PIONEERING THE NEXT GENERATION OF NUCLEAR MATERIALS AND FUELS

MATERIALS AND FUELS COMPLEX

INL
Idaho National Laboratory

A 1967 view inside the EBR-II containment dome.

LEGENDARY INNOVATORS OF NUCLEAR MATERIALS AND FUELS

NUCLEAR PIONEERS

In 1951, the first nuclear reactor in Idaho was built, starting a legacy at what is now Idaho National Laboratory. The reactor proved the concept of a breeder reactor, which produces more fuel than it consumes. Another 51 reactors followed, and INL continued testing reactor designs, fuels and materials.

One reactor, the Experimental Breeder Reactor-II (EBR-II), was built at the current Materials and Fuels Complex (MFC). Between 1961 and 1994, EBR-II demonstrated inherently safe shutdowns, a new standard for nuclear reactors. Today, INL is the nation's lead nuclear lab, leading the charge to keep our current commercial reactors performing and to create an ever safer, less expensive and more reliable next generation of nuclear power plants.

An industry partner revives a method of fuel fabrication at MFC. The glowing billet is formed into a fuel rod with an extrusion press.

CRUCIAL TO PROVIDING CLEAN, RELIABLE POWER

PROVING FUELS & MATERIALS

A new fuel idea can be designed and fabricated, and then tested and analyzed at MFC to better understand the effects of irradiation. MFC hosts the core of U.S. nuclear research and development with a diverse array of facilities designed for remote work on highly irradiated fuels and materials. Many groups, such as universities, industry partners, other national laboratories, international research organizations and other federal agencies are currently working at MFC.

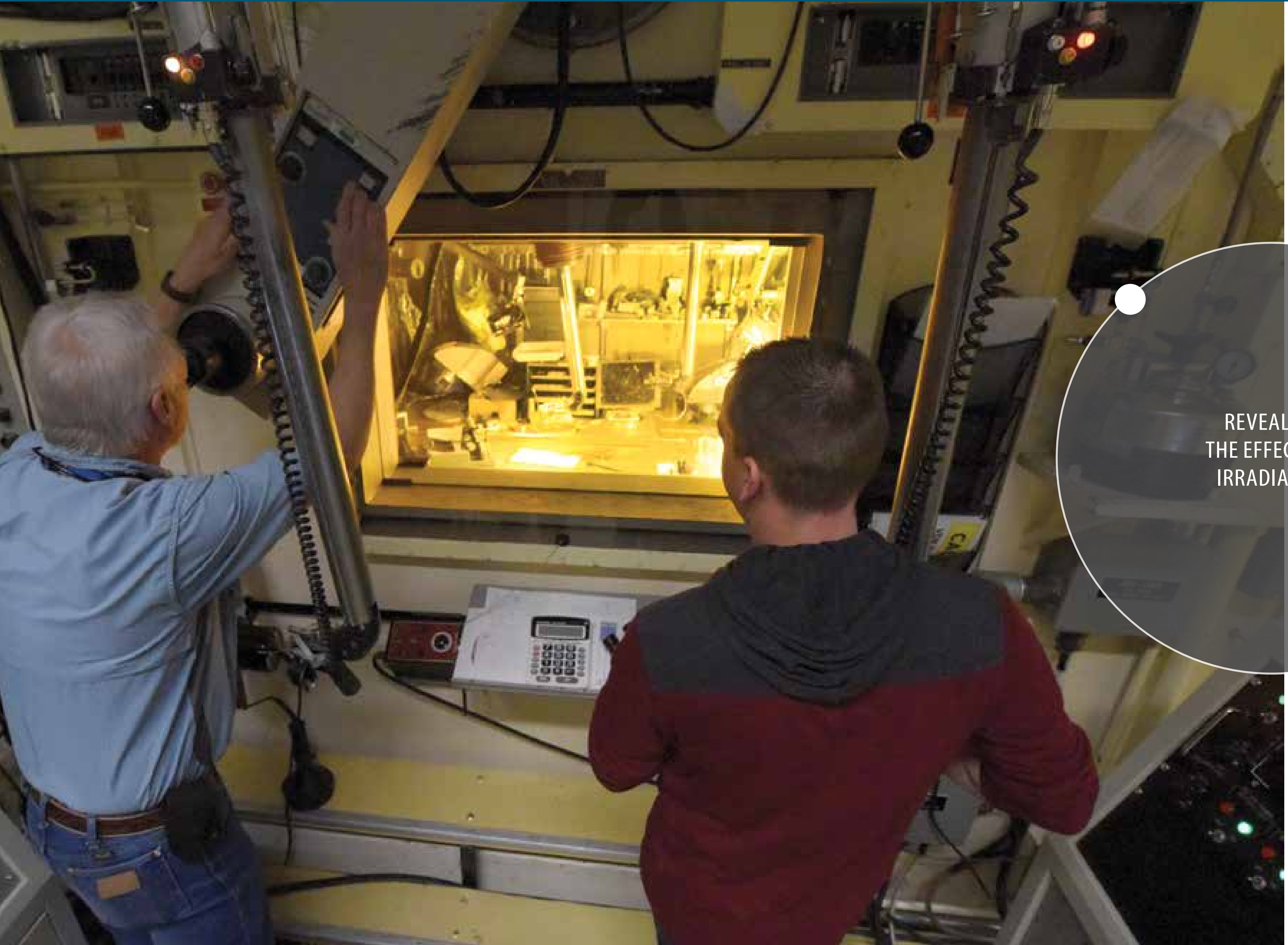
BUILDING AND TESTING NUCLEAR FUEL IDEAS

The special nuclear materials glovebox inside the Fuel Manufacturing Facility houses a sodium separation process.

FUEL FABRICATION AND NUCLEAR MATERIAL MANAGEMENT

Armed with a new fuel idea, researchers need to bring it to life. MFC can produce nearly any nuclear fuel type on a research scale. The nuclear materials used for making fuel are securely stored at MFC. Some of this nuclear material is repackaged and shipped to other projects or used for nuclear nonproliferation training and testing by INL's National and Homeland Security directorate. This research and storage helps to ensure our current and future nuclear capabilities worldwide.

REVEALING
THE EFFECTS OF
IRRADIATION



Irradiated samples are prepared by operators at the containment box in the Hot Fuel Examination Facility.

POST-IRRADIATION EXAMINATION

After irradiating research fuel in a reactor, a variety of tests and measurements can reveal its secrets - good or bad. Initial, nondestructive tests detect qualities before any cuts or changes are made. Then, destructive examinations open the protective cladding to allow researchers to take slices or samples for more in-depth study. Skilled scientists complete the delicate task of preparing a variety of samples for high-powered instruments, such as a focused ion beam or a scanning electron microscope. Every type of fuel can be sampled, including miniscule fuel particles and curved fuel plates, as well as commercial fuel rods, which can be around 13 feet long.

STUDYING "HOT" FUEL ATOM BY ATOM

CHARACTERIZATION AND ADVANCED POST-IRRADIATION EXAMINATION

Large, steel walls around high-powered laboratory equipment, such as a focused ion beam and electron probe micro-analyzer, shield workers from irradiated materials at the Irradiated Materials Characterization Laboratory. Preparing and using minuscule samples, instrument scientists are able to investigate irradiation damage at the micro, nano, and atomic levels. The laboratory design allows for quick, clear imaging on irradiated samples, helping to decrease the time it takes to bring new nuclear fuels and materials to market.

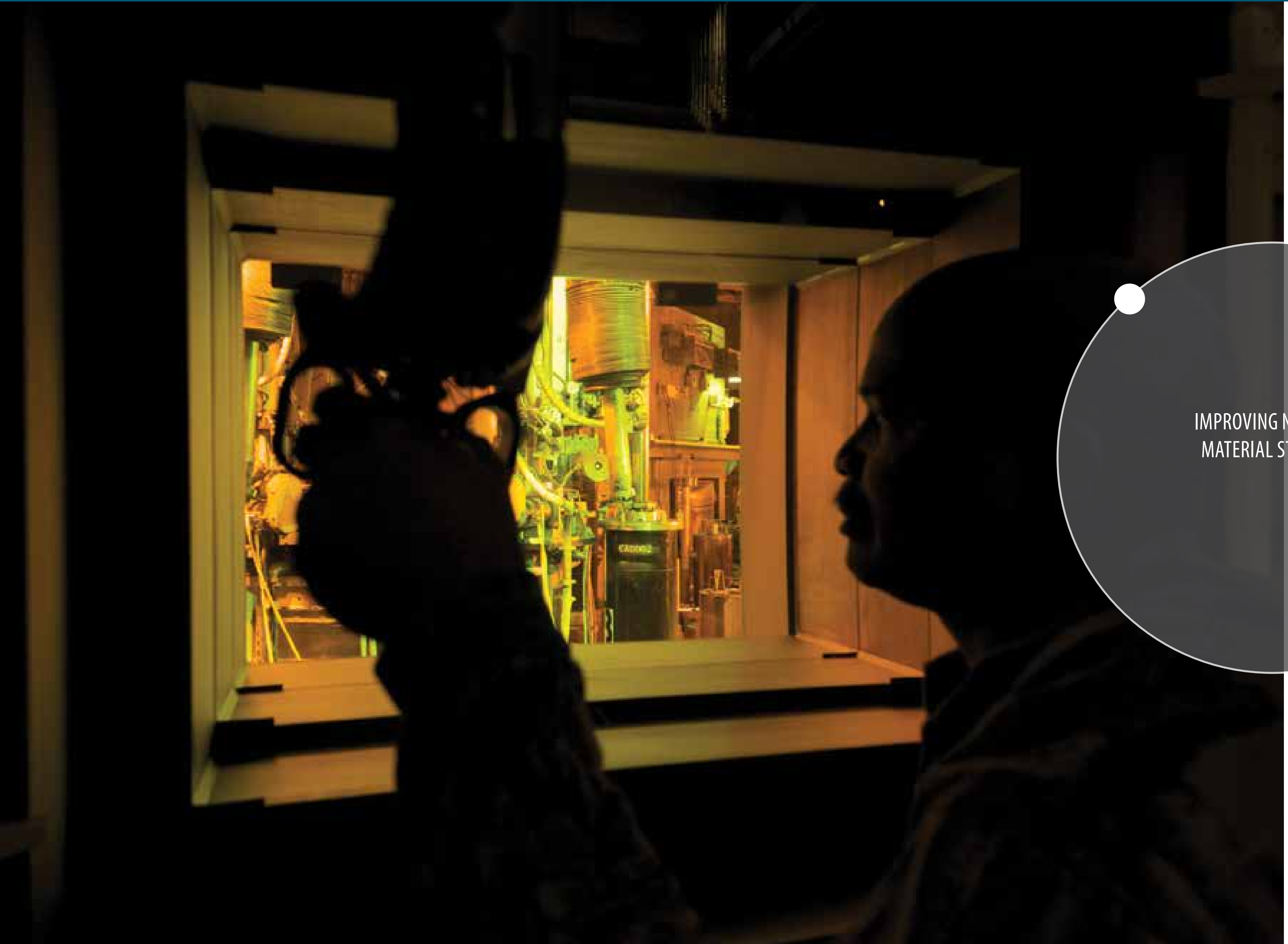
After mining a cube from the fuel sample (background image), the cube is carefully placed on one of five tips on this sample holder, transporting it for further examinations.

A DEEPER LOOK
WITH CHEMICAL
ANALYSES

Lab technicians take readings at the fresh fuels glovebox in the Analytical Laboratory.

ANALYTICAL RESEARCH LABORATORIES

Chemistry is the basis for understanding all materials – both before and after irradiation. Shielded by gloveboxes and hot cells, MFC's labs can handle a variety of chemical analyses on irradiated, or "hot", materials. Characterizing and recording chemical, isotopic and thermophysical properties are completed using an array of both standard and specialized chemistry tools.



Operating the electrorefiner in the Fuel Conditioning Facility's argon hot cell.

IMPROVING NUCLEAR MATERIAL STORAGE

WASTE FORMS AND SEPARATIONS

Spent nuclear fuel is a critical part of the nuclear energy cycle. At MFC, used fuel is treated, separating and down-blending the uranium inside to a version with lower enrichment, making solid waste forms suitable for geologic disposal. A closed nuclear fuel cycle has the potential to reduce the need for waste disposition (since fuel is recycled and reused) and provide a more economical nuclear power plant.

NUCLEAR-POWERED SPACE EXPLORATION

The nuclear-powered rover Curiosity explores Mars.

SPACE NUCLEAR POWER AND ISOTOPE TECHNOLOGIES

Deep space exploration that spans the limits of our solar system and beyond is achieved through a unique capability. The radioisotope power system (RPS), assembled and tested at MFC, uses the decay heat of plutonium-238 to power spacecrafts such as Pluto New Horizons and the Curiosity rover (currently exploring Mars). MFC personnel prepare power systems for launch, transport the RPS to Kennedy Space Center, and provide ground operations support during launch.

"WHAT IF" SCENARIOS IMPROVE ACCIDENT TOLERANCE OF FUELS

Workers at the Transient Reactor Test Facility complete an inspection of the reactor fuel.

TRANSIENT TESTING CAPABILITY

No one expects or wants nuclear fuel to malfunction; transient testing proves safety of new nuclear fuel ideas. By submitting fuels to extreme accident conditions, developers can test how well the fuel performs. Testing at the Transient Reactor Test Facility applies short, custom bursts of accident-strength power to better understand materials and fuels. Scientists use these results to improve their new fuel designs.

ENABLING INDUSTRY TO JOIN THE THE NUCLEAR RESEARCH AND DEVELOPMENT CONVERSATION

Industrial plant operators train with digital reactor consoles in the Human System Simulation Laboratory.

MFC THROUGH GAIN

As the nation's lead nuclear lab, INL supports a U.S. initiative called the Gateway for Accelerated Innovation in Nuclear (GAIN).

MFC is a test bed for those with big ideas, an important aspect of GAIN. A test bed is a place for conducting research, development and demonstration. GAIN works with advanced nuclear developers to help manage risk, overcome barriers of real-world use, and help commercialization of new ideas by reducing time, cost and other uncertainties. MFC's vital array of capabilities support GAIN and the advancement of the nuclear industry.

GAIN
Gateway for Accelerated Innovation in Nuclear

ALIGNING TOP-NOTCH FUELS AND MATERIALS DEVELOPMENT CAPABILITIES

FUTURE OF MFC

MFC (and INL as a whole) will continue developing new capabilities, ensuring current capabilities remain state-of-the-art, and partnering with other laboratories, universities and private industry. With enough investment in capabilities, INL can continue building its legacy in nuclear - and MFC can do its part to keep improving new reactor technology and the future of nuclear power, providing tomorrow with clean energy.

SPL will provide additional sample preparation capabilities in close proximity to the Irradiated Materials Characterization Laboratory and the Hot Fuel Examination Facility. RCB and REC will furnish technical staff and visiting users with much-needed working and meeting space.

IMPROVING NEW
REACTOR TECHNOLOGY AND
THE FUTURE OF NUCLEAR POWER

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