Radiochemical Processing Laboratory

Pacific Northwest
NATIONAL LABORATORY

This nuclear research facility is a unique U.S. asset, supporting national security, environmental management, nuclear energy, and fundamental science missions.

SCIENCE FOR THE NATION'S NUCLEAR CHALLENGES AND OPPORTUNITIES

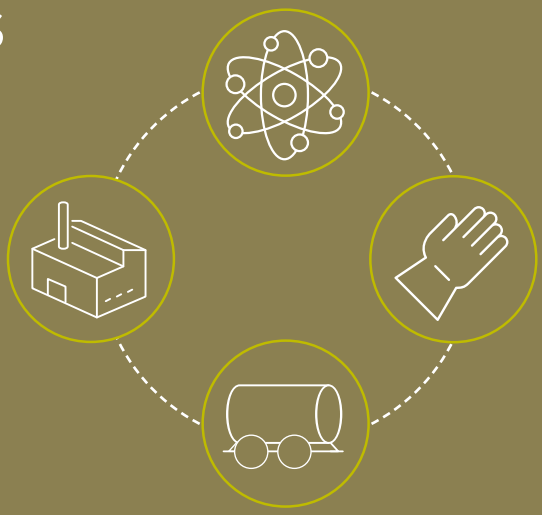
- NUCLEAR NONPROLIFERATION & FORENSICS
- NUCLEAR STOCKPILE SUPPORT
- CARBON-FREE NUCLEAR POWER
- LEGACY NUCLEAR WASTE TREATMENT
- MEDICAL ISOTOPES
- SPENT NUCLEAR FUEL MANAGEMENT

Pacific Northwest National Laboratory's (PNNL) position as a U.S. Department of Energy (DOE) Office of Science multiprogram laboratory is coupled with a national security heritage that is inextricably tied to the Hanford Site's materials production history. This deep expertise gives us unique perspectives and capabilities for the delivery of science-based solutions to address critical missions for the DOE National Nuclear Security Administration (NNSA), Office of Environmental Management, Office of Nuclear Energy, and Office of Science.

The Radiochemical Processing Laboratory (RPL) is a Hazard Category 2 nonreactor nuclear research facility that began operations in 1953 during the height of the Cold War. Today, RPL has 87 laboratory spaces within its 144,000 square feet. Researchers from around the U.S. can partner with PNNL to access the RPL's highly specialized capabilities, including through DOE's Nuclear Science User Facilities Program.

RADIOLOGICAL CAPABILITIES

- Large inventory limit for radiological and nuclear materials
- 50,000 square feet of radiological laboratory space
- 16 hot cells
- 22 gloveboxes
- 160 radiological fume hoods
- Ability to receive irradiated materials in shipping casks
- Ability to receive spent nuclear fuel, irradiated test rods, and highly radioactive tank waste



EXPERTISE IN RPL SUPPORTS MULTIPLE MISSIONS

Reducing the Threat of Nuclear Proliferation

PNNL is focused on the NNSA's Nuclear Nonproliferation mission of preventing nuclear weapon proliferation and reducing the threat of nuclear and radiological terrorism around the world.

- Understanding signatures of plutonium metal production for nuclear forensics
- Reducing proliferation risks by testing alternative fuel for civilian and test reactors
- Understanding and developing solutions for nuclear nonproliferation challenges associated with material production
- Supporting forensic investigations of radiological materials and incidents

Securing the Nation's Nuclear Weapons Stockpile

PNNL is committed to supporting NNSA's mission to provide the research, development, and production capabilities needed to maintain the reliability, security, and safety of the weapons stockpile. PNNL strives to achieve the following mission outcomes for NNSA:

- Advancing the science and engineering of tritium production, and meeting requirements for a resilient long-term supply
- Designing, developing, testing, and certifying the transportation packages used to convey materials and components
- Researching actinide sciences, particularly plutonium and uranium—including characterization down to the atomic scale
- Developing advanced process and product diagnostics, and the application of advanced data analytics

Advancing the Science of Carbon-free Nuclear Power

PNNL supports the DOE Office of Nuclear Energy mission and the commercial nuclear energy industry by resolving technical, cost, safety, and security barriers through early-stage research, development, and demonstrations. The critical nuclear R&D we perform draws on our deep multidisciplinary capabilities in engineering, chemistry, material science, earth sciences, data analytics, and more along with our state-of-the-art facilities and equipment:

- Extending the operation of existing U.S. nuclear power reactors through post-irradiation examination of existing commercial fuel and new accident tolerant fuels
- Maturing molten salt reactor technologies for the next generation of advanced nuclear reactors
- Developing proliferation-resistant fuel cycle concepts and technologies
- Enabling the safe storage, transportation, and disposal of spent nuclear fuel

Overcoming Technical Challenges with Legacy Nuclear Waste

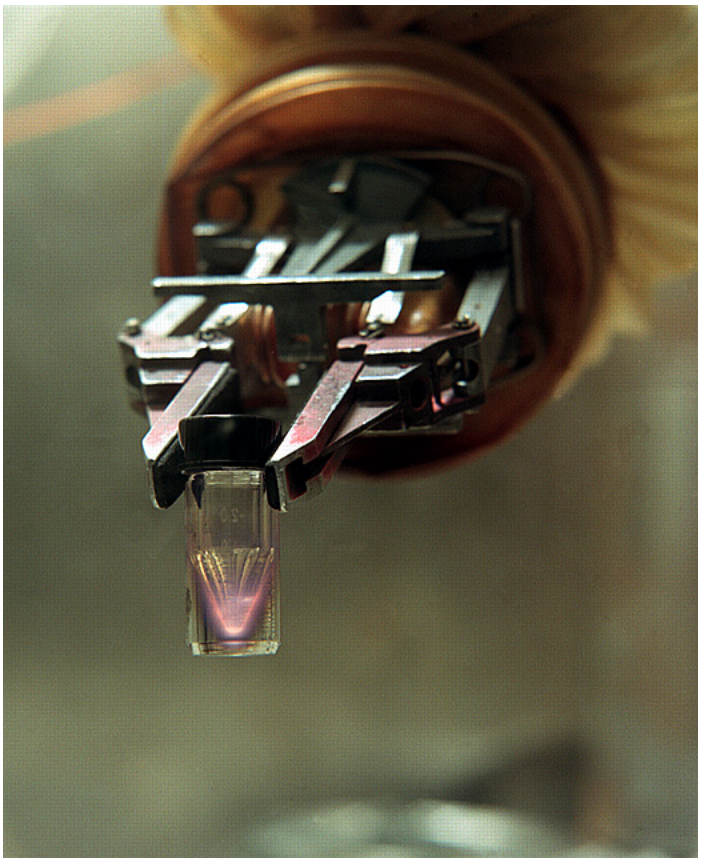
PNNL has partnered with DOE's Office of Environmental Management since its inception to support the Hanford Site's waste processing operations—enabling milestone-driven mission outcomes. We work to mature key technologies, processes, and systems designed to safely, efficiently, and effectively retrieve, treat, and immobilize nuclear waste. Our five major sponsor mission outcomes are:

- Enabling the startup of the Direct Feed Low-Activity Waste vitrification process
- Maturing technologies for sludge retrieval, processing, and high-level waste vitrification
- Providing the technical basis for tank farm closure
- Studying the effectiveness of proposed grout waste forms
- Performing radiation hardness and effects qualification testing for Hanford cleanup systems

Innovating the Development of Medical Isotopes

PNNL supports DOE's Isotope R&D and Production Program by providing scientific advances in the production and use of stable radioisotopes for research, medicine, and industrial applications. Together with top-of-the-line advanced biology, computational chemistry, and spectrometry research capabilities, PNNL also helps pharmaceutical companies and medical research centers develop new drugs, medical devices, and delivery systems. To advance these missions, we are:

- Researching cutting-edge radiochemical separations and automated systems
- Applying artificial intelligence and machine learning to develop automated radiochemical separation systems
- Developing radioisotopic power sources
- Producing high-purity radium-226, radium-224, lead-212/bismuth-212 generators, strontium-90, yttrium-90, and zirconium-89 for medical applications
- Researching new drugs, medical devices, and delivery systems
- Developing novel isotope production methods



People Dedicated to the Missions – *The heart of RPL*

Approximately 200 staff members are based in RPL, including over 100 researchers representing a variety of science, technology, engineering, and mathematics (STEM) degrees and diverse expertise.

1/3 Doctorate-level	*1/3 Masters-level*	*1/3 Bachelors-level*

Key Scientific and Engineering Fields

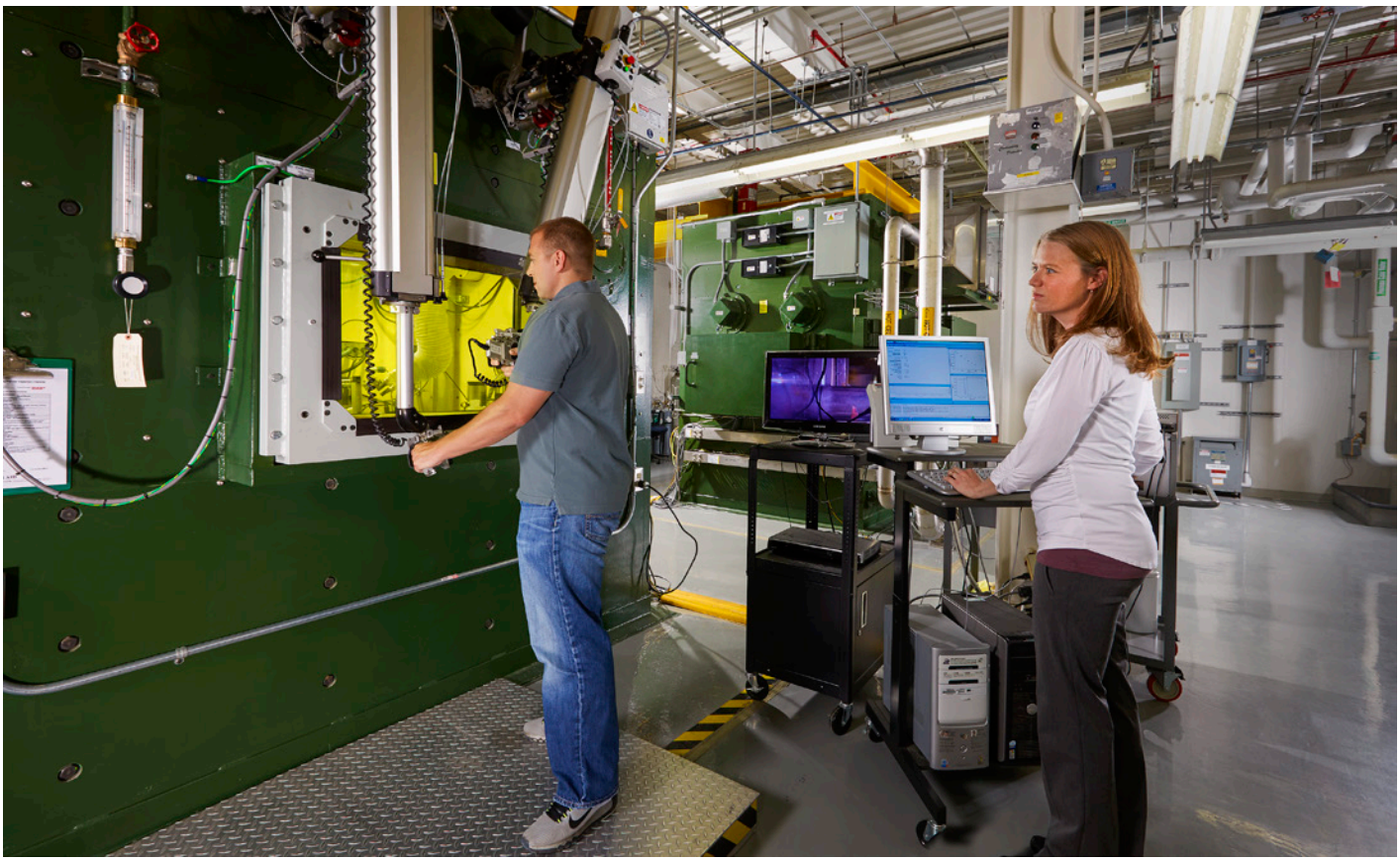
- Chemical Engineering
- Chemistry
- Materials Science
- Nuclear Engineering
- Physics
- Radiochemistry

Areas of Expertise

- Analytical Chemistry
- Automated Process Monitoring and Radiochemical Separations
- Expert Chemical and Physical Separations
- Heavy Element Chemistry
- Microanalysis and Characterization
- Nuclear Forensics
- Nuclear Fuel Reprocessing
- Nuclear Materials Examination
- Nuclear Nonproliferation Monitoring
- Radiochemical Process Development
- Radiological Nuclear Magnetic Resonance Spectroscopy
- Reactor Dosimetry
- Spectroscopic On-line Process Monitoring
- Spent Nuclear Fuel
- Tritium Processing

Shielded Nuclear Operations – *Studies involving high-activity materials*

High-Level Radiochemistry Facility Large quantities of gamma emitters	**Shielded Analytical Laboratory** Characterization and engineering	**Modular Hot Cells** Medical isotopes and special projects
• Three large interconnected hot cell workstations • Electromechanical manipulators to perform work inside the cells • Shielded with 48-in.-thick, high-density concrete walls and windows • Various access ports for equipment and material transfers into and out of the hot cells • Real-time in-cell monitoring of solution composition by optical spectroscopy/chemometrics • Cask handling area equipped with a 5/30-ton overhead bridge crane • In-cell cranes rated for half-ton capacity • Loading/unloading of a variety of shipping casks	• Six mid-sized interconnected hot cell workstations • Electromechanical manipulators to perform analytical chemistry inside the cell at each station • Shielded walls with 26 in. of magnetite concrete and windows • Access ports for equipment and material transfers into and out of the hot cells • Suite of standardized analytical equipment • Washington State-approved treatment, storage, and disposal unit	• Seven standalone modular hot cells • Constructed of carbon steel 9 to 12 in. thick with windows • Two isotope separations cells • A high-activity separations cell • Two process development cells • Two mechanical examination cells



Nuclear Materials Science – *Investigating mechanisms at the atomic scale*

High-Resolution Microscopy of Radiological Materials World-class instruments for atom-level examinations of radioactive samples	**Radiological Nuclear Magnetic Resonance (NMR) Spectroscopy** Unique NMR capability for studying solids and liquid radiological samples
• STEM—300kV aberration-corrected scanning transmission electron microscope • SEM/FIB—Scanning electron microscope focused ion beam • ESEM—Environmental scanning electron microscope • AFM—Atomic-force microscope • ATP—Atom probe tomography	• 11.75 Tesla (500 MHz) wide bore magnet • 7.05 Tesla (300 MHz) wide bore magnet • Zero field nuclear quadrupole resonance spectrometer

Radiological Analytical Services – *Characterizing difficult and hard-to-detect specimens*

State-of-the-art analytical services organization featuring standard analytical capabilities coupled with one of a kind radioisotope determination capability to provide detailed chemical analysis of radioactive samples.

High Accuracy and Precision Inorganic/Isotopic Analyses	Wide Range of Radioanalytical Counting Capabilities	Quality Assurance/Quality Control
• Inductively coupled plasma/optical emission spectrometry (ICP/OES) and inductively coupled plasma/mass spectrometry (ICP/MS) for determination of elemental and isotopic composition—Detection limits capable of reaching sub ppm to sub ppt levels • High-resolution gas mass spectrometry • Ion chromatography • Total organic carbon (TOC) and total inorganic carbon (TIC) measurements • Thermal ionization mass spectrometry	• 30 high-purity germanium (HPGe) gamma detectors • 3 liquid scintillation counters • 2 dual alpha/beta gas proportional counters • 6 Ludlum alpha counters • 24 low background alpha spectrometers • 4 low energy photon spectrometers • Advanced gamma detectors with Compton suppression • Gamma-gamma and beta-gamma coincidence detectors	• Operates to a quality program designed to support regulatory programs including ASME NQA-1, Office of Civilian Radioactive Waste Management, and Hanford Analytical Services Quality Assurance Requirements Documents • Quality assurance requirements can be customized using a graded approach based on the data quality objectives of the project

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