Pacific Northwest NATIONAL LABORATORY

Proudly Operated by **Battelle** *Since 1965*

Advancing the next generation of nuclear energy research and development

The United States has a growing need for safe, reliable, and clean sources of energy. The Energy Information Administration, which publishes U.S. government energy statistics, indicates that electricity demand will continue to increase an average of one percent per year over the next 20 years. Electricity needs will require expansion of power production and distribution systems—in a manner that meets U.S. goals for reducing carbon emissions.

As industry begins to invest in nuclear power expansion to meet these objectives, the U.S. Department of Energy's Pacific Northwest National Laboratory recognizes the challenges that hinder nuclear energy advancement in domestic and international arenas. Consequently, PNNL is working with DOE and industry to:

- *develop options for the safe, effective recycle and disposal of spent nuclear fuel*
- *provide the technical basis for extending the life of the existing reactor fleet*
- *promote economic sustainability in the development and design of next-generation reactors and fuel cycle technologies*
- *support the development of advanced nuclear material safeguards technologies.*

Nuclear energy plays a key role in securing the nation's energy future. Nuclear energy is re-emerging on a global scale, with world energy demand expected to double in the next few decades. More than 30 new nuclear reactors are proposed or planned for the United States alone.

DELIVERING SAFE SOLUTIONS FOR DOMESTIC FUEL RECYCLING

In a nuclear power growth scenario, fuel recycling is critical to resolving the spent fuel disposition issue and the long-term economic sustainability of nuclear power. PNNL is developing technologies and advancing the scientific understanding of fuel recycling using our proven capabilities in:

- *nuclear sciences associated with materials, separations, and waste forms*
- *nuclear safety and regulations*
- *safeguards technology*
- *unique research facilities.*

Researchers at PNNL are determining how recycling used, or spent, nuclear fuel in a next-generation fast reactor will create smaller quantities of waste. Using expertise gained through years of developing glass and ceramic forms to encapsulate defense

PNNL's vision is to achieve national impact by helping to enable the development of advanced fuel cycle technologies through fuel cycle research utilizing the Radiochemical Processing Laboratory and other facilities located on the Hanford Site in southeastern Washington state.

U.S. DEPARTMENT OF ENERGY

waste, researchers are working on advanced materials to contain the types of waste that will be created in future recycling plants.

Promoting clean, nuclear power for the future also relies on advanced separations technologies that enable scientists to recycle nuclear fuel for power generation and minimize radioactive waste for disposal and storage. For example, PNNL is performing research to determine the stability of chemicals used to recycle nuclear materials in extreme radiation environments. PNNL also is conducting research and development of a process that dissolves targeted components of spent fuel, such as uranium, in order to significantly reduce the subsequent separations that need to be performed.

ENABLING INNOVATIVE REACTOR CONCEPTS

PNNL is actively engaged in the development of remote viewing systems in opaque liquids. This technology allows operators to view the internal workings of some complex nuclear systems such as sodium-cooled fast reactors, better enabling reliable operations of these next-generation reactor designs. PNNL is also leading archival and data management efforts for the vast collection of design and operational data generated during the testing program of the Fast Flux Test Facility, a test reactor that operated for approximately 10 years and is located on the Hanford Site in southeastern Washington state. Ready access to this data management system will greatly assist future designers and developers of fast reactor systems.

EXAMINING COMPLEX NUCLEAR PROCESSES IN REAL TIME

Approaches for monitoring the behavior of equipment, materials, and processes in a nuclear plant environment are an integral part of PNNL's work. One way PNNL is providing this benefit is through real-time chemical process monitoring.

AT PNNL, OUR NUCLEAR ENERGY SECTOR IS ADVANCING CONTRIBUTIONS IN THE FOLLOWING KEY AREAS:

- Nuclear safety and safeguards
- Fast reactor expertise
- Aqueous-based separations technologies
- Waste form development and qualification
- Unique and complementary facilities.

The conventional monitoring method in a nuclear plant involves sampling solutions that have accumulated in a tank, taking those samples to an analytical laboratory, and waiting for results before moving to the next stage in the process. Meanwhile, the accumulated materials require more tank storage and housing for large hot cells, which results in construction, labor, and higher costs. PNNL's technology simplifies the process by putting real-time monitors online that allow researchers to watch and gather data from chemical solutions as the solutions are flowing through a pipeline.

OPERATING WORLD-CLASS, UNIQUE FACILITIES

PNNL's history is tied to the distinctive Hanford Site facilities and capabilities that helped build America's strong nuclear foundation. PNNL operates the Radiochemical Processing Laboratory (RPL), a Hazard Category II nuclear facility. Within this facility, interdisciplinary scientists and engineers are developing safety basis and design documentation to build into the next generation of structurally sound, secure nuclear plants. Groundbreaking achievements in the use of medical radioisotopes for cancer treatment are being developed and refined within the RPL.

ABOUT PNNL—ADVANCING FRONTIERS IN ENERGY RESEARCH

PNNL is located in Richland, Wash., employs more than 4,000 staff, and conducted more than $880 million in research in fiscal year 2008. In the quest for energy and environmental solutions, PNNL marshals interdisciplinary research teams, collaborates with a range of partners, and leverages research funding to maximize results. Our staff, facilities, capabilities, and approach to inquiry and innovation have established PNNL as a premier science and technology enterprise.

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