

Sep 2025

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MARVEL Microreactor Lead

# MARVEL Microreactor Overview

## DOE Microreactor Program

# MARVEL Can Enable a New Class of Nuclear Reactors

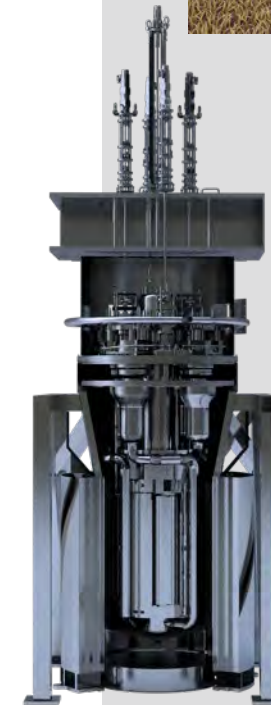
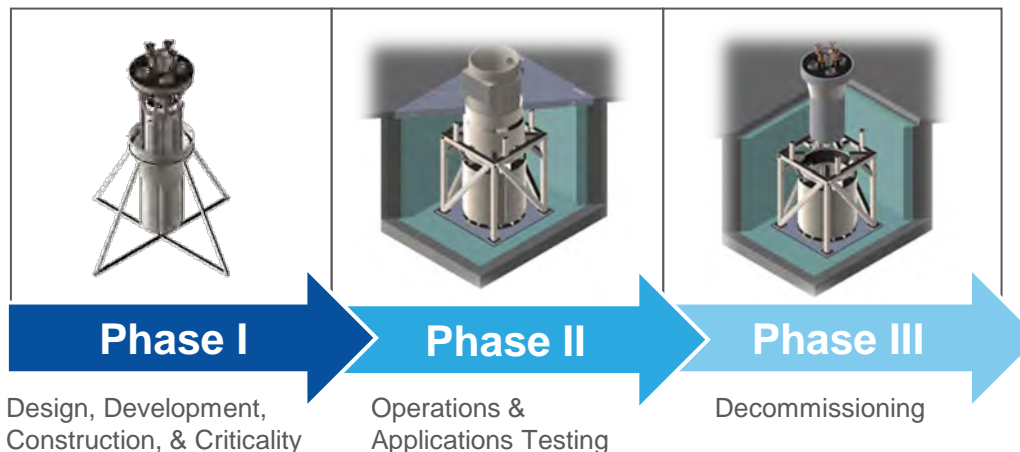
*(Microreactor Applications Research, Validation & Evaluation)*

## Project Goals:

Development of a small operational fission reactor that enables the nuclear community to gain useful data and lessons from the design, review, fabrication, installation, and operation (including novel applications) of a microreactor.

## Primary Objectives:

- Enable follow-on commercial demonstration by trailblazing path forward
- Share data & lessons learned to help mature commercial designs
- Train future advanced reactor operators
- Demonstrate passive safety and self-regulating aspects of microreactors
- Provide a testbed to demonstrate advanced controls, novel nuclear-electricity application, and novel nuclear-heat applications.



- 85 kW-thermal
- <20 kW-electric
- ~15 feet tall, <10 tons
- NaK primary coolant, natural circulation
- TRIGA fuel
- Radial control drums
- Graphite, Be and BeO reflector
- 2 operators
- Self-regulating

# Summary of Recent Developments

**MARVEL is the first DOE advanced reactor to achieve 90% final design.**

## PREVIOUS ACCOMPLISHMENTS

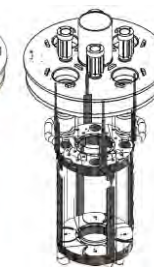
- 90% reactor system final design completed September 2023
- Guard vessel fabrication completed in September 2024
- Completed non-nuclear testing campaign in May 2025
- Submittal of initial preliminary documented safety analysis (PDSA) to DOE-ID in Sep 2025

## MAJOR FY26 PRIORITIES

- Complete assembly and qualification of Reactivity Control System (RCS).
- Complete Primary Coolant System (PCS) fabrication
- Complete fuel fabrication at TRIGA International Inc.
- Finalizing layout for MARVEL balance of plant



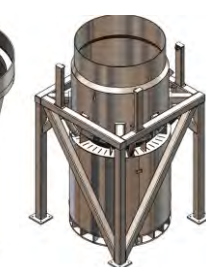
Primary Coolant Boundary Reactor Support Frame



Reactor Support Structure



Guard Vessel

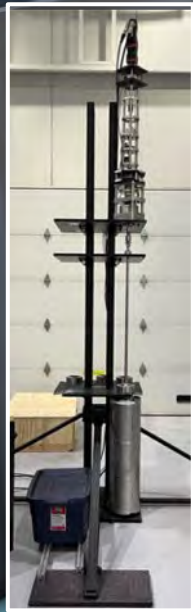


Secondary Support Structure

# Moving from Paper to Real Reactor



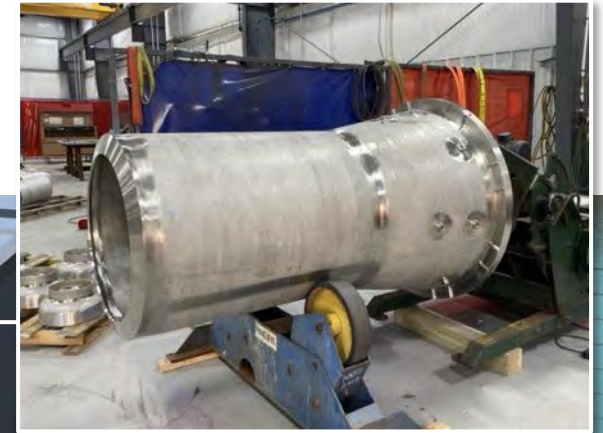
Primary Coolant System Prototype



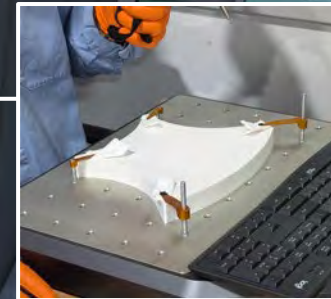
Control Drum Prototype



Plenum Fabrication



Guard Vessel



Reflector Blocks

## T-REXC Facility

- Multi-use facility
- MARVEL is the first experiment
- All components are general purpose

# How MARVEL is Helping Unleash Advanced Nuclear Energy



## Environmental Assessment

- First EA for an advanced reactor in history
- Pathfinder for streamlined NEPA approvals and training staff on submission process
- Process being leveraged by DOME, MCRE, VALKRE

## Design Analysis

- Trained INL staff to perform key safety analyses (e.g., structural analysis, transient simulations)
- Benefiting Pele, MCRE, VALKRE and Westinghouse + Radiant demonstrations

## Safety Review

- First new reactor PDSA submission to DOE in history
- Novel approach using risk-informed methodology for reactor safety
- Submittal paved the path for other DOE-authorized reactors (e.g., Pele, MCRE, eVinci)

## Guard Vessel Fabrication

- First time in history that a nuclear vessel manufactured by a non-'N' stamp supplier
- Broadening supply chain by enabling non-nuclear vendors to compete
- Helped identify errors in ASME code that will accelerate future advanced reactor manufacturing

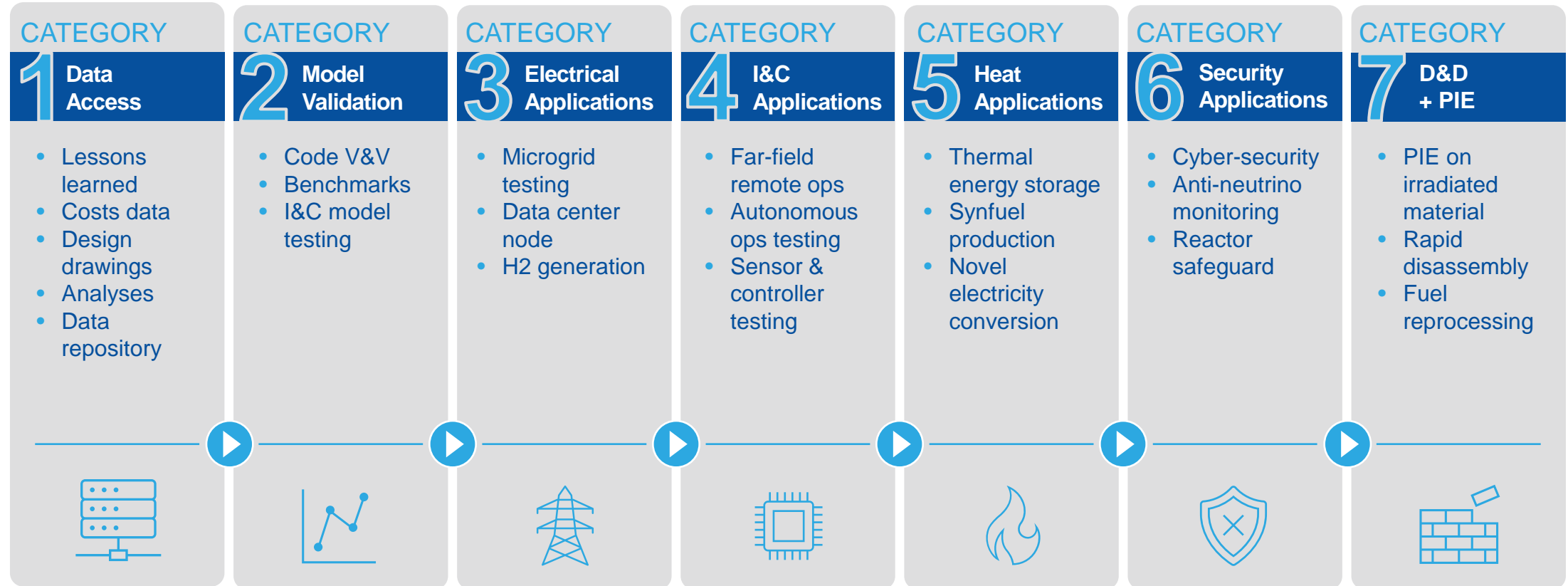
## Reactivity Control System

- Established a complete design/fabrication package for microreactor control systems
- Being directly leveraged by VALKRE - under evaluation by commercial vendors (e.g., Antares)

## 2025 Executive Orders

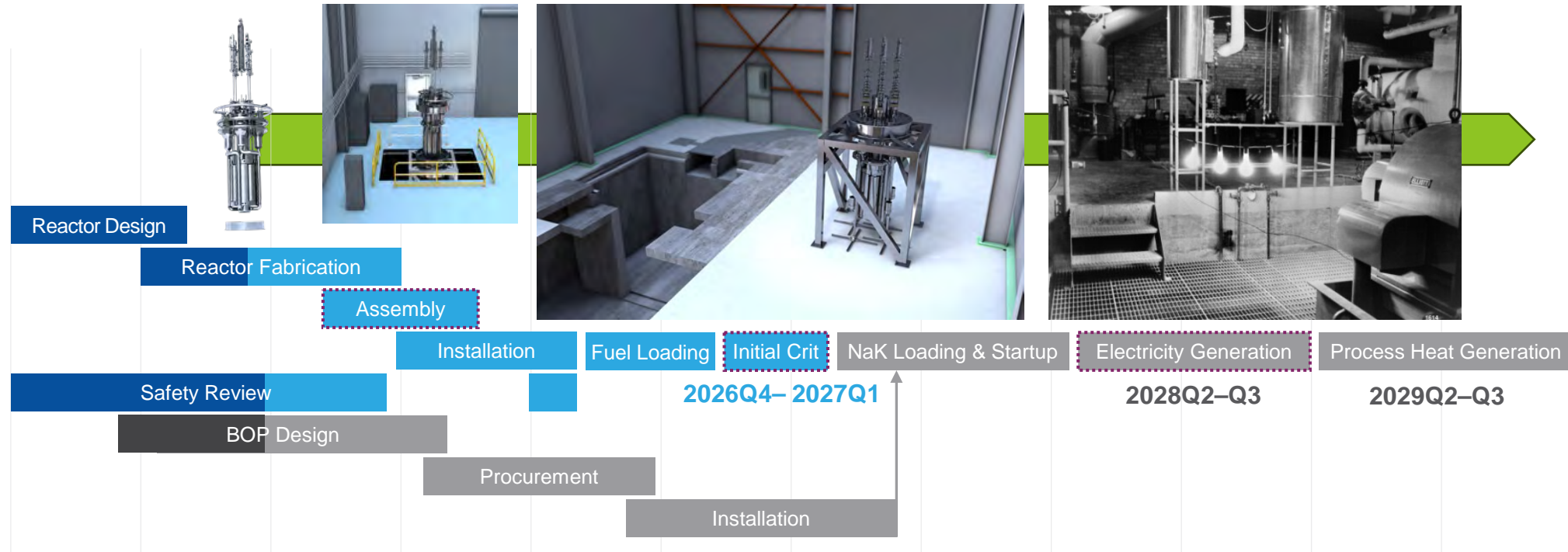
- Using regulatory pathways laid out by MARVEL and Pele to support responses to Executive Orders for expediting the review, approval, and deployment of advanced reactor

# Expression of Interest on Potential MARVEL Applications



**High-Priorities:** Powering data center node | AI autonomous controls | Novel nuclear heat applications  
*And many more possibilities!*

# MARVEL Timeline: *Decoupled*



## Opportunities for schedule acceleration:

Streamlined safety and readiness reviews

Increased funding level to support parallel activities

De-coupling balance of plant analysis from reactor system

Exploring opportunities to leverage AI for document generation, etc.

# QUESTIONS



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# Idaho National Laboratory

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