U.S. Department of Energy

Annual Report on Technology Partnering Activities

at

National Laboratories and Other Departmental Facilities

for

Fiscal Year 2001

As Required by 15 USC 3710(f)

March 2002

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I. Programs and Plans

The U.S. Department of Energy's five-fold mission is to: (1) foster a secure and reliable energy system that is environmentally and economically sustainable; (2) be a responsible steward of the Nation's nuclear weapons; (3) clean up the Department's facilities; (4) lead in the physical sciences and advance the biological, environmental, and computational sciences; and (5) provide premier scientific instruments for the Nation's research enterprise.

In order to achieve this mission, and for the public benefit, the Department's 11 national laboratories and 13 other facilities having research or technology development programs, are authorized to engage in technology partnering activities, including cooperative research and development agreements (CRADAs), with other Federal and non-Federal entities. The purposes of these authorities are to:

- Facilitate the efficient and expeditious development, transfer, and exploitation of Federally owned or originated technology to non-DOE entities.
- Leverage DOE resources, through its programs and facilities, through partnering, and
- Ensure fairness of opportunity, protect the national security, promote the economic interests of the United States, prevent inappropriate competition with the private sector, and provide a variety of means to respond to private sector concerns and interests about facility technology partnering activities.

Fundamental scientific discoveries and technologies supporting DOE mission areas can play an important role as building blocks for new commercial opportunities. DOE facilities and resources may be made available for partnering with industrial partners to reduce their technical risk and to gain access to facilities and experts with skills outside the normal scope of their own workforce. At the same time, the Department can strengthen its mission-oriented R&D and keep vital technological capabilities at the leading edge. Successful collaborations benefit industry and the DOE laboratories by saving money and by gaining access to each other's talent, technology, knowledge, and facilities.

DOE encourages its facilities to enter into technology partnering activities using a variety of mechanisms, including Cooperative Research and Development Agreements (CRADAs), Work for Others (WFO), Licensing, User Facility Agreements, and others, in order to encourage research partnerships with non-Federal organizations.

DOE expects its facilities to:

- Recognize that technology transfer, through partnering in all its forms, is a mission of DOE and its facilities, consistent with the provisions of legislation and, as directed by Congress.
- Carry out technology partnering activities in accordance with their applicable laws and authorities.
- Carry out policy and assign roles and responsibilities for the oversight, management, and administration of DOE facility technology partnering activities.
- Ensure the consistent development and application of policy and procedures in planning and conducting technology partnering activities at DOE facilities.
- Ensure the availability of timely and accurate technology partnering data and information to monitor, evaluate, and describe DOE technology partnering activities.

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II. Data

The following data summarizes Department of Energy National Laboratory technology partnering data for FY 2001:

1. Collaborative Relationships for Research, Development, and Demonstration

CRADAs

Active CRADAs	558
New CRADAs	204

2. Intellectual Property Management

Invention Disclosure and Patenting

Invention Disclosures	1527
Patent Applications	792
Issued Patents	605

Licensing

Active Invention Licenses		1162
New Invention Licenses		226
"Other IP" Licenses		843
Total Royalty-bearing Active Licenses		1012
Exclusive	174	
Partially-Exclusive	112	
Non-Exclusive	726	
Terminated Licenses		60
Elapsed time to license execution		See Note 1

Note 1: This data is not currently collected or readily available. DOE hopes to address this requirement in future reports.

Income

Total Active License Income	$21,403,362
Active Invention License Income	$18,921,843
"Other IP" License Income	$1,870,071
Royalty Sharing to Inventors	$5,942,497
Royalty Sharing for Other Purposes	$10,413,555
Total Earned Royalty Income (ERI)	$7,832,481
Range of ERI Values	$2 - $1,584,922
Median ERI Value	$3,889
ERI for top 1% of Licenses	$2,699,134
ERI for top 5% of Licenses	$5,271,631
ERI for top 20% of Licenses	$7,162,951

III. Outcomes

The following examples are illustrative of outcomes from Department of Energy technology partnering activities.

Separation Technology for Biology and Chemistry

It is anticipated that the MCE 2000, an R&D-100 Award winning separation technology based on multiplexed capillary electrophoresis, using absorption detection, will eventually replace high-performance liquid chromatography, one of the most successful commercial instruments for chemical separation used in both biology and chemistry laboratories. It was developed by Edward S. Yeung, director of Ames Laboratory's Chemical and Biological Sciences Program. Ames Lab's technology makes it possible to rapidly separate samples of complex chemical or biochemical mixtures and has the ability to decipher an individual's entire genetic code faster, more accurately and less expensively than conventional

instrumentation - a feat that could potentially revolutionize the diagnosis of diseases and the development of treatments.

A new spin-off company was launched to turn the multiplexed capillary electrophoresis technology into a commercial instrument - the MCE 2000. In an effort to accelerate the development process, CombiSep Inc. was established with the licensed technology from Iowa State University in 2001and is located in Ames, IA. It took the startup company only nine months to design, develop, test and sell the first instrument. *Ames Laboratory; POC: Debra Covey, 515-294-1048.*

A New Catalyst for Fuel Cell Development

A new catalyst, which forms the heart of a component that will allow fuel-cell-powered cars to run on conventional fuel, was developed by Michael Krumpelt and his colleagues of the Chemical Technology Division, at the U.S. Department of Energy's Argonne National Laboratory. This catalyst is expected to accelerate bringing ultra-efficient, environmentally friendly electric cars to the marketplace. The catalyst has been named one of the top 100 technological innovations of the preceding year by R&D 100 Magazine in its R&D 100 Awards. As a result of their work, Argonne and Süd-Chemie, Inc. (formerly United Catalysts Inc.) have signed a licensing agreement under which Süd-Chemie Inc. will manufacture and distribute a partial oxidation catalyst developed and patented by Argonne. *Argonne National Laboratory; POC: Stephen Lake, 630-252-5685, slake@anl.gov*

Nuclear Medicine on the Go

Digirad, Inc., a small business based in California, began the first significant number of deliveries of its award-winning Digirad 2020tc Imager at the beginning of FY2001. The 2020c Imager is based on licensed Berkeley Lab photodiode technology first developed for astrophysics use. It is the world's first solid-state digital gamma camera for nuclear medicine.

Digirad recently received its 100th order for the Digirad 2020tc Imager in June 2001, and the 2020tc Imager is poised to replace the existing vacuum tube technology that is the current industry standard for nuclear medicine. It serves clinical applications not open to traditional cameras because of their bulkiness, lack of mobility, and comparatively inferior performance. Digirad's 2020tc imager weighs only 425 pounds while a standard stationary vacuum tube camera weighs 1.5 to 2.5 tons. Digirad also offers mobile nuclear cardiology in 13 states

throughout the United States. This imaging service is also based on the Berkeley Lab technology. As of November 2001, Digirad was performing approximately 22,000 diagnostic patient studies on an annualized basis. *Lawrence Berkeley National Laboratory; POC: Viviana Wolinsky, 510-486-6463, viwolinsky@lbl.gov*

Energy Efficient Insulation and Packaging

Gas-filled panels, or GFPs, were originally conceived in the early 1990s by Berkeley Lab as a new thermal-insulation material that could be used as an alternative to CFC and HCFC blown foams. Unlike such foams, GFPs are environmentally safe. GFPs are made from thin, infrared, reflecting, multilayer, aluminized plastic baffles. The baffles are enveloped by a sealed barrier and filled with a low conductivity inert gas or air.

Cargo Technology, Inc., a San Diego-based small business, licensed the GFP technology from Berkeley Lab to make insulated packaging materials for shipping perishable cargo (including foods and pharmaceuticals). Cargo Tech introduced its GFP product, AirLiner, in December 2000. Besides offering superior thermal performance, AirLiner is viewed as an inexpensive replacement for polystyrene foam containers, which are bulkier, more cumbersome, more prone to cracking and leaking, and result in a larger volume of solid waste than GFPs. New advances in GFP production arising in the development of the AirLiner has opened the door for many other uses of this technology. Berkeley Lab already has optioned GFPs for building insulation and is working with other companies on other thermal-insulation applications such as appliances (refrigeration) and transportation (airplanes and automobiles (For more information, please consult the GFP web site at gfp.lbl.gov). *Lawrence Berkeley National Laboratory; POC: Viviana Wolinsky, 510-486-6463, viwolinsky@lbl.gov*

Extreme Ultraviolet Lithography Program for Next Generation Computer Chips

Lithography is the process by which complex integrated circuit designs are miniaturized and transferred to semiconductor wafers, or computer chips. It is an essential technology that has enabled the growth of a trillion-dollar computer and information technologies industry. Of all of the manufacturing steps required in the production of integrated circuits, lithography is the most costly and technologically difficult to develop and implement, with each new generation of equipment requiring almost a billion dollars of investment. Lithography that uses

extreme ultraviolet light, which has a very narrow wavelength, enables much the manufacture of much smaller circuits with many more transisters.

As a result of a cooperative technology partnering program between the semiconductor industry and several of the Department of Energy's national laboratories, this new technology, called EUV lithography, has emerged as the leading solution for the manufacture of advanced chips. In April of 2001, the technology achieved a major milestone by demonstrating a prototype machine called the Engineering Test Stand (ETS). With this machine, laboratory researchers were able to print, for the first time, full field images with features less than 100 nanometers. This lithography technology will be introduced into manufacturing by the middle of the decade and will serve the semiconductor industry for the next 15 years. *Lawrence Livermore National Laboratory; Sandia at Livermore; at Lawrence Berkeley National Laboratory; POC Don Sweeney (LLNL), (925) 422-5877, sweeney4@llnl.gov ; Dave Attwood from LBNL, (510) 486-4463, dtattwood@lbl.gov ; Glenn Kubiak from SNL, (925) 294-3375, kubiak@sandia.gov .*

Combustion Control and Diagnostics Sensors

In May of 2000, researchers at the National Energy Technology Laboratory, filed a patent titled, "Flashback Detection Sensor for Lean Premix Fuel Nozzles." The Flashback Detection Sensor (FDS) relates to lean premix combustion systems, in general, and to the detection of a flashback-condition in lean premix fuel nozzles of gas turbine combustion systems, in particular. It is believed that this technology will monitor and help meet stringent emission regulations for gas combustion design and operation, which use some form of lean-premix combustion (LPM), which enables a significant reduction of thermal NOx formation.

With additional research, focused on flame ionization for in-situ monitoring, the inventors realized the potential for FDS embodiment to be used for both control and diagnostics. As a result of this new information, the name of the technology was changed to Combustion Control and Diagnostics Sensors (CCADS). From May 2001 until present time, the inventors began testing the CCADS at turbine conditions. A leading independent designer and manufacturer of gas turbine controls later signed a CRADA. NETL and the industrial partner will jointly develop the in-situ monitoring device for gas turbine systems and are currently discussing possible strategies for licensing the patented technology. *National Energy Technology Laboratory; POC: Diane Newlon, 304-285-4086, newlon@netl.doe.gov*

Identification Technology

The radio-frequency (RF) identification (ID) system, developed at the Department of Energy's Pacific Northwest National Laboratory, and marketed by a technology transfer spin-off company known as Wave ID, is based on small, inexpensive RF tags that can identify, locate, and even determine the condition of any item to which they are attached. The RF tag is programmed with information that can be read by a hand-held reader, or interrogator, and sent to a computer. Tags can be read at a rate of 500 tags per second, and at a distance of up to a 600-feet, which is 10 times greater than similar products. The new system is the only one that can pinpoint the exact coordinates of a tagged item.

The tags are being used to locate, secure, and deactivate equipment; locate injured soldiers and send information to medical units; inventory and track weapons, tools, and clothing (the antitheft hard plastic tags attached to merchandise in stores are RF tags); locate tools left in aircraft engines during maintenance; monitor aircraft brake temperatures and rocket motor health; inventory and control shipyard supplies; monitor nuclear reactors and material; monitor and inventory munitions; monitor emissions from vehicles; and track honeybees for detecting landmines. Their small size (2.5 x 0.75 x 0.5 in.) makes them easy to use. Unlike other tags, the RF tags work well within highly metallic environments, such as ships and airplanes. Current global security concerns will likely increase the demand for these products. The ability to track and deactivate items, such as military equipment and weapons, may become an important aspect of security in the war against terrorism. *Pacific Northwest National Laboratory; POC: Cheryl Cejka, 509-375-3700, cheryl.cejka@pnl.gov*

Radiation-Hardened Pentium Processors for Space and Defense

One of the most widely used computer chips in the world, the Pentium processor was developed by Intel Corporation at an estimated cost of more than $1 billion. Its speed, flexibility, and reliability made it a valuable resource for critical government applications. Radiation-hardening helps to protect such chips and other critical-system components from the harsh effects of cosmic and nuclear radiation, ensuring reliable performance. The Department of Energy (DOE) has used five generations of rad-hard chips in earth satellites, space probes, missiles, nuclear weapons, and in other applications that contain electronics that could be damaged by radiation.

In technology partnering agreement between Sandia National Laboratories and Intel Corp., Sandia was granted a no-fee license to redesign the Pentium®

processor into a radiation-hardened (rad-hard) chip for space and defense uses. The agreement allows the government to own the rights to this rad-hard version of a top-quality commercial microprocessor design, and allows Sandia to fabricate the chips, if no industry source can be developed. *Sandia National Laboratory; POC: John Kelly, 505-843-4206, jekelly@sandia.gov; technical contact: Robert Blewer, (505) 844-6125, blewerr@sandia.gov*

Modeling of Tire Stress Dynamics Produce Dual-Use Benefits

When Sandia National Laboratory and the Goodyear Tire & Rubber Co. teamed up in 1993, Goodyear was hoping that Sandia could use its computer modeling and simulation capability to help the company design and manufacture better tires. Scientists and engineers at Sandia hoped that the work would challenge them to test their computer modeling tools and to sharpen their skills in materials development and analysis. Neither partner expected the agreement to yield more than a simple technology transfer.

Sandia's mission in weapon systems design and stewardship appeared to be completely different from an automobile tire manufacturer's goal of enhancing its market position by shortening its product development process, but the fundamental technologies required for both have many common elements. Simulating the performance of laminated tire structures, consisting of fabric, steel, and various rubber compounds, was a particularly difficult modeling challenge. Sandia brought to the partnership its substantial computer power and insights, while Goodyear contributed its expertise and experience in polymer sciences. Ultimately, the combination of capabilities produced breakthroughs that not only provided insight into tire design, but also were applicable for weapons design and manufacturing. As Goodyear applied Sandia's computer code innovations to better optimize tire performance for new car platforms, Sandia began to utilize the feedback acquired from the work to streamline the labs' own processes. Sandia was able to improve its neutron generator manufacturing and to develop more accurate computer models of polymer stresses, deformations, and aging effects, which in turn helped to improve the fidelity of its weapon-system models.

Over time, the partners recognized and pursued other common interests in areas as diverse as manufacturing, fluid dynamics, vibration, acoustics, materials, and chemical-separations technologies. Sandia was drawing technological innovations from industry for the first time, and in the process, it was learning an important lesson – partnerships based on mutual benefit are the most enduring. Currently, Sandia and Goodyear are working within their sixth cooperative

research and development agreement, exploring low-energy technologies to separate hydrocarbons monomers for synthetic rubber production. If successful, the work will reduce energy consumption in petrochemical processes and advance chemical separation technologies for other uses.

But this partnership is just one part of Sandia's broader business development effort to partner with U.S. industries. What started as technology transfer has now become an integral part of Sandia's strategy to effectively fulfill its national mission by engaging in strategies that bring added expertise to the process from outside the laboratory. *Sandia National Laboratory; POC: Dick Steichen, (505) 845-7252; rjsteic@sandia.gov*