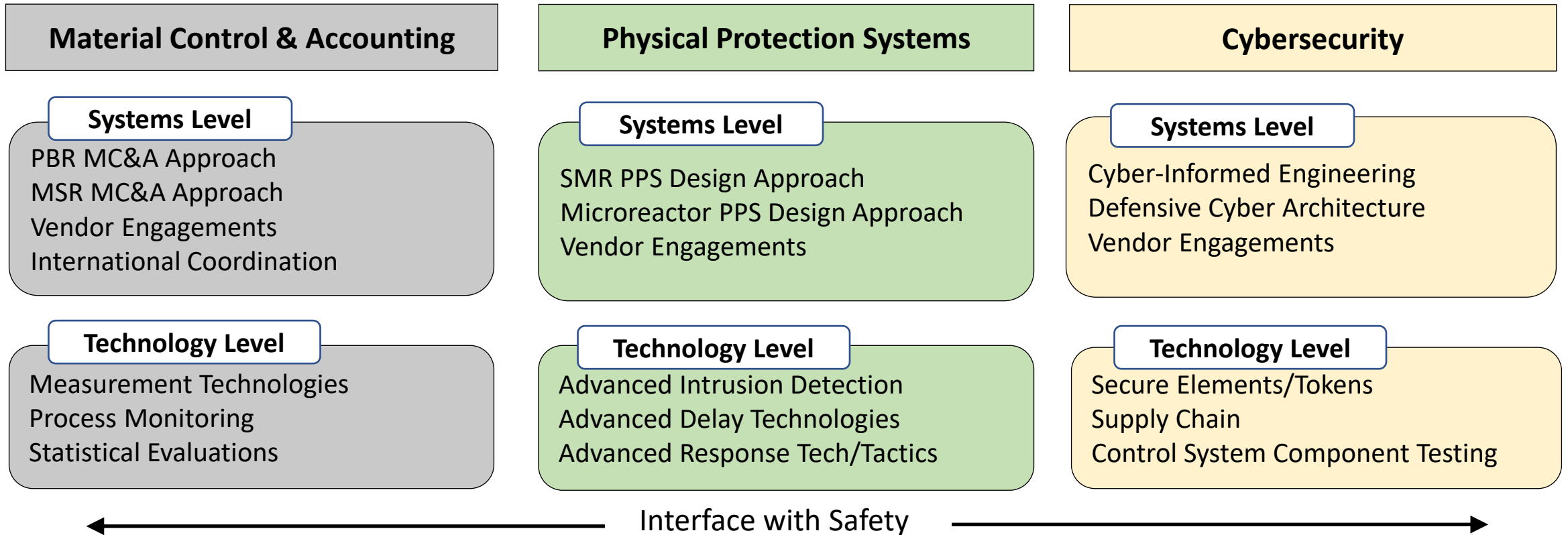
## Physical Security

- Improve efficiency of physical security posture
- Conduct research on risk-informed techniques, apply advanced modeling and simulation tools assess benefits from proposed enhancements and novel mitigation strategies



# ARSS Program Goal and Objectives

The ARSS program is addressing near term challenges that advanced reactor vendors face in meeting material control and accounting (MC&A), physical protection system (PPS), and cybersecurity requirements for reactors built in the U.S.



# Nuclear Integrated Energy Systems

## National Impact of Nuclear Integrated Energy Systems

- Estimates the U.S. market potential and environmental impact of systems that integrate nuclear reactors and their thermal energy into industrial processes that produce fuels, chemicals, materials, and electricity.

## Nuclear Applications R&D

- Develops industrial requirements, reference processes, and plant designs to support techno-economic assessments, site integration, and the safety basis for implementing nuclear energy applications.

## Thermal Systems R&D

- Evaluates and develops thermal energy transport systems for a variety of temperatures, distances, and industrial uses. This includes heat extraction, thermal storage, temperature boosting, and control systems.

## Chemical Conversion R&D

- Develops chemical conversion pathways and tests processes for synthesis of fuels, chemicals, and materials from nuclear energy.



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# **Office of Advanced Reactors (NE-52) Overview**

**Janelle Eddins, Acting Director**

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NE-5

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# ART R&D Program - Mission

**Mission:** Support the development and commercialization of innovative concepts including microreactor, fast reactor, molten salt reactor (MSR), and high temperature gas-cooled reactor (HTGR) technologies through national laboratory-led R&D, university research programs, and cost-shared private-public industry partnerships

- **MSR Technologies**

- Investigate fundamental salt properties.
- Materials, models, fuels and technologies for salt-cooled and salt-fueled reactors.

- **Fast Reactor Technologies**

- Demonstrate feasibility of advanced systems and component technologies.
- Methods and code validation to support design and licensing.

- **Gas Reactor Technologies**

- Advanced alloy qualification.
- Scaled integral experiments to support design and licensing.

- **Graphite Qualification**

- Irradiate, examine and qualify nuclear grades of graphite for use in high temperature reactors.

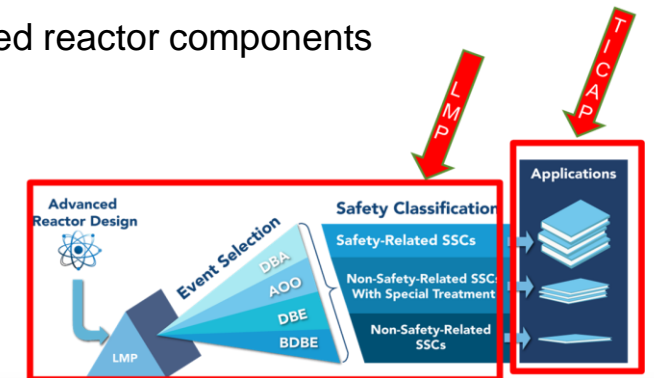
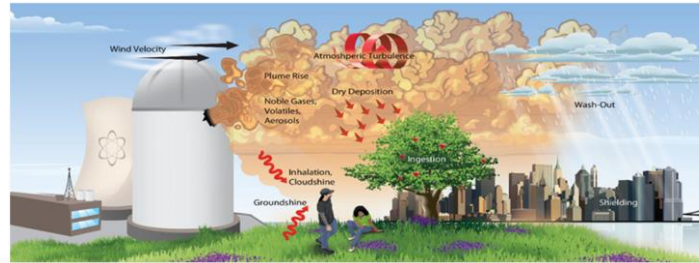
- **Microreactors**

- Non-nuclear and nuclear integrated system testing supporting commercial demonstrations and end-user applications.
- Maturation of innovative components and semi-autonomous operating regimes.

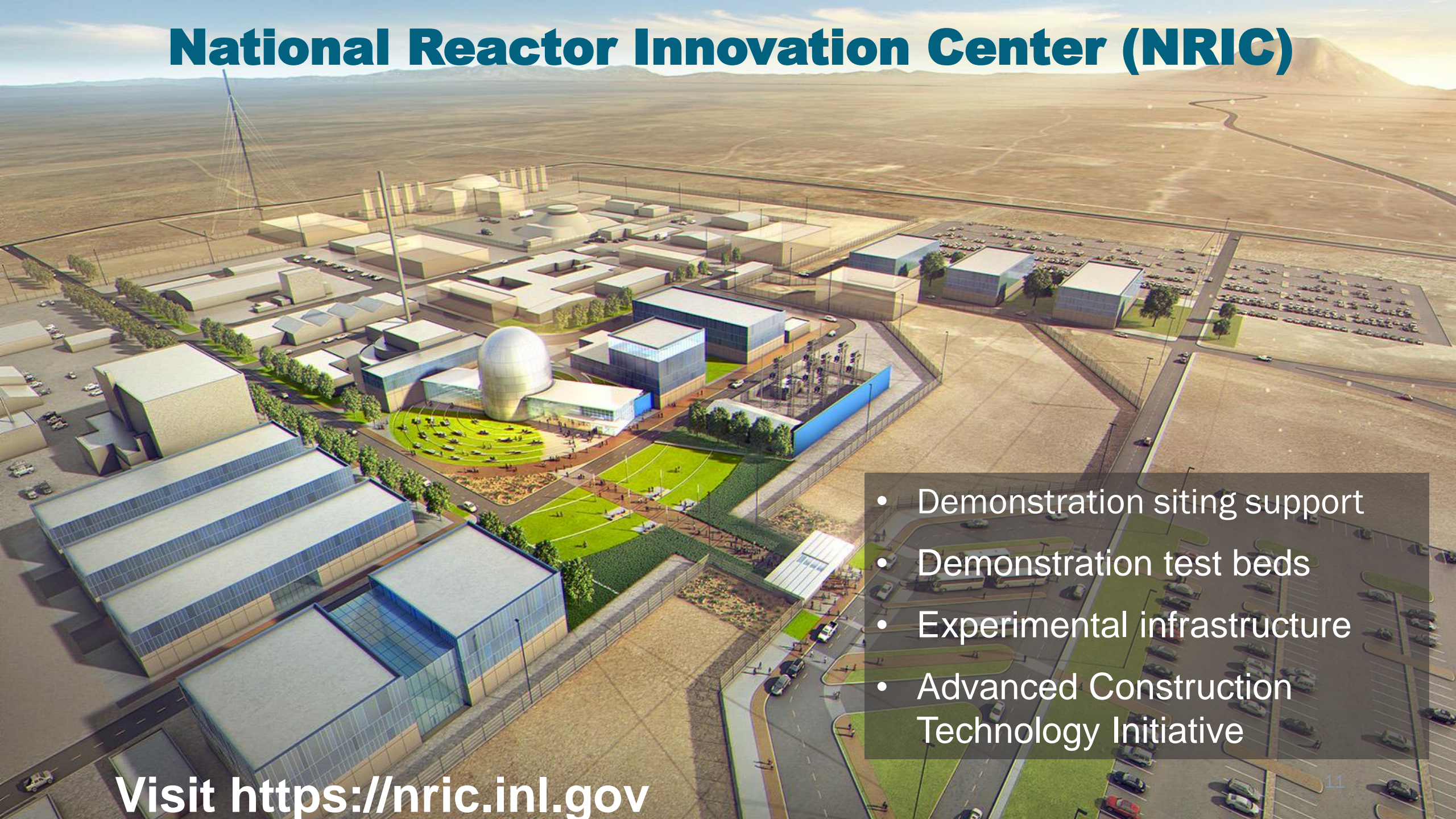
# Advanced Reactor Regulatory Development

**Mission:** Coordinate with the Nuclear Regulatory Commission (NRC) and industry to address and resolve key regulatory framework issues that directly impact the “critical path” to advanced reactor demonstration and deployment.

- **DOE NE cost-share support of industry-led initiatives to adapt and establish a regulatory framework for advanced reactors**
  - Technology-Inclusive Content of Applications Project (TICAP) is a risk-informed, performance-based (RIPB) approach to right-size information in a license application to increase efficiency of generating and reviewing an application
  - Builds on NRC-endorsed Licensing Modernization Project systematic risk-informed process
  - Opportunity for early movers to demonstrate implementation of risk-informed, performance-based approach
- **NE R&D activities directly reduce technical and regulatory risks by providing bases for establishment of licensing technical requirements**
  - Establish technical insights and tools regarding radionuclide transport and release from advanced reactors, including fast reactors, gas-cooled reactors, and molten salt reactors
  - Supporting NRC endorsement of codes and standards important for the manufacture of advanced reactor components
  - Validation and access to priority material property data to be used in safety codes and models



# National Reactor Innovation Center (NRIC)



- Demonstration siting support
- Demonstration test beds
- Experimental infrastructure
- Advanced Construction Technology Initiative

Visit <https://nric.inl.gov>

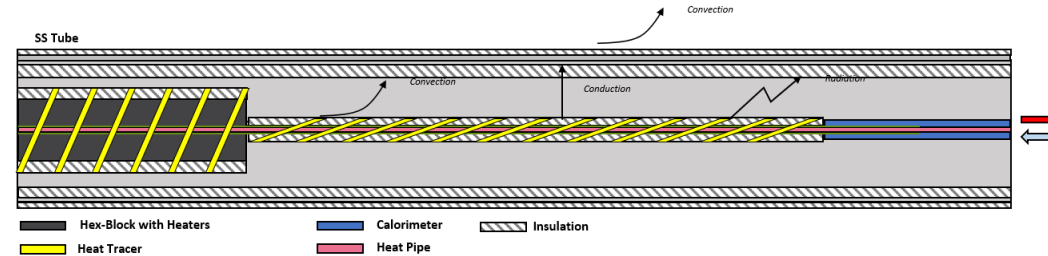
# Advanced Reactor Experimental Test Beds

## Mechanisms Engineering Test Loop (METL) Facility



Contact: Chris Grandy (ANL), [cgrandy@anl.gov](mailto:cgrandy@anl.gov)

## Single Primary Heat Extraction and Removal Emulator (SPHERE)



Contact: Piyush Sabharwall (INL), [piyush.sabharwall@inl.gov](mailto:piyush.sabharwall@inl.gov)



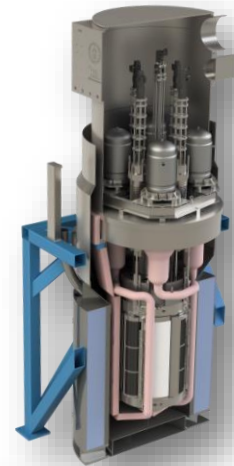
## Facility to Alleviate Salt Technology Risks (FASTR)

Contact: Kevin Robb (ORNL), [robbkr@ornl.gov](mailto:robbkr@ornl.gov)



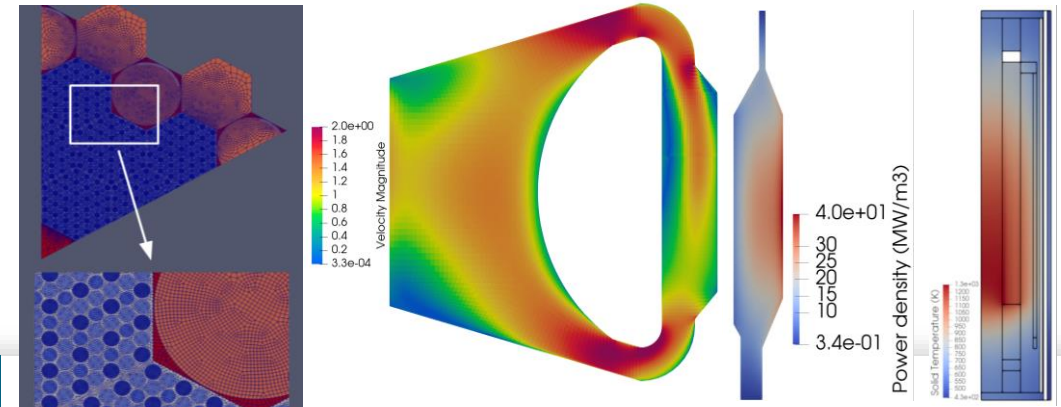
## Microreactor Agile Non-nuclear and Experimental Testbed (MAGNET)

Contact: Piyush Sabharwall (INL), [piyush.sabharwall@inl.gov](mailto:piyush.sabharwall@inl.gov)



Contact: John Jackson (INL), [john.jackson@inl.gov](mailto:john.jackson@inl.gov)

## Microreactor Application Research Validation and Evaluation (MARVEL)



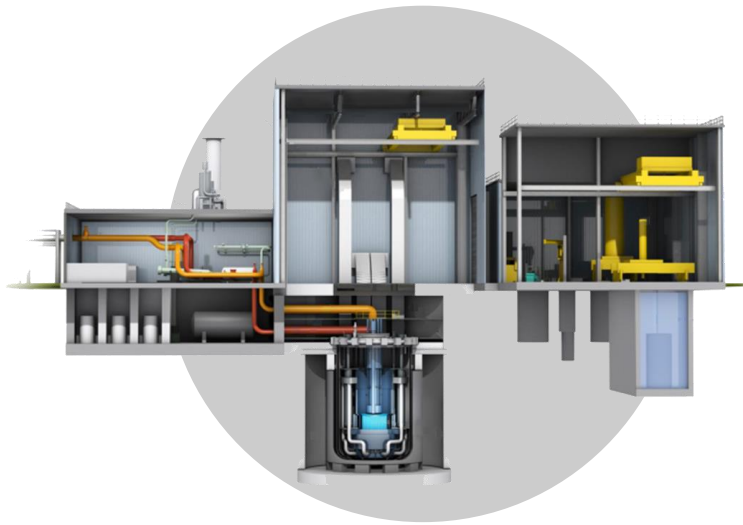
## NRIC Virtual Test Bed [Launched 2020]

Contact: Greg Core (INL), [gregory.core@inl.gov](mailto:gregory.core@inl.gov)

# Advanced Reactor Demonstration Program

## 1 DEMONSTRATION

Bipartisan Infrastructure Law – Advanced Reactor Demonstration Program (\$2.5 B)

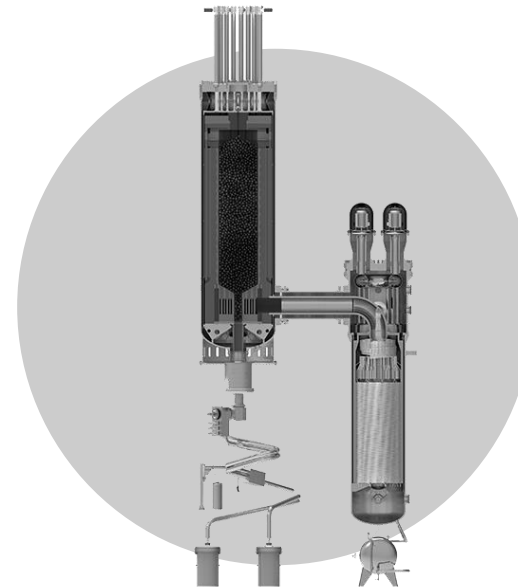


### Natrium Reactor

Sodium-cooled fast reactor +  
molten salt energy storage system

TERRAPOWER

Kemmerer, WY



### Xe-100

High-temperature gas reactor

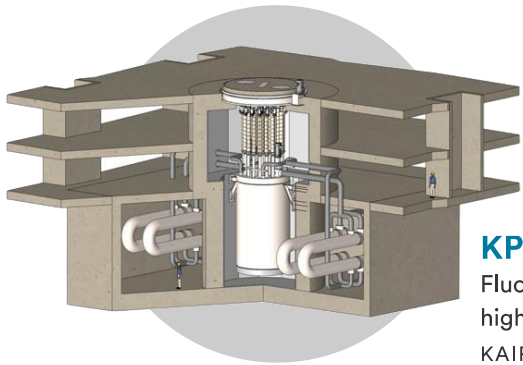
X-ENERGY

Dow Seadrift Site, TX

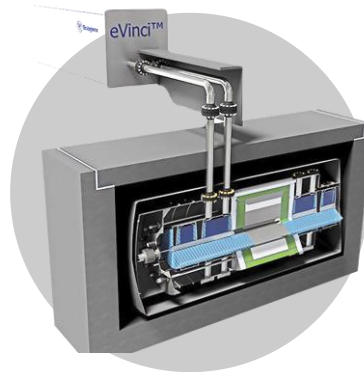
# Advanced Reactor Demonstration Program

## 2 RISK REDUCTION

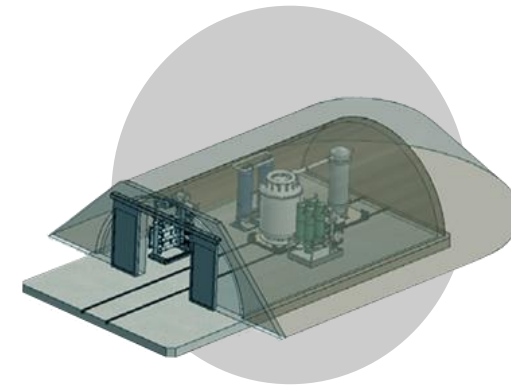
Solve technical, operational, and regulatory challenges to support demos by 2035



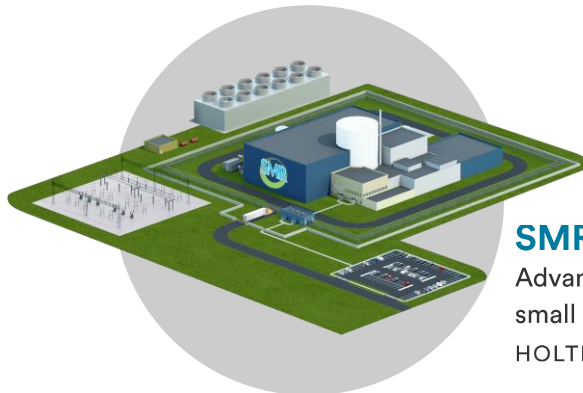
**KP-FHR**  
Fluoride salt-cooled  
high-temperature reactor  
KAIROS POWER



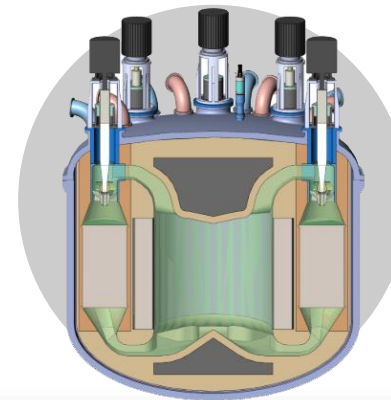
**eVinci**  
Heat pipe-cooled microreactor  
WESTINGHOUSE NUCLEAR



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



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

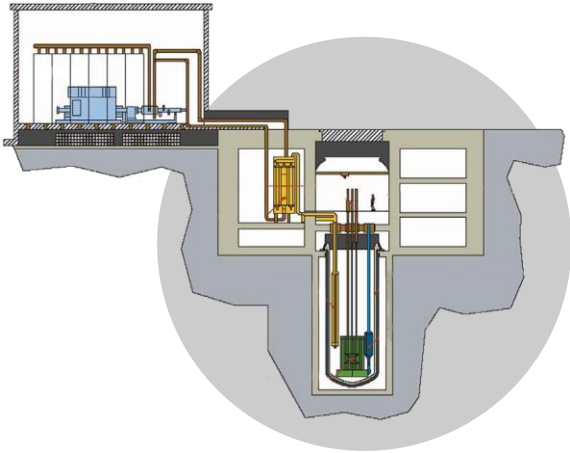


**Molten Chloride Fast Reactor**  
SOUTHERN COMPANY

# Advanced Reactor Concepts – 2020 Program

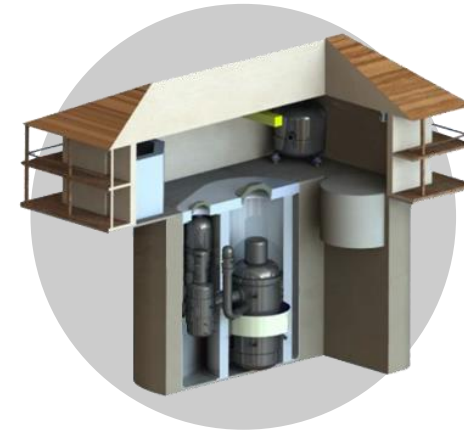
## 3 CONCEPT DEVELOPMENT

Solidify concept to mature technology for potential demo in mid-2030s



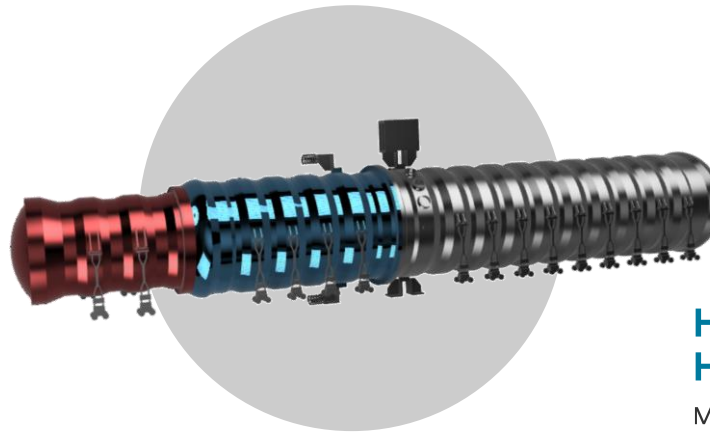
**Advanced Sodium-Cooled Reactor Facility**

ADVANCED REACTOR CONCEPTS



**Fast Modular Reactor**

GENERAL ATOMICS



**Horizontal Compact High-Temperature Gas Reactor**

MASSACHUSETTS INSTITUTE OF TECHNOLOGY



**THANK YOU**

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