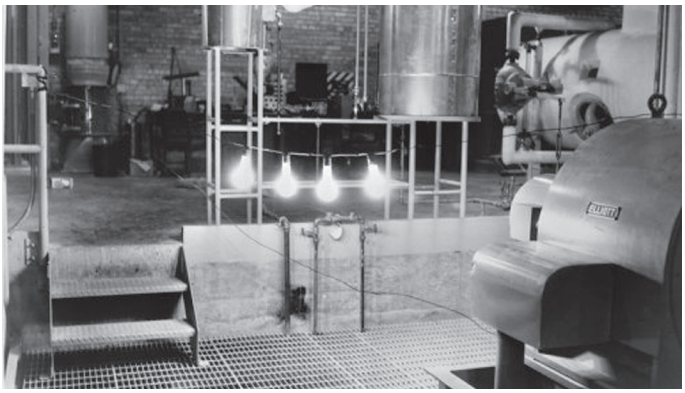
Nuclear Programs

Multiple INL programs contribute to the safe operation of today's reactors.

NUCLEAR POWER PIONEERS

In 1949, the U.S. Atomic Energy Commission established the National Reactor Testing Station, now known as Idaho National Laboratory (INL), to take on the top-priority mission of harnessing the power of the atom for peaceful applications. Since then, thousands of world-class scientists and engineers made Idaho their home and devoted their careers to advancing nuclear research and development (R&D). From developing the first reactor to produce usable amounts of electricity, to prototyping nuclear propulsion plants for Navy submarines and aircraft carriers, INL is known for its innovations in the field of nuclear energy.

Over the years, INL's mission broadened into areas such as bioenergy, materials research, and cybersecurity. Today, INL researchers address the nation's energy, nuclear technology, science, and national and homeland security needs.



EBR-I was the first reactor built in Idaho at the National Reactor Testing Station (forerunner to today's INL).

SUSTAINING THE CURRENT FLEET OF POWER REACTORS

Multiple INL programs contribute to the safe operation of today's reactors.

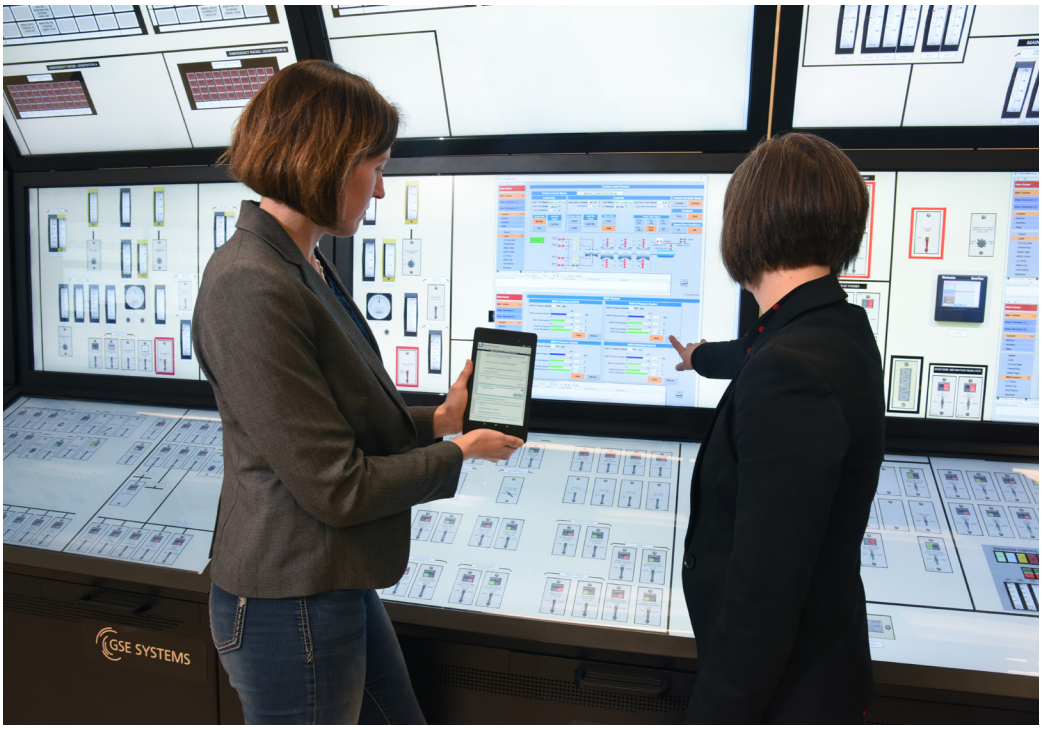
Light Water Reactor Sustainability Program

INL manages the Department of Energy's multi-laboratory Light Water Reactor Sustainability (LWRS) Program. The program conducts research to develop technologies and other solutions to improve economics and reliability, sustain safety, and extend the operation of the nation's fleet of nuclear power plants.

Advanced Test Reactor

The Advanced Test Reactor (ATR) is a thermal spectrum test reactor designed to irradiate fuels and materials to evaluate how they will respond over the long term in Naval or commercial power reactors. At 250 MW thermal, ATR is the most powerful

Idaho National Laboratory



INL's Human Systems Simulation Laboratory is devoted to the study of human performance in a near-realistic operational context.

test reactor in the world, providing a large-volume, high-flux neutron irradiation capability in both pressurized loops and drop-in experiment capsules. ATR also provides valuable isotopes for medical treatment, industrial uses and deep space exploration.

Integrated energy systems

Integrated energy systems couple nuclear and renewable energy sources. Such integrated systems can increase efficiency and reliability. One benefit is the ability to diversify nuclear energy end uses beyond electricity production — such as producing economical hydrogen and synthetic fuel. INL's Dynamic Energy Transport and Integration Laboratory houses several components of an integrated system, including an electrical grid simulator, an electrically heated nuclear power plant simulator, a thermal energy distribution system, and a high-temperature electrolysis test station that produces hydrogen. Integrated energy systems can provide the U.S. with a secure, domestic and flexible source of energy while reducing carbon emissions.

Safety and risk assessment

INL engineers provide advanced risk and reliability analyses to support complex systems and processes. For example, human factors experts design and test digital instruments and controls to determine the safety and risks associated with a given procedure or tool. Other experts build and test risk assessment methods, models and applications to support the U.S. Nuclear Regulatory Commission.

FUEL CYCLE RESEARCH AND DEVELOPMENT

New fuel cycle technologies will reduce the amount of high-level radioactive waste requiring geologic disposal and get more useful energy from nuclear fuel.

Materials and Fuels Complex

The Materials and Fuels Complex (MFC) is a vital component of U.S. nuclear energy R&D efforts, with facilities designed for everything from analytical work to fuel fabrication. With capabilities ranging from post-irradiation examination of new fuel types to producing radioisotope power systems that power spacecraft such as the Perseverance rover on Mars, MFC is a leader in developing tomorrow's nuclear technologies. MFC's areas of expertise include nuclear fuels,

radiation-tolerant materials, fuel recycling, basic research, nuclear nonproliferation, nuclear forensics, and space nuclear power technologies.

Transient Reactor Test Facility

At INL's Transient Reactor Test (TREAT) Facility, scientists test the limits of reactor fuels and materials by applying controlled, short bursts of intense neutron irradiation to analyze performance under a variety of operational conditions and hypothetical accident scenarios. TREAT's simple design safely accommodates a range of test specimens, enabling the study of safety-related phenomena such as fuel melting dynamics, liquid metal reactions, overheated fuel and coolant reactions, and the transient behavior of fuels for high temperature system applications.

Modeling and simulation

Modeling and simulation are essential to nuclear energy innovation, as well as the continued safe, secure and efficient operation of existing nuclear systems. INL offers programs and software that aids in modeling and simulation of a range of nuclear-related phenomena, from those occurring on the microscale up to full reactor systems.

As part of INL's modeling and simulation work, the Nuclear Computational Resource Center streamlines access to computational tools, high performance computing resources and training.

ADVANCED REACTORS

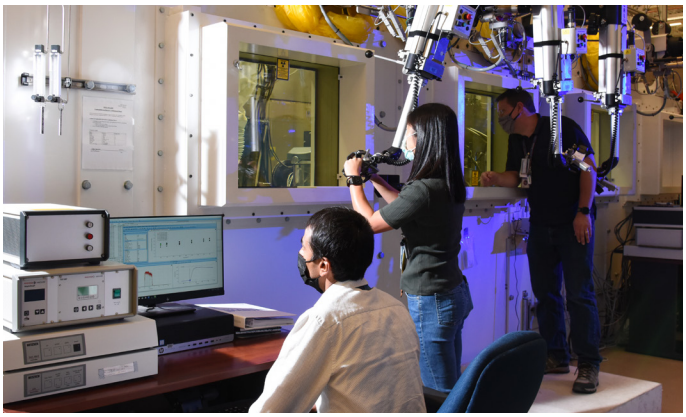
INL contributes to the innovation of new reactor designs and systems. As DOE's nuclear energy laboratory, INL leads and houses national programs with distinct missions and purposes.

The Advanced Reactor Technologies (ART) Program

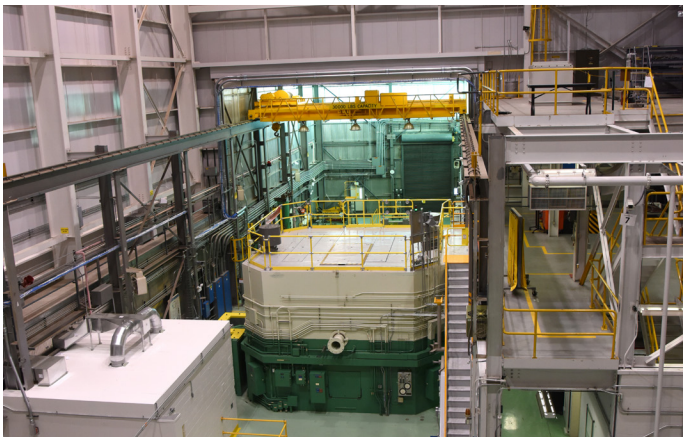
The Advanced Reactor Technologies (ART) Program, a multi-laboratory effort, develops new advanced reactor designs and technologies. Designed to improve nuclear energy competitiveness, ART supports meeting the nation's energy, environmental, and national security needs. Currently, ART research focuses on developing a high-temperature gas-cooled reactor. This modular reactor enables power plants to adjust to a community's energy needs without extra design work. Modular reactors also increase safety and efficiency by allowing a single module to stop or start up in the event of an incident or a change in energy demand.

Gateway for Accelerated Innovation in Nuclear (GAIN)

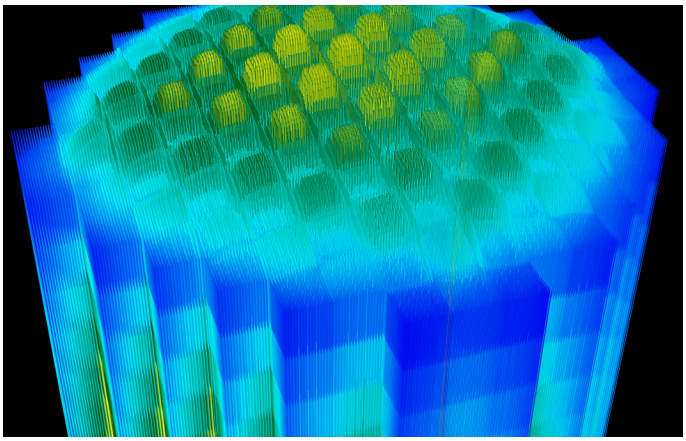
The U.S. Department of Energy's Office of Nuclear Energy (DOE-NE) established the Gateway for Accelerated Innovation in Nuclear (GAIN) to provide the nuclear industry with access to the technical, regulatory, and financial support necessary to move new or advanced nuclear reactor designs toward commercialization while ensuring the continued safe, reliable, and economic



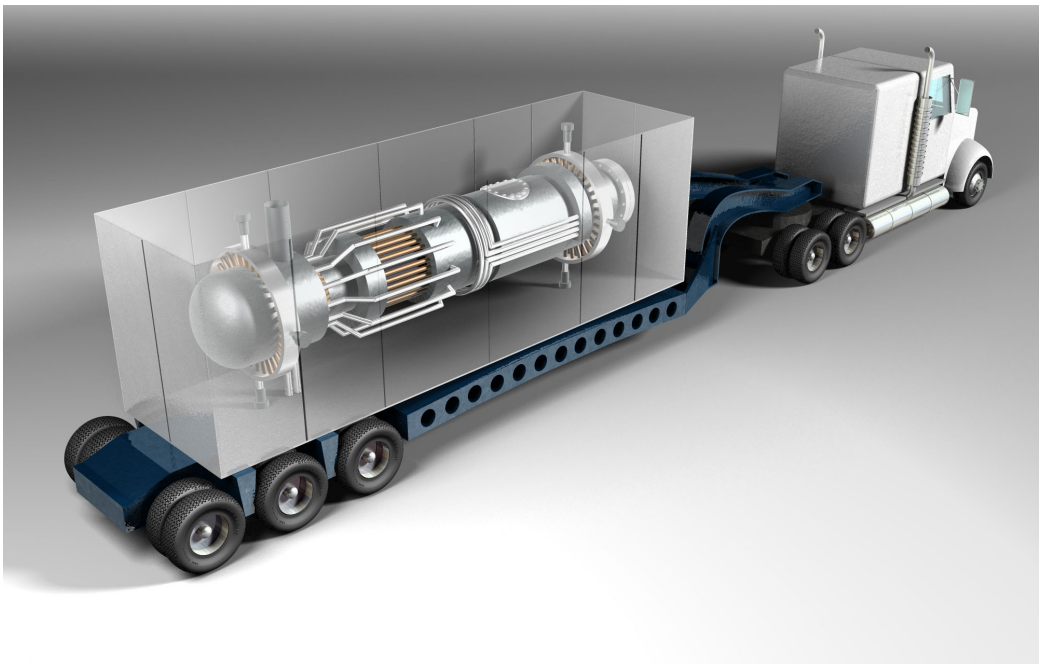
Researchers utilize hot cell technology in the Irradiated Materials Characterization Laboratory at the Materials and Fuels Complex.



INL's TREAT facility is an air-cooled, thermal-spectrum test facility specifically designed to evaluate the response of reactor fuels and structural materials to accident conditions.



Modeling and simulation—especially with INL's flagship modeling and simulation platform, MOOSE—is an essential component to nuclear energy research.



Microreactors have the potential to play an important role in a carbon-free energy future.

operation of the existing nuclear fleet. GAIN provides the nuclear community with a single point of access to the broad range of capabilities — people, facilities, materials, and data — across the DOE complex and its national lab capabilities.

The Microreactor Program

The Microreactor Program is a DOE program involving several national laboratories. The program supports R&D of technologies related to the demonstration and deployment of very small, factory fabricated, transportable reactors. Microreactors will provide power and heat for decentralized generation in civilian, industrial and defense energy sectors.

The program conducts both fundamental and applied R&D to reduce the risks associated with new technology performance and manufacturing readiness of microreactors. The intent of the program is to ensure microreactor concepts can be developed, licensed, and deployed by commercial entities to meet specific use case requirements.

The National Reactor Innovation Center

The National Reactor Innovation Center (NRIC) accelerates the demonstration and deployment of advanced nuclear energy through its mission to inspire stakeholders and the public, empower innovators, and deliver successful outcomes. NRIC's core team leverages government resources to help developers navigate permitting and regulatory pathways, engage local stakeholders, support site preparation for new projects and collaborate to support existing ones. NRIC facilitates the construction and demonstration of advanced reactor systems through a suite of services and capabilities.

NRIC is a national program, led by INL, allowing collaborators to harness the world-class capabilities of the U.S. national laboratory system. It is charged with and committed to demonstrating advanced reactors by the end of 2025.

Versatile Test Reactor

Versatile Test Reactor (VTR) is a proposed sodium-cooled fast reactor that will support long-term innovation in fuels, materials and sensors development and qualification. A key test reactor for the U.S. to establish fast-neutron testing capabilities, VTR will provide prototypical environments to support the development of advanced reactor technologies, fusion and the existing fleet. VTR's design also enables multiple researchers to simultaneously conduct a broader range of experiments using larger samples for more nuclear technologies.

FOR MORE INFORMATION

General contact
Joel Hiller
208-526-7456
joel.hiller@inl.gov

www.inl.gov

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