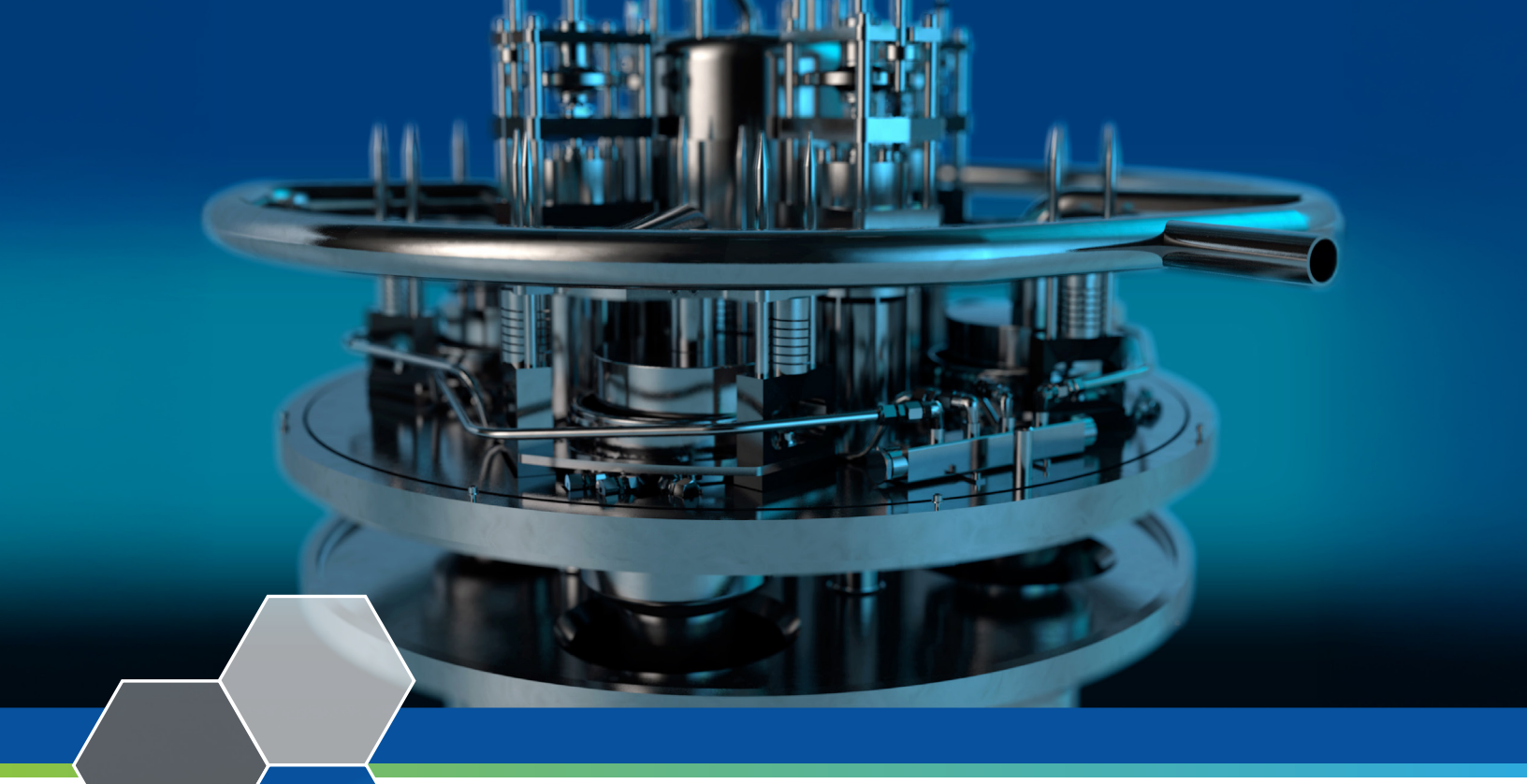


# Microreactor Application Research Validation and Evaluation Project (MARVEL)

*MARVEL will be an 85-kW thermal microreactor installed at INL to help advance the technical maturity of advanced reactor designs.*

## MARVEL PROJECT GOAL

The goal of the Microreactor Application Research Validation and Evaluation project (MARVEL) is to design and construct a small operational fission reactor that will enable researchers and technology developers to gain useful data and lessons from. MARVEL will help developers advance the technical maturity of their designs and enable new microreactor applications.

## PROJECT OVERVIEW

Through the U.S. Department of Energy Office of Nuclear Energy's Microreactor Program, the Idaho National Laboratory is developing a nuclear microreactor applications test bed. MARVEL will enable research and development on the operational features of microreactors and improve the integration of microreactors with end-user applications.

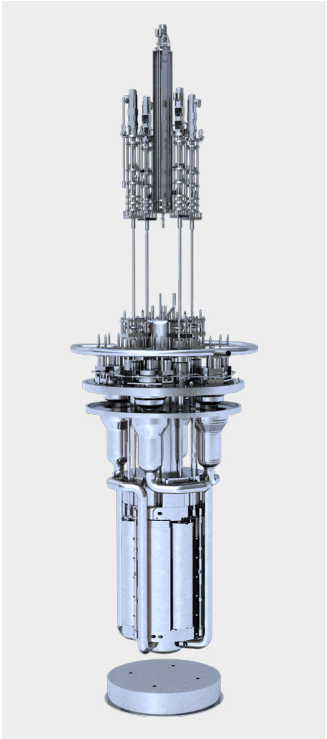
MARVEL will support microreactor demonstrations by addressing these challenges:

- Understanding how micro-reactors could meet the need of potential end users.
- Going through the process of developing a small-scale reactor for research and development purposes for the first time in nearly 50 years.
- Engaging with end users and stakeholders on the integration of microreactors with a range of anticipated applications, such as load-following electricity demand, process heat, hydrogen production and water purification.
- Resolving challenges related to fabricating, assembling, rapidly installing, deploying, authorizing and operating microreactors to facilitate end-user adoption.

## TECHNICAL CHARACTERISTICS

MARVEL consists of a 85-kW thermal fission reactor that will be installed and operated at INL's Transient Reactor Test facility. Its fuel will be standard Training Research Isotope General Atomics fuel elements, consisting of 36 fuel rods containing 30 weight-percent of uranium. A power conversion system will convert thermal energy to around 10-20 kilowatts of electrical power. The reactor has a design life of two effective full-power years but will operate intermittently for two calendar years.

Idaho National Laboratory



*Rendering of MARVEL with the shielding removed.*

## COOLANT SYSTEM

The MARVEL primary coolant system (PCS) is a four-loop hydraulic circuit that transports heat from the fuel pin to intermediate heat exchangers (IHX) by natural circulation of sodium potassium (NaK). Heat is then extracted to a secondary system of pumped NaK. The secondary NaK is connected to Stirling Engines to generate electricity in the first stage of operations. In the second stage of operation, the NaK is connected to another heat exchanger for process heat applications.

## REACTIVITY CONTROLS

Four control drums rotating outside the core barrel provide active reactivity control, along with a central insurance absorber (CIA) in the middle of the core that is fully withdrawn during operation and inserted during shutdown. Additional stationary reflectors provide passive reactivity control. Hydrogen and graphite components within the fuel will ensure safety in cases of loss of power or other abnormal conditions.

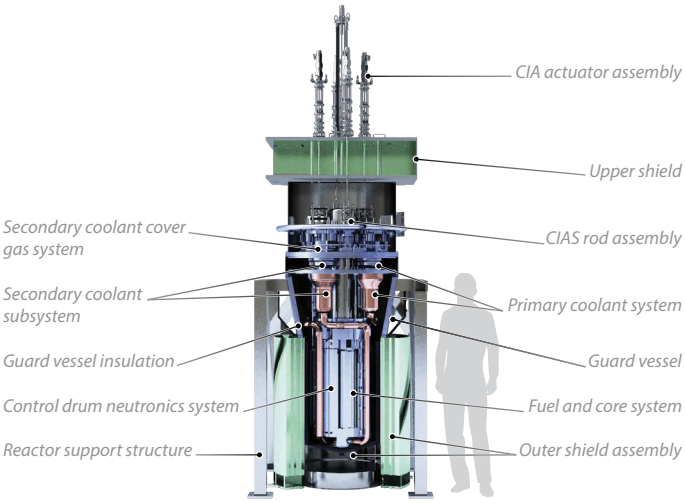
## DECOMMISSIONING

At the end of MARVEL's life, it will be defueled and removed. The decommissioning plan is to dispose of equipment and materials as waste, with the fuel sent to long-term interim storage.

More on MARVEL use for novel technologies: <link to utilization factsheet>.

### Key design features

| | |
|---|---|
| Reactor type | Liquid metal thermal reactor |
| Thermal power | 85 kWth |
| Electrical power | <20 kWe |
| Coolant drive | Natural circulation |
| Primary coolant | Sodium potassium (NaK) |
| Primary coolant temperature | 500–550°C |
| Secondary loop | Pumped NaK at > 400degC |
| System life | 2 years |
| Fuel | UZrH TRIGA Fuel |
| Enrichment | 19.75 wt-% |
| Reflector material | Be metal + BeO |
| Reactivity control | $B_4C$ Control Drum x4<br>$B_4C$ Shutdown Rod x1 |
| Weight | < 12 tons |
| Height | <15 feet |
| Number of operators | 2 |




*Cutaway view of MARVEL and its subsystems.*

## FOR MORE INFORMATION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