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PACIFIC NORTHWEST LABORATORY
operated by
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UNITED STATES DEPARTMENT OF ENERGY
under Contract DE-AC06-76RLO 1830

On the cover

A process developed at Pacific Northwest Laboratory with U.S. Department of Energy support converts the carbohydrates in agricultural byproducts such as potato processing waste into acrylates that can be used to manufacture biodegradable plastics and many other important commodities. The technology was transferred through a coordinated effort with a sugar producer in Hawaii.

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MEET THE BEST!
AWARD-WINNING TECHNOLOGIES
FROM
PACIFIC NORTHWEST LABORATORY

September 1990

Prepared for
the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830

Pacific Northwest Laboratory
Richland, Washington 99352

MASTER

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Preface

Welcome to PNL.

The Battelle Memorial Institute has managed the Pacific Northwest Laboratory (PNL) for the U.S. Department of Energy for 25 years. During this time, numerous new technologies have been discovered and developed at PNL as a result of our research programs. This document will introduce you to some of the more significant discoveries and newly commercialized technologies. Each of the technologies described has received an award from *Research & Development* magazine or the Federal Laboratory Consortium—sometimes both! Each technology is available to you through PNL's technology transfer program or one of our licensees.

Similarly, our award-winning scientists and engineers are available to assist you as you search for innovative technologies to solve your technical problems. These researchers are familiar with current problems confronting industry, government agencies, and the academic community. They are happy to apply their skills and PNL's resources to your problems.

PNL encourages its researchers to work with government agencies, universities, and U.S. industries. PNL technology transfer programs address the nation's drive toward increased competitiveness by being flexible and aggressive, and are designed to tailor results to fit your needs and those of your clients. If you are in search of a new technology or increased competitiveness, consider collaborative efforts with our award-winning staff, whose accomplishments are synopsized in this booklet.

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Meet The Best!

Award-Winning Technologies

From Pacific Northwest Laboratory

"Discovery consists of looking at the same thing as everyone else and thinking something different."

**(Albert Szrent-Gyorgyi,
Nobel Prize-Winning Physicist)**

Who We Are and How to Meet Us

Over the past 25 years, scientists and engineers at Pacific Northwest Laboratory (PNL) have applied "discovery" thinking to a host of technical problems. Many of them have added the touch of genius that earns patents, software awards, and honors in nationwide and international competitions such as those sponsored by *Research and Development (R&D)* magazine and the Federal Laboratory Consortium (FLC). These people are special to Battelle and the U.S. Department of Energy (DOE) because of their creativity and contributions to technology transfer.

As part of its 25th anniversary, the Laboratory is honoring its technological achievers. This report is a salute to the winners of R&D 100 and FLC awards—grateful that they "think something different." We invite you to join the many who have found PNL to be a valuable technical resource. Call or visit, and find out how you can benefit from the creativity and expertise of PNL researchers.

Who We Are

PNL is a national laboratory, operated for the DOE by Battelle Memorial Institute. One of nine DOE multiprogram laboratories, we

conduct research in support of the DOE's mission relative to energy, the environment, national security and defense, and international competitiveness. Integral components of PNL's mission include expediting technology transfer to users in the public and private sectors, developing and operating scientific user facilities for researchers from those sectors, and contributing to the education of scientists.

The Laboratory's principal focus is environmental research and waste management technology; other programs of emphasis include molecular science research, chemical and biological sciences, national

The results of research conducted at PNL for the DOE are regularly transferred from the Laboratory to the private sector. Visitors attending workshops and seminars or touring PNL facilities can obtain first-hand information about the Laboratory and its technologies.

security technology, and energy conservation technologies. PNL also provides technical support for Hanford Site operations, including independent environmental surveillance and oversight.

Nearly all PNL programs feature technology transfer and science education. Annually, the Laboratory routinely works with more than 150 different companies to develop and transfer technology for industrial applications.

How You Can Meet Us

The DOE has made a substantial investment in PNL; Battelle Memorial Institute has also invested in private facilities and equipment to augment this government investment. An innovative contract between the DOE and Battelle consolidates these resources, providing an extensive capability for scientific investigation and technology transfer to industry and other government agencies.

Each year, Laboratory staff members assist numerous federal and state agencies and U.S. companies. Efficient, flexible procedures help business and industry gain access to PNL's government-owned facilities, equipment, and staff. This flexibility enriches PNL's technology transfer program by enhancing the ability to tailor Laboratory-developed technologies for specific commercial applications.

The Laboratory's technology transfer activities facilitate access to its technologies by industrial firms, agencies of state and local government, and universities. We put science and technology to work in several ways:

- providing technical assistance, as described above
- establishing user facilities, such as the National Environmental Research Park and the Environmental and Molecular

Sciences Laboratory, where PNL scientists collaborate with university and industry to conduct basic research and seek solutions to practical, real-world problems

- granting licenses to companies for the use of technologies developed at the Laboratory
- forming new "spin-off" companies to manufacture products or market services
- supporting universities by providing opportunities for research and through innovative licensing agreements that enable universities to use PNL-developed technologies for research and training.

The Laboratory welcomes inquiries and visitors. Potential users are invited to workshops and conferences where staff scientists present technologies developed to address specific problems. Each year we host more than 500 meetings on topics ranging from the molecular sciences to solar radiation. Press releases and publications from the technology transfer program help "spread the word" about new, available technologies.

The technology transfer program acts as a bridge between government laboratories and the private and public sectors. PNL's Office of Research and Technology Applications (ORTA) responds

to inquiries, coordinates the utilization of research results and technical capabilities developed for the DOE, and arranges for individual applications. Through the ORTA and this synopsis of our finest technologies, you are invited to call or visit. Find out today how PNL and its technology transfer program can help you.

FLC and R&D 100

Each year, the Laboratory receives awards for its excellence in research and development. This document recognizes the winners of two annual awards, each with nationwide participation: the R&D 100 award for technological merit and the FLC award for excellence in technology transfer. These awards reflect examples of the creativity, versatility, and persistence found in PNL and other DOE multipurpose laboratories.

The R&D 100 awards program is the only competition in the world that recognizes the 100 most significant new technical products of the past year. This international competition, now in its 29th year, has a twofold purpose:

- to recognize innovators and organizations for outstanding practical technical developments
- to identify significant technological advances.

The competition is sponsored by *Research & Development* magazine. For the first 25 years, the publication was titled *Industrial Research*, and the awards were called the I•R 100 awards; however, the name was changed in 1988 to R&D 100, reflecting the magazine's new title.

The FLC was established in 1974 as an association of 400 federal research and

development laboratories and centers representing 14 federal agencies. Its mission is to promote the rapid movement of research results and technologies from federal laboratories into the mainstream of the economy. This cooperative approach allows laboratories such as PNL to strengthen their technology transfer efforts. Moreover, the consortium can help small companies by opening doors to federal laboratories and making contacts that might otherwise be difficult.

As an incentive to technology transfer, the FLC sponsors an annual competition, open to all FLC members. Its awards **"recognize individuals or groups within federal laboratories who have demonstrated uncommon creativity and initiative in transferring technology that provides significant benefits to private industry or state and local governments."** The quality of the technology is considered, but the FLC focuses on the transfer effort.

Double Winners: When the Very Best is Developed and Transferred

Every research and development laboratory has some very special achievements of which it is especially proud. PNL is no exception. Here, we honor three technologies and their principal investigators who have won both R&D 100 and FLC awards. These, our "double winners," are symbols of the Laboratory's multipurpose nature, our ongoing quest for excellence in science, and our commitment to technology transfer.

Thermochemical Environmental Energy System™

A unique system that can turn wet industrial and food-processing wastes from a disposal problem into an energy asset, the Thermochemical Environmental Energy System™ (TEES™) was developed by John Sealock, Douglas Elliott, R. Scott Butner, Eddie Baker, and Gary Neuenschwander. The award-winning process, whose evolution has been supported by a number of DOE organizations, provides an economic breakthrough to companies producing large amounts of wet organic waste such as food-processing byproducts, agricultural residues, and other biomass. Inside a closed reactor, a catalytic gasification system combines low temperatures, high pressures, and a reduced nickel catalyst, converting the wet material to gases—primarily

methane and carbon dioxide—and a residue that is less than 2 percent of the original mass. The methane can be used to fuel the natural gas-fired boilers that are found in many food-processing plants. If the carbon dioxide is separated, it can be used for carbonating beverages or sold outright. The wastewater can be readily clarified and treated for reuse or disposal. The system can serve as a portable unit or be integrated into a larger plant, in both cases helping industry meet stringent environmental standards.

The novel approach to technology transfer involved a special agreement with a small, private engineering and management company, Onsite*Offsite, Inc., which is experienced at solving industrial engineering problems. This company aids the Laboratory in tailoring the technology to the needs of the food-processing and beverage industries and expedites efforts to commercialize and transfer the process.

PNL's Thermochemical Environmental Energy System™ could enable food processors to turn waste products into usable sources of energy. Among the developers (from left): R. Scott Butner, Eddie Baker, John Sealock, and Norm Banns (Onsite*Offsite).

Sludge-To-Oil Conversion

PNL's sludge-to-oil reactor system (STORS) also swept the winners' boards. A process to convert sewage sludge and agricultural wastes to a useful petroleum product, STORS was the result of innovative work by PNL's Alex Fassbender and Pete Molton. The system can produce up to three times as much energy as it uses and reduces the volume of sludge for disposal by 80 percent. The resulting oil is similar to diesel fuel. STORS has the potential for saving more than 50 percent in energy costs while providing an environmentally preferable option to current disposal practices of incineration, landfill burial, and ocean dumping.

Molton and Fassbender were also recognized for their work in transferring the STORS technology to the American Fuel and Power Corporation, which funded Battelle to help design, construct, and

demonstrate a pilot plant in Richland. The Innotek Corporation, a successor to American Fuel and Power, plans to construct full-scale municipal waste plants to serve cities with populations of 75,000 or larger. PNL's research on the project was co-sponsored by the DOE, the U.S. Environmental Protection Agency, and American Fuel and Power.

PNL's sludge-to-oil conversion system turns sewage sludge and agricultural wastes into useful petroleum products and can produce up to three times as much energy as it consumes. Shown here: Alex Fassbender and Pete Molton.

CAGE/GEM™ Software Toolkit for Genetic Engineering

PNL's CAGE/GEM™ (computer-aided genetic engineering/genetic engineering machine) software toolkit uses information about genetic phenomena and DNA

(deoxyribonucleic acid) sequences to produce computer designs enabling scientists to isolate genetic structures on the computer screen. The CAGE/GEM software also provides a choice of data bases so that the user can select the one best suited for a particular genetic engineering operation. The kit has proven valuable in university classrooms and research laboratories; it also has applications in industries related to food, petroleum, and pharmaceutical products.

The transfer of CAGE/GEM included an effective nationwide outreach program that has benefited both university and industry interests. Initially, the closest regional research institutions—Washington State University and the University of Idaho—were granted use of CAGE/GEM for education and research programs in genetic engineering. The software was then provided to six minority universities now active as part of a national network for biomedical research. Simultaneously, the Laboratory targeted selective placement of the new software with established firms in the biotechnology field. The principal developers, Richard Douthart and James Thomas, and other PNL staff members conduct classroom instruction at educational institutions and open-forum technical workshops at PNL, thus exploring new research applications and providing practical feedback for system upgrades.

Technological Achievements: 1969-1990

The technologies described below are also representative of PNL's exceptional research, development, and deployment. In 1969, the first year that PNL entered I•R 100 competition, the Laboratory was included in the award-winning top 100, and we have been a consistent winner ever since. Our technology transfer innovations have also been recognized. The FLC

competition has been in existence since 1984, and in that time, PNL has won 13 of 16 possible awards, more than any other DOE laboratory. The expanding use of innovative technology transfer mechanisms has enabled PNL to win; creative agreements with industry, universities, and others have significantly increased the rapidity and effectiveness with which the products of PNL's research and development efforts leave the Laboratory and are put to work.

Q-Endoscreen (R&D 100)

Q fever, highly infectious and sometimes fatal, annually afflicts thousands of people worldwide. Yet, until now, it has proved nearly impossible to diagnose. Q-Endoscreen, a new detection method developed by PNL scientist Marvin Frazier in cooperation with researchers from the University of Washington and the University of New Mexico, will enable quick, accurate, and inexpensive identification of the elusive disease.

The Q-Endoscreen procedure will enable quick, accurate diagnosis of the elusive Q fever in stock animals or humans. PNL researcher Marvin Frazier received an R&D 100 award for his development.

The Q-Endoscreen procedure is used to detect *Coxiella burnetii*, a very specialized bacterium that—depending on the strain present—can cause either the acute febrile illness known as Q fever or an inflammation of membrane lining the cavities of the heart. The latter, a chronic endocarditis, is usually fatal to humans. The Q-Endoscreen test also determines which strain is present. The organism need not be grown or isolated in the laboratory, and test results are available in only 12 to 16 hours. Q-Endoscreen is a sensitive method for monitoring the efficiency of treatment regimes, detecting as few as two organisms in a biological sample.

Physicians should find Q-Endoscreen a valuable tool for quick diagnosis. The procedure should also be extremely valuable to veterinarians. While Q fever is not transmitted between humans, it originates in animals. Q-Endoscreen provides the ability to determine on short notice which animals harbor *C. burnetii* and whether certain species, or herds, are serving as natural reservoirs for chronic disease-causing strains that infect humans.

The Pyroflux Process (R&D 100)

This energy-efficient, low-cost method for making glass was developed by Alex Fassbender, Lyle Mudge, and Paul Walkup. The Pyroflux process can be used to make any type of glass that uses a low-viscosity flux material. The concept utilizes energy-efficient, direct-contact heat transfer to preheat batch materials before injecting them into the glass furnace. A specialized venturi mixes molten sodium carbonate with the other particulate glass-forming materials at temperatures greater than 1000°C. This hot mixing step enables the use of more advanced equipment, saves energy and costs, and reduces the possibility of nitrogen oxide pollution.

PNL's technology for the Pyroflux glass-melting process enables low-cost, energy-efficient production of several kinds of glass. Shown here (from left): Paul Walkup, Lyle Mudge, and Alex Fassbender.

With the DOE, the U.S. glass industry has supported development of the award-winning process, and rights in the fields of flat glass, drawn fiber glass, and sodium silicate have been licensed to a major American glass company. The technology is available from PNL, however, for other licensees.

Conversion of Fermentable Carbohydrates to Acrylate Esters (FLC)

A team of PNL researchers worked with the cane sugar industry to develop and commercialize a technology that could significantly reduce costs in the manufacture of acrylate products while enabling production of a wide variety of commodities. The process enables the conversion of fermentable carbohydrates, including byproducts of beet and sugar cane production, corn wet milling, and potato processing. The byproducts are converted to lactates and

then to acrylate esters. The lactate materials could be used for animal feed or could solve an acute environmental problem by providing an inexpensive raw material for biodegradable plastics. Acrylate materials are major articles of commerce, in high demand for use in surface coatings, adhesives, sealants, textiles, and detergents.

To transfer this technology, which evolved from PNL research in the DOE's Fuel-from-Biomass program, the PNL research team of Paul Walkup, Charles Rohrmann, David Eakin, and Richard Hallen developed a working agreement with the Hamakua Sugar Company of Hawaii. Hamakua Sugar agreed to support development of the process in return for rights to commercialize the technology in Hawaii. Today, several years after the initial agreement, Hamakua Sugar is speeding transfer of the technology to other Hawaiian companies by way of licensing. The Laboratory retains title to the technology and is actively seeking licensees outside Hawaii.

A process that converts agricultural byproducts such as blackstrap molasses to lactates and then to acrylate materials has been transferred from the Laboratory to the sugar industry. Shown here with fermentation equipment (from left): David Eakin, Richard Hallen, Charles Rohrmann, and Paul Walkup.

PNL researchers worked with the American Iron and Steel Industry to develop and transfer a technology for measuring the internal temperatures of hot steel. Shown here (from left): Donald Boyd, Douglas Lemon, and Gary Spanner.

High-Temperature Steel Measurement Technology (FLC)

The transfer of a high-temperature steel measurement technology from PNL to the U.S. steel industry was the result of an organized effort by a PNL research team, a federal agency, and members of the industrial sector. The team, including Donald Boyd, Douglas Lemon, and Gary Spanner, worked with the DOE and the American Iron and Steel Institute (AISI) to develop and transfer the technology, which could save the U.S. steel industry up to 5.5 million tons of coal or 90 billion cubic feet of natural gas each year.

PNL's system determines the internal temperature of a hot steel slab or billet. The Laboratory retained Magnasonics, Inc., a small electronics company located in Albuquerque, New Mexico, as a subcontractor to help develop the transducer for operation at the high temperatures (up to 1300°C) present in steel during the casting process. Representatives of AISI member steel companies spent portions of a year working with the team at PNL and provided engineering support and facilities for testing the technology in an actual plant environment. Magnasonics plans to manufacture the systems for industrial use.

Electrospray Ionization (R&D 100)

A technology that combines high-resolution separation (capillary zone electrophoresis) with mass spectrometry to analyze chemical and biological samples at previously nonmeasurable levels was developed by PNL's Richard Smith and Harold Udseth. The new electrospray ionization interface provides an extremely sensitive analytical instrument that can detect materials no other instrument can measure. Potential applications include identification of cancer-causing pollutants, examination of acid rain samples, and development of new pharmaceutical products. The interface has already proved its effectiveness at PNL for analyzing acid rain samples, recombinant DNA, and vaccines from recombinant DNA.

Electrospray ionization enables researchers to analyze chemical and biological samples at levels so minute that measurement has been impossible until now. Shown here: Richard Smith and Harold Udseth.

Rapid Expansion of Supercritical Fluids (R&D 100)

A process for the rapid expansion of supercritical fluid solutions (RESS) was a winner for PNL scientists Richard Smith and Dean Matson. RESS enables researchers to produce small particles of uniform composition and size directly from a vapor in less than one-millionth of a second. The process can also be adapted for production of continuous thin films and the formation of fine polymer fibers. The RESS technology has several potential applications in the pharmaceutical, electronic, ceramic, and paint manufacturing industries. Possible uses include the development of more effective medicines, construction of rocket propellants with improved burning characteristics, and ceramic powders and coatings for optical lenses and micro-electric components.

Many manufacturing processes will benefit from PNL's technology for the rapid expansion of supercritical fluids, which enables production of thin films, fibers, and minute but uniform products. Shown here: Richard Smith and Dean Matson.

Through PNL's technology for hydrogen recovery and sulfur abstraction, hazardous hydrogen sulfide gas can be separated from natural gas and converted to hydrogen. Shown here: Michael Lilga and David Nelson.

Recovery of Hydrogen and Abstraction of Sulfur (R&D 100)

A technology that could significantly increase the world's supply of usable natural gas while producing hydrogen gas efficiently and economically was developed by two PNL investigators, David Nelson and Michael Lilga. So-called "sour natural gas" may contain more than 50 percent hydrogen sulfide and cannot be used as a fuel because of environmental and safety considerations. However, during the abstraction/recovery process, hydrogen sulfide is converted into hydrogen. The hydrogen can be reinjected into the gas stream or can be isolated as a pure product. Hydrogen is valuable as a fuel and would enhance the heating value of the natural gas product.

Kinetic Phosphorimetry (FLC)

The principal developers of the kinetic phosphorimetry technology for uranium bioassays were PNL's Bruce Bushaw and

Tom Whitaker. Kinetic phosphorimetry is used to measure uranium concentrations in human body fluids, particularly in bioassays of urine specimens. Workers who are potentially exposed to uranium, as in mining and milling, are required to have routine uranium bioassays, and PNL's technique is quicker, less expensive, and more accurate than other measuring methods.

A spin-off company, Chemchek Instruments, Inc., was established to commercialize the bioassay device. Under a license granted by the DOE, the company is now manufacturing and marketing the technology and conducting analyses for customers throughout the United States.

A Low-Cost Sampling Pump (FLC)

PNL's sampling pump, an innovative and inexpensive device originally developed for use on government sites, improves the process of monitoring groundwater for contaminants. Because of its creative design and low cost, a pump can be dedicated to a single well, eliminating the need for removal and cleaning between samples and improving sample quality.

A large team was honored for the development of the sampling pump: Kenneth Ames, James Doesburg, Eugene E. Schbach, Roy Kelley, David Myers, Phil Oberlander, Ronald Schalla, and Robert Sullivan. They explored several options for transferring the technology. Ultimately, a small firm, Instrumentation Northwest, Inc., was issued a license for the use of the system, the pump, and technical information to sample and test groundwater in the U.S. and Canada. Instrumentation Northwest is now marketing the sampling pump under the name Hydrostar™.

Synthetic Aperture Focusing (FLC)

PNL researchers Steven Doctor and Thomas Hall developed the synthetic aperture focusing technology for ultrasonic testing (SAFT-UT) to be used in detecting structural defects. The technique enables the nondestructive determination and characterization of defects in structural components. The technology was developed at PNL with support from the U.S. Nuclear Regulatory Commission (NRC) for use in nuclear power plants. Under an agreement with the NRC and industry, PNL tested the system at several U.S. commercial nuclear power stations. The technology is being further refined for use by the nuclear industry.

Root Barrier Technology (FLC)

The controlled-release chemical root barrier technology developed at PNL is a cost-effective and environmentally safe process in which a controlled-release chemical, trifluralin, is used to prevent unwanted plant root penetration. The research team of Dominic Cataldo, Peter Van Voris, and Fred Burton was honored for development and transfer in a variety of applications. The root barriers have been applied in sewer gaskets, where the technology is being marketed by Mantaline Corporation; in a geotextile manufactured by Reemay, Inc., for use under sidewalks and other structures; and as part of underground drip irrigation emitters marketed by Agrifim Irrigation International. Licenses for further applications are available from the Laboratory.

PNL's root barrier technology has many applications, including incorporation as a geotextile that is used to prevent roots from cracking sidewalks, airport runways, and other structures.

Dry-Cooling Enhancement Program (FLC)

PNL's dry-cooling technology for electric generating plants was developed and transferred by PNL researchers Rudolph Allemann, Ben Johnson, and Ellwood Werry. The dry-cooling concept— which

utilizes air instead of water for cooling electric power generating plants— offers the potential for saving millions of gallons of water required in conventional cooling systems. Research and development of this technology was a cooperative effort between government, laboratory, and industry: PNL, the U.S. Environmental Protection Agency (EPA), the Electric Power Research Institute (EPRI), Union Carbide, and four utility companies. The utility companies and EPRI supported construction and operation of the dry-cooling test facility.

Advanced Decontamination Technology (FLC)

PNL researchers Richard Allen, Leland Fetrow, and Michael McCoy were principal investigators for the electropolishing decontamination technology, an industrial metal finishing process tailored by PNL for use by the commercial nuclear power industry. An electric current is applied to metal objects immersed in an acid electrolyte to selectively remove surface imperfections and produce a smooth, polished surface. Through PNL's technology transfer efforts, three major U.S. nuclear service organizations now offer utility decontamination services using electropolishing techniques. One firm, Quadrex, has established a new service division based on the technology.

Recovery of Noble Metals From Spent Fuel (I•R 100)

PNL researchers developed a process for treating fission waste for the recovery of noble metals, a small group of rare metals that are vital in the manufacture of communications equipment, electronic components, laser mirrors, automobile catalytic converters, and aircraft engines. These

metals also are used as catalysts for producing gasoline and nitrogen fertilizer and for converting coal and other carbonaceous materials into liquid fuel. Oswald Wick, Charles Rohrmann, and George Jensen discovered the recovery process, which could enable the nuclear power industry to recycle palladium, ruthenium, and rhodium from spent nuclear reactor fuel, thus avoiding the need to import the metals at great expense.

Neutron Dosimetry Technology (FLC)

In 1984, the first year that the FLC award was available, PNL staff member George Endres was recognized for transferring a tissue equivalent proportional neutron counter to nuclear reactor facilities for use in personnel dose equivalent measurements. The use of these dosimeters, developed under the DOE's Environmental Research and Development Program, allows dose measurements that previously could only be estimated.

Thermal Hydraulics for Reactors (FLC)

Another researcher, Charles Stewart, won one of the first FLC awards for providing the electric utility industry with a consistent and integrated computer approach that enables the analysis of coolant flow and heat transfer in light-water reactor cores. As part of the transfer process, PNL conducted information and training sessions with about 30 U.S. utility companies.

Supercritical Fluid Chromatograph and Mass Spectrometer (I'R 100)

PNL's supercritical fluid chromatograph and mass spectrometer technologies established new capabilities for the application of supercritical fluid processes. The new technologies allow direct, sensitive

characterization of many nonvolatile, high-molecular-weight materials. PNL's principal investigator was Richard Smith.

Portable Blood Irradiator (I'R 100)

PNL's portable blood irradiator was successfully tested in veterinary research on tissue and organ transplants. Researchers Roy Bunnell, Frank Hungate, and William Reimath used a thulium isotope to lower levels of lymphocytes, the white blood cells that fight infections and reject foreign materials in the body, and to reduce the possibility of tissue or transplant rejection.

Optical Digital Recording (I'R 100)

PNL pioneered in the development of optical digital recording, a technique for storing and retrieving information at very high densities by optical means. This technology is best known today through the audio recording industries, which have incorporated parts of PNL's invention. PNL's optical information storage technology was transferred to Digital Recording Corporation, Scarborough, New York. The inventor was James Russell.

Void Metal Composite (I'R 100)

A unique porous metal structure with great promise for the biomedical community, "void metal composite" can be used to form a union between bone tissue and prosthetic devices. The uniform pores, or "voids," in the metal permit tissue ingrowth and supply long-term support and repair for bone and other tissues. Three PNL researchers, Kenneth Sump, Manuel Karagianes, and Kenneth Wheeler, were principal inventors of the technology, which was developed in cooperation with Washington State University.

Acoustic Emission Tester (I'R 100)

PNL's acoustic emission tester can instantly and accurately detect flaws in a weld as the weld is being made. This nondestructive inspection method detects the acoustic emissions of pressure waves generated in a metal when a fracture or failure takes place. The tester, which is applicable to the manufacture of automobiles, tubing, heavy equipment, and aerospace equipment, is currently being manufactured by Staveley Instruments. PNL's Donald Jolly was recognized for his work on this technology.

Tomorrow's Technologies

After more than two decades of research excellence, PNL continues to develop technologies worthy of special honor. Although we cannot always predict which efforts will be the award winners, PNL's scientists and engineers will continue to develop significant new technologies and make them available to universities, government agencies, and industry.

Some of PNL's potential winners may be chemical processes, software tools, and energy-saving devices. Some will facilitate environmental monitoring and restoration; some will increase the efficiency and cost effectiveness of hazardous waste remediation. A sample of other excellent (and available) PNL technologies is presented below.

Advanced Ceramic Fabric Materials: strong, durable, and flexible textiles woven from fibers of metal oxides or elements such as carbon and silicon.

Analytical Repository Source-Term (AREST) Computer Code: implements a model of near-field performance of high-level radioactive waste packages in a deep geologic repository.

Catalyzed Electrochemical Production Oxidation Device (CEPOD): an innovative chemical processing system that dissolves, destroys, or decontaminates organic and inorganic materials for hazardous waste remediation.

Computer-Controlled Automated Rain Sampler: a compact instrument enabling researchers to automatically collect a timed sequence of rain samples for chemical analysis as part of acid rain and other environmental studies.

Double-Resonance Ionization Mass Spectrometry (DRIMS): a laser technique that selectively measures ultratrace quantities of isotopes such as those of interest in environmental and health research.

Electro-Optic Liquid Sensor: a small, inexpensive device that detects and measures liquids present in soil, sand, cement, or other porous materials.

PNL's electro-optic liquid sensor could enable environmental researchers and managers of waste storage sites to detect and trace underground leaks or monitor the progress of remediation measures. Farmers could use the technology to determine when and how much to irrigate.

Envelope and Lighting Standards Software: two microcomputer software systems that automate the calculations required to demonstrate compliance with DOE building energy conservation standards.

Inside Knowledge: a computer program enabling an analyst to determine the appropriateness, feasibility, and potential effectiveness of applying artificial intelligence (knowledge-based) systems.

Miniature Tissue Equivalent Proportional Counter Spectrometer: a small, portable radiation detector designed for measuring the amount of radiation received by astronauts and their equipment in space.

Solid-State Gas Reservoir: a combination pump capable of operating efficiently in the 1 Pascal pressure range, and a fabrication method for producing bulk metal alloys containing up to 10 atom percent gas.

TEES II: a thermocatalytic conversion process that is used to destroy hazardous organic and halogenated organic compounds contained in various types of water streams.

The multifaceted nature of PNL and the versatility of its research and development teams make such achievements likely candidates for future awards. We can be assured that the Laboratory's research and development programs will continue to expand; techniques and equipment will be advanced and refined; and PNL's staff will continue to grow in versatility and expertise. These ingredients—and the ability to look at the same thing as everyone else and think something different—comprise PNL inventors and their inventions. The inventions, inventors, and developers are available as you search for new and improved answers to technological questions.

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