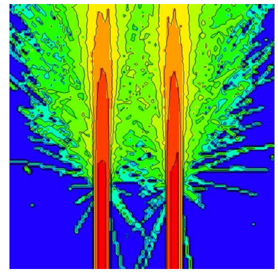
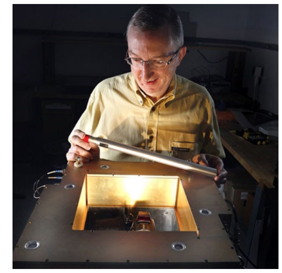


We develop nuclear energy solutions with our unique scientific expertise, key facilities, real-world experience, and long history of domestic and international partnering.

Advanced Nuclear Energy

Nuclear energy is an important source of power, supplying 20 percent of the nation's electricity. More than 100 nuclear power plants are operating in the U.S., and countries around the world are implementing nuclear power as a carbon-free alternative to fossil fuels. We can maximize the climate and energy security benefits provided by responsible global nuclear energy expansion by developing options to increase the energy extracted from nuclear fuel, improve waste management, and strengthen nuclear nonproliferation controls. To develop viable technical solutions, these interdependent challenges must be addressed through tightly integrated multidisciplinary research and development efforts. Los Alamos National Laboratory is playing a key role in developing these solutions with its core strengths in

- nuclear fuels development, testing, and characterization
- advanced structural and cladding materials science
- high-accuracy nuclear data measurements
- nuclear nonproliferation
- modeling, simulation, and high-performance computing
- actinide chemistry
- repository science
- reactor design
- licensing support

With these combined strengths, we can improve fuel performance, reduce the long-lived content of radioactive waste, develop new tailored waste forms, understand and predict repository performance, and address the safeguards challenges associated with the future global nuclear fuel cycle.

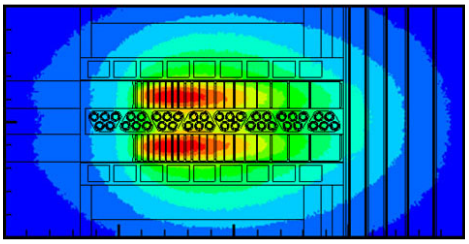
Advanced Nuclear Fuels

Nuclear waste can be greatly reduced if spent uranium fuel is recycled and reprocessed into a new type of "TRU" fuel (named for the TRansUranic elements it would contain) that could be consumed in advanced burner reactors. This process would extract more energy from the fuel and result in less waste needing storage in high-level repositories. It also eases long-term storage requirements because the waste is mostly a short-lived fission product. To implement this advanced method, we must understand how new TRU fuels will react in a fast-neutron reactor. This will require an integration of new materials fabrication, materials testing under new reactor conditions, and modeling and simulation.

Unique Facilities for Fabrication and Testing

Fabrication and testing of new nuclear materials require unique facilities like those at Los Alamos. Los Alamos is using the resources in its Plutonium Facility and Materials Science Laboratory to develop advanced ceramic fuels. The new fuels can be tested at the Materials Test Station (MTS)—a new facility planned for construction at the Los Alamos Neutron Science Center (LANSCE) and expected to open in 2012. The MTS will be powered by LANSCE's 800-million-electronvolt proton beam, and will be the only experimental facility in the U.S. capable of providing the neutron intensity approaching that expected within new fast-neutron reactors. LANSCE and the Lab's Lujan Center also make possible highly accurate measurement of key nuclear data. A new level of accuracy for neutron cross section measurements will be possible with a time projection chamber designed to allow the first-ever 3D visualization of nuclear fission events; these data will improve the design and cost of new reactors. And "hot cells" at the Laboratory's Chemistry and Metallurgy Research facility allow safe and remote research into the development of new fuels and cladding and structural materials. Researchers are currently using this facility to analyze an irradiated fuel duct retrieved from a decommissioned fast reactor, providing valuable data for the future design of fast reactors.

Los Alamos uses hot cells to develop remote nuclear fuel fabrication techniques and conduct advanced materials research. This year, Los Alamos fabricated first-of-a-kind ceramic oxide fuels containing americium and delivered them to Idaho National Laboratory for testing in a nuclear reactor. In addition, ceramic nitride fuel pellets fabricated at Los Alamos were inserted into the PHENIX fast reactor in France. Results from these and other ongoing experiments will provide the scientific community with critical data on fuel performance.



MCNP simulation of nuclear fuels and reactor materials undergoing performance tests.

Modeling and Simulation

Designing the nuclear fuel cycle of the future will also require advanced modeling and simulation. Los Alamos has decades of reactor modeling experience and can simulate the entire nuclear energy process from the detailed physics in the reactor's core to the operation of an entire nuclear power plant and the flow and transport of nuclear materials throughout the nuclear fuel cycle. Los Alamos' Monte Carlo N-Particle (MCNP) code, with over 1,100 users in 250 institutions, is the gold standard for predicting nuclear reactions. Fission, the process that creates nuclear power, relies on the behavior of neutrons in nuclear fuels. Since MCNP provides accurate predictions of the movement of neutrons during nuclear reactions, it is a critical tool in the design of advanced fuels and reactors. Los Alamos scientists are now combining MCNP with other computer codes to create one overarching code that can accurately predict the flow of energy in a fast reactor and track other reactor behaviors in addition to neutron movement. Los Alamos also has reactor modeling experience dating back to the 1970's with the pioneering TRAC code—the first computer code capable of realistic reactor safety analysis. TRAC safety evaluations extended the lives of 18 nuclear reactors for more than 20 years. With TRAC, Los Alamos can perform multi-dimensional modeling and simulation of advanced fast-neutron reactors, from microscale investigation of the fuel cladding materials to macroscale modeling of an entire facility.

Nuclear Safeguards and Nonproliferation

Over 40 years ago, Los Alamos National Laboratory implemented a program to secure, track, and account for nuclear materials worldwide. Advanced nuclear materials management will continue to be a critical component of assuring peaceful use of nuclear energy technologies. Los Alamos researchers use the MCNP code to design radiation detectors that different organizations, like the International Atomic Energy Agency (IAEA), use to keep tabs on nuclear materials worldwide and verify that users are honest with regard to their nuclear fuel and waste inventories. Tailoring these codes to new applications is also an active area of research; a new burn capability was recently incorporated into the MCNPX radiation transport code to further enable the development of a new generation of advanced safeguards instruments. Los Alamos also brings together its expertise in nonproliferation, nuclear energy technologies, and nuclear weapons science to provide information for policy makers. For example, a team of Los Alamos scientists, in cooperation with Lawrence Livermore National Laboratory, evaluated the proliferation risk associated with advanced nuclear fuel cycle materials. The resulting data and analyses are a critical part of an objective multi-component risk assessment for an advanced nuclear energy technology or fuel cycle system.

With nuclear energy making a comeback around the world, it will be important to collaborate internationally to reduce the risk of proliferation. Los Alamos has a long history of partnering with nuclear research labs around the world, as it did with Russia after the breakup of the Soviet Union. Los Alamos staff helped Russia enhance the security of its nuclear facilities and install protection systems and sophisticated electronic eyes to monitor and track nuclear materials. In addition to their significant contributions to developing an overall safeguards systems approach, Los Alamos researchers are developing most of the monitoring instruments for organizations that will inspect the fuel reprocessing plant in Rokkasho, Japan. Los Alamos also participated in nonproliferation activities in Iraq, North Korea, and Libya and has long helped support the Nonproliferation Treaty.

Repository Science

The continued use and growth of nuclear energy will require safe repositories for radioactive waste. For over 25 years, Los Alamos scientists have collaborated with other institutions to understand the subsurface geology, mineralogy, hydrology, and geochemistry of potential repository sites. These field and laboratory studies have led to numerical models of water flow and radionuclide transport through Yucca Mountain, the most promising candidate for the nation's first high-level geologic repository. The Los Alamos Finite Element Heat and Mass (FEHM) computer code is used by the Yucca Mountain project to predict water flow and the migration of radionuclides through the entire natural system. Los Alamos scientists have also assessed the probability and potential consequences of future volcanic activity on the repository's ability to isolate radioactive waste. For 20 years, the Los Alamos-led Test Coordination Office has assisted project scientists by coordinating all surface-based and underground tests to ensure that technical objectives, quality assurance, ES&H, and potential impacts to the integrity of a future repository were systematically addressed. Finally, Los Alamos scientists were lead authors or co-authors on several major sections of the 8,600-page license application submitted to the Nuclear Regulatory Commission in June 2008, and they will work to address issues that may arise in the upcoming licensing process.

To support advanced fuel cycle initiatives, Los Alamos is working in collaboration with Argonne and Sandia National Laboratories to develop an advanced performance assessment model that can evaluate and compare the performance requirements for a variety of geology environments. Los Alamos and Sandia are investigating the potential use of salt as a disposal medium for high level wastes produced in a closed nuclear fuel cycle.

With its unique facilities and expertise in nuclear materials, modeling and simulation, repository science, and international program management, Los Alamos National Laboratory is a world leader in the advancement of nuclear energy.

Los Alamos National Laboratory is operated for the Department of Energy's National Nuclear Security Administration by Los Alamos National Security, LLC, a team of Bechtel National, the University of California, The Babcock & Wilcox Company, and Washington Group International.

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