



**Solving Global
Problems**

■
*with Premier Staff
and Facilities*



**Radiochemical
Processing
Laboratory**



**Pacific Northwest
National Laboratory**

Operated by Battelle for the
U.S. Department of Energy

February 1, 2000

A new millennium, a new focus, a revitalized mission, a plan for the future, energetic staff, restored facilities, unique science capabilities, and an enabled operational approach describe the Radiochemical Processing Laboratory (RPL) at PNNL. The attached brochure illuminates the results of this transformation, and feel free to look over our business reports, which includes a copy of our 1999 income statement and a brief glimpse of our performance in 2000.

The RPL has changed dramatically in the past 4 years. There are still pockets of the cold war legacy. But, the facility is cleaner than people can remember, the operational approach is disciplined but adaptable to programmatic needs, the business outlook is positive, and the technical infrastructure is sound. The RPL is uniquely qualified in both staff competence and facility infrastructure to perform any mission that requires radionuclide handling, technology development, or process optimization.

To help us achieve our scientific and business objectives we've made some changes:

- Restructured the research teams to build better technical relationships
- Reinforced our focus on science and technology
- Instituted a user group to help us see past our own blind spots
- Streamlined the delivery of support services
- Lowered our charge out rate, and
- Set the stage for effective strategic investments that help us move quickly into the 21st Century

For those colleagues and clients that have worked with us recently, I want to thank you and look forward to maintaining the relationships. For those that haven't visited recently, please review the brochure, take advantage of my open invitation to call for a tour, and talk with our researchers about your needs and objectives. I'm positive that you will be pleasantly surprised with the facility, the staff, and the technical capabilities of the Radiochemical Processing Laboratory.

Sincerely,

Dale E. Knutson
Group and Laboratory Manager
Radiochemical Processing Laboratory

Solving Global Problems with Premier Staff and Facilities



Organizations needing innovative processes for environmental cleanup or new and beneficial uses for radioactive materials can look to the Pacific Northwest National Laboratory's Radiochemical Processing Laboratory for help.

At the Radiochemical Processing Laboratory (RPL), we are committed to developing innovative and creative solutions to a client's most difficult problems by providing highly

In the RPL's counting room, isotopes are identified in environmental samples.

qualified staff, safe and efficient operations, state-of-the art laboratories and facilities and an organization dedicated to teamwork.

The RPL houses specialized facilities for work with microgram to kilogram quantities of fissionable materials and megacurie activities of other radionuclides. These provide a platform for radiochemical process development, radiomaterials characterization, medical isotope production, chemical and physical separations, reactor dosimetry, thermal processing and radioactive and hazardous waste management.

quality

Handling Radioactive Materials Safely

The Radiochemical Processing Laboratory was built in 1953 to safely house and handle radioactive materials associated with chemical process development. The original missions of the facility were production support and process improvement for the Reduction-Oxidation (REDOX) process, improvements for the uranium metal recovery process and waste separations studies.

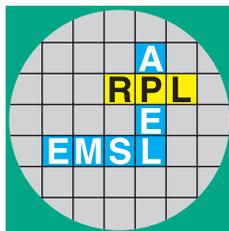
During the 1970s and 1980s, the RPL provided chemistry support for the Fast Flux Test Facility and the Nuclear Waste Vitrification Project. For the latter, the facility housed a small PUREX plant that was used to separate the nuclear wastes eventually turned into glass.



innovation

The Radiochemical Processing Laboratory is housed within the Department of Energy's (DOE's) Hanford Site in southcentral Washington State. The facility is the responsibility of DOE's Office of Environmental Management, whose focus at Hanford is directed toward site clean-up. The RPL is one of Pacific Northwest's three major scientific facilities. The others are the

William R. Wiley Environmental Molecular Sciences Laboratory (EMSL) and the Applied Processing Engineering Laboratory (APEL).



These three facilities are anchors to Pacific Northwest's mission of research, development and deployment of solutions to the nation's critical environmental problems.



Non-hazardous samples (shown on benchtop) come into the RPL's sample receiving office. The RPL analyzes a wide range of samples for radionuclides and metals.

state-of-the-art facilities

The Radiochemical Processing Laboratory is currently a U.S. Department of Energy Hazard Category II Non-Reactor Nuclear Facility. The 144,092-square-foot building has more than 35,000 square feet of laboratory space, nearly 15,000 square feet of office space, more than 8000 square feet of hot cell space, and 86,000 square feet of storage, mechanical and common space.

One of Pacific Northwest's Three Major Scientific Facilities

The Radiochemical Processing Laboratory has the following key capabilities available to clients:

- *Radiochemical process development*
- *Chemical and physical separations*
- *Radiomaterials characterization*
- *Medical isotope production*
- *Thermal processing*
- *Reactor dosimetry*
- *Analytical chemistry*
- *Nondestructive assay*
- *Shielded facilities*
- *Hazardous waste treatment units.*

Developing Radiochemical Processes at All Scales

Among the key features of the Radiochemical Processing Laboratory are our extensive radiochemical processing cells and laboratories. The RPL's expertise lies in development, scale-up and deployment of first-of-a-kind processes to solve environmental problems, which includes extensive experience over the last two decades with high-level and low-level mixed tank wastes.

Our clients use our capabilities in radiochemical process engineering to

- Develop process flowsheets
- Design, install and test radiochemical process systems (leaching, solvent extraction, ion exchange, vitrification, fuel dissolution, decontamination, evaporation, grouting, solid waste packaging and shipment, high-level liquid waste shipping, receiving, and transportation)
- Develop engineered systems for toxic and highly radioactive systems.

For more than a decade, the RPL has provided waste separation, processing and immobilization technologies to the Hanford Site. Much of the development and testing has been performed with actual Hanford waste. Recent waste separations process testing has concentrated on ion exchange, sludge washing/leaching, ultrafiltration and oxidation/precipitation. Separated species are then immobilized into waste forms, which are then characterized for product acceptability.

In addition, the RPL has thermoanalytical capabilities to measure reaction enthalpies, kinetics and mass changes to determine the thermal sensitivity of the reaction. By analyzing this information, we can assess a chemical system's stability and develop fundamental information on the operable chemical mechanisms.



Many of the RPL's capabilities can be used to investigate highly energetic systems having very rapid reaction rates. Our staff have analyzed reaction off-gases on a real-time or end-of-reaction basis to identify and quantify the gaseous reaction products, and investigated the thermal stabilities of candidate radioisotope waste forms, volatile radioisotope trapping materials and the potentially hazardous reactions between radioactive waste constituents.

Our expertise lies in development, scale-up and deployment of first-of-a-kind processes to solve environmental problems.

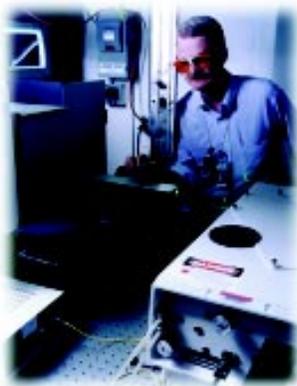
first-of-a-kind

The Radiochemical Processing Laboratory's analytical chemistry capabilities are used to characterize materials in support of process development. The RPL's experienced staff, state-of-the-art facilities and specialized instrumentation provide clients access to a broad spectrum of capabilities.

We specialize in the analysis of highly radioactive materials and very complex sample matrices. Since

state-of-the-art
instrumentation

This Raman spectrometer is used to analyze inorganic species within Hanford tank waste, as well as a wide variety of radioactive and nonradioactive samples.



1987, the RPL has provided extensive support to the Hanford Tank Characterization Program and other site remediation activities.

The RPL has the only Waste Isolation Pilot Plant-certified nondestructive assay (NDA) laboratory for transuranic waste at Hanford and the only one of five nationally. In addition, we have a mobile NDA lab for performing measurements in the field.



Our 28-foot mobile NDA lab is used both as a lab and to deliver NDA assay equipment to offsite measurement locations.

Analytical
Chemistry—
From Hot to Not

processes

The Laboratory's experienced staff, state-of-the-art facilities and specialized instrumentation provide clients access to a broad spectrum of capabilities.

Characterizing Radiomaterials

The Radiochemical Processing Laboratory provides integrated characterization capabilities to solve a wide range of processing problems related to radioactive materials. We provide clients with

- Unique facilities for handling and processing highly radioactive materials
- Specialized state-of-the-art instrumentation
- Staff who know how to handle and analyze highly radioactive samples and materials.

Spent Nuclear Fuels

Commercial and defense spent nuclear fuels present challenging cleanup and disposition problems. The RPL's extensive expertise coupled with our materials characterization and testing capabilities support development of processing and disposal pathways for these highly radioactive materials. Our work with these materials supports several missions, ranging from development of a geologic repository for disposal of high-level nuclear waste to development of interim storage strategies for DOE site-specific materials.

Radioanalytical Surface Science Laboratory

The RPL's Radioanalytical Surface Science Laboratory is being used to study the interfacial interactions of highly radioactive material surfaces with the environment. Capabilities exist to study the interaction of spent nuclear fuels and other highly radioactive materials with water or other species in the presence of ionizing radiation. For example, we can predict what happens to radioactive materials in storage environments that are not completely dry.

The shielded scanning electron microscope (shown here with shielding removed) with light-element-dispersive spectroscopy is used to analyze highly radioactive samples such as spent nuclear fuel.



The Radiochemical Processing Laboratory provides integrated characterization capabilities to solve a wide range of process problems related to radioactive materials.

The RPL's state-of-the-art thermogravimetric analysis/differential scanning calorimeter/mass spectrometer system is used to analyze gram-size pieces of materials and study material reactions in varied atmospheres.



radio

fundamental
science

Radioimmunotherapy

The development of processes to produce medical isotopes for cancer treatment is an exciting and promising capability offered within the RPL. Radioisotopes can be separated from nuclear materials and then purified for use in cancer radioimmunotherapy. Moreover, the radioisotopes can be linked to targeting molecules such as monoclonal antibodies that attach to specific sites on the surface of a cancer cell.



AMIG, the Automated Medical Isotope Generator, separates bismuth-213 for cancer therapy without operator intervention. Human error, waste generation and operator exposure to radiation are all minimized in this small, efficient package.

computer-controlled, automated generator system by which very short-lived alpha emitters can be quickly separated from a parent isotope species with a much longer half-life. Research is also under way on the complex chemistry required to chelate alpha-emitting radioisotopes and tightly link them to antibodies for use in pre-clinical research and cancer therapy trials.

A major success for the RPL was the development of a patented radiochemical process for producing ultrapure yttrium-90, a byproduct of the decay of strontium-90. Because of the reliable supply of high-quality yttrium-90 provided by RPL scientists, this beta-emitting radioisotope is one of the more popular isotopes used for cancer radioimmunotherapy worldwide.

An exciting frontier in radioimmunotherapy is one use of short-lived alpha emitters. Scientists in the RPL have developed several innovative procedures for separating and purifying alpha emitters with medical applications, recently developing a

Medical Isotope Production for Cancer Treatment



The ultrapure Y-90 process enables production of extremely pure yttrium-90 for use in cancer therapy with radiolabeled monoclonal antibodies.

Work is under way on the complex chemistry required to chelate alpha-emitting radioisotopes and link them to antibodies for use in pre-clinical research and future cancer therapy trials.

medical
research
& treatment

Chemical and Physical Separations

Our expertise includes testing of materials and adaptation of technologies to improve processing as well as process development to achieve many different separations.

Our expertise in the fundamental chemistry of radionuclides enables us to develop innovative separation technologies to support clients' radiological and hazardous material processing and disposal requirements. These technologies include

- Removal and concentration of hazardous and radioactive components
- Separation of hazardous and/or radioactive materials
- Recovery of specific components for recycle and reuse
- Coupling of separation technologies with conversion technologies for improved processing.

We address fundamental research issues in the areas of solvent extraction, ion exchange, supercritical fluids, electrophoresis, capillary electrophoresis, colloidal chemistry and materials science and characterization.

Integrated project teams consisting of scientists, industrial chemists and process engineers collaborate to develop and deploy separation technologies to solve complex environmental problems. Our expertise includes testing of materials and adaptation of technologies to improve processing as well as process development to achieve many different separations. Our staff can discuss applications in specific areas on request.



separations

Dosimetry for a Wide Range of Needs

The RPL's dosimetry services can help characterize complex reactor environments, effectively use U.S. and foreign materials' test data, increase reactor safety and plant life



extension, develop advanced reactor alloy materials and design advanced fission and fusion reactors. Our comprehensive services include neutron fluence and spectral measurements, hydrogen and helium gas measurements, and extensive computer calculations of radiation damage effects.

This high-sensitivity helium mass spectrometry system provides highly accurate measurements of helium in very small solid materials and in selected liquids and gases.

knowledge

Radiochemical Processing Laboratory staff are leaders in the development and deployment of technically and economically superior thermal and vitrification processes to immobilize hazardous and radioactive materials into acceptable waste forms. With more than three decades of thermal processing technology—design, flowsheet and process development, remote operations and numerical and computational modeling waste vitrification development experience—we offer the process and equipment knowledge to apply and adapt thermal and vitrification processes to almost any relevant waste material.

The world's first remotely operated liquid-fed ceramic melter (LFCM) process was successfully designed, constructed and operated here and has since been adopted worldwide as the reference technology for high-level waste vitrification. We have

successfully transferred vitrification technology expertise to the Savannah River Site, the West Valley Demonstration Project, and high-level waste treatment facilities in Japan and Germany.



An adiabatic calorimeter is one of the many thermo-analytical instruments used in the RPL to investigate the stability and reactivity of materials.

Thermal Processing for Waste Management

cleaning up the environment

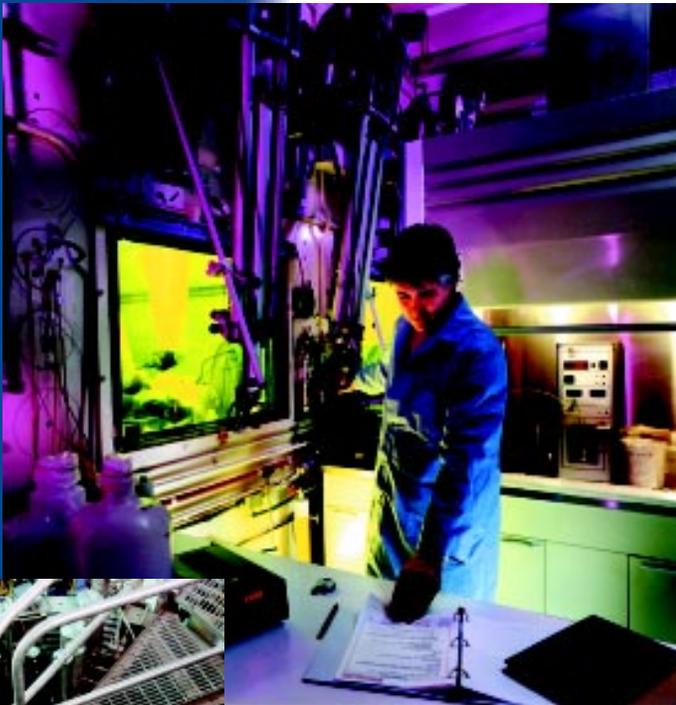
With more than three decades of thermal processing technology, we offer the process and equipment knowledge to apply and adapt thermal and vitrification processes to almost any relevant waste material.

Shielded Facilities for Radioactive Materials

The Radiochemical Processing Laboratory contains two fully staffed and equipped hot cell complexes for conducting work with highly radioactive materials. These complexes provide unique, complementary capabilities for conducting bench-scale to pilot-scale work with wide varieties and forms of radioactive materials.

Experience and capabilities include

- Radiochemical separation and purification
- Irradiated fuel/target sectioning and processing
- Metallography and ceramography
- Activated metals physical properties testing
- Thermal processing
- Materials physical properties testing (solid/liquid separation, centrifugation, settling behavior)
- Radioanalytical and preparatory chemistry operations (acid dissolution, aqueous/solvent extraction or leaching, distillation, ion exchange, caustic fusion).



The High-Level Radiochemistry Facility provides a variety of services for radioactive materials, including secret and highly classified data. These services include tank characterization, pretreatment, advanced analytical methods development, isotope processing, advanced separations and reactor fuel handling.

The Shielded Analytical Laboratory (SAL) is specially designed for performance of a variety of analytical chemistry operations on radioactive samples with dose rates of up to 2000 R/h. The SAL consists of six cells totaling 200 square feet of floor space.

The Gamma Irradiation Facility is used to test the effects of gamma radiation on materials (adhesives, grout, and polymers), components and test systems. The facility plays an important role in a wide range of programs, including analyzing Hanford waste tank solutions,

conducting corrosion and stress-corrosion cracking studies and evaluating various types of probes under irradiated conditions.

remote
operations



Special Features of the Radiochemical Processing Laboratory

- ✓ Permitted waste treatment storage and disposal facility
- ✓ 3000-gallon radioactive liquid waste system tank and shipping station
- ✓ Low-level waste compactor
- ✓ Double-shielded, instrumented waste tanks for hot cell use
- ✓ Remote capabilities to inspect dangerous waste tanks
- ✓ Continuous program alarming and monitoring systems to ensure safe operating conditions
- ✓ Exhaust air sampling capabilities for radioactive material sampling
- ✓ Maintenance shop
- ✓ Laboratory gas distribution system for P10, methane, UPH methane, acetylene, hydrogen
- ✓ Specially shielded sample receiving area with walk-in sample storage cooler



Ensuring Safety, Efficiency, Compliance

The RPL's operations organization works in tandem with scientists and researchers to ensure that all work is performed safely and efficiently.

The RPL is in full compliance with all applicable quality, environmental safety and health, radiological control, and waste management regulations and Laboratory implementing systems and procedures. Our staff have extensive experience interacting with federal and state regulatory agencies on a variety of issues.

Integrated Operations Software

Our Integrated Operations (IOPS) software provides tools to conduct safety and health self-assessments, initiate and manage staff and visitors' access, determine training and qualification requirements, and facilitate productivity, efficiency and safety.

Online Manuals and Facility Use Agreements

Because the RPL is a Hazard Category II nuclear facility, it has its own online operations manual that covers every aspect of doing work in the facility.

Quality Assurance Program

Our Quality Assurance and self-assessment program go hand in hand with Laboratory operations, ensuring delivery of the highest value for our customers.

safe
operations

Solving Problems...

Over 50 years of Technical Excellence

The Radiochemical Processing Laboratory can provide what you need through the combination of our outstanding technical staff, facilities and operations. Our broad spectrum of capabilities, from materials characterization and process development to waste treatment and disposal, are available in one facility.



Around the Globe.

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