Summary Report on Federal Laboratory Technology Transfer

Agency Approaches; FY 2001 Activity Metrics and Outcomes

2002 Report to the President and the Congress under the Technology Transfer and Commercialization Act

Office of the Secretary
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DEPARTMENT OF COMMERCE

FOREWORD

The sizable and sustained investment that the United States has made in science and technology over the past several decades, coupled with our world-class scientists and entrepreneurial businesses, has paid off handsomely and helped position us well as the 21st century starts. Our economy and technology sectors lead the world, thanks in large part to our unique innovative capacity.

With the President's Trade Promotion Authority and increased trade, however, will come not only new economic opportunities but also new policy considerations. The forces of globalization are changing trade, technology sourcing, capital flows, and the movement of technical talent in significant ways. Despite our present ascendancy, we are likely in the years ahead to face more significant challenges to our innovative capacity and long-term competitiveness than ever before.

America's Federal lab system, comprising world-class scientists and research facilities, has been an important element of the Nation's infrastructure for innovation. Beyond helping to meet the Nation's defense and international security needs, Federal lab science and technology has also been the source of important innovations with wide commercial relevance, such as clean room technologies, cell sorting machines, atomic clocks, stronger and lighter materials for such things as more fuel efficient cars, and the Global Positioning System (GPS). Our Federal labs provide unique, hard-to-duplicate facilities and longstanding relationships with top innovators. They offer a critical and fertile resource for early-stage, high-risk research and development (R&D)—the kind of work on basic science and basic technology that gives rise to revolutionary new technologies with important commercial impacts.

Effective transfer of Federal technology—that is, diffusing the new knowledge and inventions created by Federal R&D funds to American firms and entrepreneurs with the capabilities to translate these advances into commercially viable products and processes—is likely to play a critical role in sustaining U.S. competitiveness and leadership in the global economy. And Congress has mandated that part of the Federal labs' mission be to promote this transfer as well as possible.

Recognizing the importance of this contribution, Congress has asked the Department of Commerce to regularly assess and report on the status of technology transfer by the Federal labs. This Summary Report for 2002 responds to that mandate. We hope this report will inform policymakers, facilitate feedback and discussion, and help to encourage Federal labs in their technology transfer efforts.

Donald L. Evans
Secretary of Commerce

Acknowledgments

Many people contributed to the preparation of this, the first Summary Report on Federal Lab Technology Transfer. The Office of Technology Policy, U.S. Department of Commerce (OTP/DOC) appreciates the effort and cooperation of senior tech transfer personnel at the ten Federal agencies involved: the Departments of Agriculture, Defense, Energy, Health and Human Services, Interior, Transportation, and Veterans Affairs; the Environmental Protection Agency; and the National Aeronautics and Space Administration; in addition to DOC's own Federal labs. Thanks also is due to the Interagency Working Group on Technology Transfer, whose thoughtful efforts to develop a common reporting framework facilitated reporting and analysis of the Federal lab tech transfer program statistics and information which are the basis of this Summary Report.

This report was assembled and drafted by the Office of Technology Competitiveness, Office of Technology Policy, Technology Administration, Department of Commerce.

Principal staff

Karen Laney-Cummings, Acting Director, Office of Technology Competitiveness

Mark Boroush, Technology Policy Analyst, Office of Technology Competitiveness

Other Contributors

John Raubitschek, Patent Counsel, Office of General Counsel

Questions about the statistics or other content of this report should be directed to Mark Boroush, Office of Technology Competitiveness, 202.482.6394.

Jon Paugh

We also want to recognize the significant contributions of Jon Paugh, late Director of the Office of Technology Competitiveness at the Department of Commerce, both to this report and to U.S. technology transfer policy over numerous years. Peers and colleagues throughout the technology transfer community held Jon in the highest regard. In addition to his thoughtful contributions to the development of public policies in federal technology transfer, Jon directed initial interagency efforts to improve the Federal labs' reporting processes—improvements reflected in this Summary Report. Jon's knowledge, wisdom, and character are much missed.

CHAPTER 1
PURPOSE AND SUMMARY OF MAJOR FINDINGS

1.1 Background

This Summary Report provides a review and analysis of the Federal laboratories'[1] utilization of the technology transfer authorities opened to them by Federal law.[2] It is the first edition in a new annual report series for the President and Congress in response to the Technology Transfer Commercialization Act of 2000 (P.L. 106-404, signed November 1, 2000). The report covers Federal laboratory technology transfer activities through FY 2001.

Periodic reporting to the President and Congress about the Federal laboratories' technology transfer activities has been a statutory requirement since 1986 under the Stevenson-Wydler Technology Innovation Act of 1980.[3] From 1987 until recently, the Office of Technology Policy (OTP) at the Department of Commerce prepared Biennial Reports in response to this requirement.[4]

In late 2000, the Technology Transfer Commercialization Act revised and enlarged the existing Stevenson-Wydler Act reporting process. Under the new law, reporting responsibilities are bifurcated. Each Federal agency that operates or directs Federal laboratories (or engages in patenting or licensing of federally owned inventions) is required to provide the Office of Management and Budget with an annual report on its technology transfer plans and recent achievements as part of its annual budget submission. The Secretary of Commerce then

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[1] "Federal labs" refers to government-owned or -leased / federally staffed facilities for performing research, development, or engineering activities relevant to an agency's missions and interests. The government-owned but contractor-operated facilities with a similar purpose also fall under the "Federal lab" title. The U.S. Federal lab system presently encompasses more than 700 Federal labs and research centers, including the Department of Energy's "national laboratories."

[2] Most notably, the Technology Innovation Act of 1980 (often referred to as the Stevenson-Wydler Act) and the University and Small Business Patent Procedures Act of 1980 (often referred to as the Bayh-Dole Act). The Stevenson-Wydler Act (P.L. 96-480, 15 U.S.C. Sec. 3701-3714) and Bayh-Dole Act (P.L. 96-517, 35 U.S.C. Sec. 200-211) remain the primary statutory moorings for technology transfer between the Federal laboratories and the private sector. Since the mid-1980s, however, there has been continuing congressional review of agency experiences in implementing these laws, which has resulted in amending legislation to both Stevenson-Wydler and Bayh-Dole.

[3] The Federal Technology Transfer Act of 1986 (P.L. 99-502) amended the Stevenson-Wydler Act in several respects, including adding a requirement for the Biennial Report.

[4] The most recent Biennial Report is Office of Technology Policy, U.S. Department of Commerce, *Recent Trends in Federal Lab Technology Transfer: FY 1999–2000 Biennial Report*, May 2002 (http://www.ta.doc.gov/Reports.htm).

prepares an overall Federal assessment for the President and Congress based on the program information in these agency reports.[5]

This revised reporting process is being implemented this year (calendar year 2002), in conjunction with the FY 2003 Federal budget cycle, and requires agencies to report on their FY 2001 technology transfer activities.

The long-standing—and now expanded—requirement for public reporting broadly reflects national policymakers' interest in facilitating greater use of the considerable scientific and engineering resources of the Nation's Federal laboratory system, in order to hasten promising technologies toward commercialization and strengthen the competitiveness of U.S. industries.

1.2 Scope of This Report

Ten major Federal agencies have significant Federal laboratory operations. Each of these agencies, together with their component organizations and labs, has established programs for transferring the technology arising out of their lab science and technology activities. This Summary Report provides information and analysis about each of these 10 agencies:

- Department of Agriculture (USDA)
- Department of Commerce (DOC)
- Department of Defense (DOD)
- Department of Energy (DOE)
- Environmental Protection Agency (EPA)
- Department of Health and Human Services (HHS)
- Department of the Interior (DOI)
- National Aeronautics and Space Administration (NASA)
- Department of Transportation (DOT)
- Department of Veterans Affairs (VA)

[5] The statutory annual agency report (termed an "agency report on utilization") is described by 15 U.S.C. Sec. 3710 (f). The Secretary of Commerce's report (termed an annual "Summary Report") is described by 15 U.S.C. Sec. 3710 (g)(2).

In general, the content of the agency reports builds on that established over the years by OTP and the agencies in preparing the Biennial Reports, as well as responding to the new data requirements of the Technology Transfer Commercialization Act. To ensure consistency across the agencies in the nature and statistical content of these reports, OTP worked closely with them throughout 2001—chiefly through the Interagency Working Group on Technology Transfer[6]—to develop a common report content and format.[7]

The agencies are required to discuss the current content of and plans for their technology transfer programs. Each is also asked to provide statistics for a set of core technology transfer activity measures, including the incidence of Cooperative Research and Development Agreements (CRADAs) and frequently cited indicators of intellectual property management such as invention disclosure, patenting, and licensing. The statistics on licensing have been expanded in response to the requirements of the Technology Transfer Commercialization Act to include greater detail on license management and licensing income. The agencies were again asked, in response to strong congressional and administration interest, to provide information about the "downstream outcomes" of their technology transfer activities—such as new products in the commercial marketplace or improved private industry production processes.

In this first cycle of the new process, all the agencies compiled reports, which together provide the primary basis for this Summary Report. Most provided reasonably complete information. A few agencies provided information on their technology transfer activities beyond the core measures.

A short summary of the report's key findings follows. Chapter 2 is organized by agency and summarizes each agency's annual report for FY 2001. These summaries discuss the agency's technology transfer programs and plans, tabulate key technology transfer activity statistics, and discuss the technology transfer outcome cases submitted by the agency. Chapter 3 analyzes the trends in Federal technology transfer activities within and across the Federal lab agencies over the past several years and since the late 1980s. Chapter 4 comments on the agencies' recent progress in improving performance metrics for their technology transfer programs. The appendix provides detailed tabulations of the complete time series (FY 1987–2001) of technology transfer activity statistics collected for this report and past editions of the Biennial Report under the Stevenson-Wydler Act.

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[6] The Interagency Working Group on Technology Transfer (IWG-TT) is a long-standing committee that includes technology transfer principals from most of the Federal science and technology agencies. The IWG's activities are coordinated by the Department of Commerce's Office of Technology Policy. The group meets monthly to discuss policy issues and related topics of significant interest to the Federal lab technology transfer community.

[7] The reporting guidelines include a set of core activity measures for all agencies and also provide flexibility to the agencies to include information on additional measures each may deem important in presenting the nature and current achievements of its technology transfer program.

1.3 Principal Findings

In reviewing the principal findings below and throughout this report, it should be recognized that there are considerable differences among agencies in the levels of Federal budget resources for laboratory research and development operations. In FY 2001, almost 37% of the Federal total was directed toward DOD labs. Federal lab operations at DOE received 19% and lab operations at HHS and NASA about 15% each in the same year. USDA and DOC accounted for 3% and 2%, respectively. The other four agencies (DOI, VA, DOT, EPA) together received the remaining 5%. These differences in resources are important considerations when comparing agencies' levels of tech transfer activities.

■ **Collaborative Research and Development Relationships.** CRADAs remain widely used by the Federal labs as a means to establish and conduct research and development (R&D) partnerships with U.S. industry or other non-Federal parties. Over the past 5 years, all Federal labs together have executed about 1,000 new CRADAs annually; the total of active CRADAs has been between approximately 3,100 and 3,500. In FY 2001, DOD, DOE, and HHS together accounted for 84% of all active CRADAs; including USDA and DOC brings this cumulative total to 95%. The other five departments (NASA, DOI, VA, DOT, EPA) have active CRADAs but account for only a small fraction of the overall total.

While much greater than the several hundred such agreements in place in the early 1990s, the total number of active CRADAs over the past several years has been significantly below the FY 1996 peak of 3,688. The FY 2000 data (in the *FY 1999–2000 Biennial Report*) indicated that the overall decline was due primarily to large drops at DOE and DOC, with CRADA utilization at the other agencies either continuing to grow or remaining at historically high levels. However, the FY 2001 data suggest that the slowdown has extended to other agencies. The reasons for this decline appear to involve numerous factors—including a shift toward greater selectiveness on the part of the Federal labs in partnering, declining budget resources for partnering, and perhaps declining interest by some potential partners owing to perceived logistical/administrative burdens in establishing CRADAs.

Some of the Federal labs are exploring alternative mechanisms for collaborative R&D relationships with external partners. One such example discussed in this report is the Agricultural Research Services' use of Trust Fund or Reimbursable Cooperative Agreements. Other Federal labs, such as the National Institute of Standards and Technology, indicate that program activities such as facility use agreements and the hosting of guest scientists and engineers are collaborative R&D mechanisms that play important roles in the overall technology transfer effort.

■ **Invention disclosure and patenting.** The annual level of invention disclosures across the Federal labs has generally remained flat since the early 1990s. However, the annual level of Federal lab patenting (patents applied for, patents received) appears to be trending gradually upward since the late 1990s. DOD and DOE together now account for 65% of all Federal lab invention disclosures, 74% of all Federal lab patent applications, and 76% of all Federal lab patents received. Adding HHS and NASA activities brings these cumulative shares to 94% (invention disclosures), 92% (patent applications), and 94% (patents received). The other six agencies disclose inventions and patent, but at much lower levels.

■ **Licensing.** The Federal labs' licensing of intellectual property continues to grow. In FY 2001, the total of active licenses for all Federal labs was 4,396—up 4% over the level in FY 2000 and 9% over the level in FY 1999. The majority were licenses for inventions (e.g., patented technologies), which totaled 3,142 in FY 2001. The Federal labs' licensing of "Other Intellectual Property" (i.e., computer software; tangible research products, such as biological materials; and protected data) is also significant, accounting for the 1,254 balance in FY 2001.

All the Federal lab agencies currently have active invention licenses. Nevertheless, there are large differences among the agencies in the comparative levels. HHS and DOE accounted for the majority of this licensing activity—37% and 32%, respectively—in FY 2001. NASA (9%), DOD (9%), and USDA (8%) accounted for most of the rest. The other five departments (DOC, DOI, VA, DOT, EPA) together accounted for 5% of all active invention licenses in FY 2001. The licensing of Other Intellectual Property is much less widely spread—DOE (67%) and HHS (29%) account for the vast majority.

Income from Federal lab licensing also continues to increase—$80.3 million (including royalties and other payments) across all the Federal labs in FY 2001, up 3% from the FY 2000 level and 26% above the FY 1999 level. Of the FY 2001 total, $71.1 million resulted from invention licenses, $8.0 million from licensing of Other Intellectual Property.

Nearly all the agencies currently derive some income annually from invention licenses, and most have experienced a rising level of license income throughout much of the past decade. However, there are significant differences among the agencies in the amount. Historically, HHS invention licenses have predominated, accounting yearly for some 70% of all Federal lab invention license income for many of the past 10 years. However, in FY 2001 that majority lessened somewhat, with HHS accounting for only about 58%. In the same year, DOE accounted for 27% and DOD for 9%. The remaining 6% reflected the income of the other seven agencies.

For the Federal labs as a whole, 2,191 (about 70%) of the 3,142 invention licenses active in FY 2001 were royalty bearing. Of these royalty-bearing licenses, 22% were exclusive, 9% partially exclusive, and 70% non-exclusive. (However, these percentages vary widely for any given agency.) The statistics on the distribution of "earned royalty income" in FY 2001 differ widely across the agencies—from licenses yielding several dollars annually to those yielding $4.2 million annually, and median values for an agency's portfolio ranging from a low of $4,000 to a high of $75,000 annually.

With regard to income from Other Intellectual Property licenses, HHS accounted for 68% of the Federal lab total in FY 2001; DOE, 23%; NASA, 8%; and DOD, 1%.

■ **Downstream outcomes from Federal lab technology transfer.** As part of the FY 2001 reporting, all 10 agencies indicated successful downstream outcomes from the transfer of their Federal labs' technologies. Eight provided case histories of these successes as part of their reports. When these examples are considered together with the examples submitted for the *FY 1999–2000 Biennial Report,* it is apparent that the Federal technology transfer mechanisms are helping to move science and technology beyond the Federal labs and are having useful impacts in the commercial marketplace and on the well-being of U.S. citizens.

■ **Agency progress in improving performance metrics.** There has been important progress over the past several years in improving the data available on the current activities and achievements of Federal lab technology transfer programs. Some of this progress comes from the need to respond to new and expanding requirements for statutory reporting; some is the result of agency efforts to improve their overall management capabilities, of which technology transfer is a part. Nevertheless, there is still a need for further improvement, most notably for metrics that can help technology transfer managers better gauge the effectiveness and productivity of the programs they operate.

CHAPTER 2
SUMMARY OF FY 2001 AGENCY REPORTS

The primary source of data on Federal lab technology transfer activities for this Summary Report is each agency's Annual Utilization Report submitted earlier this year in accordance with 15 U.S.C. Sec. 3710(f). As previously noted, each agency is directed to discuss in these annual documents its present plans for technology transfer by its Federal labs, along with information about recent program activities.

This chapter seeks to provide a comparable summary of the content of these ten agency reports. Three main topic areas are addressed:

- The agency's description of its current approach and plans for technology transfer by its Federal labs;
- Statistical data on the agency's technology transfer activity levels for a number of measures (e.g., cooperative research and development relationships, invention disclosure and patenting, and intellectual property licensing) over the most recent fiscal years (FY 1999–2001) and several other selected comparison years; and
- Reported examples of successful downstream outcomes arising from the agency's technology transfer activities (such as new products or improved industrial processes available in the marketplace that arise from the transfer and commercialization of Federal lab inventions).

This chapter is not intended to provide an exhaustive account of the information submitted in the agencies' individual reports.[1] Readers are encouraged to review the primary agency documents for further detail; citations are provided in the sections below.

[1] Given the summary nature of this report, the technology transfer statistics in this chapter are provided only at the aggregate department/agency level. A number of the agencies' individual reports provide disaggregated figures for agency bureaus/divisions/services/offices, which should be consulted for further detail.

2.1 Department of Agriculture[2]

Agency Approach and Plans for Technology Transfer

The Agricultural Research Service (ARS) has been delegated authority by the Secretary of Agriculture to administer the patent and license programs for USDA. The ARS Office of Technology Transfer (OTT) is assigned the responsibility for protecting intellectual property, developing strategic partnerships with outside institutions, and performing other appropriate functions that enhance the effective transfer of ARS technologies to users.

To accomplish this, OTT is organized around four broad function areas. The *Administrative/ Headquarters Section* conducts the day-to-day operations, coordinates the development of technology transfer policy, and signs licenses and Cooperative Research and Development Agreements (CRADAs). Patent advisors in the *Patent Section* assist scientists in protecting intellectual property (IP), coordinate invention reports, prepare and prosecute patent applications, and oversee any patent applications prepared by contract law firms. The *Licensing Section* negotiates licenses for ARS IP and monitors license performance. The *Marketing Section* develops, implements, and coordinates targeted marketing strategies to facilitate technology transfer, distributes information on ARS technologies that are available for licensing or cooperative partnerships, provides answers to stakeholder questions on technology transfer in ARS, and ensures that information about the commercial successes of ARS research is made available to the public.

These objectives are accomplished via written information, reports to stakeholders, trade shows, the ARS Information Staff, the National Agricultural Library, meetings with industry and universities, and electronic media. ARS has six regional Technology Transfer Coordinators (TTCs) stationed across the United States that are responsible for facilitating the development and effective transfer of USDA technologies. They serve as liaisons with scientists, line and program managers in ARS, university partners, users, and the private sector. They also negotiate CRADAs, other technology transfer agreements, and some licenses.

Because our mission is to transfer technologies to the private sector for broad beneficial use by the public, we pursue patents and licensing only when protection of IP is essential for the transfer of technology. This is usually the case when further research and development (R&D) investment by the private sector is necessary to commercialize a product, and patent protection is required to protect this investment. ARS has Patent Review Committees that meet periodically to review invention disclosures and make recommendations to the Assistant Administrator on whether a patent is necessary and practical (sufficient scope, enforceable, appropriate for the size of the market, etc.).

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[2] This section draws on text and statistics in USDA's FY 2001 "agency report on utilization" under 15 U.S.C. Sec. 3710(f). For additional details, readers should consult the Department's report: *U.S. Department of Agriculture FY 01 Annual Technology Transfer Report* TT01.USDA, January 30, 2002 (submitted by ARS with FY 2004 budget to OMB, July 15, 2002).

Other mechanisms of technology transfer include publication of research findings, release of germ plasm to the public, and field day activities at various ARS locations. ARS policy is to allow researchers and breeders to use any ARS technology freely and without license for research purposes.

Currently, OTT is expanding its capacities to transfer technology through new initiatives as follows:

- Tech Alerts is a self-subscribing web-based system that allows businesses to be notified as new technologies become available for licensing. New subscribers are also actively sought at tradeshows, industry meetings, workshops, and targeted mailings. These technologies are grouped into the five broad categories: Biobased Products, Crop Production, Food Safety & Health, Natural Resources, and Animal Production.

- Other web-based services are designed to assist the Agency in finding potential CRADA partners to complete the process of R&D and commercialization of ARS-generated ideas.

- Technology Showcase Exhibitions are conducted periodically at selected ARS locations. These 1-day events provide a venue for corporations and Federal scientists to meet and view selected technologies available for licensing or research projects for which private-sector partnership is desired. They also offer businesses the opportunity to see a particular technology firsthand and to gather more information on the commercial potential of a particular technology.

- Select Software Model Downloads may be accessed from the OTT web page to facilitate the transfer of research models, such as the Cotton Production Model, to private and public sector researchers, extension agents, and the growers.

- New in-house database programs are being developed to better manage the development and monitoring of CRADAs and license agreements.

- Memorandums of Understanding (MOUs) are being developed with various State economic development groups and organizations. They are designed to stimulate new business, improve industrial efficiency, increase employment, enhance U.S. trade, preserve the environment, and improve the quality of American life.

- TTCs mail information sheets on specific CRADA and licensing opportunities to select companies as another outreach tool.

- Small businesses are invited to participate in special workshops, meetings, and site visits to specifically facilitate development of emerging businesses.

FY 2001 Overview of Technology Transfer by the Agency's Federal Labs

Table 2.1. Summary Measures of Technology Transfer Activities

	FY 1990	FY 1995	FY 1999	FY 2000	FY 2001
I. Collaborative Relationships for R&D					
■ CRADAs, total active in the FY	128	229	298	257	219
- New, executed in the FY	—	—	101	69	49
• Nontraditional[1] CRADAs, total active in the FY	—	—	—	—	0
- New, executed in the FY	—	—	—	—	0
■ Other types of collaborative R&D relationships					
• Trust Fund / Reimbursable Cooperative Agreements					
- New, executed in the FY	—	—	—	—	106
II. Intellectual Property Management					
■ New inventions disclosed	158	133	162	109	118
■ Patent applications filed	76	80	84	78	83
■ Patents issued	—	—	74	64	64
■ Invention licenses, total active in the FY	—	—	218	225	255
- New, executed in the FY	33	21	29	24	31
■ Licenses for Other IP[2], total active in the FY	—	—	0	0	0
■ Elapsed execution time, licenses granted in the FY					
- Range (low-high) / Median (months)	—	—	—	—	2-6 / 3.1
■ Licenses terminated for cause in the FY	—	—	—	—	1
■ Total income from all active licenses (thousands)	—	—	$2,377	$2,555	$2,622
• Income from invention licenses (thousands)	$559	$1,635	$2,377	$2,555	$2,622
• Income from Other IP licenses (thousands)	—	—	0	0	0
■ Licenses bearing royalty income in the FY	—	—	n / a	n / a	120
- Exclusive / partially exclusive / nonexclusive	—	—	—	—	78 / 19 / 23
• Earned royalty income (ERI) in the FY (thousands)	—	—	$1,843	$1,843	$1,409
- Range of ERI (low-high)	—	—	—	—	$.08-563
- Median ERI	—	—	—	—	$6
- ERI subtotal from top 1% of licenses	—	—	—	—	*
- ERI subtotal from top 5% of licenses	—	—	—	—	$723
- ERI subtotal from top 20% of licenses	—	—	—	—	$1,109
■ Disposition of income (royalties, other payments)	—	—	—	—	
• Income distributed (thousands)	—	—	—	—	$2,622
- Inventor awards	—	—	—	—	26%
- Salaries of some tech transfer staff	—	—	—	—	41%
- Patent filing preparation, fees, annuity payments					27%
- Other tech transfer expenses					6%
III. Other Activity Measures					
(none cited by the agency)	—	—	—	—	nr

The data in this table cover the following departmental bureaus / divisions / services / offices: Agricultural Research Service and other Federal lab tech transfer activities across the Department.

(1) Executed under CRADA authority (15 U.S.C. Sec. 3710a) but used for special purposes, such as material transfer CRADAs or technical assistance that may result in protected information.

(2) "Other Intellectual Property (IP)" includes computer software, tangible research products (such as biological materials), and protected data.

R&D = research and development; CRADA = Cooperative Research and Development Agreement; FY = fiscal year; ERI = earned royalty income; n / a = Data not available from agency at time of this report; — = Data not requested from agency in previous years' reports; nr = Data not relevant: either the agency does not engage in this type of technological transfer activity or the information is not useful in describing the agency's programs; * = Cannot disclose without revealing proprietary information.

Technology Transfer Outcomes

USDA's FY 2001 report provided the following examples of successful downstream outcomes arising from the agency's technology transfer activities:

- *Dragonfly*™ is an insect trap that effectively attracts and kills mosquitoes and biting flies. The technology, which became commercially available in 2001, represents an environmentally friendly alternative to chemical pesticides for mosquito control and broadly supports increasing public interest in less toxic pest management practices. The final product was a result of a CRADA between ARS's Center for Medical, Agricultural, and Veterinary Entomology (Gainesville, Florida) and BioSensory, Inc. (Willimantic, Connecticut).

- *An artificial diet and diet-based insect-rearing system* that allows producers to rear beneficial insects at reduced costs was successfully transferred to commercial producers. As a result, these beneficial insects can now, for the first time, be produced on a large scale. The technology was transferred as a result of a CRADA between ARS' Biological Control and Mass Rearing Research Unit (Mississippi State, Mississippi) and Beneficial Insectary (Redding, California).

- *AquaVac_ESC*™ became the world's first approved, licensed, and manufactured live fish vaccine. The vaccine prevents enteric septicemia (ESC) caused by *Edwardsiella*. ESC is a major catfish disease that costs farmers as much as $60 million a year in losses. This new vaccine will help the catfish industry solve a key problem and provides producers with a more cost-effective way to raise healthy fish for consumers. The technology resulted from a CRADA between the ARS Aquatic Animal Health Research Laboratory (Auburn, Alabama) and Intervet, Inc. (Millsboro, Delaware). In 2001, Intervet first launched AquaVac_ESC™ and sold about 300 million doses to catfish farmers in the Mid-South area.

- *Three ARS-developed soybean varieties,* with plant variety protection patents, licensed to three companies, reported revenues from sales in FY 2001. Derry, Donegal, and Tyrone are the first improved forage-type soybean cultivars bred for animal feed. These new varieties can be used for grazing, hay, or silage over a wide geographic area of the United States. The varieties differ in maturity dates, disease resistance, and areas where they will grow best. Donegal matures earliest and is suited to the Northeast; Derry matures later and is ideal for the Midwest; and Tyrone matures last and is best for the South.

- *Forty-six plant germ plasm releases* to U.S. farmers, nurseries, breeders, and researchers to help speed transfer of those technologies to the public. These releases included a new citrus rootstock and new wheat, dry pea, potato, soybean, chickpea, lentil, grape raisin, blueberry, small dry bean, and plum varieties; as well as several new germ plasm lines (sunflower, corn, sugar beet, sweet potatoes, and cotton) with enhanced or improved qualities.

- *Control of fire ant populations.* In a unique technology transfer effort, two USDA agencies (ARS and the Animal and Plant Health Inspection Service) and the Florida Department of Agriculture and Consumer Services set up a 5-year initiative to help Southern States combat red imported fire ants, which have increased exponentially since their arrival from South America in the 1930s. Under the initiative, Florida's Department of Agriculture and Consumer Services will mass rear *Pseudacteon tricuspis*, a phorid fly species that specifically parasitizes fire ants. The flies then will be shipped to field sites for release in Southern States, including Florida, Georgia, North Carolina, South Carolina, Louisiana, Mississippi, Texas, Alabama, Arkansas, Oklahoma, and Tennessee. ARS researchers brought the tiny fly to their U.S. quarantine facilities several years ago from Brazil and have since mastered biological control strategies that use the fly against fire ant populations.

In addition, ARS has participated in numerous outreach activities to help inform industry about Agency objectives, programs, services, and information resulting from ARS research. In a pivotal event for the State of Maryland and USDA, ARS, the Maryland Technology Development Corporation, and the Prince George's Economic Development Corporation signed a Memorandum of Understanding aimed at fostering economic development in Maryland and helping transfer ARS technologies to the public. The event resulted in a cooperative agreement between ARS and Intralytix of Baltimore, Maryland, to further investigate food safety. In addition, two more cooperative agreements are under negotiation. OTT has participated in several industry and professional meetings to present new technologies available for licensing and partnering opportunities. OTT has developed and implemented "Technology Alerts" and other strategies for its industry customers to introduce new technology opportunities.

2.2 Department of Commerce[3]

Agency Approach and Plans for Technology Transfer

The Department of Commerce works in partnership with businesses, universities, communities, and workers to promote U.S. competitiveness. It does this by strengthening economic infrastructure, facilitating the development of cutting-edge science and technology, providing an information base, and managing national resources.

Technology transfer at the Department relates principally to the activities of three divisions, each with Federal lab facilities and R&D activities: the National Institute of Standards and Technology (NIST), the National Oceanic and Atmospheric Administration (NOAA), and the National Telecommunications and Information Administration (NTIA).

National Institute of Standards and Technology

NIST's mission is to develop and promote measurement, standards, and technology to enhance productivity, facilitate trade, and improve the quality of life. NIST laboratories develop and disseminate measurement techniques, reference data, test methods, standards, and other infrastructural technologies and services that support U.S. industry, scientific research, and the activities of many Federal agencies. In carrying out its mission, NIST works directly with industry partners (and consortia), universities, associations, and other government agencies.

NIST's technology transfer activities focus on broad dissemination of research results to industry, rather than the creation of patents and associated licenses. As such, NIST uses a diverse set of mechanisms to transfer the knowledge and technologies that result from its laboratory research. Cooperative Research and Development Agreements (CRADAs), patents, and licensing are part of this process. Dissemination of technical publications, Standard Reference Materials (SRMs),[4]

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[3] This section draws on text and statistics in the Department of Commerce's FY 2001 "agency report on utilization" under 15 U.S.C. Sec. 3710(f). For additional details, readers should consult the Department's report: *Annual Report on Technology Transfer: Programs, Plans, FY 2001 Activities and Achievements*, June 3, 2002. (Report available on the Internet at http://www.ta.doc.gov/reports/TechPolicy/TechTrans_2003.htm.)

[4] Standard Reference Materials (SRMs) are the definitive source of measurement traceability in the United States. All measurements using SRMs can be traced to a common and recognized set of basic standards that provides the basis for compatibility of measurements among different laboratories. NIST produces and disseminates (sells) SRMs to a large and diverse group of customers, including private-sector laboratories, universities, and other Federal agencies. NIST's SRMs support industrial materials production and analysis, environmental analysis, health measurements, and basic measurements in science and metrology.

Standard Reference Data (SRDs),[5] calibration services,[6] facility use agreements, and the hosting of guest scientists and engineers also are important aspects of the overall technology transfer effort.

National Oceanic and Atmospheric Administration

NOAA's primary mission is to transfer environmental data on a wide range of time and space scales in order to protect life and property and provide industry and government decision-makers with a reliable base of scientific information. As part of this mission, nearly half of the organization works to produce the daily weather forecast, which advises and warns the general public and, at the same time, provides a base of scientific and technical information for engineers and managers in Federal and State governments and in the heating, construction, manufacturing, transportation, and health industries.

NOAA's approach to technology transfer involves licensing intellectual property, establishing cooperative research relationships with industry, and establishing direct means of transfer. NOAA works with each of its laboratories based on its ability to provide the necessary resources.

National Telecommunications and Information Administration

NTIA's Institute for Telecommunication Sciences (NTIA / ITS) supports Agency telecommunications objectives such as promoting advanced telecommunications and information infrastructure development in the United States, enhancing domestic competitiveness, improving foreign trade opportunities for U.S. telecommunications firms, and facilitating more efficient and effective use of the radio spectrum. NTIA / ITS also serves as a principal Federal resource for solving the telecommunications concerns of other Federal agencies, State and local governments, private corporations and associations, and international organizations.

NTIA / ITS engages in technology transfer and commercialization by fostering cooperative research with industry where benefits can directly facilitate U.S. competitiveness and market opportunities. NTIA / ITS's principal mechanisms for technology transfer include CRADAs, patents and licenses, and telecommunications analysis services.

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[5] Standard Reference Data titles (SRDs) provide numeric data to scientists and engineers for use in technical problem solving, research, and development. NIST produces and makes available (sells or distributes for free) many SRDs. NIST's SRD databases cover many areas of science, including analytical chemistry, atomic and molecular physics, biotechnology, and materials science.

[6] NIST laboratories provide physical measurement services for their customers, including calibration, special tests, and measurement assurance programs. Calibration services and special tests are characterizations of particular instruments, devices, and sets of standards with respect to international and national standards.

FY 2001 Overview of Technology Transfer by the Agency's Federal Labs

Table 2.2. Summary Measures of Technology Transfer Activities

	FY 1990	FY 1995	FY 1999	FY 2000	FY 2001
I. Collaborative Relationships for R&D					
■ CRADAs, total active in the FY	82	407	275	221	188
- New, executed in the FY	—	—	67	46	26
• Nontraditional[1] CRADAs, total active in the FY	—	—	—	—	0
- New, executed in the FY	—	—	—	—	0
■ Other types of collaborative R&D relationships					
NIST					
• Facility use agreements, in effect at end of FY	—	—	—	—	372
• Guest scientists / engineers, during the FY	—	—	—	—	1,200
II. Intellectual Property Management					
■ New inventions disclosed	46	65	38	34	26
■ Patent applications filed	28	35	30	20	12
■ Patents issued	—	—	28	16	22
■ Invention licenses, total active in the FY	—	—	41	41	39
- New, executed in the FY	0	4	7	4	5
■ Licenses for Other IP[2], total active in the FY	—	—	0	0	0
■ Elapsed execution time, licenses granted in the FY					
- Range (low-high) / Median (months)	—	—	—	—	2-8 / 5
■ Licenses terminated for cause in the FY	—	—	—	—	7
■ Total income from all active licenses (thousands)	—	—	$422	$159	$269
• Income from invention licenses (thousands)	$52	$42	$422	$159	$269
• Income from Other IP licenses (thousands)	—	—	0	0	0
■ Licenses bearing royalty income in the FY	—	—	19	17	21
- Exclusive / partially exclusive / nonexclusive	—	—	—	—	13 / 5 / 3
• Earned royalty income (ERI) in the FY (thousands)	—	—	$422	$159	$269
- Range of ERI (low-high)	—	—	—	—	$1-136
- Median ERI	—	—	—	—	n / a
- ERI subtotal from top 1% of licenses	—	—	—	—	n / a
- ERI subtotal from top 5% of licenses	—	—	—	—	n / a
- ERI subtotal from top 20% of licenses	—	—	—	—	n / a
■ Disposition of income (royalties, other payments)	—	—	—	—	
• Income distributed (thousands)	—	—	—	—	$269
- Inventor	—	—	—	—	39%
- Agency	—	—	—	—	61%
III. Other Activity Measures					
NIST	—	—			
• Standard Reference Materials available	—	—	1,288	1,292	1,335
• Standard Reference Materials sold	—	—	33,347	34,020	31,985
• Standard Reference Data titles available	—	—	60	63	65
• Items calibrated	—	—	3,118	2,969	3,192
• Technical publications	—	—	2,270	2,250	2,207

The data in this table cover the following departmental bureaus / divisions / services / offices: National Institute of Standards and Technology, National Oceanic and Atmospheric Administration, and National Telecommunications and Information Administration.

[1] Executed under CRADA authority (15 U.S.C. Sec. 3710a) but used for special purposes, such as material transfer CRADAs or technical assistance that may result in protected information.

[2] "Other Intellectual Property (IP)" includes computer software, tangible research products (such as biological materials), and protected data.

R&D = research and development; CRADA = Cooperative Research and Development Agreements; FY = fiscal year; ERI = earned royalty income; n / a = Data not available from agency at time of this report; — = Data not requested from agency in previous years' reports.

Technology Transfer Outcomes

DOC's FY 2001 report provided the following examples of successful downstream outcomes arising from the agency's technology transfer activities:

National Institute of Standards and Technology

- *CRADA: Integrated Services Digital Network.* In the late 1980s and early 1990s, a new advanced technology known as Integrated Services Digital Network (ISDN) promised to revolutionize the telecommunications industry worldwide, offering immense potential benefits to government, industry, and personal users with its ability to exchange voice, data, and image information concurrently over telephone lines. Before the full potential of ISDN could be realized, however, government and industry needed to collaborate to overcome barriers to the widespread acceptance and use of ISDN technology. Pinpointing the barriers in both the national and international arenas had been difficult because of the complexity and rapid development of the technology. NIST collaborated with industry in 1988 to establish the North American ISDN Users Forum (NIUF). A CRADA with industry was established in 1991 to govern the management of the forum. The purpose of NIUF was to create a strong user voice in the implementation of ISDN applications. NIUF provided users of ISDN technology with the opportunity to work with implementers to ensure that users' needs were met in the ISDN design process. Through NIUF, users and manufacturers concurred on ISDN applications, the selection of options from standards, and conformance tests, enhancing the strength of the U.S. telecommunications industry in the world marketplace. The last NIUF meeting was held June 1999. NIST and other NIUF members have agreed that NIUF has accomplished the purposes and goals for which it was created.

- *Standard Reference Materials: Health Care.* Diagnosing and treating cardiovascular disease requires accurate measurements of cholesterol and its constituents. Since 1966, NIST has developed and disseminated measurement methods, standards, and SRMs needed to ensure the accuracy of cholesterol tests. As a result of NIST's work, clinical laboratories and other users have adopted increasingly accurate measurement techniques and have significantly reduced uncertainties in cholesterol measurement results. As a result of better measurements, fewer patients have been misdiagnosed, public health has been improved, and health care costs have been lowered significantly.

- *Standards and Conformance Tests: Data Encryption Standard.* The electronic transactions occurring routinely today in business and in our personal lives have their basis in technological developments of just a few decades ago. These developments include vastly improved computing power, increased accessibility to communications through the development of the Internet, and the implementation of "behind the scenes" infratechnologies and associated standards that ensure the privacy and security of these various transactions. Encryption algorithms and methods are among the infratechnologies that are less transparent to casual or business users but are central to virtually every funds transfer, business-to-business data transfer, or internal company data input and output.

In the early 1970s, markets for encryption products were just emerging and fragmented. No industry-wide standard existed to guide industry development efforts. Multiple and incompatible products resulted, a situation that discouraged their widespread use. In response, NIST formally issued the Data Encryption Standard (DES) in 1977. NIST also developed and implemented conformance tests for DES users to help ensure correct functioning of their DES implementations. From 1977 to 1994, NIST offered conformance-testing services to encryption hardware manufacturers and software producers. Products found to be in conformance with various cryptographic standards were listed as “validated.” Such validation greatly increased their marketplace acceptance.

National Oceanic and Atmospheric Administration

- *Suite of digital raster nautical charts.* The NOAA / National Ocean Service’s Office of Coast Survey created a bundle of technology, intellectual property, expertise, and collaboration to permit a private company, Maptech, Inc., to develop a national suite of digital raster nautical charts. These charts are used by commercial mariners, recreational boaters, the U.S. Navy, and the Coast Guard in shipboard, computer-based navigation systems. A CRADA was used to transfer the government files to Maptech, which then developed a commercial system, which includes an Internet-based Mapserver that gives limited free distribution to the public. In addition to 200 domestic licenses, the NOAA / Maptech technology has been licensed to companies or governments in Argentina, Australia, Brazil, Canada, Finland, France, Germany, Italy, Japan, the Netherlands, New Zealand, Norway, Sweden, and the United Kingdom. Technology arising under the CRADA between NOAA and Maptech also strengthened the capabilities of the NOAA laboratory when quality control software developed by Maptech was transferred back to NOAA for use in its paper nautical chart production process.

- *A new type of radar* that can run continuously and inexpensively for years, and automatically measure all types of clouds that occur in the atmosphere, was transferred by a CRADA from NOAA’s Environmental Technology Laboratory to Radian International Corporation, which then developed a commercial version. The prototype radar has been run unattended by NOAA for several years. The commercial version has been sold to the Department of Energy for its Atmospheric Radiation Measurement program. It is also being considered by the Federal Aviation Administration for better icing warnings and for finding cloud-free airspace for increased airplane safety, and by the National Aeronautics and Space Administration (NASA) for better missile launch decisions.

- *Acoustic scintillation liquid flow measurement system.* Technology was licensed by NOAA to the Canadian Ministry of Fisheries and Oceans, which licensed it to ASL Environmental Sciences, Inc., a Canadian company that made commercially available an acoustic scintillation liquid flow measurement system for use in dams, hydroelectric plants, ports, harbors, and irrigation canals.

National Telecommunications and Information Administration

- *Personal communication services (PCS).* Much of NTIA / ITS's work in PCS, over several years, has been accomplished through CRADAs with partners such as U.S. WEST, Bell South, Telesis Technology Laboratory, and Motorola. PCS has now been commercialized worldwide, and new developments continue as PCS is extended to a third generation and beyond. NTIA / ITS has continued this work in FY 2001 through a CRADA with Lucent Technologies' Bell Laboratories that is investigating multiple-input / multiple-output antenna arrays, a technology that is targeted to dramatically increase the capacity of PCS systems and, therefore, reduce the problem of spectrum crowding. This technology is 3 to 5 years from commercial application.

- *Local multipoint distribution services (LMDS).* NTIA / ITS has been a premier laboratory in millimeter wave research for two decades. CRADAs with private industry have enabled NTIA / ITS to apply this unique expertise while conducting research into radio propagation considerations for LMDS. LMDS will provide broadband wireless communications for business and residential applications and is now being commercialized. Deployment of systems is beginning in the United States, and a number of U.S. companies are exporting systems and services. Research into LMDS has been conducted with CRADA partners such as Hewlett Packard, U.S. WEST, and Lucent Technologies. Data derived from these CRADAs provided a foundation for domestic and international standards development and efficient allocation of radio frequency spectrum resources. Major contributions to PCS and LMDS technologies have been and will continue to be carried out under these CRADAs to aid U.S. efforts to rapidly introduce new communications technologies for the benefit of society.

- *Digital video communication research.* In FY 2001, NTIA / ITS performed research with two university CRADA partners (University of Pennsylvania and East Carolina University) that provided the laboratory with access to Internet 2 capabilities and medical imaging, which would not have been otherwise available to it. Through these CRADAs, NTIA / ITS continued related research in digital video communication performance, addressing such emerging and future applications as video telephony and teleconferencing, telemedicine, and interactive video distribution. The lab was also able to continue its development of multimedia test capabilities. These user-oriented test capabilities are extremely valuable in implementing and optimizing the national and international information infrastructure, including the Next Generation Internet.

- *Video quality assessment system.* A CRADA during FY 2001 was targeted at research relating to the development of a Windows-based video quality assessment system. The Windows-based system will provide a user-friendly video quality assessment system that will be usable by anyone concerned with video quality, without the need for large computer systems. This CRADA provided the laboratory with a computer system for this development and software that was developed by the CRADA partner, greatly increasing the capabilities of the laboratory. The Windows-based video quality assessment system that will be developed under this CRADA will incorporate technology covered by two patents and one patent application owned by NTIA/ITS. It is targeted for commercial development, with the potential of producing a royalty income for the laboratory within 2 years.

2.3 Department of Defense[7]

Agency Approach and Plans for Technology Transfer

The Department of Defense's (DOD) Technology Transfer Program is implemented through a decentralized process. Each Service (Army, Navy, Air Force) and participating Defense Agency (such as the National Security Agency, the Uniformed Services University of the Health Sciences) has implementing guidance, Offices of Research and Technology Application (ORTA), and patent attorneys located at various sites with appropriate authority to transfer technology both into and out of the laboratory. In FY 2001, DOD had over 100 ORTAs and patent attorneys throughout the Services and Agencies involved in the transfer of technology to enhance both DOD's mission capabilities and the economic competitiveness of U.S. industry. This decentralized approach allows the local technology transfer processes, procedures, and projects to fall within the specific mission-related activities of the local laboratories. Nonetheless, overarching DOD guidance is in place to ensure common policy and objectives.

DOD is a prime user of the technologies it is interested in developing and helping to transition into production. Accordingly, DOD views technology transfer as much more than a means to enable industry to access the technologies of DOD laboratories. Technology transfer is a way for DOD to enhance its mission capabilities. Transferring technology from DOD laboratories into the private sector and from the private sector into DOD systems are both key elements of DOD's technology transfer approach.

DOD would like to buy better capability at reduced costs. Technology transfer is one way to accomplish this. Technology transfer mechanisms provide DOD laboratories with ways to strategically facilitate spin-offs, spin-ons, and dual-use development of technologies. They provide a variety of tools with the potential to leverage outside resources and the possibility of reducing the development and acquisition costs of technology products.

DOD's focus areas in the next year for improving its technology transfer activities include the following:

- *Make technology transfer efforts a more integral part of the planning, budgeting, and execution of science and technology (S&T) programs within DOD.* Doing so is important to ensure that the productivity of DOD's S&T programs is maximized. For example, the Air Force Research Laboratory has established 5-year strategic goals for its technology transfer programs as follows:

  (1) Integrate technology transfer into the acquisition strategy—technology transfer programs need to be integrated into the laboratory's technology roadmaps to bridge resource gaps;

[7] This section draws on text and statistics in DOD's "Report to Congress on the activities of the DOD Office of Technology Transition," February 2002 (prepared in response to 10 U.S.C. 2515). (Report available at http://www.dtic.mil/techtransit/refroom/docs/ar02/index.html.)

(2) Identify technologies for commercial application;

(3) Market resources and technologies;

(4) Promote technology transfer training; and

(5) Share Air Force technology with the private and public sectors.

- *Continue and expand the use of partnership intermediaries to highlight top technologies and aid in finding potential CRADA and licensing partners.* A good example of a partnership intermediary is the TechLink program, which DOD began to sponsor in July 1999. TechLink is established at Montana State University (Bozeman, Montana) to facilitate technology transfer between companies across the TechLink region and all the DOD laboratories for development, transfer, and commercialization of new technologies. The TechLink region includes Montana, Oregon, Washington, Idaho, Utah, Wyoming, North Dakota, and South Dakota. TechLink focuses on industries important to this region: principally, advanced materials, aerospace, agriculture, biomedicine and biotechnology, electronics, environmental technologies, software and information technology, photonics, and sensors. TechLink's accomplishments in FY 2001 included assistance to approximately 70 companies, assistance in creating 6 new companies, and facilitation of over 15 patent license agreements between companies and DOD laboratories.

- *Increase use of DOD R&D databases as a means to identify potential collaborators.* DOD's Defense Technical Information Center maintains a large database with project description and financial information about independent research and development (IR&D) efforts conducted by defense contractors. Currently, this database covers a very large fraction of these contractor efforts. The database has potential to help match private-sector R&D initiatives with DOD laboratory R&D activities for mutual benefit through cooperation.

- *Strengthen marketing outreach.* This goal needs to include not only those technologies identified to have high commercial potential, but also other laboratory resources such as unique facilities, specialized equipment, and in-house expertise.

- *Increase the scientific and engineering staff's knowledge of technology transfer issues and options.* The goal is to educate DOD's scientists and engineers on what to patent and how to patent to ensure maximum protection for DOD-owned intellectual property. DOD's scientists and engineers must be educated about the licensing process, including what to expect and the pitfalls and time involved.

- *Incorporate technology transfer in job descriptions.* For those labs where it is not already present, technology transfer should be made a part of the position descriptions of laboratory directors, managers, scientists, and engineers.

FY 2001 Overview of Technology Transfer by the Agency's Federal Labs

Table 2.3. Summary Measures of Technology Transfer Activities

	FY 1990	FY 1995	FY 1999	FY 2000	FY 2001
I. Collaborative Relationships for R&D					
■ CRADAs, total active in the FY	113	845	1,350	1,364	1,965
- New, executed in the FY	—	—	449	425	459
• Nontraditional[(1)] CRADAs, total active in the FY	—	—	—	—	330
- New, executed in the FY	—	—	—	—	82
■ Other types of collaborative R&D relationships	—	—	—	—	
• Educational Partnership Agreements, other–total active in FY					217
- New, executed in the FY					81
II. Intellectual Property Management					
■ New inventions disclosed	1,383	1,168	1,060	991	1,005
■ Patent applications filed	807	759	703	774	809
■ Patents issued	—	—	547	553	619
■ Invention licenses, total active in the FY	—	—	177	189	283
- New, executed in the FY	15	34	61	67	49
■ Licenses for Other IP[(2)], total active in the FY	—	—	n / a	n / a	5
■ Elapsed execution time, licenses granted in the FY					
- Range (low-high) / Median (months)	—	—	—	—	n / a
■ Licenses terminated for cause in the FY	—	—	—	—	2
■ Total income from all active licenses (thousands)	—	—	$2,005	$2,213	$6,465
• Income from invention licenses (thousands)			2,005	$2,213	$6,383
• Income from Other IP licenses (thousands)	—	—	0	0	$82
■ Licenses bearing royalty income in the FY	—	—	42	29	113
- Exclusive / partially exclusive / nonexclusive	—	—	—	—	42 / 22 / 49
• Earned royalty income (ERI) in the FY (thousands)	—	—	$865	$672	$6,383
- Range of ERI (low-high)	—	—	—	—	$6-4,231
- Median ERI	—	—	—	—	$75
- ERI subtotal from top 1% of licenses	—	—	—	—	$4,235
- ERI subtotal from top 5% of licenses	—	—	—	—	$4,352
- ERI subtotal from top 20% of licenses	—	—	—	—	$4,593
■ Disposition of income (royalties, other payments)	—	—	—	—	
• Income distributed (thousands)					$6,383
- To inventors					20%
- To other rewards and additional R&D					80%
III. Other Activity Measures					
(none cited by the agency)	—	—	—	—	nr

The data in this table cover the following departmental bureaus / divisions / services / offices: the statistics for FY 2001 include the activities of the Air Force, Army, Navy, Defense agencies (National Security Agency, National Imagery and Mapping Agency), and the Uniformed Services University of the Health Sciences. Prior-year figures include the activities of only the Air Force, Army, and Navy.

(1) Executed under CRADA authority (15 U.S.C. Sec. 3710a) but used for special purposes, such as material transfer CRADAs or technical assistance that may result in protected information.

(2) "Other Intellectual Property (IP)" includes computer software, tangible research products (such as biological materials), and protected data.

R&D = research and development; CRADA = Cooperative Research and Development Agreements; FY = fiscal year; ERI = earned royalty income; n / a = Data not available from agency at time of this report; — = Data not requested from agency in previous years' reports; nr = Data not relevant: either the agency does not engage in this type of technological transfer activity or the information is not useful in describing the agency's programs.

Technology Transfer Outcomes

DOD's FY 2001 report included the following examples of successful downstream outcomes from the department's technology transfer activities:

Army

- *Testing of tafenoquine, an antimalarial drug developed at Walter Reed Army Institute of Research (WRAIR), began in pediatric populations.* Glaxo Smith Kline has licensed all of WRAIR's technology on live attenuated dengue vaccines and initiated a CRADA with WRAIR to identify the most suitable live virus tetravalent combination to produce a vaccine for commercial use. WRAIR entered into a unique licensing arrangement with Iomai, a spin-off company. The technology license is a technique that allows the transdermal delivery of vaccines and drugs by applying the materials to bandages, thereby eliminating the need to use needles.

- *New state-of-the-art ceramic material for communications and radar applications.* A team of Army Research Laboratory (ARL) scientists has developed a new ceramic material technology, with far-reaching possibilities for both military and commercial communications and radar. Using a unique ferro-electric ceramic material, the team designed low-cost, tunable scanning antennas for satellite communications, voltage tunable filters and devices, and ultra-fast scanning phase shifters. The Army's belief in the team's abilities, along with its significant need to reduce the size, weight, and cost of existing ferrite phase shifters, resulted in its funding of this successful effort for more than 6 years. Four members of the team created a private firm, called Paratek, for the purpose of licensing the patents that are the heart of the ceramic material technology; two members of the team remained at ARL to work on the military application of the technology. An exclusive license was negotiated by ARL and signed by Paratek in late 1999, marking the first time in Army history that an employee inventor team licensed the technology it invented. Since its startup, Paratek has grown from 4 employees to 90, and the products the company is preparing for production range from new to revolutionary. The company's ceramic material technologies will be used in personal communication devices, cell phones, and home and office direct satellite communication systems as enabling technology that can both reduce cost and expand capability. This technology has far-reaching consequences, not only for critical military needs, but also for an estimated billion-dollar commercial field of broadband wireless communication systems.

- *Recycled plastic railroad ties for public transit.* The Army Construction Engineering Research Laboratory (CERL) has been conducting developmental research on recycled plastic railroad ties for several years. In 1998, the Chicago Transit Authority (CTA) tested a few of these plastic composite railroad ties in its elevated track. The performance was so satisfactory that the CTA is going out for open bid for 21,500 recycled plastic composite ties to be placed on both elevated and ballasted track. CERL helped the CTA develop the procurement specifications for this project. In support of the Environmental Protection Agency's Region 5 Office, CERL will help monitor the performance of these new ties and publicize the results.

Navy

- *Navy center for government/industry/academia teaming partnerships.* The Navy's Space and Warfare System Center (SPAWARSYSCEN) has established a Center for Commercialization of Advanced Technology (CCAT). This is a teaming partnership among government, industry, and academia in the San Diego, California, area. A cooperative agreement was signed between SSC-San Diego (SSC-SD) and San Diego State University. The purpose of CCAT is to identify technologies that have commercial and/or dual-use potential for DOD. Technologies are assessed early in their development to identify candidates for market analysis, linking to a commercial company for production and support in the form of business and market plan development, as well as funding. The first solicitation for technologies resulted in the identification of 14 government technologies from SSC-SD and 85 industry and academia technologies.

- *High-performance microdisplay.* A Space and Naval Warfare Center (SPAWAR) scientist invented a novel, high-performance microdisplay that allows high-performance microelectronic circuitry to be fabricated within and adjacent to a transmissive liquid crystal display. The result is a high-resolution and high-brightness display that eliminates the need for millions of interconnections between the display and its control circuitry. The technology offers improved imaging and video in virtual presence applications for warfighter and emergency service personnel, as well as in advanced devices such as hand-held computers and cellular phones. To transfer the technology, an innovative process was used that involved a coalition of government and industrial partners. SPAWAR entered into a CRADA with Proxima Corporation to market the technology. A second CRADA was established with Optron Systems, a display and component manufacturer. Both CRADAs resulted in licensing agreements for the invention. In addition, Radiant Images (a spin-off company from Optron Systems) will produce the first commercial version of the microdisplays within the next year. The initial beneficiaries of the technology will be DOD and emergency service personnel. As the technology becomes commercially available, it will have the greatest impact on portable information technology devices.

- *Improved processing of bathymetric data.* In the first year of a CRADA with Interactive Visualization Systems (IVS), the Naval Meteorology and Oceanography Command (NAVOCEANO) was able to eliminate an 18-month bathymetric data validation backlog. This CRADA combined IVS's 3-D visualization software for ocean mapping of large data sets with NAVOCEANO's multibeam sonar data processing application, Area Based Editor.

Air Force

- *Application of Conformal Fuel Tanks on the F-16.* A CRADA between the Air Force's Air Armaments Command (AAC) and Lockheed Martin Tactical Aircraft Systems, directed at development of the conformal fuel tank (CFT) for F-16 application, was established in FY 2001. This cooperative effort explored and evaluated the use of CFTs on the F-16. The Air Force will gain an instrumented test aircraft with the ability to conduct conformal fuel tank testing. Lockheed will gain the use of an Air Force instrumented aircraft for test flights. The results of this CRADA will improve AAC's ability to conduct future planned tests with CFTs. Lockheed's foreign military sales program will benefit, making it more competitive in a worldwide market.

- *Improved composite structure tooling method.* Engineers and scientists at the Air Force Research Laboratory's (AFRL) Materials and Manufacturing Directorate, the Defense Advanced Research Project Agency, and Boeing-St. Louis have successfully developed and demonstrated a new way of significantly reducing the cost of tooling for composite structures. This new method lowers overall bond tool family costs by minimizing the total number of tools in a family, thus reducing fabrication cycle times. This new approach is already being used in prototype aircraft programs and could eventually be applied to other major aircraft development and production programs, saving millions of dollars while dramatically improving the quality of composite structure tooling. Application of this method may also lead to significantly reduced tool fabrication costs and span times. Use of this approach is already widespread at Boeing-St. Louis.

- *Transfer of "brake by wire" technology to the automotive industry.* A CRADA has been established between the AFRL Propulsion, Materials and Manufacturing, and Air Vehicles Directorates and Delphi Automotive Systems, LLC, to transfer the AFRL's "brake by wire" technology to the automotive industry within the next 2 years. Brake by wire is a next-generation braking system that stops vehicles by electrical signals instead of the conventional hydraulics systems on today's cars. The Air Force's interests are in validating the technology on high-temperature power applications, control theory, and reliable wiring and connectors for applications on aircraft and other aerospace systems. Cost reduction for the Air Force system is another benefit, because the auto industry would build large quantities, lowering the cost. Federal, State, and industry dollars are coming together to make this project a fiscal success.

- *Holographic polymer-dispersed liquid crystals.* Research by a team of scientists at the AFRL Materials and Manufacturing Directorate has led to significant technological advancements in the development of a wearable holographic display that allows pilots to keep their eyes on the action while viewing data and color images projected directly into the retina. Holographic polymer-dispersed liquid crystals (H-PDLCs) allow complex optics to be designed into lightweight thin films whose optical properties can be changed by applying a modest electrical field similar to that used in watch and calculator displays. This technology replaces bulky and relatively heavy lenses by reducing component weight and size. The effort to transfer this technology took shape when the AFRL team partnered with Science Applications International Corporation (SAIC) to license the H-PDLC. After achieving initial success and discovering the vast commercial outlets in which the technology could be used, SAIC became interested in securing the intellectual property rights to H-PDLC and marketing it. A dual-use cost-share program was utilized to move the technology even further. On the basis of the success of the technology transfer efforts, a startup company was created—DigiLens of Sunnyvale, California—which has an exclusive agreement with SAIC to develop the technology commercially. The lightweight high-resolution optical display may someday provide the warfighter with an added advantage in combat situations. The H-PDLC will also enable next-generation cellular phone displays for the Internet; wearable displays for videos, game devices, and personal computers; and improvements in rear-projection high-definition television.

- *Process for in-situ densification of carbon-carbon composites.* A research team at the AFRL Propulsion Directorate has developed a low-cost, rapid processing route for the production of high-quality carbon-carbon composite material. The use of carbon-carbon composites is crucial to the construction of aerospace equipment, including aircraft brakes, rocket nozzles, exit cones, and nose tips. Significant costs are associated with manufacturing equipment using these composites, as well as lead times as long as 6 to 8 months. There is a long-standing need for carbon-carbon composites that not only have a uniform density, but can also be fabricated in thick pieces. Also, as the composites are used in additional applications, there will be interest in producing them at a lower cost. The team's in-situ densification places matrix material between the carbon fibers and produces composite materials in 5 to 25 percent of the time and at 10 to 50 percent of the cost of current commercial processes. In addition to being more rapid and less expensive than commercial ones, the in-situ process can produce carbon-carbon composites that no other technology can. Once the team developed this technology, they entered into a CRADA with B.F. Goodrich Aerospace, the world's largest manufacturer of aircraft brake material. As a result of the CRADA, Goodrich has been able to incorporate the lab's densification process into its production cycles. Another technology transfer partnership involves SMJ Carbon, a spin-off company, which negotiated an exclusive license to manufacture carbon-carbon products for all markets except aircraft brakes. Currently, both technology transfer partnerships are still in progress and are proving to be successful for all parties involved.

- *Second-generation high-temperature superconducting wire.* A scientist at the AFRL Propulsion Directorate has developed several technologies that make it possible to manufacture yttrium barium copper oxide (YBCO) coated conductors for applications in high-temperature superconducting (HTS) applications. (YBCO allows generators to be significantly lighter and more compact.) A key aspect of the research was discovery of a previously unknown substrate grain boundary effect in coated conductors, which has a strong influence on the critical current that the HTS film can carry. Development of the technology was facilitated by a CRADA partnership among Intermagnetics General Corporation (IGC), the Materials Laboratory, and AFRL. One result of this relationship was a new company, IGC

SuperPower, LLC, which will use AFRL-developed technology to produce YBCO-coated conductors. In June 2000, IGC SuperPower opened a new YBCO-coated conductor manufacturing facility. Also, a research partnership between the AFRL Superconductivity Group and the University of Wisconsin Applied Superconductivity Center resulted in the discovery of a grain boundary effect that sets a standard for substrate grain alignment for production of the textured substrate used in HTS coated conductors by industry. Discovery of the grain boundary effect has helped the entire HTS coated conductor industry develop improved products. All of these technologies improve the coated conductor samples currently made and help in the development of the long-length coated conductor that is needed in the power utility market and the high-power generators used by the military. Complete development of the technology will lead to industrial commercialization of the YBCO-coated conductor in such electric power applications as transformers, transmission cables, motors, fault current limiters, and generators.

Uniformed Services University of the Health Sciences

- *Antibody technology*. Two proprietary vaccines arising under a CRADA (initiated in 1989) are now sold worldwide. Uniformed Services University of the Health Sciences (USUHS) inventors were the source of the underlying technology. The CRADA involved USUHS, the Henry M. Jackson Foundation for the Advancement of Military Medicine, and a startup biotech company created by the inventors.

2.4 Department of Energy[8]

Agency Approach and Plans for Technology Transfer

The U.S. Department of Energy's (DOE) five-part 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 DOE'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.

To achieve this mission, and for the public benefit, the Department's 11 national laboratories and 13 other facilities that have 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 industrial partners to reduce their technical risk and to offer them 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

8 This section draws on text and statistics in DOE's FY 2001 "agency report on utilization" under 15 U.S.C. Sec. 3710(f). For additional details, readers should consult the Department's report: *Annual Report on Technology Partnering Activities at National Laboratories and Other Departmental Facilities for Fiscal Year 2001*, March 1, 2002.

keep vital technological capabilities at the leading edge. Successful collaborations benefit industry and the DOE laboratories by saving money and by providing 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 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; and
- Ensure the availability of timely and accurate technology partnering data and information to monitor, evaluate, and describe DOE technology partnering activities.

FY 2001 Overview of Technology Transfer by the Agency's Federal Labs

Table 2.4. Summary Measures of Technology Transfer Activities

	FY 1990	FY 1995	FY 1999	FY 2000	FY 2001
I. Collaborative Relationships for R,D&D					
■ CRADAs, total active in the FY	1	1,392	715	687	558
- New, executed in the FY	—	—	240	151	204
• Nontraditional(1) CRADAs, total active in the FY	—	—	—	—	nr
- New, executed in the FY	—	—	—	—	nr
■ Other types of collaborative R,D&D relationships	—	—	—	—	nr
II. Intellectual Property Management					
■ New inventions disclosed	1,335	1,758	1,474	1,371	1,527
■ Patent applications filed	366	571	850	788	792
■ Patents issued	—	—	525	515	605
■ Invention licenses, total active in the FY	—	—	981	1,094	1,162
- New, executed in the FY	62	140	202	169	226
■ Licenses for Other IP(2), total active in the FY	—	—	941	976	843
■ Elapsed execution time, licenses granted in the FY					
- Range (low-high) / Median (months)	—	—	—	—	n / a
■ Licenses terminated for cause in the FY	—	—	—	—	60
■ Total income from all active licenses (thousands)	—	—	$11,764	$15,840	$21,403
• Income from invention licenses (thousands)	$2,560	$3,455	$10,199	$12,710	$18,922
• Income from Other IP licenses (thousands)	—	—	$1,545	$2,836	$1,870
■ Licenses bearing royalty income in the FY	—	—	193	220	1,012
- Exclusive / partially exclusive / nonexclusive	—	—	—	—	174 / 112 / 726
Earned royalty income (ERI) in the FY (thousands)	—	—	$1,975	$2,228	$7,832
- Range of ERI (low-high)	—	—	—	—	$.002-1,585
- Median ERI	—	—	—	—	$4
- ERI subtotal from top 1% of licenses	—	—	—	—	$2,699
- ERI subtotal from top 5% of licenses	—	—	—	—	$5,272
- ERI subtotal from top 20% of licenses	—	—	—	—	$7,163
■ Disposition of income (royalties, other payments)	—	—	—	—	
• Income distributed (thousands)					$16,356
- Royalty sharing to inventors					36%
- Royalty sharing for other purposes					64%
III. Other Activity Measures					
(none cited by the agency)	—	—	—	—	nr

The data in this table cover the following departmental bureaus / divisions / services / offices: DOE's government owned-government operated (GOGO) and government owned-contractor operated (GOCO) laboratories. The vast majority of DOE's technology transfer activities is conducted at its GOCO laboratories. These laboratories license their technology under the general guidance of 35 U.S.C. 202, rather than the authority for government licensing set forth in 35 U.S.C. 207-209. Unlike laboratories comprised of government employees (GOGOs), these GOCO laboratories are able to assert copyright and license software they produce. In addition, they generally have more flexibility than GOGO laboratories on matters such as royalty sharing and exclusive licensing.

(1) Executed under CRADA authority (15 U.S.C. Sec. 3710a) but used for special purposes, such as material transfer CRADAs or technical assistance that may result in protected information.

(2) "Other Intellectual Property (IP)" includes computer software, tangible research products (such as biological materials), and protected data.

R&D = research and development; CRADA = Cooperative Research and Development Agreements; FY = fiscal year; ERI = earned royalty income; n / a = Data not available from agency at time of this report; — = Data not requested from agency in previous years' reports; nr = Data not relevant: either the agency does not engage in this type of technological transfer activity or the information is not useful in describing the agency's programs.

Technology Transfer Outcomes

DOE's FY 2001 report provided the following examples of successful downstream outcomes arising from the agency's technology partnering activities:

- *Separations technology for biology and chemistry.* It is anticipated that the MCE 2000, an "R&D 100 Awards" winning separations technology based on multiplexed capillary electrophoresis (MCE) and using absorption detection, will eventually replace high-performance liquid chromatography (HPLC). (HPLC has been one of the most successful commercial instruments to date for chemical separations in both biology and chemistry laboratories.) The MCE technology was developed by Edward S. Yeung, Director of Ames Laboratory's Chemical and Biological Sciences Program. MCE makes it possible to rapidly separate samples of complex chemical or biochemical mixtures and can 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. In an effort to turn the MCE technology into a commercial instrument and accelerate development, a new spin-off company was launched in 2001, CombiSep Inc. (located in Ames, Iowa), with licensed technology from Iowa State University. In only 9 months, CombiSep designed, developed, tested, and sold the first instrument (the MCE 2000).

- *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 DOE's Argonne National Laboratory. This catalyst is expected to accelerate entry of ultra-efficient, environmentally friendly electric cars into 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 this 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.

- *Nuclear medicine on the go.* Digirad, Inc., a small business based in California, began the first significant number of deliveries of its award-winning 2020tc Imager at the beginning of FY 2001. The 2020tc 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 received the 100th order for its 2020tc Imager in June 2001; the imager is poised to replace the vacuum tube technology that is the current industry standard for nuclear medicine. The 2020tc Imager serves clinical applications not open to traditional cameras because of bulkiness, lack of mobility, and comparatively inferior performance (the 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.

- *Energy-efficient insulation and packaging.* Gas-filled panels (GFPs) were conceived in the early 1990s by Berkeley Lab as a new thermal-insulation material that could be used as an alternative to chlorofluorocarbon (CFC) and hydrochlorofluorocarbon (HCFC) blown foams. Unlike CFC or HCFC 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. Beyond offering superior thermal performance, AirLiner is 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 from development of the AirLiner have opened the door for many other uses of the 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).

- *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 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 (EUV) light, which has a very narrow wavelength, enables the manufacture of much smaller circuits with many more transistors. As a result of a cooperative technology partnering program between the semiconductor industry and several of DOE’s national laboratories, EUV lithography has emerged as the leading solution for the manufacture of advanced chips. In April 2001, the technology achieved a major milestone by demonstrating a prototype machine called the Engineering Test Stand. With this machine, laboratory researchers were able to print, for the first time, full field images with features less than 100 nanometers in size. 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.

- *Combustion control and diagnostics sensors.* In May 2000, researchers at the National Energy Technology Laboratory (NETL) 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, enabling a significant reduction of thermal nitrogen oxides 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 the present, the inventors began testing 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.

- *Identification technology.* The radio-frequency (RF) identification (ID) system developed at DOE'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 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 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. The small size of the tags (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.

- *Radiation-hardened Pentium processors for space and defense.* The Pentium® processor, one of the most widely used computer chips in the world, was developed by Intel Corporation at an estimated cost of more than $1 billion. The Pentium's 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. DOE has used five generations of radiation-hardened (rad-hard) chips in earth satellites, space probes, missiles, nuclear weapons, and other applications that contain electronics that could be damaged by radiation. In a technology partnering agreement between Sandia National Laboratories and Intel Corporation, Sandia was granted a no-fee license to redesign the Pentium processor into a 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.

- *Modeling of tire stress dynamics produces dual-use benefits.* Sandia National Laboratories and the Goodyear Tire & Rubber Company teamed up in 1993. Goodyear hoped that Sandia could bring its computer modeling and simulation capability to bear in a way that would help the company design and manufacture better tires. Sandia scientists and engineers hoped that the work would challenge them to test their computer modeling tools and sharpen their skills in materials development and analysis. Neither partner expected the agreement to yield more than a simple technology transfer. Simulating the performance of laminated tire structures, consisting of fabric, steel, and various rubber compounds, was a particularly difficult modeling challenge. Sandia brought its substantial computing power and insights to the partnership; 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 to 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 its 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. Currently, Sandia and Goodyear are working together through a sixth CRADA, exploring low-energy technologies to separate hydrocarbon monomers for synthetic rubber production. If successful, the work will reduce energy consumption in petrochemical processes and advance chemical separation technologies for other uses. This partnership is one part of Sandia's broader business development effort to partner with U.S. industries. What started earlier as technology transfer has become an integral part of Sandia's strategy to fulfill its national mission by engaging in partnering activities that bring added expertise to the process from outside the laboratory.

2.5 Environmental Protection Agency[9]

Agency Approach and Plans for Technology Transfer

The Environmental Protection Agency (EPA) is the principal Federal agency responsible for monitoring and regulating environmental quality. EPA's mission is to protect human health and to safeguard the natural environment, air, water, and land, upon which life depends.

To support this broad mission and related regulatory authority, EPA conducts R&D in relevant areas of science and technology, both through its own system of laboratories and through sponsoring external research by industry, universities, and other research performers. Environmental research is critical for developing the scientific understanding and technological tools to allow the Nation to enhance environmental quality for current and future generations. This investment provides a scientific basis for developing cost-effective environmental policies, creates the knowledge base for citizens to make wise environmental decisions, and enables new and better approaches to environmental protection.

EPA's Office of Research and Development (ORD) maintains research facilities around the country, including the National Center for Environmental Assessment, the National Exposure Research Laboratory, the National Health & Environmental Effects Research Laboratory, and the National Risk Management Research Laboratory. In addition, research is conducted by the Office of Air and Radiation; the Office of Water; the Office of Prevention, Pesticides, and Toxic Substances; and the Office of Solid Waste and Emergency Response. This work is performed pursuant to a series of research strategies and plans addressing important environmental issues. Presently, these strategies address ecological research, environmental monitoring and assessment, global change, particulate matter, pollution prevention, and waste research.

Technology transfer at EPA seeks to capitalize on the scientific developments of Federal laboratories to promote the technical and economic growth of the United States. In implementing the Federal Technology Transfer Act of 1986 (FTTA) and Executive Order (EO) 12591, ORD seeks relationships with industry, universities, and State and local governments to conduct cooperative research and development and to commercialize environmental technologies.

ORD's activities under FTTA involve development and implementation of Cooperative Research and Development Agreements (CRADAs) and development and oversight of the implementation of licensing agreements. Specific activities include identifying appropriate technologies and opportunities for CRADAs and licensing agreements, negotiating specific terms of such agreements, reviewing agreements to ensure conformance with the requirements of FTTA and EO 12591, fulfilling EPA's responsibilities under such agreements, and monitoring the activities of outside cooperators and licenses under these agreements. EPA has two Centers that assist the private sector in licensing of EPA patents.

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[9] This section draws on text and statistics in EPA's FY 2001 "agency report on utilization" under 15 U.S.C. Sec. 3710(f). For additional details, readers should consult the agency's report: TTCA Report, May 2002.

FY 2001 Overview of Technology Transfer by the Agency's Federal Labs

Table 2.5. Summary Measures of Technology Transfer Activities

	FY 1990	FY 1995	FY 1999	FY 2000	FY 2001
I. Collaborative Relationships for R&D					
■ CRADAs, total active in the FY	11	30	38	44	48
- New, executed in the FY	—	—	13	10	19
• Nontraditional[(1)] CRADAs, total active in the FY	—	—	—	—	3
- New, executed in the FY	—	—	—	—	1
■ Other types of collaborative R&D relationships	—	—	—	—	nr
II. Intellectual Property Management					
■ New inventions disclosed	12	15	5	11	17
■ Patent applications filed	6	24	15	10	7
■ Patents issued	—	—	8	6	12
■ Invention licenses, total active in the FY	—	—	17	18	19
- New, executed in the FY	1	1	2	3	4
■ Licenses for Other IP[(2)], total active in the FY	—	—	0	0	0
■ Elapsed execution time, licenses granted in the FY					
- Range (low-high) / Median (months)	—	—	—	—	3–10 / n/a
■ Licenses terminated for cause in the FY	—	—	—	—	0
■ Total income from all active licenses (thousands)	—	—	n/a	n/a	$544
• Income from invention licenses (thousands)	$3	$110	n/a	n/a	n/a
• Income from Other IP licenses (thousands)	—	—	n/a	n/a	0
■ Licenses bearing royalty income in the FY	—	—	n/a	n/a	19
- Exclusive / partially exclusive / nonexclusive	—	—	—	—	6 / 1 / 12
• Earned royalty income (ERI) in the FY (thousands)	—	—	n/a	n/a	n/a
- Range of ERI (low-high)	—	—	—	—	n/a
- Median ERI	—	—	—	—	n/a
- ERI subtotal from top 1% of licenses	—	—	—	—	n/a
- ERI subtotal from top 5% of licenses	—	—	—	—	n/a
- ERI subtotal from top 20% of licenses	—	—	—	—	n/a
■ Disposition of income (royalties, other payments)					
• Income distributed (thousand $)	—	—	—	—	n/a
III. Other Activity Measures					
(none cited by the agency)	—	—	—	—	nr

The data in this table cover the following departmental bureau / division / service / office: Office of Research and Development.

(1) Executed under CRADA authority (15 U.S.C. Sec. 3710a) but used for special purposes, such as material transfer CRADAs or technical assistance that may result in protected information.

(2) "Other Intellectual Property (IP)" includes computer software, tangible research products (such as biological materials), and protected data.

R&D = research and development; CRADA = Cooperative Research and Development Agreements; FY = fiscal year; ERI = earned royalty income; n/a = Data not available from agency at time of this report; — = Data not requested from agency in previous years' reports; nr = Data not relevant: either the agency does not engage in this type of technological transfer activity or the information is not useful in describing the agency's programs.

Technology Transfer Outcomes

EPA's FY 2001 report provided the following examples of successful downstream outcomes arising from its technology transfer activities:

- *MI Agar* is a new technology that provides an improved way to test for coliforms and *E. coli*. The method provides both enumeration of total coliforms and *E. coli* and presence / absence determinations. Results are available in 16 to 24 hours, and some positives may be detected in as little as 9 hours. MI Agar's ability to provide both quantitative and qualitative results is an advantage over the simple presence / absence tests presently used in the food, drinking water, and beverage industries.

The MI Agar technology resulted from a CRADA. The technology has been licensed (nonexclusively) to a pair of companies (one small, one large).

- *Fungal Detection System*. This is a new system—based on the polymerase chain reaction (PCR) method for rapidly copying DNA sequences—for detecting and quantifying more than 100 species or groups of species of potentially problematic fungi (including black mold).

Samples can be analyzed in a matter of hours, as opposed to days or weeks with other methodologies. Up to 96 analyses can be run at one time. This new methodology provides for both the identification and quantification of mold species, taking subjective bias out of the heretofore usual microbial identification approaches.

The methodology was developed via a CRADA. The technology has been licensed (nonexclusively) to three large companies. This new test system has also strengthened EPA's ability to assist local, State, and Federal government officials with rapid detection abilities for black mold.

2.6 Department of Health and Human Services[10]

Agency Approach and Plans for Technology Transfer

The Department of Health and Human Services (HHS) is the principal agency for protecting the health of Americans and providing essential human services. HHS carries out this mission through more than 300 programs in such areas as medical and social science research, preventing the outbreak of infectious disease, ensuring food and drug safety, managing the Medicare and Medicaid health insurance programs, running the Head Start program, and managing many other programs for low-income families, children, and older Americans.

A key aspect of HHS's overall mission is to protect and improve public health. This objective frequently requires the availability of new and more powerful therapeutic drugs, vaccines, therapies, diagnostic tools, and medical devices brought to the commercial marketplace by private-sector companies. These new products and services often depend directly on research work supported by HHS and on subsequent transfers of technologies to the private sector for further development and commercialization. Research conducted by HHS's Public Health Service components—particularly the National Institutes of Health (NIH), the Food and Drug Administration (FDA), and the Centers for Disease Control—generally has the greatest potential for yielding new technologies.

National Institutes of Health

NIH is one of the world's foremost medical research centers, currently composed of 27 separate Institutes and Centers (such as the National Cancer Institute, National Institute for Allergies and Infectious Diseases, National Institute on Aging, National Human Genome Research Institute, and National Library of Medicine). NIH annually conducts around 2,000 projects at its own (intramural) laboratories and funds some 35,000 research grants to non-Federal scientists in universities, medical schools, hospitals, and other research institutions throughout the country and abroad. The majority of NIH's annual budget is used to support external (extramural) research activities; about 10 percent supports intramural research.

Scientific discoveries arise each year from NIH's intramural laboratories. These discoveries then begin their journey on the road to benefiting the public and improving the global research enterprise. Most of NIH's inventions are drugs, vaccines, medical instruments, and diagnostic tests, or methods of making or using them. These technologies require extensive clinical testing and ultimately regulatory approval by the FDA prior to market entry. NIH relies on industry

[10] This section draws on text and statistics from the following HHS reports: National Institutes of Health, "Sec. 10 Reports on Utilization of Federal Technology, Technology Transfer Commercialization Act: FY 2001 Activities," June 2002; Food and Drug Administration, "Sec. 10 Reports on Utilization of Federal Technology, Technology Transfer Commercialization Act: FY 2001 Activities," June 2002; Centers for Disease Control, "Sec. 10 Reports on Utilization of Federal Technology, Technology Transfer Commercialization Act: FY 2001 Activities," June 2002. For additional details, readers should consult these reports.

partners to provide the stewardship for postdiscovery activities, including drug development, scale-up, clinical testing, marketing, and distribution. Professionals at NIH's Office of Technology Transfer are dedicated to maintaining this vital link, through patenting, marketing, and licensing inventions that originate from research in NIH laboratories. This link between discovery and the marketplace supports NIH's primary mission of improving public health.

Food and Drug Administration

The FDA seeks to promote and protect the public health by ensuring that safe and effective products reach the market in a timely way and by monitoring products for continued safety after they are in use. The FDA has two R&D investment programs: Orphan Products Development and FDA Research Grants. In addition, components of the FDA's Centers also conduct scientific studies that support the FDA's regulatory policy and decision-making processes.

Scientific discoveries arise each year out of the FDA's intramural laboratories. As technology transfer is part of its mission, the FDA has been delegated authority by the Secretary of HHS to enter into CRADAs and to administer patent and licensing activities. FDA Technology Transfer is charged with protecting intellectual property, developing and entering into partnerships with outside institutions, and performing other functions to enhance the effective transfer of FDA technologies to users. Under terms of an interagency agreement, NIH's Office of Technology Transfer represents the FDA in licensing FDA-patented technologies for commercialization. Partnering under CRADAs, as well as patenting and licensing of inventions that originate in FDA laboratories, supports the FDA's mission to promote and protect the public health; it also benefits the competitiveness of U.S. industry.

Centers for Disease Control

The mission of the Centers for Disease Control and Prevention (CDC) is to promote health and quality of life by preventing and controlling disease, injury, and disability. CDC works toward that mission by working with partners throughout the Nation and world to monitor health, detect and investigate health problems, conduct research to enhance prevention, develop and advocate sound public health policies, implement prevention strategies, promote health behaviors, foster safe and healthful environments, and provide leadership and training. CDC has developed and sustained many vital partnerships with public and private entities that improve service to the American people.

Each year, scientific discoveries arise out of CDC's intramural laboratories, a number of which represent new inventions with potential for practical application for the benefit of the public. Most of the CDC inventions are vaccines, medical and occupational safety devices, and diagnostic tests, or methods of making or using them. Many of these technologies require extensive clinical testing and ultimately FDA approval prior to reaching the market. CDC relies on industry partners to provide the stewardship for post-discovery activities, including commercial drug development, scale-up, clinical testing, marketing, and distribution. The professionals at the Technology Transfer Office (TTO) are dedicated to making this vital link happen by patenting, marketing, and licensing inventions that originate from research in CDC laboratories.

Ultimately, this vital link between discovery and the market supports CDC's primary mission of improving the health and quality of life for the American public.

As CDC's licensing activities continue to increase, the TTO will continue to expand its staff to increase the monitoring of our licensee activities to ensure compliance with license terms.

FY 2001 Overview of Technology Transfer by the Agency's Federal Labs

Table 2.6. Summary Measures of Technology Transfer Activities

	FY 1990	FY 1995	FY 1999	FY 2000	FY 2001
I. Collaborative Relationships for R&D					
■ CRADAs, total active in the FY	110	152	468	438	490
- New, executed in the FY	—	—	136	125	137
• Nontraditional[(1)] CRADAs, total active in the FY	—	—	231	194	209
- New, executed in the FY	—	—	78	75	76
■ Other types of collaborative R&D relationships	—	—	—	—	nr
II. Intellectual Property Management					
■ New inventions disclosed	215	307	328	375	434
■ Patent applications filed	239	166	241	263	255
■ Patents issued	—	—	180	132	119
■ Invention licenses, total active in the FY	—	—	1,041	1,222	1,007
- New, executed in the FY			208	192	212
■ Licenses for Other IP[(2)], total active in the FY	—	—	323	386	360
■ Elapsed execution time, licenses granted in the FY					
- Range (low-high) / Median (months)	—	—	—	—	n / a
■ Licenses terminated for cause in the FY	—	—	—	—	
■ Total income from all active licenses (thousands)	—	—	$44,821	$52,547	$46,722
• Income from invention licenses (thousands)	$5,839	$19,727	$42,599	$48,592	$41,322
• Income from Other IP licenses (thousands)	—	—	$2,222	$3,955	$5,400
■ Licenses bearing royalty income in the FY	—	—	223	230	727
- Exclusive / partially exclusive / nonexclusive	—	—	—	—	108 / 13 / 606
• Earned royalty income (ERI) in the FY (thousands)	—	—	$34,599	$43,892	$36,612
- Range of ERI (low-high)	—	—	—	—	n / a**
- Median ERI	—	—	—	—	n / a**
- ERI subtotal from top 1% of licenses	—	—	—	—	n / a
- ERI subtotal from top 5% of licenses	—	—	—	—	n / a
- ERI subtotal from top 20% of licenses	—	—	—	—	n / a
■ Disposition of income (royalties, other payments)					
• Income distributed (thousands)	—	—	—	—	n / a
III. Other Activity Measures					
(none cited by the agency)	—	—	—	—	nr

The data in this table cover the following departmental bureaus / divisions / services / offices: National Institutes of Health, Food and Drug Administration, and Centers for Disease Control.

(1) Executed under CRADA authority (15 U.S.C. Sec. 3710a) but used for special purposes, such as material transfer CRADAs or technical assistance that may result in protected information.

(2) "Other Intellectual Property (IP)" includes computer software, tangible research products (such as biological materials), and protected data.

**NIH, FDA, and CDC each list statistics for these measures in their separate reports. An HHS-wide figure was not, however, provided.

R&D = research and development; CRADA = Cooperative Research and Development Agreements; FY = fiscal year; ERI = earned royalty income; n / a = Data not available from agency at time of this report; — = Data not requested from agency in previous years' reports; nr = Data not relevant: either the agency does not engage in this type of technological transfer activity or the information is not useful in describing the agency's programs.

Technology Transfer Outcomes

HHS's FY 2001 report did not provide specific examples of successful downstream outcomes arising from the technology transfer activities of NIH, FDA, or CDC.

Nevertheless, NIH observed that its technology transfer program, based on royalty income generated from over 1,500 licenses, is presently the most successful technology transfer program in the U.S. Government. NIH technologies are currently part of 200 products on the market, including 15 therapeutic drugs and vaccines.

2.7 Department of the Interior[11]

Agency Approach and Plans for Technology Transfer

The U.S. Department of the Interior (DOI) is the Nation's principal land and water resource management agency. DOI's stated mission is to protect and provide access to the Nation's natural and cultural heritage and honor trust responsibilities to Indian tribes and commitments to island communities. In support of this mission, DOI conducts scientific research, provides wise stewardship of energy and mineral resources, fosters sound use of land and water resources, and conserves and protects fish and wildlife.

DOI consists of eight bureaus: the U.S. Geological Survey (USGS), Bureau of Reclamation (Reclamation), Bureau of Land Management, Fish & Wildlife Service, Minerals Management Service, the National Park Service, Bureau of Indian Affairs, and Office of Surface Mining. USGS is recognized as the primary science arm of DOI and manages the largest R&D budget program among the DOI bureaus.

All of the DOI bureaus work closely with universities, States and local governments, private industry, nongovernment entities and other Federal agencies to meet their science and technology needs. In any given year, the DOI bureaus usually have several thousand scientific cooperative projects and volunteer programs under way across the Nation.

Only USGS and the Bureau of Reclamation maintain technology transfer functions that are funded and staffed. USGS has historically provided technology transfer assistance to the unstaffed bureaus when requested. The Bureau of Reclamation has conferred technology transfer authority to the Director of Research. In the Fish & Wildlife Service, CRADA authority has been given to the R&D Centers. In the National Park Service, individual parks and scientific support centers have authority to enter into CRADAs. Legal assistance for all the bureaus with patent filing, licensing, and CRADAs is obtained from the Solicitor's office in Washington, D.C., with additional patent search, application, and prosecution support provided by private firms.

U.S. Geological Survey

USGS is responsible for monitoring ground and surface water quality and providing scientific information related to the environment, natural hazards, mineral, energy, water, and biological resources, as well as serving as the principal civilian mapping agency. For technology transfer, USGS is deemed a single laboratory with its Office of Research and Technology Applications (ORTA) located in Reston, Virginia. This ORTA coordinates technology transfer at 35 major USGS laboratories and several hundred field offices across the country.

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[11] This section draws on text and statistics in DOI's FY 2001 "agency report on utilization" under 15 U.S.C. Sec. 3710(f). For additional details, readers should consult the agency's report: *U.S. Department of the Interior, Annual Report on Technology Transfer: Programs, Plans, FY 2001 Activities and Achievements,* September 2002.

Technology under development at USGS ranges widely, from underwater mining technology to high-power software search engines. Several new cooperative projects begun in 2001 illustrate this range:

- *A unique cooperation with Florida International University* and a newly formed spin-off company is demonstrating seamless images over personal computers; offering choices for selection of layered data; offering the capability to create new mapping data; and developing new customers for USGS DOQ and LANDSAT data.

- *A cooperation with the National Stone and Gravel Association (NGSA)* incorporates USGS data and map generation technology with databases and contact information provided by NGSA to offer new directory and sales contact resources for an underserved industry segment.

- *In the environmental arena, a major U.S. oil company is working with the National Wetlands Research Center* to explore how LIDAR images can be used for environmental benchmarking and to track and quantify biodiversity concerns.

- *USGS has several cooperative partnerships with both independent and national gas suppliers* interested in USGS capability and geophysical tool kits for identifying coal-bed methane. This work is expected to help identify and quantify new coal methane reserves in the United States.

- *USGS has teamed with a Fortune 500 company* to analyze and retest government and private core samples for chemicals of commercial interest to contemporary industry. The original characterization of chemical elements was done with less sophisticated equipment and focused on traditional minerals; the current characterization is looking for chemical elements that may not even have been economically relevant 50 years ago.

- *USGS biologists are working on several cooperative projects with pharmaceutical companies* to test and develop new aquaculture drugs that will benefit wild fish populations as well as U.S. aquaculture.

Bureau of Reclamation

The Bureau of Reclamation is responsible for Federal water management and hydropower production in numerous facilities throughout the 17 Western States. Reclamation operates 348 reservoirs and 58 hydroelectric plants, making it the Nation's largest wholesale water supplier and the fifth largest electric utility in the West. Reclamation manages several research programs that provide advanced solutions to a broad range of water and power management issues. The research results serve to improve Reclamation water management practices, increase water supply, and ensure cost-effective power-generation operations to the benefit of stakeholders.

The Director of Research, based in Washington, DC, supports technology transfer through staffing of a Technology Transfer Liaison (TTL) function. Strengthening the role of this function, with the objective of enhancing the outcomes of the research programs, is a new and important initiative currently under way at Reclamation.

- *Four research focus areas.* Reclamation conducts research in the following four mission-related focus areas: water and power infrastructure reliability and safety, water delivery reliability, reservoir and river operations decision support, and water supply technologies. The broad scope of Reclamation research means that licensable innovations can range from a special diet for insects bred to eat noxious weeds, to improved methods for concrete repair. Much of the research is conducted in-house by scientists and engineers at the laboratories of the Technical Service Center (TSC) at the Federal Center in Denver, Colorado; the Water Quality Improvement Center (WQIC) in Yuma, Arizona; and at numerous field facilities. A significant portion of R&D is also procured through contracts and cooperative agreements, with ever-increasing care taken to ensure sound private-sector stewardship of intellectual property developed under these vehicles.

- *RD^3—a new emphasis for Reclamation research.* Reclamation's mission-focused research programs are highly applied. Since such is the case, there is now, under new research leadership, a strong push to demonstrate and deploy, not merely publish, successful research results. Researchers are being encouraged to adopt an RD^3 (research, development, demonstration, and deployment) mindset. This new thrust is aimed at promoting rapid deployment of new innovations throughout those Reclamation water and power operations that can benefit from them. This objective stems from the need to shorten what have historically been long adoption cycles for new Reclamation innovations.

- *A "DOD paradigm" for technology transfer.* This new emphasis on accelerating deployment of Reclamation research results creates the need for a technology transfer paradigm very similar in objective, albeit much smaller in scope and size, to that employed by DOD. Reclamation, like DOD, views technology transfer as much more than a means to enable industry to access government-developed innovations. Because Reclamation, like DOD, is a prime user of the technologies it develops, promoting technology transfer is a way to meet its mission more effectively and to do it in win-win-win fashion: promoting economic development in the private sector, leveraging outside resources through private-sector partnerships, and enhancing the organization's ability to reliably procure enhanced capabilities at reduced costs.

- *TTL plays a key role in enhancing RD^3 outcomes.* The research programs, now measured and rewarded on their support of demonstration and deployment, are recognizing how private-sector partnerships can accelerate the process. By raising the researcher's awareness of the enabling technology transfer legislation, emphasizing the benefits and rewards of exploiting it, and providing hands-on support, TTL can contribute significantly to the success of the research program.

- *TTL program management—past, present, and future.* Prior to FY 2002, the TTL function was based in Washington, DC, and staffed by an individual who provided Reclamation-wide technology transfer support. In mid-FY 2002, the Washington TTL manager retired and Reclamation's Research Director contracted with a management firm to fill the role. The function was moved to Denver to enable more hands-on support to the largest group of innovators. The contractor provides an on-site facilitator that serves both the TSC and field offices. The current program is conducted according to four guiding principles:

  - *Inform:* Promote the benefits, raise awareness, and infuse new skills Reclamation-wide.
  - *Engage:* Provide responsive, on-the-ground, one-on-one support to the innovators.
  - *Reward:* Reward the innovators for their contributions and managers for their support.
  - *Measure:* Keep score on program outcomes, costs, and trends.

Providing support to the innovators near the source of the innovations is proving to be a successful model. Overall, the program is geared toward bottom-up empowerment of Reclamation engineers and scientists, with an emphasis on encouraging more grassroots, entrepreneurial business thinking and infusing new skills into the repertoire of those innovators who are inclined to participate in the process. These program enhancements should significantly increase the number of both CRADAs and royalty-bearing licenses.

FY 2001 Overview of Technology Transfer by the Agency's Federal Labs

Table 2.7. Summary Measures of Technology Transfer Activities

	FY 1990	FY 1995	FY 1999	FY 2000	FY 2001
I. Collaborative Relationships for R&D					
■ CRADAs, total active in the FY	12	15	30	40	50
- New, executed in the FY	—	—	10	8	21
• Nontraditional[(1)] CRADAs, total active in the FY	—	—	—	—	9
- New, executed in the FY	—	—	—	—	7
■ Other types of collaborative R&D relationships	—	—	—	—	nr
II. Intellectual Property Management					
■ New inventions disclosed	26	2	8	16	6
■ Patent applications filed	15	2	3	5	22
■ Patents issued	—	—	1	4	2
■ Invention licenses, total active in the FY	—	—	12	6	8
- New, executed in the FY			0	2	2
■ Licenses for Other IP[(2)], total active in the FY	—	—	0	0	0
■ Elapsed execution time, licenses granted in the FY					
- Range (low-high) / Median (months)	—	—	—	—	3-4 / 3.5
■ Licenses terminated for cause in the FY	—	—	—	—	0
■ Total income from all active licenses (thousands)	—	—	$1,640	$850	$235
• Income from invention licenses (thousands)			$1,640	$850	$235
• Income from Other IP licenses (thousands)	—	—	0	0	0
■ Licenses bearing royalty income in the FY	—	—	11	5	6
- Exclusive / partially exclusive / nonexclusive	—	—	—	—	0 / 0 / 6
• Earned royalty income (ERI) in the FY (thousands)	—	—	$1,640	$850	$220
- Range of ERI (low-high)	—	—	—	—	$2-20
- Median ERI	—	—	—	—	n / a
- ERI subtotal from top 1% of licenses	—	—	—	—	n / a
- ERI subtotal from top 5% of licenses	—	—	—	—	n / a
- ERI subtotal from top 20% of licenses	—	—	—	—	n / a
■ Disposition of income (royalties, other payments)	—	—	—	—	
• Income distributed (thousands)					$235[(3)]
- Inventor awards					7%
- Salaries of some tech transfer staff					43%
- Patent filing prep. fees, patent annuity payments					43%
- Fees to laboratories					8%
III. Other Activity Measures					
(none cited by the agency)	—	—	—	—	nr

The data in this table cover the following departmental bureaus / divisions / services / offices: Figures for FY 2001 include the activities of the U.S. Geological Survey and the Bureau of Reclamation. Prior years include only the U.S. Geological Survey.

(1) Executed under CRADA authority (15 U.S.C. Sec. 3710a) but used for special purposes, such as material transfer CRADAs or technical assistance that may result in protected information.

(2) "Other Intellectual Property (IP)" includes computer software, tangible research products (such as biological materials), and protected data.

(3) Most of the reported income stems from the royalty stream created by a patent infringement judgment won by the Department of the Interior. Because of the particulars of the case, no significant portion of these royalties is payable to the individual inventors. As general policy for the sharing of royalty income with inventors, the U.S. Geological Survey's sharing percentage is 33 percent and Reclamation's is 30 percent.

Technology Transfer Outcomes

DOI's FY 2001 report identified several USGS-industry field test / engineering support projects and Bureau of Reclamation technologies and related projects that illustrate the successful downstream outcomes arising from the department's Technology Transfer Program (TTP):

U.S. Geological Survey

- *Coal mine drainage technology demonstration.* The program provided a technical operator and independent research evaluation of a coal mine drainage technology demonstration at Friendship Hill National Historic Site. Influent acidity at this site was about 1,000 mg / L, with up to 200 mg / L Fe. During the 14 months of operation, 40 million liters of AMD were neutralized using 60,000 pounds of limestone. Among other things, the data developed by this demonstration showed that the technology could handle acidic sludge, and that the process, despite highly acidic coal, resisted armoring. The active remediation method was developed by USGS Restoration Technology Group, Leetown Science Center. This technology received a Federal Laboratory Consortium award for Technology Excellence and Commercialization in FY 2001. There are entities interested in licenses.

- *Multisensor monitoring of salt water intrusion.* TTP expanded a project started last year with the City of Cape Cod, Massachusetts. As a result of the water quality information generated by the demo unit, the city has now installed a series of sensor arrays at strategic locations to test multisensor monitoring of salt water intrusion. TTP initially funded the research that developed the Robowell technology under its competitive grant program and funded the field tests for another year as part of the USGS commitment to the Coastal Initiative. As a result of the data developed for the city, a small U.S. company has taken a 2-year research license.

- *Upgrade of aerial mapping calibration unit.* Under an interagency agreement with DOE-Kansas City, TTP has funded the retrofit of the USGS analog Optical Science Laboratory (OSL), which serves as the official aerial mapping calibration unit for cameras in the United States and North American Free Trade Agreement partners. The retrofit focuses on upgrading the light source and electrical wiring in the 50-year-old system. The importance of the USGS Report of Calibration is that it allows private companies to compete for Federal agency aerial image contracts. The importance of the calibration program was the subject of a 1998 paper by the American Society for Photogrammetry and Remote Sensing and an industry panel report looking into the technical needs of the OSL into the 21st century.

R&D = research and development; CRADA = Cooperative Research and Development Agreements; FY = fiscal year; ERI = earned royalty income; n / a = Data not available from agency at time of this report; — = Data not requested from agency in previous years' reports; nr = Data not relevant: either the agency does not engage in this type of technological transfer activity or the information is not useful in describing the agency's programs.

Bureau of Reclamation

- *Armorwedge™* is a low-cost concrete tile used in a multiple block array to protect against erosion resulting from overtopping of earthen embankment dams. This technology was developed and patented by Bureau of Reclamation hydraulic engineers at the Technical Service Center (TSC). The product is licensed to Armortec of Bowling Green, Kentucky.

- *Selenium removal process.* This is an innovative chemical process for removing selenium from wastewater prior to discharge into the environment. Developed by a Reclamation chemist in the TSC to address selenium levels in irrigation water found to be harmful to wildlife, this process is licensed to Radian-URS Corp. (Austin, Texas) for reducing emissions in fossil-fueled power plants. Interest has recently been rekindled in utilizing this process for its original irrigation water treatment application.

- *The Water Quality Improvement Center,* in Yuma, Arizona, where the Colorado River crosses the U.S. border into Mexico, is a particularly noteworthy operation in respect to technology transfer, especially the utilization of CRADAs. Reclamation operates the WQIC as a part of the overall operation of the 73 million gallon-per-day reverse osmosis Yuma Desalting Plant (YDP). The YDP purifies agricultural drainage for return to the Colorado River immediately upstream of its crossing into Mexico. Inaugurated in 1997, WQIC investigates and evaluates processes and technology to reduce the costs of operating the YDP. WQIC supports an applied research program that serves as an evaluation and deployment site for research products developed both on-site and elsewhere. To date, WQIC has yielded excellent results in a number of areas:

Recent CRADAs

- Soil-Aquifer Treatment Comparison—with Arizona State University
- Membrane Spacer Testing—with a New Mexico company
- Scaling/Fouling Reduction Testing—with a U.S. firm
- Compatibility Testing of Low-Pressure Membranes—with a U.S. chemical company
- Membrane Pretreatment of Groundwater Test—with a Canadian firm
- Somerton, Arizona, Water Quality Testing—with the City of Somerton, Arizona
- Development of a New Reverse Osmosis Membrane—with a small business U.S.

R&D firm

- Mobile Pilot-Treatment Plant Design / Build for Saudi Arabia—with a Saudi corporation

Lab Enhancements

- CRADAs typically executed by WQIC are funded by the collaborator to exploit WQIC's unique facilities and work with the knowledgeable lab staff. The revenue from these efforts has been re-invested in the laboratory to enhance its capabilities and maintain state-of-the-art facilities.

Professional Degree Program

- To complement its research program and further the transfer of advanced water treatment technology, WQIC co-created and now hosts an award-winning college degree program in water treatment technology and operations.

2.8 National Aeronautics and Space Administration[12]

Agency Approach and Plans for Technology Transfer

The National Aeronautics and Space Act of 1958, as amended (42 U.S.C. Sec. 2451 et seq.) provides the statutory basis for the National Aeronautics and Space Administration's (NASA) activities. Section 102(d) (42 U.S.C. Sec. 2451(d)) requires the conduct of NASA's aeronautical and space activities, among other things, to materially contribute to

> The preservation of the role of the United States as a leader in aeronautical and space technology and in the application thereof to the conduct of peaceful activities within and outside the atmosphere.

To further this goal, NASA has both an Intellectual Property Program and a Commercial Technology Program.

NASA's Intellectual Property Program, which is administered by the Office of General Counsel, includes policy development and operations necessary for the establishment, protection, maintenance, licensing, right to use, and disposal of intellectual property rights in inventions, discoveries, innovations, writings, data, computer software, and semiconductor mask works that are created, acquired, or used in the performance of NASA programs. Such rights include those relating to inventions, patents, copyright, trademarks, trade secrets, and other legal means affording proprietorship in a person or the government. The program is managed to achieve the following objectives:

- Stimulate the creation, identification, and use of new technology in NASA programs;
- Foster the widest practical and appropriate dissemination and commercial utilization of new technology arising out of NASA programs;
- Protect the government's interests in intellectual property;
- Protect private interests in intellectual property; and
- Recognize and reward innovation.

NASA's Commercial Technology Program, which is a part of the Office of Aerospace Technology, includes Commercial Programs, Technology Transfer Agents, and the Small Business Innovative Research (SBIR) Program. NASA's Commercial Technology Program facilitates the transfer of NASA inventions, innovations, discoveries, and improvements developed

[12] This section draws on text and statistics in NASA's FY 2001 "agency report on utilization" under 15 U.S.C. Sec. 3710(f). For additional details, readers should consult the agency's report: *Annual Report on Technology Transfer: Programs, Plans, FY 2001 Activities and Achievements,* April 24, 2002.

by NASA personnel or in partnership with industry / universities to the private sector for commercial application leading to greater U.S. economic competitiveness.

The goal of Commercial Programs is to share the harvest of NASA's technology programs with the U.S. industrial / scientific community. The goal encompasses the commercialization of technology developed in all of NASA's enterprises, in past as well as current programs. The NASA Commercial Programs mission includes a variety of mechanisms for achieving its goals: partnerships with industry / academia; Federal / State / local alliances; emphasis on commercialization in new R&D procurements; electronic commerce; training and education of NASA employees / contractors; employee accountability; and application of performance goals / metrics.

The goal of Technology Transfer Agents is to facilitate the transfer of NASA and other federally sponsored research and technology (and associated capabilities) to the U.S. private sector for commercial application. The purpose of this program goal is to enhance U.S. industrial growth and economic competitiveness.

The goal of the SBIR Program is to promote the widest possible award of NASA research contracts to the small business community as well as to promote commercialization of the results of this research by the small business community. Established by Congress, the SBIR program (which includes NASA's Small Business Technology Transfer (STTR) programs) helps NASA develop innovative technologies by providing competitive research contracts to U.S.-owned small businesses.

Strategies for Achieving Goals

NASA's strategies for pursuing these goals are as follows:

Commercial Programs

Commercial Programs introduce a new way of doing business that involves a mix of practices / mechanisms that enable the Agency to align its way of doing business more closely with that of the private sector. The common denominator in these practices is technology partnerships. Technology partnerships are business arrangements among government, industry, and / or academia wherein each party commits resources to the accomplishment of mutually agreed upon objectives and shares the risks and rewards of the endeavor.

The success of Commercial Programs is accomplished through

- An extensive outreach program (technology dissemination and marketing);
- An electronic commerce / information network (via the Internet) that greatly facilitates the transfer of technology and allows very efficient implementation of our technology business contacts and services;

- Training and education of NASA employees to emphasize program relevance to national needs and to facilitate program implementation; and

- The use of metrics that address day-to-day management processes as well as bottom-line results.

Technology Transfer Agents

Technology Transfer Agents facilitate the transfer / use of NASA and other federally sponsored research and technology (and associated capabilities) to the U.S. private sector for commercial application to enhance U.S. industrial growth and economic competitiveness. Technology Transfer Agents include funding for the National Technology Transfer Center (NTTC) at Wheeling Jesuit College in West Virginia and the TechLink Center at Montana State University.

In conformance with congressional direction, NASA has funded the NTTC since 1990. The NTTC serves as a national resource for the transfer and commercialization of Federal research and technology. A key, ongoing strategy is to align and integrate NTTC operations with the NASA Commercial Technology Programs in support of the NASA Commercial Technology Mission. This strategy provides a foundation upon which the NTTC may fulfill its national role through technology transfer programs funded by other Federal agencies and the provision of cost-recovery products and services. Accordingly, NASA has facilitated the involvement of other Federal agencies to leverage and extend NTTC capabilities funded by NASA and has enabled the NTTC to implement cost-recovery activities in support of the overall Federal technology transfer mission. The NTTC performs four core roles:

(1) Serves as a national gateway for Federal technology transfer and commercialization, assisting U.S. industry to locate and access NASA and other federally sponsored technology resources and sources of technical / business assistance;

(2) Assesses NASA and other Federal technologies for commercial potential, and facilitates partnerships for technology commercialization;

(3) Develops and delivers professional-level training in technology transfer and commercialization for NASA, Federal agencies, and other public- and private-sector audiences; and

(4) Promotes U.S. industry awareness and utilization of NASA and other federally sponsored research and technology resources available for commercial purpose.

Also in conformance with congressional direction, NASA continues to fund a cooperative agreement with Montana State University to operate the TechLink Center, a rural technology transfer and commercialization center. The mission of the TechLink Center is to assist firms and targeted industries in Montana, North Dakota, South Dakota, Wyoming, and Idaho to utilize and commercialize technologies from NASA, Federal laboratories, and universities.

Small Business Innovative Research Program

The SBIR Program helps NASA develop innovative technologies by providing competitive research contracts to U.S.-owned small businesses. The program is structured in three phases. Phase I is the opportunity to establish the feasibility, technical merit, and NASA mission need of a proposed innovation. Selected competitively, Phase I contracts have a term of 6 months and currently do not exceed $70,000. Phase II is the major R&D effort in SBIR. The most promising Phase I projects are selected to receive contracts worth up to $600,000 for up to 2 years. Approximately 45 percent of Phase I projects are approved for Phase II. Phase III is the completion of the development of a product or process to make it marketable. SBIR Program funding cannot be used to support Phase III. Private-sector investment and sales of products and services based on the SBIR technology are the usual sources of Phase III funding.

FY 2001 Overview of Technology Transfer by the Agency's Federal Labs

Table 2.8. Summary Measures of Technology Transfer Activities

	FY 1990	FY 1995	FY 1999	FY 2000	FY 2001
I. Collaborative Relationships for R&D					
■ CRADAs, total active in the FY	0	0	1	1	1
- New, executed in the FY	—	—	1	0	0
• Nontraditional[1] CRADAs, total active in the FY	—	—	—	—	0
- New, executed in the FY	—	—	—	—	0
■ Other types of collaborative R&D relationships	—	—	—	—	0
II. Intellectual Property Management					
■ New inventions disclosed	538	517	525	574	696
■ Patent applications filed	181	164	129	109	151
■ Patents issued	—	—	87	99	159
■ Invention licenses, total active in the FY	—	—	249	214	292
- New, executed in the FY			40	47	42
■ Licenses for Other IP[2], total active in the FY	—	—	22	32	36
■ Elapsed execution time, licenses granted in the FY					
- Range (low-high) / Median (months)	—	—	—	—	4–49.9 / 14.4
■ Licenses terminated for cause in the FY	—	—	—	—	23
■ Total income from all active licenses (thousands)	—	—	$823	$1,008	$1,971
• Income from invention licenses (thousands)			$818	$762	$1,319
• Income from Other IP licenses (thousands)	—	—	$5	$246	$652
■ Licenses bearing royalty income in the FY	—	—	19	17	114
- Exclusive / partially exclusive / nonexclusive	—	—	—	—	57 / 13 / 44
• Earned royalty income (ERI) in the FY (thousands)	—	—	$388	$175	$521
- Range of ERI (low-high)	—	—	—	—	$.07–232
- Median ERI	—	—	—	—	$22
- ERI subtotal from top 1% of licenses	—	—	—	—	*
- ERI subtotal from top 5% of licenses	—	—	—	—	*
- ERI subtotal from top 20% of licenses	—	—	—	—	$420
■ Disposition of income (royalties, other payments)	—	—	—	—	
• Income distributed (thousands)					$1,451
- Inventors					42%
- NASA Centers					15%
- U.S. Treasury					17%
- California Institute of Technology					25%
III. Other Activity Measures					
■ See note (3) below.	—	—	—	—	

The data in this table cover the following departmental bureaus / divisions / services / offices: The FY 2001 figures are comprehensive of NASA's Federal labs and research centers, including the Jet Propulsion Laboratory. The figures for prior years do not include the JPL activities.

(1) Executed under CRADA authority (15 U.S.C. Sec. 3710a) but used for special purposes, such as material transfer CRADAs or technical assistance that may result in protected information.

(2) "Other Intellectual Property (IP)" includes computer software, tangible research products (such as biological materials), and protected data.

(3) NASA regards its communication of information about NASA technologies to industry (including small businesses and individuals) as another important aspect of its overall technology transfer activities. For this purpose, NASA publishes *Innovations*, *Spin-off*, and *TechBriefs*. It also maintains an agency-wide technology transfer database, *TechTracS*, which provides World Wide Web (Internet) access to 18,000 supported NASA technologies. NASA collects and maintains data on the distribution of these publications and

Technology Transfer Outcomes

NASA's FY 2001 report indicated that diverse kinds of downstream benefits had arisen from the agency's technology transfer activities:

(1) Technology arising under a collaborative RD&D relationship had either become commercially available or worked to strengthen NASA's capabilities;

(2) Technology licensed by the agency had become commercially available; and

(3) Products or processes developed by agency licensees had strengthened NASA's capabilities.

NASA's report included the following examples of these successful outcomes:

- *Plant stress detection technology.* NASA and Spectrum Technologies, Inc. (of Plainfield, Illinois) worked together to transfer a plant stress detection technology, originally developed for the Stennis Space Center, to the commercial marketplace. The product, the Spectrum Chlorophyll Meter, can detect plant stress up to 16 days before plant deterioration is visible, by measuring chlorophyll content through the amount of light energy reflected from the plant. Early detection of plant stress through chlorophyll loss can lead to healthier forests and more productive farms. The Spectrum Chlorophyll Meter became available in Spectrum's 2001 Spring Product Catalog.

- *Technology assistance to a major U.S. auto company that solves an important manufacturing problem.* NASA's Technology Assistance Program at the Stennis Space Center provided assistance to Saturn Electronics & Engineering, Inc. (of Marks, Mississippi) to solve an intermittent problem with automotive underhood lamps. Saturn's production facility produces more than 1 million lamps and switches monthly but had been experiencing intermittent problems with underhood lamp assemblies for some time. Saturn's own prior efforts to diagnose and solve the problem had been unsuccessful. Technical assistance provided by NASA's Materials and Contamination Laboratory and Stennis Prototype Laboratory indicated that the failures were caused by a buildup of carbon-based contaminants on switch components. Saturn's implementation of NASA's recommendations resulted in the failure rate dropping from an unacceptable 2 percent to less than 0.02 percent.

- *Command and Control Toolkit.™* NASA licensed its Control Monitor Unit software technology to the Command and Control Technologies Corporation (CCT, of Titusville, Florida)

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accessions to *TechTracS* and related websites. However, these data are not presently used in the formulation of policy or management of NASA's technology transfer programs.

R&D = research and development; CRADA = Cooperative Research and Development Agreements; FY = fiscal year; ERI = earned royalty income; — = Data not requested from agency in previous years' reports; * = Cannot disclose without revealing proprietary information.

in 1997. CCT is now commercializing a trio of products based on this technology and is automating commercial, multivehicle spaceport launch control systems in four States (spaceport agencies in Florida, Alaska, Virginia, and Washington). One of the products is the Command and Control Toolkit. The other two are T-Zero(tm) launch control software and the Spaceport RangeNet(tm) software, both of which augment the capabilities of the Command and Control Toolkit. CCT was started in 1997 as a spin-off of a three-person McDonnell Douglas Space Systems (now Boeing) management team. In April 2000, CCT moved its headquarters to an office near the Kennedy Space Center. The company was recognized as the NASA Kennedy Space Center Small Business Subcontractor of the Year for 1998; in 2000 it was named one of the hundred fastest-growing companies in Florida.

- *SureBolt™ ultrasonic bolt tension gage system.* The American Remote Vision Company (ARVC, of Titusville, Florida) is marketing a highly accurate ultrasonic bolt tension gage: the SureBolt system, a complete unit contained within a laptop computer. ARVC developed its product based on technology invented and patented by NASA at the Kennedy Space Center (KSC). NASA engineers used the prototype to remotely measure tension in critical bolts attached to a space station structure and its six access hatches during preflight pressurized verification testing. Using a digital signal processing technique, the gage proved more reliable on every test and bolt than all other available gages. SureBolt analyzes bolt tension instead of torque and uses the entire echo for more reliability, accuracy, and ease of use.

- *Active Particle Fallout Monitor.* The Aerospace Engineering Group (AEG, of Beltsville, Maryland) is commercializing the Active Particle Fallout Monitor (APFM), an automated monitoring system that will benefit both NASA and private industry. AEG joined with NASA in January 1999 at the Kennedy Space Center in a Cooperative Agreement to commercialize the KSC-developed prototype. AEG obtained exclusive license rights to the APFM, developed by NASA's Contamination Monitoring Laboratory. AEG has targeted numerous private and government sectors for marketing the commercial APFM, including the aerospace, aeronautical, semiconductor processing, electronics fabrication, and medical industries, and other arenas in which space-flight hardware is processed or fabricated. The market also potentially includes hotels, apartment complexes, corporate buildings, and any environment where the quality of air is of sufficient concern that facilities managers perceive the need to provide assurance of air quality to occupants.

- *Colorless and Low Dielectric Polyimide Thin Film* is a high-tech thermoplastic invented by scientists at NASA's Langley Research Center (Hampton, Virginia). Originally developed for solar propulsion and power, the material has remarkable qualities of transparency, ultraviolet (UV) resistance, and operating temperatures. This material technology is regarded to have numerous commercial applications and has been licensed to SRS Technologies (Huntsville, Alabama) and Triton Systems Inc. (Chelmsford, Massachusetts) for development. The material offers protection from UV radiation as a coating for art and outdoor statues. It promises UV protection as an additive to cosmetics and exterior paints. It offers temperature resistance when used in the form of solid components in electronic devices like liquid crystal displays and in flexible, printed circuit boards. When cast as large thin films, the thermoplastic material serves exceptionally well as a solar thermal concentrator for space-based propulsion and power concepts and, potentially, for inflatable large space antennas. Future aerospace applications may include use in optics for space telescopes or spaceborne lasers; antennas for communications, surveillance, and positioning; solar shielding; and aircraft and missile cabling.

- *Multiwavelength laser with dental applications.* Lantis Laser, Inc. (a start-up company in Hewitt, New Jersey) is working with the NASA Langley Research Center (under a Space Act agreement) to refine a NASA Langley-developed method for producing two distinct wavelengths from a single laser and apply it to dentistry. NASA Langley developed the technology in support of one of NASA's remote sensing programs. Lantis Laser views the multiwavelength laser as the breakthrough needed for a dental laser that would knock down the price barrier that has kept painless laser dentistry out of reach of most dentists and their patients. The goal of the joint work is to produce the two specific wavelengths that have been approved by the FDA for use in dentistry. One wavelength is effective on hard tissue, such as teeth, and will replace the dentist's drill. The other wavelength is effective on soft tissue, such as gums, and will replace the scalpel for gum surgery.

- *Application of VISAR technology.* Intergraph Government Solutions (Huntsville, Alabama) has employed NASA's Video Image Stabilization and Registration (VISAR) technology to develop its Video Analyst System™ which offers broadcast-quality analysis features on Intel-based hardware. VISAR was developed by NASA Marshall Space Flight Center scientists to improve the clarity of video footage by correcting distortions caused by adverse conditions. VISAR uses a video processing algorithm to co-align video image fields by analyzing the picture pixel and removing the effects of translation, magnification, and rotation. Video Analyst is a comprehensive, effective, and affordable solution for advanced video analysis and enhancement. It combines capabilities previously found only in high-end broadcast quality systems with the tools necessary to capture, analyze, enhance, and edit any type of video.

2.9 Department of Transportation[13]

Agency Approach and Plans for Technology Transfer

The Department of Transportation (DOT) is the Federal steward of the Nation's transportation system. It houses many transportation agencies and programs, all of which aim to use their R&D work to fulfill DOT's key goals: safety, homeland security, mobility and economic growth, human and natural environment, and organizational excellence.

Although the majority of DOT's research funds support extramural research, four of DOT's modal administrations operate R&D facilities of a type that warrant participation in CRADA and patent licensing programs: the Federal Aviation Administration (FAA), the Federal Highway Administration (FHWA), the Research and Special Programs Administration (RSPA), and the United States Coast Guard (USCG).

Federal Aviation Administration

The FAA plays a variety of regulatory roles in air transportation and carries out an extensive research and technology program to support those responsibilities. The program is carried out in cooperation with the regulated industries and other Federal agencies and includes research on air traffic control systems, weather research, airport technology, aircraft safety technology, and airport security technology.

Federal Highway Administration

The FHWA plays a key role in improving the quality of the Nation's transportation systems, providing grants and an aggressive research program to support the State and local agencies primarily responsible for our highways. The research it sponsors explores material, structural, and information technologies designed to promote efficient and safe use of the highways. The Intelligent Transportation System, one of its most interesting programs, works with industry, State and local agencies, and consumers to support research applying information technologies to improve highway safety, increase efficiency, and reduce energy use and adverse environmental impacts. Many other FHWA programs promote the development and transfer of innovative transportation technologies to State and local agencies.

Research and Special Programs Administration

RSPA is responsible for the safe and secure movement of hazardous materials to industry and consumers by all modes of transportation, including pipelines; coordination of rapid response to transportation emergencies; and the advancement of science and technology for national transportation needs.

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[13] This section draws on text and statistics in DOT's FY 2001 "agency report on utilization" under 15 U.S.C. Sec. 3710(f). For additional details, readers should consult the Department's report: *FY 2001 Annual Report on Technology Transfer,* July 2002. (See http://t2.dot.gov.)

RSPA manages DOT's multimodal research programs; coordinates DOT's research and development strategic planning efforts; supports multimodal research, education, and technology transfer through 33 University Transportation Centers; and oversees the work of the Transportation Safety Institute. Through R&D, engineering, and analysis, RSPA's Volpe National Transportation Systems Center in Cambridge, Massachusetts, helps decision-makers define problems and pursue solutions to lead transportation into the 21st century. Its work includes a broad mix of projects that cut across traditional transportation modes and technical disciplines.

United States Coast Guard

USCG has a wide-ranging mission that includes setting standards for commercial vessels, licensing seamen, safeguarding ports and waterways, and providing radio-navigation systems. Its research programs support all of these missions, including work on search and rescue capabilities, marine navigation, marine safety, maritime law enforcement, and integrated command, control, communications, computer, and intelligence systems.

Technology transfer activities across DOT are coordinated at the departmental level through the Technology and Innovation Committee. Each DOT modal administration designates a representative to the committee, which meets bimonthly to discuss technology transfer issues and upcoming plans and opportunities, and to exchange information on cross-cutting technologies.

Each year, the committee publishes a "Guide to Transportation Technology and Innovation." This guidebook is intended as an overview of innovation and technology transfer activities in DOT. It serves both as a quick reference to points of contact for a basic understanding of innovation, research, and technology activities at DOT and as a source of help for pursuing more formal technology- and innovation-sharing partnerships.[14]

Presently, DOT is forging partnering ventures in the areas of strategic planning, enabling research, and education. Some examples are the initiatives of the National Transportation Science and Technology Strategy; partnerships on transportation information infrastructure, next-generation vehicles, and transportation physical infrastructure; and the Garrett A. Morgan Technology and Transportation Futures Program.

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[14] The annual "Guide to Transportation Technology and Innovation" can be found on DOT's website at http://t2.dot.gov/guide/index.html. DOT's Technology Transfer website (http://t2.dot.gov) provides additional information on DOT agencies, DOT laboratories, partnership opportunities, the Small Business Innovation Research (SBIR) Program, as well as other current information on the Department's technology transfer. Another DOT website, the Transportation Science and Technology homepage, http://scitech.dot.gov, is a one-stop resource for additional information on Federal, national, and international transportation planning, technology, and R&D activities.

FY 2001 Overview of Technology Transfer by the Agency's Federal Labs

Table 2.9. Summary Measures of Technology Transfer Activities

	FY 1990	FY 1995	FY 1999	FY 2000	FY 2001
I. Collaborative Relationships for R&D					
■ CRADAs, total active in the FY	1	37	51	79	82
- New, executed in the FY	—	—	5	38	11
• Nontraditional[1] CRADAs, total active in the FY	—	—	—	—	4
- New, executed in the FY	—	—	—	—	0
■ Other types of collaborative R&D relationships	—	—	—	—	n/a
II. Intellectual Property Management					
■ New inventions disclosed	1	0	1	0	2
■ Patent applications filed	1	2	0	3	3
■ Patents issued	—	—	0	3	0
■ Invention licenses, total active in the FY	—	—	0	0	1
- New, executed in the FY			0	0	1
■ Licenses for Other IP[2], total active in the FY	—	—	0	0	0
■ Elapsed execution time, licenses granted in the FY					
- Range (low-high)/Median (months)	—	—	—	—	n/a
■ Licenses terminated for cause in the FY	—	—	—	—	0
■ Total income from all active licenses (thousands)	—	—	$0	$0	$5.5
• Income from invention licenses (thousands)			$0	$0	$5.5
• Income from Other IP licenses (thousands)	—	—	$0	$0	$0
■ Licenses bearing royalty income in the FY	—	—	0	0	1
- Exclusive/partially exclusive/nonexclusive	—	—	—	—	0/0/1
• Earned royalty income (ERI) in the FY (thousands)	—	—	$0	$0	n/a
- Range of ERI (low-high)	—	—	—	—	n/a
- Median ERI	—	—	—	—	n/a
- ERI subtotal from top 1% of licenses	—	—	—	—	n/a
- ERI subtotal from top 5% of licenses	—	—	—	—	n/a
- ERI subtotal from top 20% of licenses	—	—	—	—	n/a
■ Disposition of income (royalties, other payments)	—	—	—	—	
• Income distributed (thousands)					$3.6
- To inventor					61%
- Patentability search and provisional patent filing					39%
III. Other Activity Measures					
(none cited by the agency)	—	—	—	—	nr

The data in this table cover the following departmental bureaus/divisions/services/offices: Federal Aviation Administration, Federal Highway Administration, and Research and Special Programs Administration.

(1) Executed under CRADA authority (15 U.S.C. Sec. 3710a) but used for special purposes, such as material transfer CRADAs or technical assistance that may result in protected information.

(2) "Other Intellectual Property (IP)" includes computer software, tangible research products (such as biological materials), and protected data.

R&D = research and development; CRADA = Cooperative Research and Development Agreements; FY = fiscal year; ERI = earned royalty income; n/a = Data not available from agency at time of this report; — = Data not requested from agency in previous years' reports; nr = Data not relevant: either the agency does not engage in this type of technological transfer activity or the information is not useful in describing the agency's programs.

Technology Transfer Outcomes

DOT's FY 2001 report provided the following examples of successful downstream outcomes arising from its technology transfer activities:

- *Operational capabilities of security screening equipment.* FAA has used the CRADA mechanism to evaluate the operational capabilities of security screening equipment. This approach allows use of real test samples, providing actual performance data. Should the technology not be advanced to the stage of deployment, the company then has the opportunity to work with the scientists and test director to improve performance. The data generated through this mechanism are shared with the appropriate government entities.

- *Microscale combustion calorimeter to determine flammability properties of new polymers.* Use of a microscale combustion calorimeter patented by an FAA scientist has allowed scientists at the FAA's Fire Safety Laboratory to develop a process to determine the flammability properties of new polymers in milligram sample sizes. A licensing agreement with Dow Chemical, along with access to Dow's ultra-fire-resistant polymers (as well as polymers developed by the FAA), has resulted in improvements in the mathematical characterization of required fire-retardant properties and a decrease in the amount of new material necessary for sampling and evaluation.

- *Laser illuminators.* As part of aviation safety efforts, the FAA initiated a CRADA to assess the use of laser illuminators and to ascertain which areas of airport visual guidance could benefit from this technology. This work indicated that the surfaces of existing runway and taxiway markings on the airfield were an application. As a result, the FAA initiated a Broad Agency Announcement to solicit products that might directly reduce runway incursions.

2.10 Department of Veterans Affairs[15]

Agency Approach and Plans for Technology Transfer

The Department of Veterans Affairs (VA) research program has, in the past, supported the development of innovations with major clinical and commercial impact. Examples include the radioimmunoassay, computerized axial tomography (CAT) scanner, "Seattle Foot" (a special prosthesis that allows lower-limb amputees to run and engage in active movements), and the nicotine patch. Nevertheless, the VA's role in these advances has not been well recognized. For many years, the VA adopted a simple hands-off approach to the intellectual property generated by VA researchers. The VA waived ownership rights, tasking the inventor and usually the local VA medical center academic affiliate with patenting, marketing, and licensing responsibilities. As a result, the VA lost opportunities to show veterans, Congress, and the American public the tangible products resulting from its intramural research program. In addition, this approach meant that important discoveries by VA investigators with no access to a local technology transfer program or not of interest of a private firm were not disseminated for the public good.

Accordingly, to better serve the VA and the Nation's veterans, the VA Office of Research and Development (ORD) has taken steps to track, assess, translate, and disseminate VA-supported discoveries and inventions. In February 2000, a first Director of the VA's Technology Transfer Program (TTP) was appointed. Since then, the TTP's mission has been redefined to include translating results of worthy discoveries by VA researchers into clinical practice.

To facilitate this effort, ORD has implemented a program that rigorously evaluates all inventions, educates inventors about their rights and obligations, obtains patents, and assists in the commercialization of new products. In addition, consistent policies have been established to govern the relationships among the investigator/inventor, local VA medical center, academic partner, and industry. Also, the VA is working with and promoting collaboration with its academic affiliates (university medical schools) through a model Cooperative Technology Administration Agreement (CTAA). Use of the CTAA allows the VA to advantageously access existing intellectual property expertise at these universities, resulting in a beneficial situation for both the VA and academic partners, and strengthening existing collaborations.

The VA currently lists the following overall goals for its technology transfer activities:

- Move VA innovations "from bench to bedside";
- Continue building internal/external capacity and expertise for managing intellectual property;

[15] This section draws on text and statistics in the VA's FY 2001 "agency report on utilization" under 15 U.S.C. Sec. 3710(f). For additional details, readers should consult the agency's report: *Annual Reporting on Agency Technology Transfer*, Department of Veterans Affairs, Office of Research and Development, Technology Transfer Program, June 2002.

- Identify, select, and implement an IP tracking system;
- Refine the system for acquiring patents and property rights;
- Continue negotiating CTAAs with VA academic affiliates;
- Continue to seek the counsel of the TTP advisory subcommittee;
- Continue internal and external education programs;
- Educate VA staff at all levels about the new technology transfer policy;
- Retain ownership and internal licensing rights, to ensure access by veterans to new technologies resulting from the VA's investment in research;
- Support a high-quality intramural research program and move discovery from the laboratory to clinical practice in a timely manner;
- Insure that inventors and their host VA medical centers receive optimal advice and support, so that they may realize equitable compensation and recognition;
- Maintain and improve the TTP website (www.vard.org);
- Enhance the partnership with academic affiliates in the area of technology transfer; and
- Continue to fund cutting-edge research that leads to discoveries or inventions that advance medical science and benefit veteran patients, investigators, the taxpayers, and the entire Nation.

FY 2001 Overview of Technology Transfer by the Agency's Federal Labs

Table 2.10. Summary Measures of Technology Transfer Activities

	FY 1990	FY 1995	FY 1999	FY 2000	FY 2001
I. Collaborative Relationships for R&D					
■ CRADAs, total active in the FY	2	14	1	2	2
- New, executed in the FY	—	—	1	2	0
• Nontraditional[1] CRADAs, total active in the FY	—	—	—	—	0
- New, executed in the FY	—	—	—	—	0
■ Other types of collaborative R&D relationships	—	—	—	—	nr
II. Intellectual Property Management					
■ New inventions disclosed	58	36	48	85	78**
■ Patents applications filed	1	2	37	35	38**
■ Patents issued	—	—	0	1	4**
■ Invention licenses, total active in the FY	—	—	n/a	n/a	76**
- New, executed in the FY			47	3	5**
■ Licenses for Other IP[2], total active in the FY	—	—	0	0	10**
■ Elapsed execution time, licenses granted in the FY					
- Range (low-high)/Average (months)	—	—	—	—	n/a
■ Licenses terminated for cause in the FY	—	—	—	—	2**
■ Total income from all active licenses (thousands)	—	—	n/a	$1,021	$38**
• Income from invention licenses (thousands)	n/a	n/a	n/a	$1,021	$23**
• Income from Other IP licenses (thousands)	—	—	0	0	$14**
■ Licenses bearing royalty income in the FY	—	—		n/a	58**
- Exclusive/partially exclusive/nonexclusive	—	—	—	—	3/2/53**
• Earned royalty income (ERI) in the FY (thousands)	—	—	n/a	n/a	$17**
- Range of ERI (low-high)	—	—	—	—	$0.008-6**
- Median ERI	—	—	—	—	$0.481**
- ERI subtotal from top 1% of licenses	—	—	—	—	n/a
- ERI subtotal from top 5% of licenses	—	—	—	—	n/a
- ERI subtotal from top 20% of licenses	—	—	—	—	n/a
■ Disposition of income (royalties, other payments)	—	—	—	—	
• Income distributed (thousands)					$0
III. Other Activity Measures					
■ See note (3) below.	—	—	—	—	

The data in this table cover the following departmental bureaus/divisions/services/offices: Veterans Affairs (VA) laboratories and VA academic affiliates (university medical schools) with which the VA has an active Cooperative Technology Administration Agreement (CTAA).

(1) Executed under CRADA authority (15 U.S.C. Sec. 3710a) but used for special purposes, such as material transfer CRADAs or technical assistance that may result in protected information.

(2) "Other Intellectual Property (IP)" includes computer software, tangible research products (such as biological materials), and protected data.

(3) While not an activity measure in the output sense above, the VA report also provided statistics that indicated it was continuing to expand the scope of its tech transfer system through new CTAAs with additional academic affiliates.

**Reported figures are incomplete – the majority of the VA's CTAA academic affiliates data was not available at the time of preparation of this report, since they were not yet due according to the CTAA reporting schedule.

R&D = research and development; CRADA = Cooperative Research and Development Agreements; FY = fiscal year; IP = intellectual property; ERI = earned royalty income; n/a = Data not available from agency at time of this report; — = Data not requested from agency in previous years' reports; nr = Data not relevant: either the agency does not engage in this type of technological transfer activity or the information is not useful in describing the agency's programs.

Technology Transfer Outcomes

The VA's FY 2001 report indicated that technology arising from one of its CRADAs had become commercially available. It did not, however, include specific examples of downstream outcomes arising from the agency's technology transfer activities.

Chapter 3
Trends in Federal Lab Technology Transfer

The information provided by the agency reports covers a diversity of topics related to Federal lab technology transfer activities (such as cooperative research and development [R&D] relationships, patenting, invention licensing) and some of the downstream outcomes arising from these transfer relationships. Nonetheless, cross-agency comparisons of activity levels or how the FY 2001 program statistics relate to those of previous years are not readily visualized through the previous chapter's presentation format. The broad purpose of this chapter is to analyze the recent and longer-term trends in technology transfer activities that have prevailed for the Federal lab system as a whole and to compare and contrast individual agencies' activities. This analysis combines the FY 2001 data with that of the prior Federal lab technology transfer surveys prepared by the Department of Commerce (Office of Technology Policy) for the periodic Biennial Reports under the Stevenson-Wydler Act[1] (many of the data series are complete back to FY 1987).

The analysis and discussion cover a number of topics; a basic roadmap of the focus and organization is as follows:

	Category of Federal Lab Tech Transfer Activity	Tech Transfer Measures Discussed
Activities	Collaborative Research & Development (R&D) Relationships	■ Cooperative Research and Development Agreements (CRADAs) ■ Other types of collaborative R&D relationships
	Intellectual Property Management	■ Invention Disclosure ■ Patenting • Patent applications • Patents received ■ Licensing: lab inventions and other intellectual property • Licensing levels • License management • Licensing income - Total income - Royalty income - Disposition of income
	Other Activity Measures	■ As identified and discussed by the agencies
Downstream Outcomes		■ Case examples provided by the agencies

[1] The most recent Biennial Report is Office of Technology Policy, U.S. Department of Commerce, Recent Trends in Federal Lab Technology Transfer: FY 1999-2000 Biennial Report, May 2002. (Report available on the Internet at http://www.ta.doc.gov/Reports.htm.)

DEPARTMENT OF COMMERCE

The statistics and trends discussed throughout this chapter again confirm there are significant differences among the agencies in the nature and intensity of technology transfer activities. Some of these differences reflect differences in agency mission, strategy to achieve mission, and associated program priorities. However, there are also large differences among the agencies in the level of budget resources available to support Federal lab science and technology, which ultimately influences the resources available to support lab technology transfer activities.[2]

Table 3.1. Estimated Budget Resources for Federal Lab R&D Spending, FY 1999–2001, Ranked by Budget Level

	FY 1999		FY 2000		FY 2001	
Department	**Total Obligations (million $)**	**Obligations—Federal Labs* (million $)**	**Total Obligations (million $)**	**Obligations—Federal Labs* (million $)**	**Total Obligations (million $)**	**Obligations—Federal Labs* (million $)**
Defense	$35,646	$9,271	$36,876	$9,826	$36,297	$9,329
Energy	6,010	4,308	6,306	4,520	6,793	4,885
HHS	15,915	3,337	18,140	3,714	19,235	3,934
NASA	9,526	3,665	9,568	3,614	9,602	3,793
Agriculture	1,614	1,083	1,752	1,134	1,779	1,251
Commerce	990	713	1,041	753	1,127	776
Interior	642	568	566	495	619	546
Veterans Affairs	339	339	367	367	367	367
Transportation	667	223	700	217	866	296
EPA	532	211	537	127	530	125

Budget figures include spending for basic research, applied research, development, R&D facilities and equipment. Budget "authority" and "obligations" measure spending in different ways. "Obligations" are reported here, rather than the more frequently cited "budget authority" figures, because the latter generally do not distinguish between spending on Federal lab activities and spending on extramural performers (e.g., universities).

*Obligations – Federal Labs" sums spending for Federal research by intramural performers and all Federally funded Research and Development Centers (FFRDCs). This sum is used as a measure of federal lab budget resources and is the basis for the above ranking of the departments.

Source: National Science Foundation, *Federal Funds for Research and Development, Detailed Historical Tables, Fiscal Years 1951-2001*. The figures for FY 2000 and 2001 are listed by the National Science Foundation as "preliminary."

Comparisons of agencies' estimated budget resources are important in understanding the relative size and scope of Federal lab technology transfer activities. As Table 3.1 indicates, DOD receives by far the greatest level of budget support for its Federal lab operations. Federal lab operations at DOE, HHS, and NASA also receive sizable budget support, but at levels 40 to 50% that of DOD. USDA and DOC represent a "third tier" of budget support, each receiving roughly a tenth of DOD's level. The other four departments receive still smaller levels of bud-

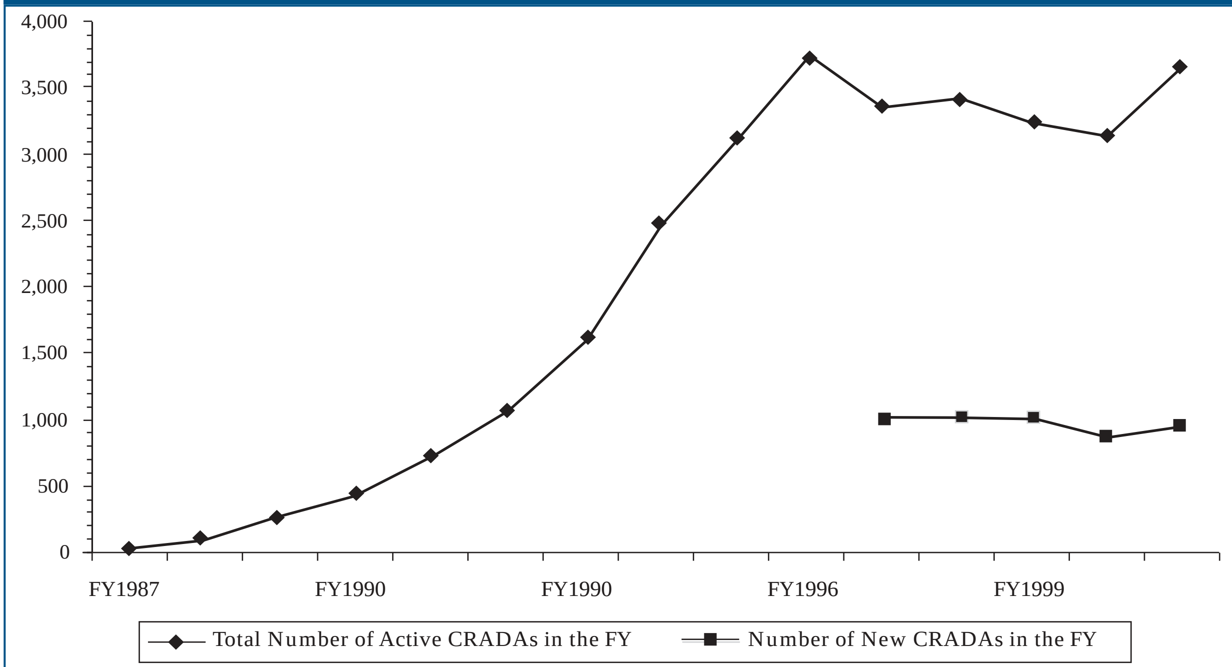
[2] Across the departments, budget resources for Federal lab technology transfer activities are generally not a separate budget line item. Typically, technology transfer is funded from a lab's overhead account and usually must compete with other demands for these general resource dollars.

get support. From another perspective, DOD and DOE together account for 56% of total Federal budget support for Federal lab R&D operations; adding HHS and NASA brings the cumulative total to 87%; and with USDA and DOC, to 95%. (This array of percentage comparisons is worth noting as a working basis for considering agency fractions of technology transfer activities discussed in the rest of this chapter.)

In addition, for comparison of annual statistics for program performance, single, year-to-year comparisons may not be informative. Performance is influenced by complex factors, including the usually irregular pace at which R&D yields new knowledge and inventions. Trends evident over several years or longer normally will provide a sounder basis for useful conclusions.

3.1 Collaborative Research and Development Relationships

Figure 3.1 Active CRADAs, All Federal Labs, FY 1987–2001



Data on the number of new CRADAs executed each year were not collected from the agencies until FY 1997.

Cooperative Research and Development Agreements

CRADAs remain widely used by the Federal labs as a means of establishing and conducting R&D partnerships with U.S. industry or other non-Federal parties. Congress legislated the

CRADA mechanism in the late 1980s to encourage the Federal labs to participate in R&D partnerships for the purpose of advancing promising technologies toward commercialization.[3]

The statistics indicate that over the past 5 fiscal years (FY 1997-2001) the Federal labs have executed roughly a thousand new CRADAs annually (Figure 3.1). Over the same period, the total of active CRADAs has been approximately between 3,100 and 3,600.[4]

The vast majority of active CRADAs, however, arise from the activities of only a few of the agencies (Figures 3.2a,b). In FY 2001, DOD, DOE, and HHS together accounted for 84%; including USDA and DOC, the cumulative total is 95%. The remaining five departments (NASA, DOI, VA, DOT, EPA) account for only a small fraction of the total.[5] This basic pattern has remained largely the same since the early 1990s.

The sharp slowdown in the growth of active CRADAs after FY 1996 — readily apparent in Figure 3.1 — has been the subject of comment in the most recent editions of the Department of Commerce's (Office of Technology Policy) *Biennial Report* on Federal lab technology transfer.[6] The FY 2001 data point (Figure 3.1) might seem to indicate a forthcoming CRADA resurgence; this uptick results from a FY 2001 accounting revision by one of the more CRADA-intensive

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[3] CRADA authority was first established by the Federal Technology Transfer Act of 1986. This Act applied only to government-owned/government-operated (GOGO) laboratories. But only a few years later, the National Competitiveness Technology Transfer Act of 1989 enlarged the authority to government-owned/contractor-operated (GOCO) labs (most of which are part of the Department of Energy's laboratory system). The effect of both Acts together was to extend the CRADA option fully throughout the U.S. Federal lab system.

[4] The figures for "active CRADAs" listed in Figure 3.1 (and elsewhere in this document), for the period of FY 1996 and later, are somewhat larger this year than reported in previous editions of the Department of Commerce's Federal lab technology transfer reports. These revisions reflect modifications in the guidelines on counting CRADAs, which took effect with the FY 2001 reporting. The agencies are now asked to tally all CRADAs executed under the authority of 15 U.S.C. Sec. 3710a, including both "standard" and "nontraditional" CRADAs. (An example of a "nontraditional" CRADA is the material transfer CRADAs increasingly used in recent years by agencies such as HHS.) This procedural revision was implemented to ensure consistency in counting across the agencies. Note that additional statistics are now provided to indicate the incidence of these differing CRADA mechanisms across the agencies (see the statistical tables in Chapter 2 and the Appendix).

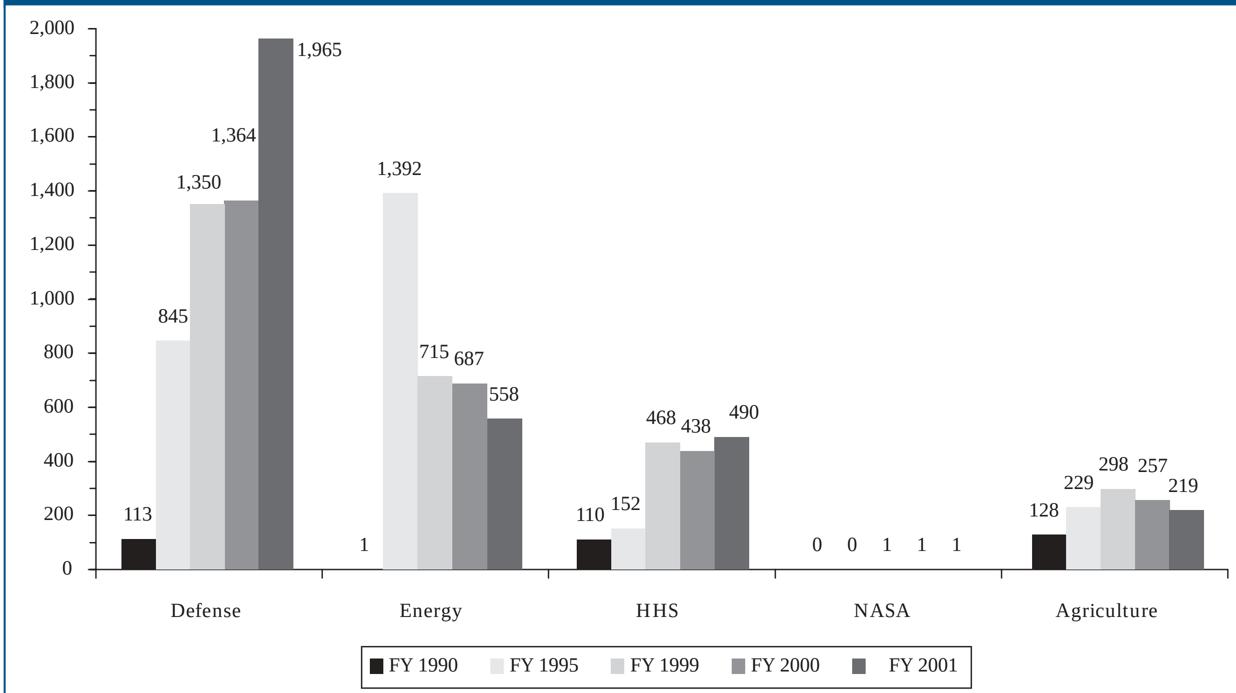
[5] NASA is an exception among the Federal labs in its use of the CRADA mechanism. NASA continues to rely primarily on transfer authorities granted to it by the Space Act of 1958. This Act gives NASA broad authority to enter into "other agreements" with the private sector and others. These agreements are not regarded as procurements, grants, or cooperative agreements and are not subject to the rules governing such agreements. NASA believes its technology transfer objectives can be achieved with greater flexibility through use of the Space Act.

[6] Office of Technology Policy, U.S. Department of Commerce, *Recent Trends in Federal Lab Technology Transfer: FY 1999-2000 Biennial Report*, May 2002, p. 13. Office of Technology Policy, U.S. Department of Commerce, *Tech Transfer 2000: Making Partnerships Work*, May 2000, p. 88. (Both documents are available on OTP's website: http://www.ta.doc.gov/Reports.htm.)

agencies.[7] But when adjusted, the FY 2001 level for total active CRADAs is largely the same as the FY 2000 level.

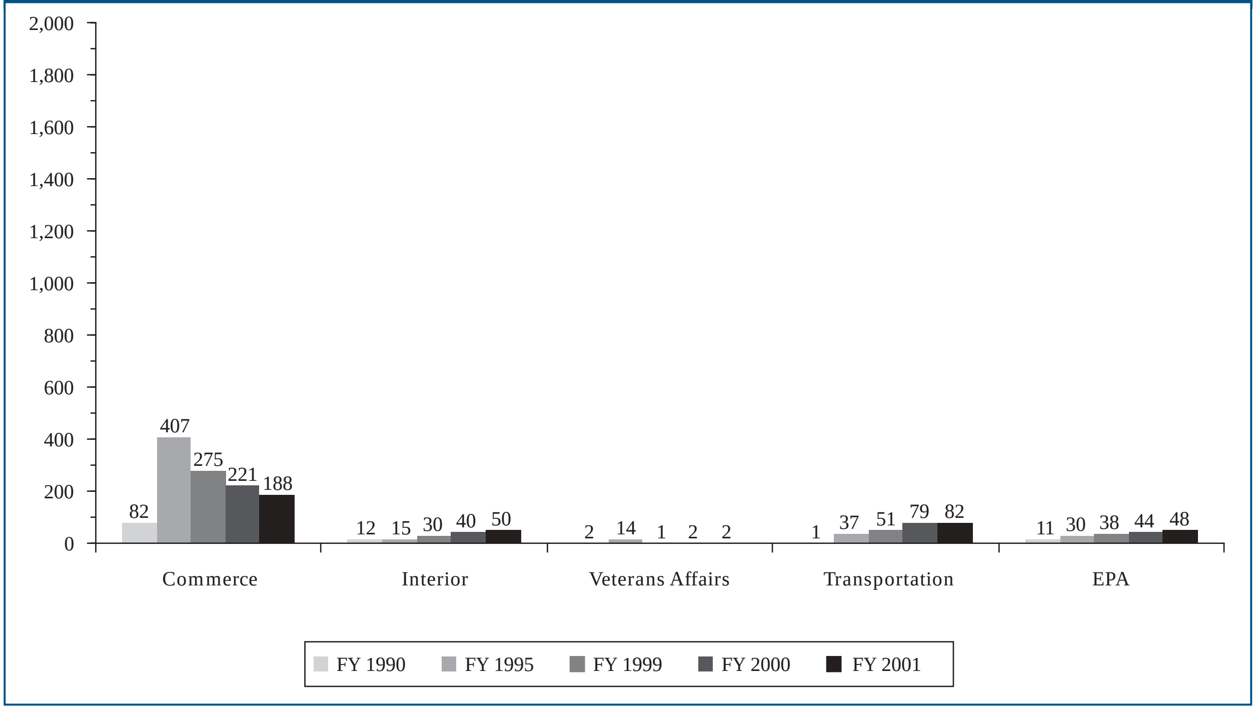
The Department of Commerce's *Biennial Report* of May 2002 (covering through FY 2000) indicated that much of the post-FY 1996 decline in all active CRADAs arose from steep declines in CRADA incidence at both DOE and DOC. With the FY 2001 data now included, it is apparent there has been a further CRADA decline at both these agencies. With the FY 2001 data, the USDA also now appears to be experiencing a decline in CRADA incidence, although at a much more gradual pace than DOE and DOC. By contrast, CRADA use at HHS remains on a modest expansionary path. And stronger growth appears under way at DOD, although more than half the expansion in FY 2001 stems from the broader counting base now being used. DOI, DOT, and EPA all continue to exhibit some growth in CRADA use, but at far lower levels than the other agencies.

Figure 3.2(a) Active CRADAs, by Agency, Selected Years



7 With FY 2001, DOD has expanded statistical coverage of the department's technology transfer activities to include a number of defense agencies (see DOD section in Chapter 2). Previously, the coverage had been limited to the three major military services (Army, Navy, Air Force). This revision brought more than 300 defense agency CRADAs into the active tally that had not previously been included in the reported data.

Figure 3.2(b) Active CRADAs, by Agency, Selected Years



A variety of factors appear involved in the agencies where CRADA use has been declining in recent years. Some labs have shifted toward greater selectiveness in partnering — the result of emerging budget constraints and/or a desire to focus on fewer but higher quality CRADA relationships. For others, revisions in lab mission strategy are working to decrease the need for exclusive relationships with individual companies. Externally, interest by some potential CRADA partners may be declining because of perceived logistical/administrative burdens in establishing such relationships. Also, some agencies are now exploring alternative mechanisms for collaborative R&D relationships (see below). Finally, there is a natural nonlinearity at play in the incidence numbers — a good example being the expiration of a consortia CRADA with many partners, which would not typically be immediately replaced in kind.

Other Types of Collaborative R&D Relationships

CRADAs are not the only means by which the Federal labs can conduct cooperative R&D with private industry or other non-Federal organizations. The revised Federal lab technology transfer reporting process provided agencies with a FY 2001 opportunity to identify the use of such alternative mechanisms and comment on their contribution to the agency's technology transfer program. Several of the agencies indicated their use of such alternative approaches.

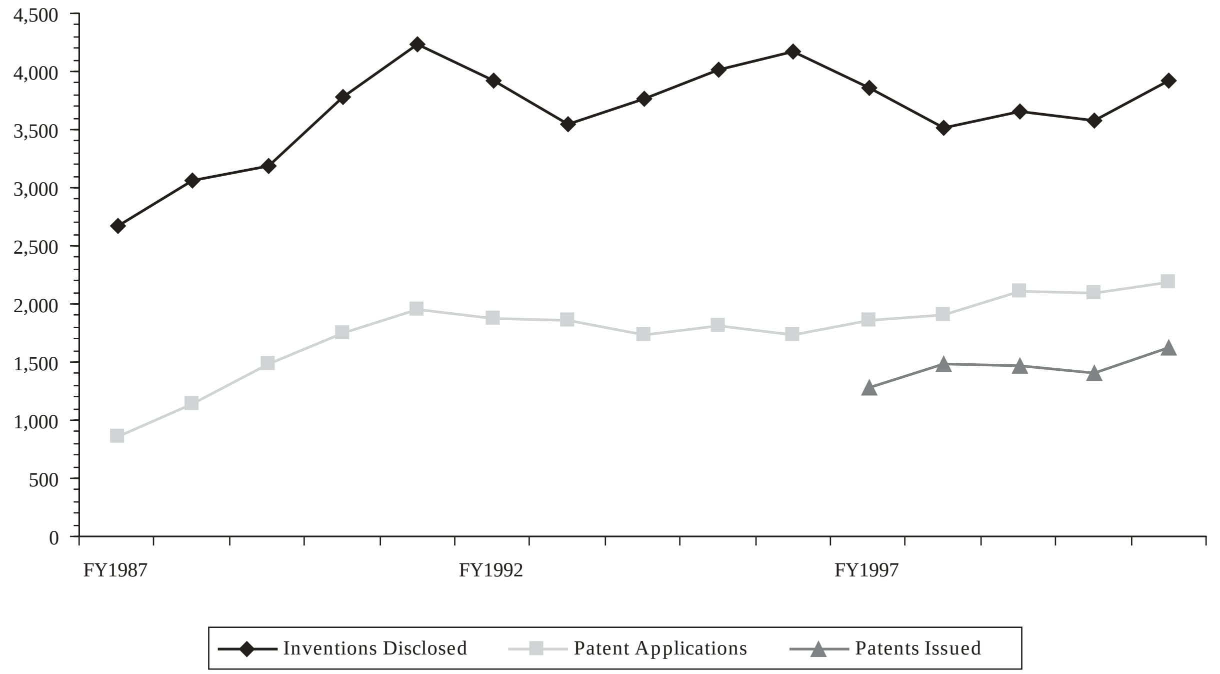
- *Department of Agriculture, Agricultural Research Service (ARS): Trust Fund and Reimbursable Cooperative Agreements.* A *Trust Fund Cooperative Agreement* involves cooperative research between ARS and another party in which ARS is paid in advance to conduct research and the exclusivity of resulting intellectual property is not a priority for the cooperating party. This agreement may also request the private-sector partner to share in the cost of a research project conducted by ARS. The agreement can also be used to allow private-sector partners the use of laboratory facilities, which in some cases may require a formal lease. A *Reimbursable Cooperative Agreement* is like a Trust Fund Agreement in arrears; the private-sector partner pays ARS the difference. For either agreement, both the private-sector partner and ARS should be actively engaged in the cooperative effort, mutually contribute resources to the research effort, and specifically state mutual interest in the agreement's objectives.

Either type of agreement may offer companies an advantageous way to directly support an ARS project or program. USDA's technology transfer statistics (see Chapter 2) indicate that 106 Trust Fund / Reimbursable Cooperative Agreements were executed in FY 2001 through facilitation by ARS' Office of Technology Transfer, compared with 49 new CRADAs and 219 total active CRADAs.

- *Department of Commerce, National Institute of Standards and Technology (NIST): guest researchers and facility users.* Each year, numerous researchers visit NIST to participate in collaborative projects and / or to use NIST's research facilities. NIST makes its facilities available for limited periods to domestic guest researchers to collaborate with NIST staff on R&D projects of mutual interest or to transfer NIST techniques, procedures, and best practices. NIST provides neither direct salary nor subsistence support to domestic guest researchers. NIST's Foreign Guest Researcher Program offers scientists from around the world the opportunity to work collaboratively with researchers in the NIST laboratories. Foreign guest researchers enter into clearly defined Guest Researcher Agreements that describe the proposed research project and its mutual benefit to the guest researcher and the NIST host. The majority of foreign guest researchers receive no stipend from NIST. However, NIST has the authority to pay financial assistance to foreign guest researchers when such payment would facilitate a NIST program. NIST's statistics for FY 2001 (see Chapter 2) indicate that these collaborative relations number in the many hundreds annually.

3.2 Invention Disclosure and Patenting

Figure 3.3 Invention Disclosure and Patenting, All Federal Labs, FY 1987–2001



Data on the number of patents issued annually were not collected from the agencies until FY 1997.

The overall level of **invention disclosure** annually by the Federal labs has generally remained constant since the early 1990s (Figure 3.3).[8] Much the same is true for Federal lab **patenting** (i.e., patents applied for and patents received). However, it appears that the level of patenting has been trending somewhat upward since the late 1990s.

DOD, DOE, HHS, and NASA are particularly prominent when it comes to Federal lab invention disclosures and patenting (Figures 3.4a-e). In FY 2001, DOD and DOE accounted for 65% of all invention disclosures, 74% of all patent applications, and 76% of all patents received by the Federal labs. With the addition of HHS and NASA activities, these cumulative shares become, respectively, 94%, 92%, and 94%. The other six agencies disclose inventions and patent, but at much lower levels. This basic pattern has prevailed for some time.

[8] The Federal labs' activities in the areas of invention, patenting, and licensing are frequently cited as indicators of their active management of intellectual assets and technical know-how. One of the challenges in identifying valid trends in time series data for these activity measures is that single year-to-year comparisons can be misleading. Performance is influenced by complex factors, notably the irregular pace at which ongoing R&D yields new knowledge and inventions.

These aggregates mask, however, substantial differences in the trends for individual agencies (Figures 3.4a-e). Among the four major agencies for the past 5 years, the annual number of invention disclosures has been trending upward at NASA and HHS and downward at DOD, and has remained largely unchanged at DOE. Over the same period, patent applications and patents received rose at DOE, but remained relatively unchanged at DOD. The number of patent applications has been unchanged at NASA and HHS. The number of patents received has moved upward at NASA, but downward at HHS.

Figure 3.4(a) Invention Disclosure and Patenting, by Agency, Selected Years

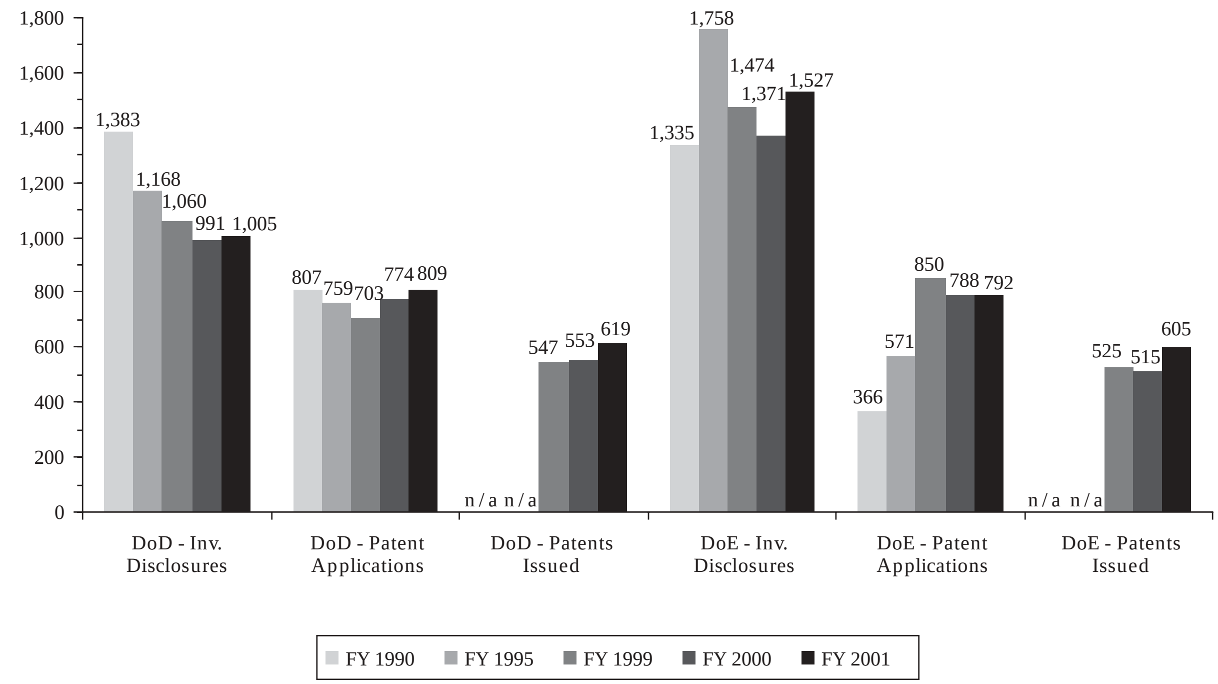


Figure 3.4(b) Invention Disclosure and Patenting, by Agency, Selected Years

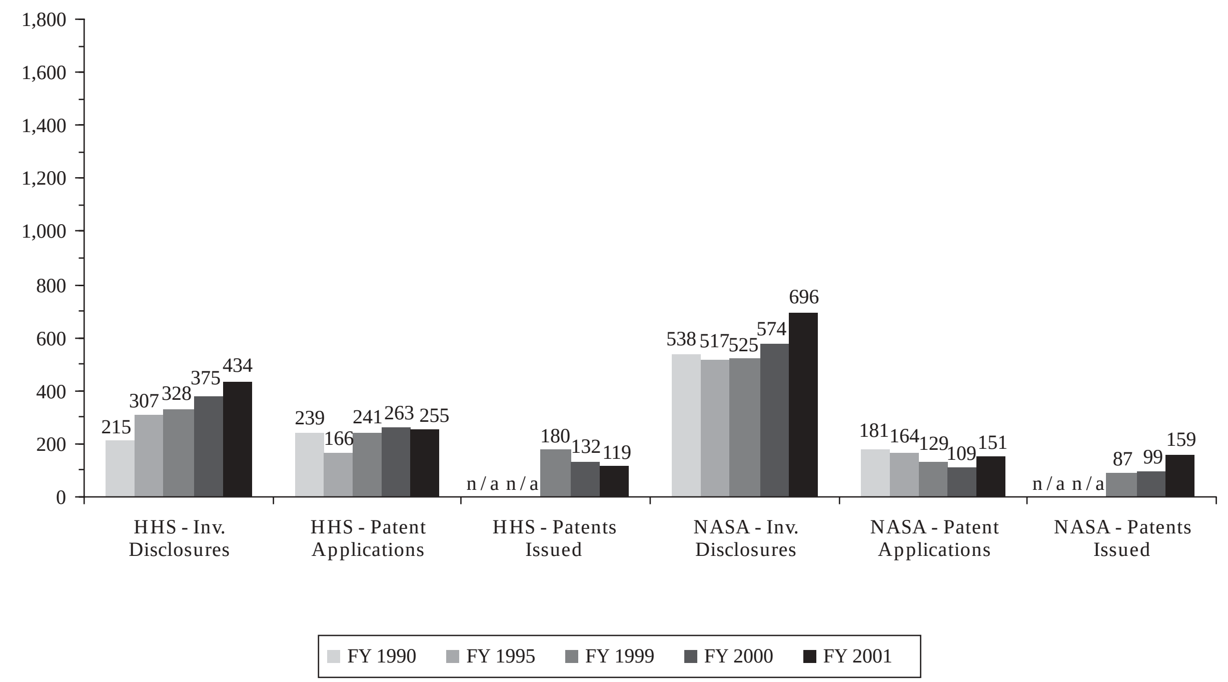


Figure 3.4(c) Invention Disclosure and Patenting, by Agency, Selected Years

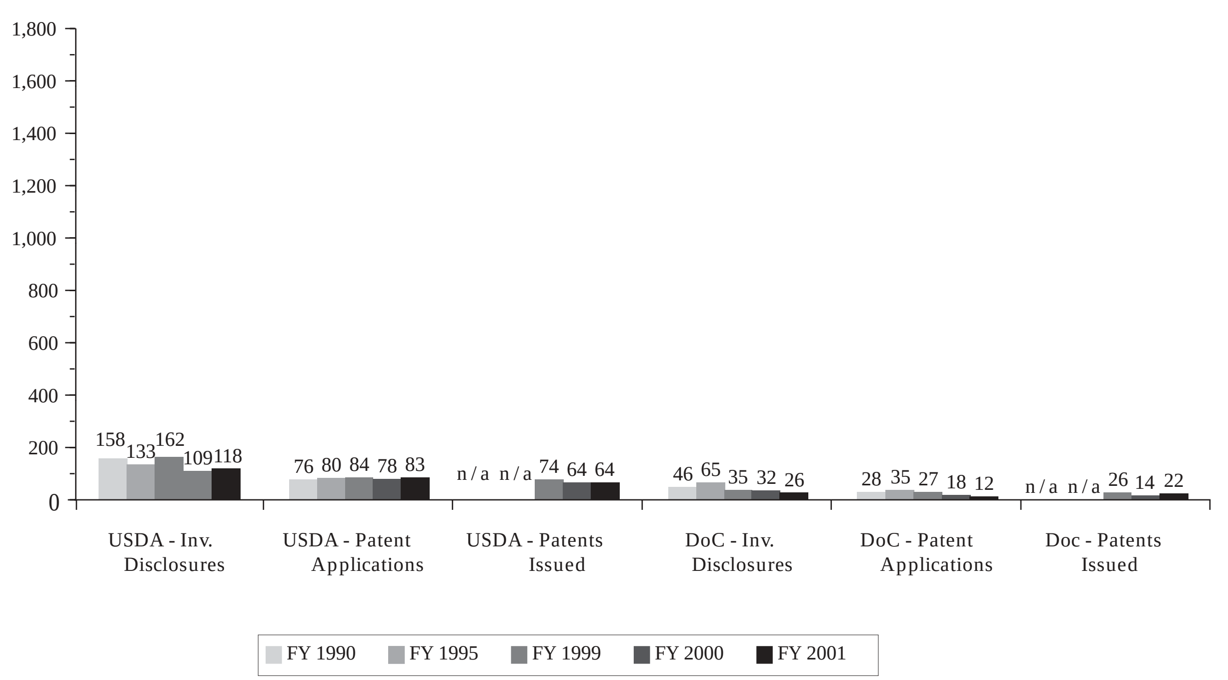


Figure 3.4(d) Invention Disclosure and Patenting, by Agency, Selected Years

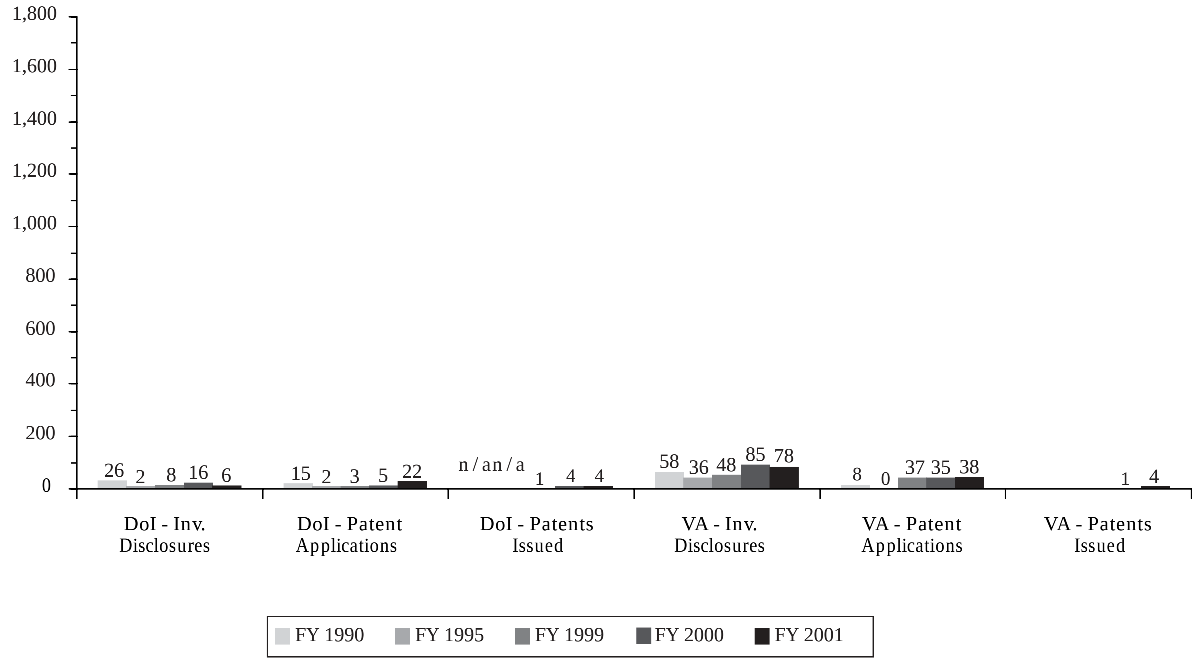
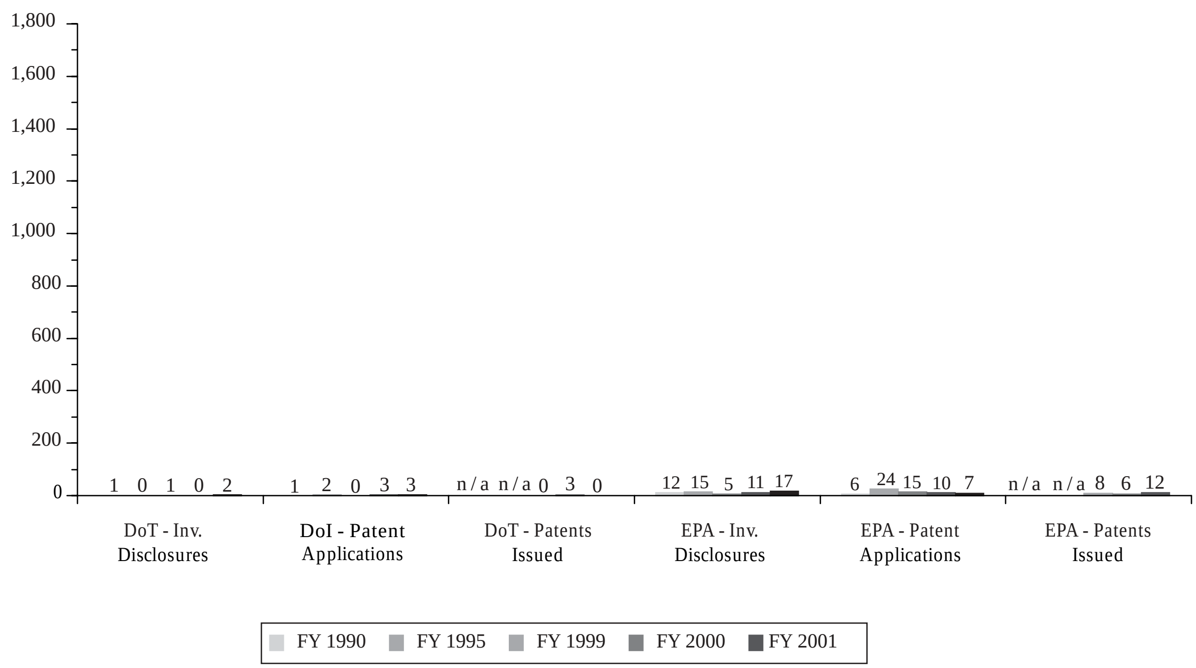
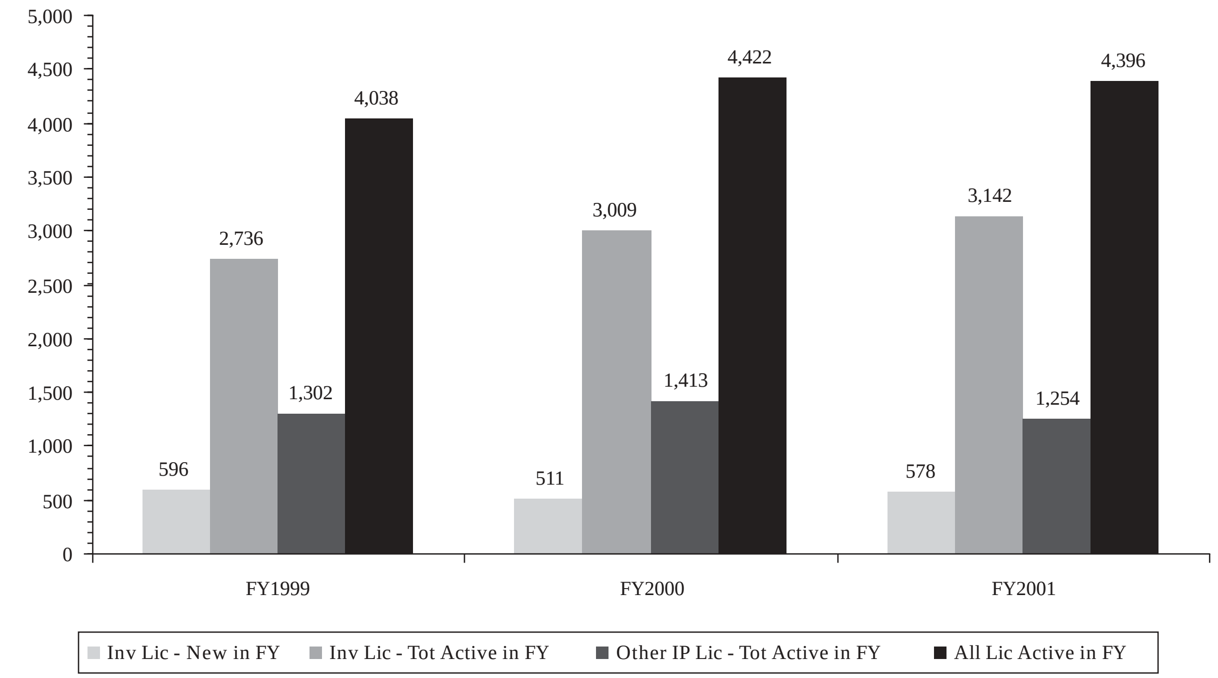


Figure 3.4(e) Invention Disclosure and Patenting, by Agency, Selected Years



3.3 Licensing: Lab Inventions and Other Intellectual Property

Figure 3.5 Active Licenses, Inventions, and Other Intellectual Property, All Federal Labs, FY 1999–2001



Data collection for most of the measures began in FY 1999. Only figures for “Invention Licenses – New in FY” are available for earlier dates (see Appendix Table A.3).

Licensing Levels

Licensing of Inventions. The Federal labs reported 3,142 active licenses for inventions in FY 2001 (Figure 3.5). This figure is 4% greater than the FY 2000 total of 3,009; growth in FY 2000 over the previous year was about 10%.[9] In the past several years, the Federal labs have been executing some 500 to 600 new invention licenses annually, compared with 300 to 400 in the mid-1990s.

Collection of data on total active invention licenses began in FY 1999 and, thus, the longer-term trend for this measure, either across the Federal labs or by agency, is unknown. However, data on *new* invention licenses executed in the fiscal year have been collected since 1987 (see Appendix Table A.3). And these data suggest that total annual active invention licenses have been consistently growing from a low level in the later 1980s.

[9] The total invention licenses figures cited here for FY 1999 and 2000 are slightly higher than listed in the Department of Commerce’s (Office of Technology Policy) May 2002 *Biennial Report* for FY 1999-2000. The upward revisions reflect counting adjustments applied in FY 2001 by several of the agencies.

All the Federal lab agencies currently have active invention licenses (Figures 3.6a,b). Nonetheless, there are large differences in the comparative levels. HHS and DOE account for the majority of this licensing activity — 37% and 32%, respectively, in FY 2001. NASA (9%), DOD (9%), and USDA (8%) account for most of the rest. The other five departments (DOC, DOI, VA, DOT, EPA) together accounted for 5% of all active invention licenses in FY 2001.

Licensing of Other Intellectual Property. The definition of “Other IP” for the FY 2001 report encompasses the following: computer software, tangible research products (such as biological materials), and protected data.[10]

The agencies reported a total of 1,254 active “Other IP” licenses across all the Federal labs in FY 2001, compared with 1,302 and 1,413 in FY 1999 and 2000, respectively.[11] The vast majority of these are Other IP licenses by DOE (67%) and HHS (29%). The rest is accounted for by NASA (2.9%), VA (0.8%), and DOD (0.4%). The other five agencies reported no active “Other IP” licenses.

License Management Issues. The FY 2001 revised reporting process requested the Federal labs to address the following items:

Elapsed time for license execution: Five of the ten agencies provided statistics for this question. Among these reporting agencies, the median value ranged from 3.1 to 14.4 months. The shortest reported time was 2 months; the longest was 49.9 months.

Licenses terminated for cause: The agencies reported a total of 105 license terminations in FY 2001 (out of 4,396 total active licenses, including inventions and Other IP). DOE accounted for 60 of these; NASA for 23; HHS for 10; and DOC for 7. The other six agencies reported zero or a very small number.

The specific data for these indicators can be found in the statistical summary tables for each agency in Chapter 2.

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[10] To improve clarity, the FY 2001 definition of “Other IP” was revised somewhat from that used for the FY 1999–2000 agency survey. The principal components of the FY 1999–2000 definition were non-patented intellectual property (tangible research products such as biological materials), authored works (such as software, engineering drawings, reference data), and information deemed commercially valuable by a partner and appropriately protected by the lab (such as know-how used at the lab and applied to solve a specific problem relating to the partner’s product). This revision of the definition does not appear to have significantly affected the comparability of the agencies’ counts of Other IP licenses across FY 1999, 2000, and 2001.

[11] The Other IP licenses figures cited here for FY 1999 and 2000 are significantly reduced from those reported previously in the May 2002 *Biennial Report* for FY 1999-2000. These changes reflect corrected data submitted by the DOE.

Figure 3.6(a) Active Invention Licenses, by Agency, FY 1999–2001

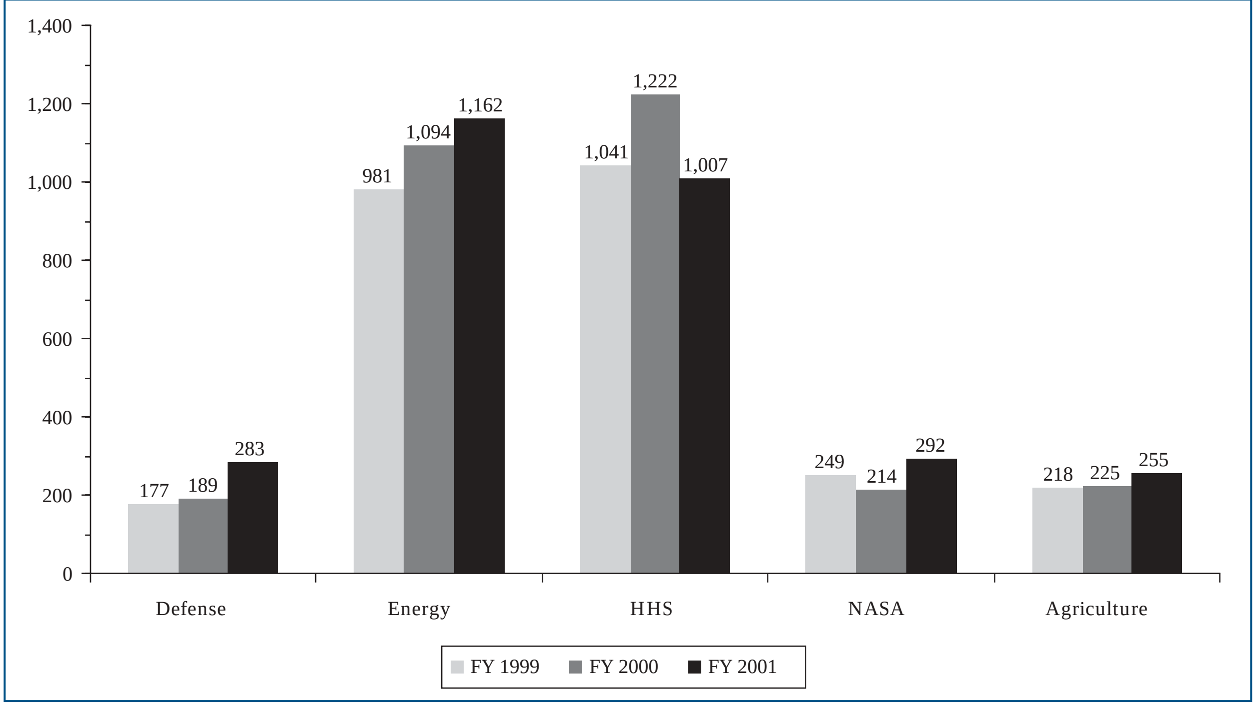
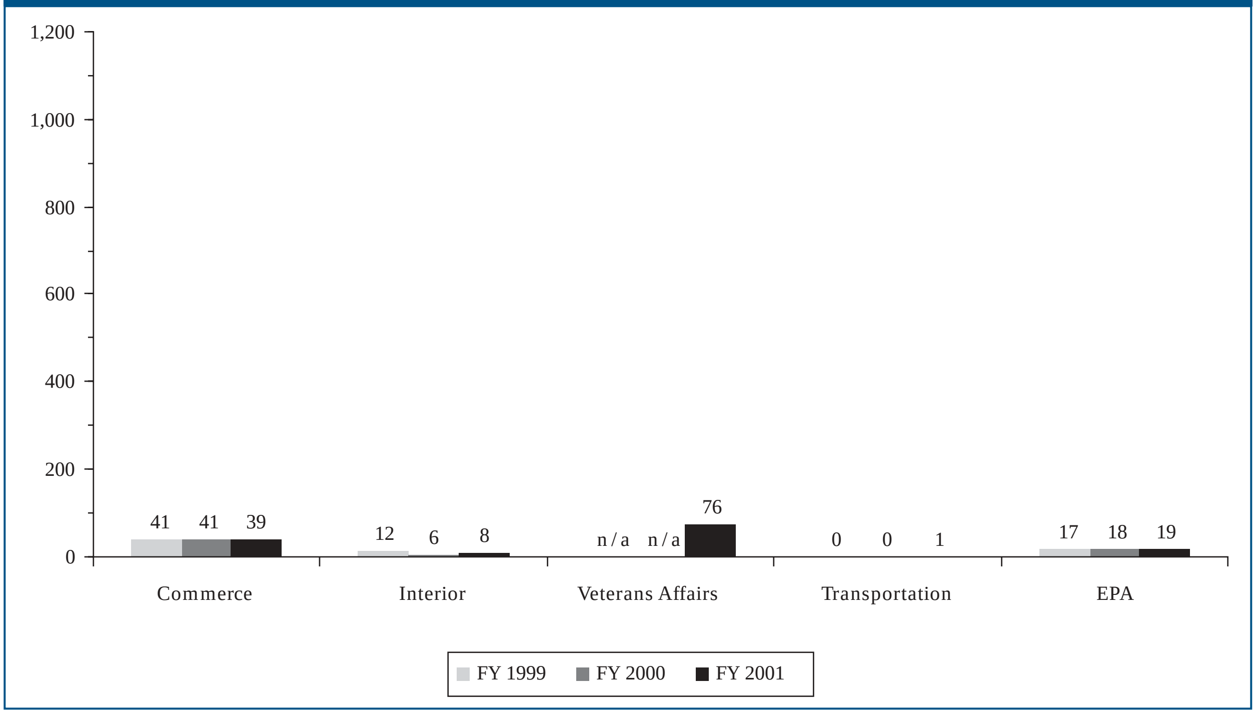
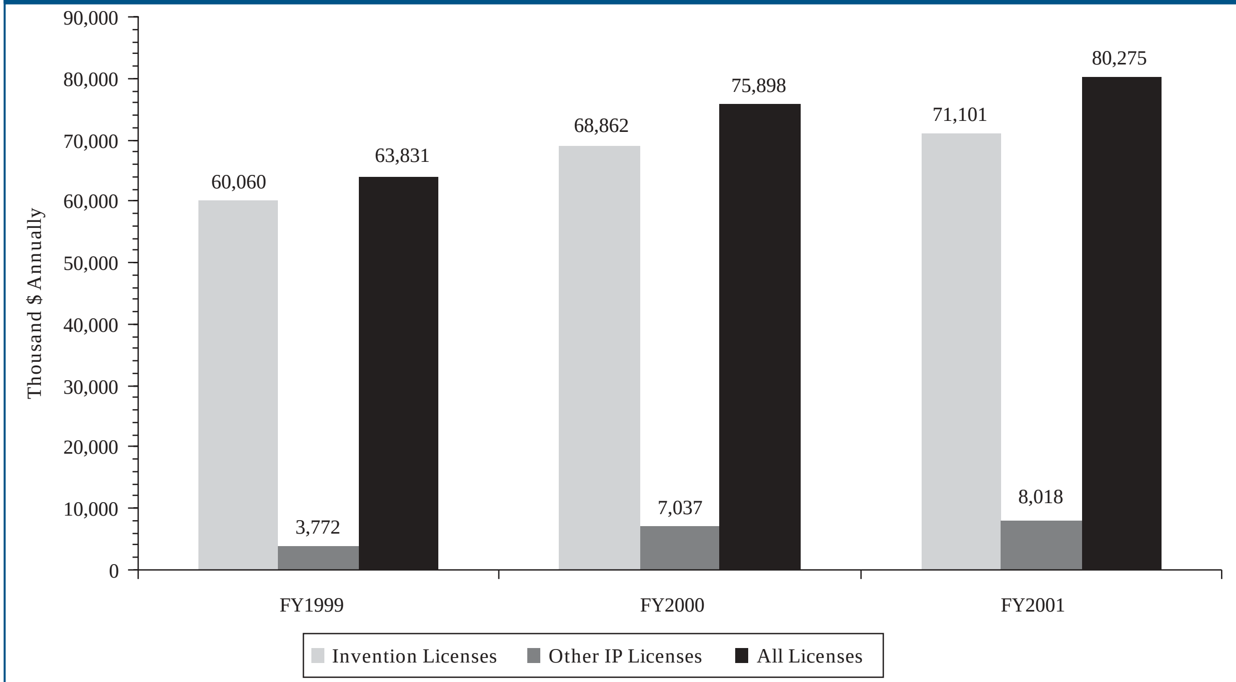


Figure 3.6(b) Active Invention Licenses, by Agency, FY 1999–2001



Income from Licensing

Figure 3.7 Annual Income from Licenses—Inventions and Other IP, All Federal Labs, FY 1999–2001



Income figures in this chart are inclusive of all forms of income forthcoming from active licenses in the fiscal year, whether from earned royalties or other kinds of payments.

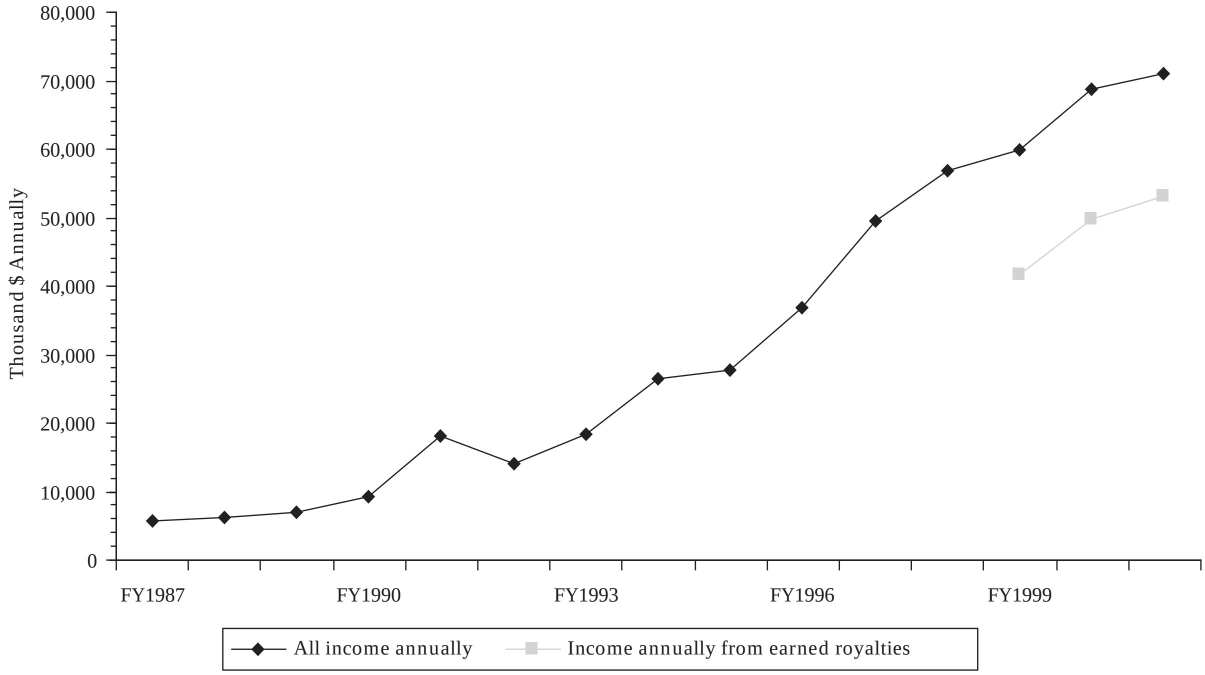
Income from Invention Licenses. The Federal labs reported $71.1 million in income (royalties and other payments) from invention licenses in FY 2001 (Figure 3.7). This figure is about 3% greater than the comparable FY 2000 total of $68.9 million.

Invention license income has grown vigorously for many years (Figure 3.8). Nearly all the agencies presently derive some income annually from invention licenses, and most have experienced a rising level of license income throughout the past decade (Figures 3.9a,b).

Nevertheless, there are significant differences among departments in the amount of income derived from invention licenses. Historically, HHS licenses have predominated, accounting yearly for some 70% of all invention license income for most of the past decade. However, in FY 2001, that majority lessened somewhat; HHS accounted for only about 58%. In the same year, DOE accounted for 27% and DOD for 9%. The other seven agencies, which accounted for the remaining 6%, presently have much smaller annual income flows from invention licensing.

Royalty-Bearing Licenses: For all the Federal labs in FY 2001, some 2,191 licenses were royalty bearing (compared to a total of 3,142 active invention licenses in that year). About 70% of these royalty-bearing licenses were nonexclusive; 22% were exclusive; and 9% were partially exclusive. Agency by agency, however, the distribution among these three kinds of licenses varied widely (see each agency's summary statistics table in Chapter 2 and also Appendix Table A.4).

Figure 3.8 Income Annually from Invention Licenses, All Federal Labs, FY 1987–2001



Figures on earned royalties were not systematically collected from the Federal labs until FY 1999.

Earned Royalty Income: About 75% ($53.2 million) of the $71.1 million invention license income from all Federal labs in FY 2001 came in the form of earned royalty income (Figure 3.8).[12] However, this figure is heavily influenced by HHS' large fraction of all invention license income, as earned royalty income accounted for about 89% of all invention license income at HHS in FY 2001. Earned royalty income's share of all invention license income varied considerably across other agencies, from 40% to 100%.

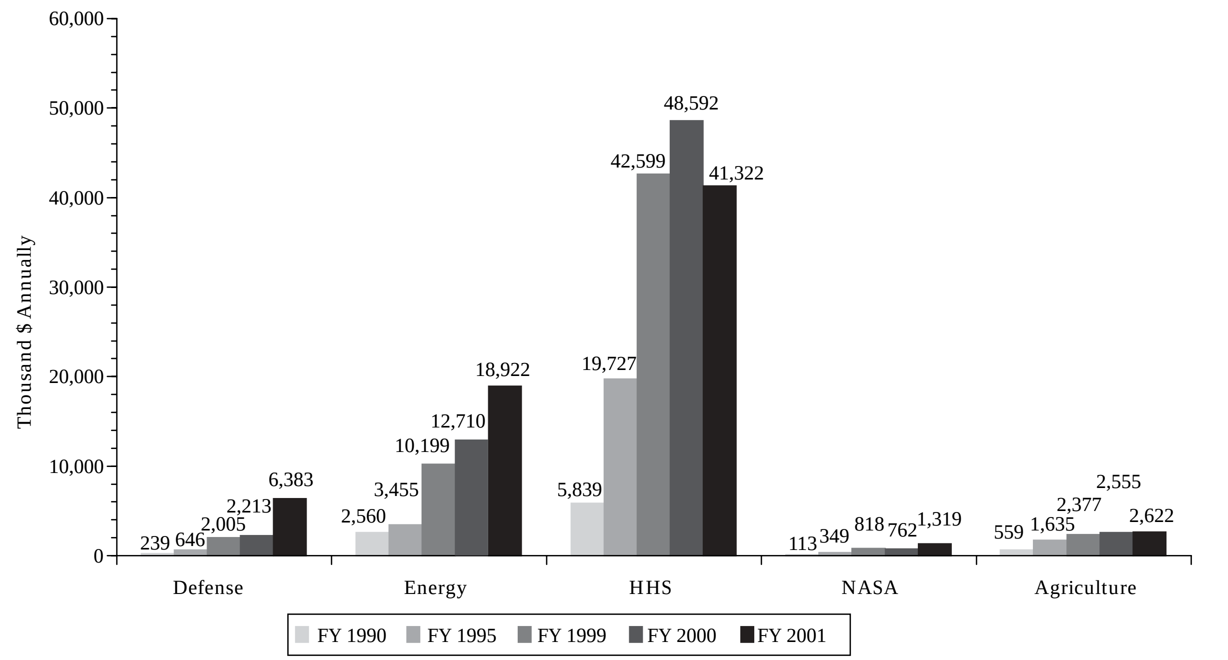
Starting with the FY 2001 reporting, the Federal labs were requested to provide data on the distributional characteristics of the earned royalty income annually per license across their portfolio of active licenses (i.e., median, range, by income percentiles). Four of the ten agencies provided most, if not all, of this information; another three agencies provided at least some key elements. The reported figures differ widely across the agencies; for details, see the summary

[12] "Earned royalties" are annual payments made to a lab by the licensee that are based on the sale or use of licensed laboratory intellectual property. Such payments are earned income from the commercial marketplace, which can be taken as a measure of a lab's active management and successful transfer of its intellectual property.

statistics table for each agency in Chapter 2. In brief summary, earned royalty income per license ranged from several dollars to more than $4.2 million annually; the lowest median value was $4,000 annually, and the highest was $75,000.

Income from "Other Intellectual Property" Licenses. Annual income from "Other IP" licenses by all Federal labs in FY 2001 totaled a little over $8 million. The distribution is as follows: HHS (68%), DOE (23%), NASA (8%), and DOD (1%).

Figure 3.9(a) Annual Income from Invention Licenses, by Agency, Selected Years

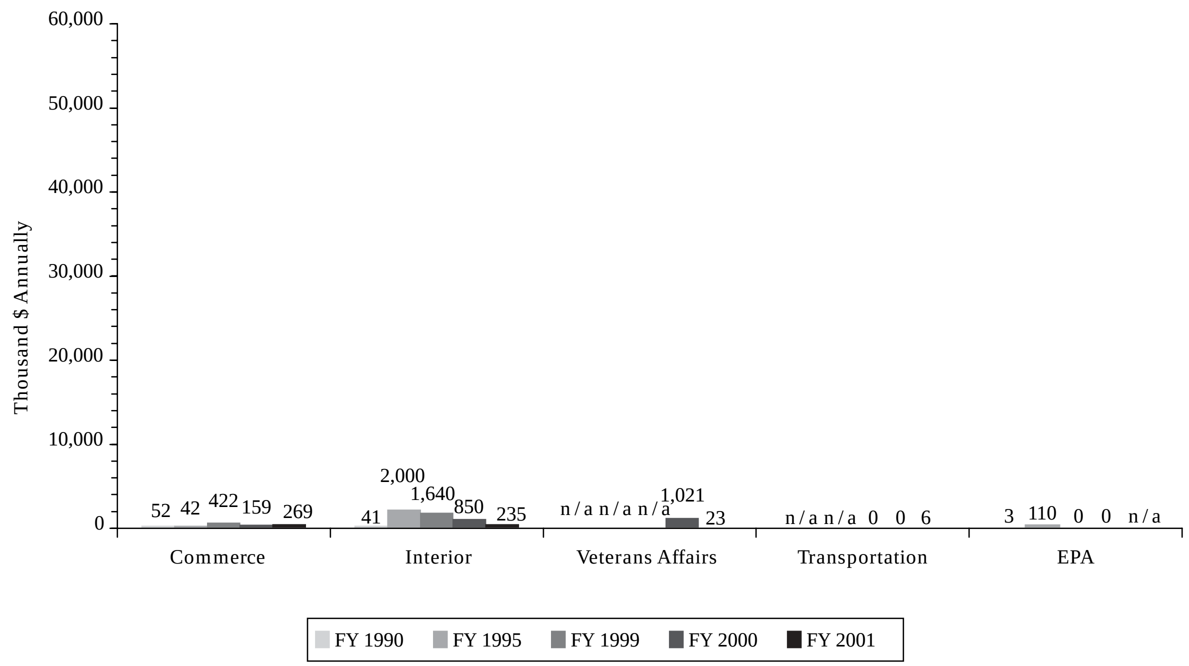


Disposition of Income. As part of the FY 2001 revised reporting process, the Federal labs were asked to provide data on their disposition of income derived from licenses active in the fiscal year — that is, license income dollars distributed to various types of recipients (e.g., inventors, within-agency uses). Eight of the ten agencies provided quantitative responses to this question.

The agencies differed somewhat in the recipient categories used to report. Nonetheless, "to inventors" was common to all the reporting agencies. The range of responses was 0 to 61%, with most of the agencies reporting between 20 and 42%. The balance of disposed income, for most of the agencies, was devoted to internal purposes such as "additional R&D," "patent filing expenses," or "other fees."

Further details on these measures can be found in the statistical summary tables for each agency in Chapter 2.

Figure 3.9(b) Annual Income from Invention Licenses, by Agency, Selected Years



3.4 Other Activity Measures

The FY 2001 revised reporting process provides the Federal labs with the opportunity to include data on “additional” activity measures deemed important in characterizing the overall technology transfer program — that is, measures other than the usual indicators for cooperative R&D, patenting, and licensing.

The DOC’s NIST responded at some length in the FY 2001 reporting, providing a number of supplementary activity measures. Other agencies indicated the prospect of doing so in the future.

- *Department of Commerce, National Institute of Standards and Technology: Standard Reference Materials, Standard Reference Data, calibration services, technical publications.* NIST indicated that the general focus of its technology transfer activities is the broad dissemination of research results to industry, rather than the creation of patents and associated licenses (see DOC section in Chapter 2). Thus, NIST uses a diverse group of mechanisms to transfer the knowledge and technologies that result from its laboratory research. So, in addition to activity data for cooperative R&D, patenting, and licensing, the NIST report also provided quantitative measures (see Chapter 2) for the following:

- **Standard Reference Materials.** Standard Reference Materials (SRMs) are the definitive source of measurement traceability in the United States. NIST produces and disseminates (sells) SRMs to a large and diverse group of customers, including private-sector laboratories, universities, and other Federal agencies. NIST SRMs support industrial materials production and analysis, environmental analysis, health measurements, and basic measurements in science and metrology.

- **Standard Reference Data.** Standard Reference Data titles (SRDs) provide numeric data to scientists and engineers for use in technical problem solving, research, and development. NIST produces and makes available SRDs through sales or free distribution. NIST's SRD databases cover many areas of science, including analytical chemistry, atomic and molecular physics, biotechnology, and materials science.

- **Calibration Services.** NIST laboratories provide physical measurement services for their customers, including calibration services, special tests, and measurement assurance programs (MAPs). Calibration services and special tests are characterizations of particular instruments, devices, and sets of standards with respect to international and national standards. NIST's calibration services are designed to help the makers and users of precision instruments achieve the highest possible levels of measurement quality and productivity. NIST offers more than 500 different types of physical calibrations covering the following measurement areas: dimensional; mechanical, including flow, acoustic, and ultrasonic; thermodynamic; optical radiation; ionizing radiation; electromagnetic; and time and frequency.

- **Technical Publications.** NIST uses publications as one mechanism to transfer the results of its work to the U.S. private sector and to other government agencies that need cutting-edge measurements and standards. Many of these results appear in prestigious scientific journals and withstand peer review by the scientific community. Others appear in technological forums where measurement standards and technologies developed by NIST staff (at times in collaboration with private-sector partners) are disseminated.

In addition, **the National Aeronautics and Space Administration** indicated the important role that communication of information about NASA technologies to industry (including to small businesses and individuals) played in its overall technology transfer program. The NASA report noted a number of current agency venues through which this purpose is being pursued: the agency publishes *Innovations*, *Spin-off*, and *TechBriefs*; it also maintains an agencywide technology transfer database, *TechTracS*, which provides World Wide Web (Internet) access to 18,000 supported NASA technologies. The agency did not, however, provide metrics for these activities for this year's report.

3.5 Outcomes from Technology Transfer

The transfer of Federal lab know-how and technology to private industry partners can provide benefits to the partners and to society. For example, (1) new technology developed by a Federal lab's scientists and engineers (and protected as intellectual property) might be licensed to one or more private industry partners that develop and successfully commercialize new products and processes based on that technology; (2) new technology or know-how developed as the result of a cooperative R&D partnership between a Federal lab and an industrial partner may provide new ways for the industrial partner to improve a product line or production processes; or (3) the same kind of cooperative Federal lab / industry partnership can yield new technology and know-how that may improve the Federal lab's capabilities for its mission-related work. Realizing such outcomes continues to be a primary motivation for Federal technology transfer policy.

It is often difficult, however, to analytically demonstrate direct connections between Federal lab technology transfer actions and eventual commercial products / processes, because many actors and actions may be involved after transfer from a Federal lab. Moreover, the actual development and commercialization of an idea often takes a number of years, so that tangible results can take some time before becoming apparent.

To better understand what outcomes are being achieved from Federal lab technology transfer, the agencies have been invited as part of the overall annual reporting process (starting with the Department of Commerce's *Biennial Report* of May 2002 and continuing on in the present report) to submit current examples of successful downstream technology transfer outcomes.

The example cases submitted as part of the FY 2001 activities report are described in each agency's section in Chapter 2. As a summary tally of this FY 2001 outcomes information, all 10 of the agencies indicated that there had been successful downstream outcomes from the technology transfer of their Federal labs. Eight of the ten agencies provided several illustrations of these successes (which are described in Chapter 2).

CHAPTER 4
AGENCY PROGRESS IN STRENGTHENING PERFORMANCE METRICS

Throughout the past few years there has been significant progress in improving the data available about the current activities and achievements of Federal lab technology transfer programs. Some of this progress reflects the agencies' need to respond to the new and expanding requirements for statutory reporting. Some is the result of agency efforts to improve overall management capabilities, of which technology transfer is a part. At the same time, there remain some enduring challenges for performance metrics, particularly with regard to program productivity and effectiveness.

- **Improvements in Technology Transfer Data from the Expanded Statutory Reporting**

The new reporting requirements of the Technology Transfer Commercialization Act of 2000 (TTCA) have prompted improvements in the scope and quality of the data from the Federal labs about the status of their technology transfer programs. This has added to improvements that were already underway as part of the evolving procedures for the Biennial Report, prepared by the Department of Commerce's Office of Technology Policy (OTP), under the Stevenson-Wydler Act.

For the *FY 1999–2000 Biennial Report*, OTP developed a more extensive survey instrument to collect data on technology transfer activities from the Federal labs. New questions were asked to better gauge the latest trends in cooperative R&D relationships and licensing. A wider set of questions about licensing activities was raised—such as questions about royalty income and the licensing of intellectual property other than patented inventions. Also, in recognition of strong congressional and administration interest, the Federal labs were asked to provide examples of downstream outcomes resulting from their technology transfer activities (such as new products in the commercial marketplace, improved private industry production processes, or enhanced Federal lab capabilities flowing back from joint R&D activities with outside partners). The agencies generally were responsive to OTP's request for such data.

Changes in the Federal lab reporting process instituted in 2002 as part of implementing the TTCA have further expanded the scope of the data collection. Notably, the new law required the Federal labs to discuss in some depth how they managed their intellectual property and the nature of their current programs and plans to implement the technology transfer function. It also requested greater statistical detail about licensing—concerning the nature and distribution of earned royalty income, the annual disposition of income (e.g., to inventors, to other agency purposes), and licensing management practices (such as the time involved in license execution). As noted in Chapter 1, OTP worked closely with the Interagency Working Group on Technology Transfer to review and refine the data collection procedures of the existing Stevenson-Wydler Act reporting and to integrate the TTCA's new data requirements. That process yielded general guidelines and clarifications of data collection issues that were useful to the agencies in preparing their own annual reports in 2002.

Similarly, in this first cycle of reporting under the new TTCA procedures, the Federal labs generally were responsive in reporting the required data. Not all agencies were able to respond completely to all the data requests—but most agencies proved able to provide much of it. The greatest difficulty appeared to be posed by some of the new questions related to license income and license management, for which data were not immediately available to some of the agencies. However, it appears that most data limitations should diminish in subsequent reporting cycles.

One development emerging from the Interagency Working Group's efforts to craft general guidelines for metric reporting under the TTCA was the desire of some of the agencies to include performance measures for technology transfer beyond the usual indicators for CRADAs, invention licensing, and the like. This stemmed from perceptions that for some agencies the technology transfer mission may be achieved in part through means other than sole use of the Stevenson-Wydler and Bayh-Dole authorities—such as through novel R&D partnering arrangements, technical publishing, and guest use of research facilities. This first Summary Report provides metrics data for such "other" activities by two agencies: the USDA's Agricultural Research Service use of Trust Fund / Reimbursable Cooperative Agreements as another option for establishing cooperative R&D relationships with external partners and the DOC's National Institute of Standards and Technology use of guest researchers and facility users, Standard Reference Materials, Standard Reference Data, calibration services, and technical publications as key components of the overall technology transfer effort (see Chapter 3 for details). In future reporting cycles, other agencies may elect to broaden their reporting in similar ways.

With respect to information about downstream outcomes from technology transfer, in both the FY 2001 reporting under the TTCA and earlier in the *FY 1999–2000 Biennial Report*, the agencies presented numerous examples of success (typically in the form of case histories). The extent of the information provided indicates there is much the agencies are able to cite in this vein. The agencies appear to clearly recognize the interest in, and importance of, explaining the benefits that arise from the investment of public resources in R&D. Some agencies have indicated plans to expand their abilities to better track the downstream results of the technology transfer they initiate. Thus, it appears likely that agencies' information about outcomes will increase in future reporting cycles.

- **Agency Efforts to Strengthen Technology Transfer Metrics to Improve Overall Agency Management Capabilities—A Current Example**

Some agencies are also now seeking to improve their metrics and data for technology transfer as part of a larger plan to improve overall agency management performance. The **Department of Energy's** current efforts are particularly notable. With support from the organizations managing and operating its national laboratories and other facilities, the Department has recently developed a "Reporting and Appraisal Guide for Technology Partnering Programs."[1] This guide serves as an aid to systematic organization and reporting of technology partnership data and suggests objectives and measures for comprehensive and consistent evaluation of laboratory and facility performance in this area.

DOE views technology partnering—defined to include an array of activities associated with technology transfer, research collaborations, use of scientific facilities, and intellectual property—as an increasingly important means (in addition to contracts, grants, and other forms of financial assistance) for DOE to accomplish its public missions. Similarly, DOE's partners view technology partnering as an increasingly attractive means by which they can access the unique technical expertise of DOE facilities and technical personnel to help them solve problems and meet their own organizational goals.

Consistent with this growth in activity, there is growing interest in reporting information regarding technology partnering and including the matter as an area in the periodic performance appraisals of the management and operations of DOE's laboratories and facilities. Field practices for technology partnering vary widely depending on the needs and requirements of each DOE laboratory and facility, as facilities differ in the extent and nature of their partnering activities. In addition, data collection methods in the past were *ad hoc,* complicated by inconsistently defined terms, and did not well anticipate reporting needs of higher authorities.

In 2001, DOE's Technology Transfer Working Group, made up primarily of representatives from DOE headquarters and its regional offices, recognized the need for more consistent and effective methods for both reporting and evaluating technology transfer and partnership activities. This group organized a team, including additional representatives from the contractors that manage and operate DOE laboratories and facilities, that was chartered to develop a guide that would (a) provide voluntary guidelines for appraising technology transfer performance and (b) standardize requirements for record-keeping and reporting in order to satisfy a variety of monthly, quarterly, and annual reporting needs.

The resulting DOE "Reporting and Appraisal Guide for Technology Partnering Programs," completed in June 2002, provides a useful blueprint for the entire DOE technology transfer community. It provides a standard guide across a diverse DOE complex for setting expectations regarding performance and systematizing data gathering and reporting. It is also a help-

[1] Currently, an internal DOE working paper, dated June 1, 2002.

ful reference for training new technology transfer practitioners. Finally, the guide is expected to improve administrative efficiency and lessen burdens of reporting to higher authorities by lending more coherency to record-keeping and standardizing automated reporting formats.

- **Other Observations about Performance Metrics for Technology Transfer**

What remains the most difficult metrics challenge for the technology transfer community is to identify and put measures in place that can help technology transfer managers better understand the effectiveness and productivity of the programs they operate. Counts of licenses, CRADAs, royalty income, and other traditional measures are typically not difficult to assemble —although significant time and resources may be needed to establish appropriate databases, particularly where an agency's technology transfer activities are widely distributed across numerous labs. Such data can be useful in providing a picture of the priorities and depth of an agency's technology transfer activities. But these measures do not directly address questions about program effectiveness or productivity—such as how well collaborative R&D relationships with external partners are working, whether the licensing strategies employed are facilitating new technology commercialization to the maximum extent, and what return on investment is being realized from the eventual downstream outcomes. This finding is not particularly new, but it highlights the primary area of performance metrics where the community yet needs to make progress.

Finally, the TTCA's requirement for each agency to provide an annual discussion of the current plans for its Federal lab technology transfer programs and the intended contributions to agency mission could galvanize the agencies' thinking about the scope and priorities of their technology transfer activities. For most agencies, this benefit was probably not fully realized in this first cycle of reporting under the TTCA.

APPENDIX

STATISTICAL TABLES FY: 1987–2001

Table A.1 Cooperative Research and Development Agreements (CRADAS) by Federal Laboratories and Research Centers

		FY1987	FY1988	FY1989	FY1990	FY1991	FY1992	FY1993	FY1994	FY1995	FY1996	FY1997	FY1998	FY1999	FY2000	FY2001
Agriculture	CRADAs, total active	9	51	98	128	177	172	172	208	229	244	273	288	298	257	219
	New in FY	---	---	---	---	---	---	---	---	---	---	93	102	101	69	49
	Nontraditional, total active	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0
	New in FY	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0
Commerce	CRADAs, total active	0	9	44	82	115	177	292	368	407	406	377	337	275	221	188
	New in FY	---	---	---	---	---	---	---	---	---	---	90	77	67	46	26
	Nontraditional, total active	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0
	New in FY	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0
Defense	CRADAs, total active	3	10	36	113	193	277	365	563	845	1,086	1,360	1,424	1,350	1,364	1,965
	New in FY	---	---	---	---	---	---	---	---	---	---	408	399	449	425	459
	Nontraditional, total active	---	---	---	---	---	---	---	---	---	---	---	---	---	---	330
	New in FY	---	---	---	---	---	---	---	---	---	---	---	---	---	---	82
Energy	CRADAs, total active	0	0	0	1	43	250	582	1,094	1,392	1,677	963	868	715	687	558
	New in FY	---	---	---	---	---	---	---	---	---	---	274	266	240	151	204
	Nontraditional, total active	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0
	New in FY	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0
EPA	CRADAs, total active	0	0	2	11	31	30	28	35	30	35	34	37	38	44	48
	New in FY	---	---	---	---	---	---	---	---	---	---	11	12	13	10	19
	Nontraditional, total active	---	---	---	---	---	---	---	---	---	---	---	---	---	---	3
	New in FY	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1
HHS	CRADAs, total active	22	28	89	110	144	146	149	147	152	n/a	n/a	n/a	468	438	490
	New in FY	---	---	---	---	---	---	---	---	---	87	153	149	136	125	137
	Nontraditional, total active	---	---	---	---	---	---	---	---	---	n/a	n/a	n/a	231	194	209
	New in FY	---	---	---	---	---	---	---	---	---	43	121	106	78	75	76
Interior	CRADAs, total active	0	0	1	12	11	1	3	9	15	22	23	30	30	40	50
	New in FY	---	---	---	---	---	---	---	---	---	---	9	7	10	8	21
	Nontraditional, total active	---	---	---	---	---	---	---	---	---	---	---	---	---	---	9
	New in FY	---	---	---	---	---	---	---	---	---	---	---	---	---	---	7
NASA (1)	CRADAs, total active	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
	New in FY	---	---	---	---	---	---	---	---	---	---	0	0	1	0	0
	Nontraditional, total active	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0
	New in FY	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0
Transportation	CRADAs, total active	0	0	0	1	9	17	30	38	37	43	36	39	51	79	82
	New in FY	---	---	---	---	---	---	---	---	---	---	14	13	5	38	11
	Nontraditional, total active	---	---	---	---	---	---	---	---	---	---	---	---	---	---	4
	New in FY	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0
Veterans Affairs	CRADAs, total active	0	0	1	2	8	8	7	9	14	17	12	15	1	2	2
	New in FY	---	---	---	---	---	---	---	---	---	---	6	9	1	2	0
	Nontraditional, total active	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0
	New in FY	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0

Table A.1 Cooperative Research and Development Agreements (CRADAS) by Federal Laboratories and Research Centers

		FY1987	FY1988	FY1989	FY1990	FY1991	FY1992	FY1993	FY1994	FY1995	FY1996	FY1997	FY1998	FY1999	FY2000	FY2001
Totals	CRADAs, total active	34	98	271	460	731	1,078	1,628	2,471	3,121	3,530	3,078	3,038	3,227	3,133	3,603
	New in FY	---	---	---	---	---	---	---	---	---	---	1,058	1,034	1,023	874	926
	Nontraditional, total active	---	---	---	---	---	---	---	---	---	0	0	0	231	194	555
	New in FY	---	---	---	---	---	---	---	---	---	43	121	106	78	75	166

n/a = requested agency data not available at time of this report. --- = data not requested from agency in reporting for prior years.

NOTES: The figures reported by the agencies are for all CRADAs established under the authority of 15 U.S.C. Sec. 3710a. This includes "nontraditional" CRADAS such as those arranged by the National Institutes of Health. starting in FY 1996 to transfer the research materials of its intramural laboratories. Beginning with FY 2001, the agencies have been asked to identify how many of their total active CRADAs have this "nontraditional" status.

FY 2001 is the first year for which agency data on Federal lab technology transfer is available through the revised reporting process of the Technology Transfer Commercialization Act of 2000. Figures for FY 1987-2000 reflect the biennial reporting process established by the Federal Technology Transfer Act of 1986.
Figures on the number of new CRADAs yearly were not requested from the agencies until FY 1997 and, in general, are not readily available for the prior years.

(1) Prior to 1999, NASA performed all of its technology transfer under the provisions of the 1958 Space Act.

Table A.2 Invention Disclosure and Patenting by Federal Laboratories and Research Centers

		FY1987	FY1988	FY1989	FY1990	FY1991	FY1992	FY1993	FY1994	FY1995	FY1996	FY1997	FY1998	FY1999	FY2000	FY2001
Agriculture	Inventions disclosed	83	144	127	158	127	83	110	111	133	129	260	208	162	109	118
	Patent applications filed	44	50	71	76	110	70	68	40	80	91	56	64	84	78	83
	Patents issued	---	---	---	---	---	---	---	---	---	---	45	75	74	64	64
Commerce	Inventions disclosed	43	31	49	46	30	55	66	51	65	71	58	40	35	32	26
	Patent applications filed	8	15	28	28	18	53	43	41	35	60	49	66	27	18	12
	Patents issued	---	---	---	---	---	---	---	---	---	---	23	19	26	14	22
Defense	Inventions disclosed	953	1,147	1,153	1,383	1,524	1,283	1,189	1,172	1,168	1,115	1,150	1,028	1,060	991	1,005
	Patent applications filed	343	447	616	807	919	850	835	732	759	716	735	755	703	774	809
	Patents issued	---	---	---	---	---	---	---	---	---	---	554	579	547	553	619
Energy	Inventions disclosed	857	1,003	1,053	1,335	1,666	1,698	1,443	1,588	1,758	1,886	1,500	1,313	1,474	1,371	1,527
	Patent applications filed	252	336	382	366	397	432	497	543	571	564	705	751	850	788	792
	Patents issued	---	---	---	---	---	---	---	---	---	---	384	512	525	515	605
EPA	Inventions disclosed	0	0	0	12	20	9	22	19	15	20	9	14	5	11	17
	Patent applications filed	4	5	5	6	8	12	15	15	24	18	13	11	15	10	7
	Patents issued	---	---	---	---	---	---	---	---	---	---	12	1	8	6	12
HHS	Inventions disclosed	194	226	209	215	215	311	282	307	307	305	268	287	328	375	434
	Patent applications filed	98	145	225	239	261	224	193	171	166	147	148	132	241	263	255
	Patents issued	---	---	---	---	---	---	---	---	---	---	152	171	180	132	119
Interior	Inventions disclosed	3	6	3	26	26	1	2	2	2	2	5	5	8	16	6
	Patent applications filed	5	4	11	15	21	1	2	2	2	2	2	5	3	5	22
	Patents issued	---	---	---	---	---	---	---	---	---	---	1	3	1	4	4
NASA	Inventions disclosed	496	462	532	538	570	416	384	457	517	550	550	554	525	574	696
	Patent applications filed	94	129	125	181	205	225	185	179	164	123	140	105	129	109	151
	Patents issued	---	---	---	---	---	---	---	---	---	---	94	105	87	99	159
Transportation	Inventions disclosed	0	0	0	1	2	1	1	1	0	4	2	4	1	0	2
	Patent applications filed	0	0	0	1	1	0	0	1	2	2	1	3	0	3	3
	Patents issued	---	---	---	---	---	---	---	---	---	---	0	1	0	3	0

Table A.2 Invention Disclosure and Patenting by Federal Laboratories and Research Centers

		FY1987	FY1988	FY1989	FY1990	FY1991	FY1992	FY1993	FY1994	FY1995	FY1996	FY1997	FY1998	FY1999	FY2000	FY2001
Veterans Affairs	Inventions disclosed	33	28	42	58	33	44	39	45	36	71	40	50	48	85	78
	Patent applications filed	n/a	n/a	3	8	n/a	0	0	0	0	0	1	2	37	35	38
	Patents issued	---	---	---	---	---	---	---	---	---	---	n/a	n/a	0	1	4
Totals	Inventions disclosed	2,662	3,047	3,168	3,772	4,213	3,901	3,538	3,753	4,001	4,153	3,842	3,503	3,646	3,564	3,909
	Patent applications filed	848	1,131	1,466	1,727	1,940	1,867	1,838	1,724	1,803	1,723	1,850	1,894	2,089	2,083	2,172
	Patents issued	---	---	---	---	---	---	---	---	---	---	1,265	1,466	1,448	1,391	1,608

n/a = requested agency data not available at time of this report.   --- = data not requested from agency in reporting for prior years

NOTES: FY 2001 is the first year for which agency data on federal lab tech transfer is available through the revised reporting process of the Technology Transfer Commercialization Act of 2000. Figures for FY 1987-2000 reflect the Biennial Reporting process established by the Federal Technology Transfer Act of 1986.

Figures on the number of patents issued yearly were not requested from the agencies until FY 1997 and, in general, are not readily available for the prior years. For several of the years reported, the government-wide totals for lab patent applications and patents issued ignore the presence of n/a entries in the departmental data. However, the missing figures are few and small in magnitude and do not substantially bias the federal-wide totals provided.

Table A.3 Licensing—Inventions and Other Intellectual Property by Federal Laboratories and Research Centers

		FY1987	FY1988	FY1989	FY1990	FY1991	FY1992	FY1993	FY1994	FY1995	FY1996	FY1997	FY1998	FY1999	FY2000	FY2001
Agriculture	Total licenses active in the FY	---	---	---	---	---	---	---	---	---	---	---	---	218	225	255
	Invention licenses, active in the FY	---	---	---	---	---	---	---	---	---	---	---	---	218	225	255
	New, executed in the FY	30	24	23	33	29	31	28	9	21	26	22	23	29	24	31
	Other IP licenses, active in the FY	---	---	---	---	---	---	---	---	---	---	---	---	0	0	0
	For non-patented IP	---	---	---	---	---	---	---	---	---	---	---	---	0	0	---
	For authored works	---	---	---	---	---	---	---	---	---	---	---	---	0	0	---
	For other info. deemed commercially valuable	---	---	---	---	---	---	---	---	---	---	---	---	0	0	---
	Elapsed time, licenses executed in FY median (months)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	3.1
	minimum	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2
	maximum	---	---	---	---	---	---	---	---	---	---	---	---	---	---	6
	Licenses terminated for cause in the FY	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1
Commerce	Total licenses active in the FY	---	---	---	---	---	---	---	---	---	---	---	---	41	41	39
	Invention licenses, active in the FY	---	---	---	---	---	---	---	---	---	---	---	---	41	41	39
	New, executed in the FY	0	0	1	0	2	5	3	3	4	10	11	17	7	4	5
	Other IP licenses, active in the FY	---	---	---	---	---	---	---	---	---	---	---	---	0	0	0
	For non-patented IP	---	---	---	---	---	---	---	---	---	---	---	---	0	0	---
	For authored works	---	---	---	---	---	---	---	---	---	---	---	---	0	0	---
	For other info. deemed commercially valuable	---	---	---	---	---	---	---	---	---	---	---	---	0	0	---
	Elapsed time, licenses executed in FY median (months)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	5
	minimum	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2
	maximum	---	---	---	---	---	---	---	---	---	---	---	---	---	---	8
	Licenses terminated for cause in the FY	---	---	---	---	---	---	---	---	---	---	---	---	---	---	7
Defense	Total licenses active in the FY	---	---	---	---	---	---	---	---	---	---	---	---	193	208	288
	Invention licenses, active in the FY	---	---	---	---	---	---	---	---	---	---	---	---	177	189	283
	New, executed in the FY	10	10	14	15	25	19	20	28	34	41	34	34	61	67	49
	Other IP licenses, active in the FY	---	---	---	---	---	---	---	---	---	---	---	---	16	19	5
	For non-patented IP	---	---	---	---	---	---	---	---	---	---	---	---	16	19	---
	For authored works	---	---	---	---	---	---	---	---	---	---	---	---	0	0	---
	For other info. deemed commercially valuable	---	---	---	---	---	---	---	---	---	---	---	---	0	0	---
	Elapsed time, licenses executed in FY median (months)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	n/a
	minimum	---	---	---	---	---	---	---	---	---	---	---	---	---	---	n/a
	maximum	---	---	---	---	---	---	---	---	---	---	---	---	---	---	n/a
	Licenses terminated for cause in the FY	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2
Energy	Total licenses active in the FY	---	---	---	---	---	---	---	---	---	---	---	---	1,922	2,070	2,005
	Invention licenses, active in the FY	---	---	---	---	---	---	---	---	---	---	---	---	981	1,094	1,162
	New, executed in the FY	37	43	57	62	75	81	96	118	140	154	175	162	202	169	226
	Other IP licenses, active in the FY	---	---	---	---	---	---	---	---	---	---	---	---	941	976	843
	For non-patented IP	---	---	---	---	---	---	---	---	---	---	---	---	49	92	---
	For authored works	---	---	---	---	---	---	---	---	---	---	---	---	854	844	---
	For other info. deemed commercially valuable	---	---	---	---	---	---	---	---	---	---	---	---	38	40	---
	Elapsed time, licenses executed in FY median (months)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	n/a
	minimum	---	---	---	---	---	---	---	---	---	---	---	---	---	---	n/a
	maximum	---	---	---	---	---	---	---	---	---	---	---	---	---	---	n/a
	Licenses terminated for cause in the FY	---	---	---	---	---	---	---	---	---	---	---	---	---	---	
EPA	Total licenses active in the FY	---	---	---	---	---	---	---	---	---	---	---	---	17	18	19
	Invention licenses, active in the FY	---	---	---	---	---	---	---	---	---	---	---	---	17	18	19
	New, executed in the FY	0	0	0	1	2	2	2	9	1	2	1	0	2	3	4
	Other IP licenses, active in the FY	---	---	---	---	---	---	---	---	---	---	---	---	0	0	0
	For non-patented IP	---	---	---	---	---	---	---	---	---	---	---	---	0	0	---
	For authored works	---	---	---	---	---	---	---	---	---	---	---	---	0	0	---
	For other info. deemed commercially valuable	---	---	---	---	---	---	---	---	---	---	---	---	0	0	---
	Elapsed time, licenses executed in FY median (months)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	n/a
	minimum	---	---	---	---	---	---	---	---	---	---	---	---	---	---	3
	maximum	---	---	---	---	---	---	---	---	---	---	---	---	---	---	10
	Licenses terminated for cause in the FY	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0

Table A.3 Licensing—Inventions and Other Intellectual Property by Federal Laboratories and Research Centers

		FY1987	FY1988	FY1989	FY1990	FY1991	FY1992	FY1993	FY1994	FY1995	FY1996	FY1997	FY1998	FY1999	FY2000	FY2001
HHS	Total licenses active in the FY	---	---	---	---	---	---	---	---	---	---	---	---	1,364	1,608	1,367
	Invention licenses, active in the FY	---	---	---	---	---	---	---	---	---	---	---	---	1,041	1,222	1,007
	New, executed in the FY	35	42	48	47	69	96	99	151	176	193	208	215	208	192	212
	Other IP licenses, active in the FY	---	---	---	---	---	---	---	---	---	---	---	---	323	386	360
	For non-patented IP	---	---	---	---	---	---	---	---	---	---	---	---	323	386	---
	For authored works	---	---	---	---	---	---	---	---	---	---	---	---	0	0	---
	For other info. deemed commercially valuable	---	---	---	---	---	---	---	---	---	---	---	---	0	0	---
	Elapsed time, licenses executed in FY median (months)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	n/a
	minimum	---	---	---	---	---	---	---	---	---	---	---	---	---	---	n/a
	maximum	---	---	---	---	---	---	---	---	---	---	---	---	---	---	n/a
	Licenses terminated for cause in the FY	---	---	---	---	---	---	---	---	---	---	---	---	---	---	10
Interior	Total licenses active in the FY	---	---	---	---	---	---	---	---	---	---	---	---	12	6	8
	Invention licenses, active in the FY	---	---	---	---	---	---	---	---	---	---	---	---	12	6	8
	New, executed in the FY	3	3	0	0	0	n/a	n/a	8	3	n/a	0	0	0	2	2
	Other IP licenses, active in the FY	---	---	---	---	---	---	---	---	---	---	---	---	0	0	0
	For non-patented IP	---	---	---	---	---	---	---	---	---	---	---	---	0	0	---
	For authored works	---	---	---	---	---	---	---	---	---	---	---	---	0	0	---
	For other info. deemed commercially valuable	---	---	---	---	---	---	---	---	---	---	---	---	0	0	---
	Elapsed time, licenses executed in FY median (months)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	3.5
	minimum	---	---	---	---	---	---	---	---	---	---	---	---	---	---	3
	maximum	---	---	---	---	---	---	---	---	---	---	---	---	---	---	4
	Licenses terminated for cause in the FY	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0
NASA	Total licenses active in the FY	---	---	---	---	---	---	---	---	---	---	---	---	271	246	328
	Invention licenses, active in the FY	---	---	---	---	---	---	---	---	---	---	---	---	249	214	292
	New, executed in the FY	13	7	7	6	4	5	12	11	29	36	36	40	40	47	42
	Other IP licenses, active in the FY	---	---	---	---	---	---	---	---	---	---	---	---	22	32	36
	For non-patented IP	---	---	---	---	---	---	---	---	---	---	---	---	0	0	---
	For authored works	---	---	---	---	---	---	---	---	---	---	---	---	22	32	---
	For other info. deemed commercially valuable	---	---	---	---	---	---	---	---	---	---	---	---	0	0	---
	Elapsed time, licenses executed in FY median (months)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	14.4
	minimum	---	---	---	---	---	---	---	---	---	---	---	---	---	---	4
	maximum	---	---	---	---	---	---	---	---	---	---	---	---	---	---	49.9
	Licenses terminated for cause in the FY	---	---	---	---	---	---	---	---	---	---	---	---	---	---	23
Transportation	Total licenses active in the FY	---	---	---	---	---	---	---	---	---	---	---	---	0	0	1
	Invention licenses, active in the FY	---	---	---	---	---	---	---	---	---	---	---	---	0	0	1
	New, executed in the FY	0	0	0	0	0	n/a	n/a	n/a	n/a	n/a	0	1	0	0	1
	Other IP licenses, active in the FY	---	---	---	---	---	---	---	---	---	---	---	---	0	0	0
	For non-patented IP	---	---	---	---	---	---	---	---	---	---	---	---	0	0	---
	For authored works	---	---	---	---	---	---	---	---	---	---	---	---	0	0	---
	For other info. deemed commercially valuable	---	---	---	---	---	---	---	---	---	---	---	---	0	0	---
	Elapsed time, licenses executed in FY median (months)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	n/a
	minimum	---	---	---	---	---	---	---	---	---	---	---	---	---	---	n/a
	maximum	---	---	---	---	---	---	---	---	---	---	---	---	---	---	n/a
	Licenses terminated for cause in the FY	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0

Table A.3 Licensing—Inventions and Other Intellectual Property by Federal Laboratories and Research Centers

		FY1987	FY1988	FY1989	FY1990	FY1991	FY1992	FY1993	FY1994	FY1995	FY1996	FY1997	FY1998	FY1999	FY2000	FY2001
Veterans Affairs	Total licenses active in the FY	---	---	---	---	---	---	---	---	---	---	---	---	n/a	n/a	86
	Invention licenses, active in the FY	---	---	---	---	---	---	---	---	---	---	---	---	n/a	n/a	76
	New, executed in the FY	0	0	0	0	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	47	3	5
	Other IP licenses, active in the FY	---	---	---	---	---	---	---	---	---	---	---	---	0	0	10
	For non-patented IP	---	---	---	---	---	---	---	---	---	---	---	---	0	0	---
	For authored works	---	---	---	---	---	---	---	---	---	---	---	---	0	0	---
	For other info. deemed commercially valuable	---	---	---	---	---	---	---	---	---	---	---	---	0	0	---
	Elapsed time, licenses executed in FY median (months)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	n/a
	minimum	---	---	---	---	---	---	---	---	---	---	---	---	---	---	n/a
	maximum	---	---	---	---	---	---	---	---	---	---	---	---	---	---	n/a
	Licenses terminated for cause in the FY	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2
Totals	Total licenses active in the FY	---	---	---	---	---	---	---	---	---	---	---	---	4,038	4,422	4,396
	Invention licenses, active in the FY	---	---	---	---	---	---	---	---	---	---	---	---	2,736	3,009	3,142
	New, executed in the FY	128	129	150	164	206	239	260	337	408	462	487	492	596	511	577
	Other IP licenses, active in the FY	---	---	---	---	---	---	---	---	---	---	---	---	1,302	1,413	1,254
	For non-patented IP	---	---	---	---	---	---	---	---	---	---	---	---	388	497	---
	For authored works	---	---	---	---	---	---	---	---	---	---	---	---	876	876	---
	For other info. deemed commercially valuable	---	---	---	---	---	---	---	---	---	---	---	---	38	40	---
	Elapsed time, licenses executed in FY median (months)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	n/a
	minimum	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2
	maximum	---	---	---	---	---	---	---	---	---	---	---	---	---	---	49.9
	Licenses terminated for cause in the FY	---	---	---	---	---	---	---	---	---	---	---	---	---	---	105

n/a = requested agency data not available at time of this report. --- = data not requested from agency in reporting for prior years.

NOTES: FY 2001 is the first year for which agency data on federal lab tech transfer is available through the revised reporting process of the Technology Transfer Commercialization Act of 2000. Figures for FY 1987-2000 reflect the Biennial Reporting process established by the Federal Technology Transfer Act of 1986.

Many of the data elements in this table were not requested from the federal lab agencies until FY 1999; some not until FY 2001.

Table A.4 Income From Licensing by Federal Laboratories and Research Centers

			FY1987	FY1988	FY1989	FY1990	FY1991	FY1992	FY1993	FY1994	FY1995	FY1996	FY1997	FY1998	FY1999	FY2000	FY2001
Agriculture	Total income, all licenses active in the FY	(thousand $)	---	---	---	---	---	---	---	---	---	---	---	---	$2,377.0	$2,555.0	$2,622.0
	Income from invention licenses		$133.0	$120.0	$420.0	$559.0	$836.0	$1,044.0	$1,483.0	$1,450.0	$1,635.0	$2,091.0	$2,300.0	$2,400.0	$2,377.0	$2,555.0	$2,622.0
	Income from Other IP licenses		---	---	---	---	---	---	---	---	---	---	---	---	$0.0	$0.0	$0.0
	Number of licenses bearing royalty income in the FY		---	---	---	---	---	---	---	---	---	---	---	---	n/a	n/a	120
	Exclusive		---	---	---	---	---	---	---	---	---	---	---	---	---	---	78
	Partially exclusive		---	---	---	---	---	---	---	---	---	---	---	---	---	---	19
	Non-exclusive		---	---	---	---	---	---	---	---	---	---	---	---	---	---	23
	Earned royalty income in the FY	(thousand $)	---	---	---	---	---	---	---	---	---	---	---	---	$1,843.0	$1,843.0	$1,409.0
Commerce	Total income, all licenses active in the FY	(thousand $)	---	---	---	---	---	---	---	---	---	---	---	---	$421.6	$159.0	$268.6
	Income from invention licenses		$34.0	$81.0	$62.0	$52.0	$26.0	$0.0	$0.0	$0.0	$42.0	$0.3	$196.0	$241.0	$421.6	$159.0	$268.6
	Income from Other IP licenses		---	---	---	---	---	---	---	---	---	---	---	---	$0.0	$0.0	$0.0
	Number of licenses bearing royalty income in the FY		---	---	---	---	---	---	---	---	---	---	---	---	19	17	21
	Exclusive		---	---	---	---	---	---	---	---	---	---	---	---	---	---	13
	Partially exclusive		---	---	---	---	---	---	---	---	---	---	---	---	---	---	5
	Non-exclusive		---	---	---	---	---	---	---	---	---	---	---	---	---	---	3
	Earned royalty income in the FY	(thousand $)	---	---	---	---	---	---	---	---	---	---	---	---	$421.6	$159.0	$269.0
Defense	Total income, all licenses active in the FY	(thousand $)	---	---	---	---	---	---	---	---	---	---	---	---	$2,004.9	$2,212.9	$6,465.5
	Income from invention licenses		$44.0	$49.0	$211.0	$239.0	$286.0	$331.0	$567.0	$1,081.0	$646.0	$836.0	$924.0	$1,560.0	$2,004.9	$2,212.9	$6,383.5
	Income from Other IP licenses		---	---	---	---	---	---	---	---	---	---	---	---	$0.0	$0.0	$82.0
	Number of licenses bearing royalty income in the FY		---	---	---	---	---	---	---	---	---	---	---	---	42	29	113
	Exclusive		---	---	---	---	---	---	---	---	---	---	---	---	---	---	42
	Partially exclusive		---	---	---	---	---	---	---	---	---	---	---	---	---	---	22
	Non-exclusive		---	---	---	---	---	---	---	---	---	---	---	---	---	---	49
	Earned royalty income in the FY	(thousand $)	---	---	---	---	---	---	---	---	---	---	---	---	$864.9	$671.9	$6,383.5
Energy	Total income, all licenses active in the FY	(thousand $)	---	---	---	---	---	---	---	---	---	---	---	---	$11,744.0	$15,545.5	$21,403.4
	Income from invention licenses		$346.0	$545.0	$1,499.0	$2,560.0	$3,193.0	$2,369.0	$2,703.0	$2,915.0	$3,455.0	$4,122.0	$8,009.0	$10,536.0	$10,199.0	$12,710.0	$18,921.8
	Income from Other IP licenses		---	---	---	---	---	---	---	---	---	---	---	---	$1,545.0	$2,835.5	$1,870.1
	Number of licenses bearing royalty income in the FY		---	---	---	---	---	---	---	---	---	---	---	---	193	220	1,012
	Exclusive		---	---	---	---	---	---	---	---	---	---	---	---	---	---	174
	Partially exclusive		---	---	---	---	---	---	---	---	---	---	---	---	---	---	112
	Non-exclusive		---	---	---	---	---	---	---	---	---	---	---	---	---	---	726
	Earned royalty income in the FY	(thousand $)	---	---	---	---	---	---	---	---	---	---	---	---	$1,975.0	$2,228.0	$7,832.5
EPA	Total income, all licenses active in the FY	(thousand $)	---	---	---	---	---	---	---	---	---	---	---	---	n/a	n/a	$544.4
	Income from invention licenses		$0.0	$0.0	$0.0	$3.0	$74.0	$60.0	$75.0	$230.0	$110.0	$300.0	$60.0	$100.0	n/a	n/a	n/a
	Income from Other IP licenses		---	---	---	---	---	---	---	---	---	---	---	---	n/a	n/a	$0.0
	Number of licenses bearing royalty income in the FY		---	---	---	---	---	---	---	---	---	---	---	---	n/a	n/a	19
	Exclusive		---	---	---	---	---	---	---	---	---	---	---	---	---	---	6
	Partially exclusive		---	---	---	---	---	---	---	---	---	---	---	---	---	---	1
	Non-exclusive		---	---	---	---	---	---	---	---	---	---	---	---	---	---	12
	Earned royalty income in the FY	(thousand $)	---	---	---	---	---	---	---	---	---	---	---	---	n/a	n/a	n/a
HHS	Total income, all licenses active in the FY	(thousand $)	---	---	---	---	---	---	---	---	---	---	---	---	$44,821.0	$52,547.0	$46,722.1
	Income from invention licenses		$4,245.0	$5,434.0	$4,804.0	$5,839.0	$13,384.0	$10,133.0	$13,584.0	$18,654.0	$19,727.0	$27,277.0	$35,692.0	$39,500.0	$42,599.0	$48,592.0	$41,322.1
	Income from Other IP licenses		---	---	---	---	---	---	---	---	---	---	---	---	$2,222.0	$3,955.0	$5,400.0
	Number of licenses bearing royalty income in the FY		---	---	---	---	---	---	---	---	---	---	---	---	223	230	727
	Exclusive		---	---	---	---	---	---	---	---	---	---	---	---	---	---	108
	Partially exclusive		---	---	---	---	---	---	---	---	---	---	---	---	---	---	13
	Non-exclusive		---	---	---	---	---	---	---	---	---	---	---	---	---	---	606
	Earned royalty income in the FY	(thousand $)	---	---	---	---	---	---	---	---	---	---	---	---	$34,599.0	$43,892.0	$36,612.5

Table A.4 Income From Licensing by Federal Laboratories and Research Centers

		FY1987	FY1988	FY1989	FY1990	FY1991	FY1992	FY1993	FY1994	FY1995	FY1996	FY1997	FY1998	FY1999	FY2000	FY2001
Interior	Total income, all licenses active in the FY (thousand $)	---	---	---	---	---	---	---	---	---	---	---	---	$1,640.0	$850.0	$235.0
	Income from invention licenses	$1,000.0	$38.0	$61.0	$41.0	$58.0	$0.0	$0.0	$2,000.0	$2,000.0	$2,000.0	$2,000.0	$2,000.0	$1,640.0	$850.0	$235.0
	Income from Other IP licenses	---	---	---	---	---	---	---	---	---	---	---	---	$0.0	$0.0	$0.0
	Number of licenses bearing royalty income in the FY	---	---	---	---	---	---	---	---	---	---	---	---	11	5	6
	Exclusive	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0
	Partially exclusive	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0
	Non-exclusive	---	---	---	---	---	---	---	---	---	---	---	---	---	---	6
	Earned royalty income in the FY (thousand $)	---	---	---	---	---	---	---	---	---	---	---	---	$1,640.0	$850.0	$220.0
NASA	Total income, all licenses active in the FY (thousand $)	---	---	---	---	---	---	---	---	---	---	---	---	$822.7	$1,008.0	$1,971.2
	Income from invention licenses	$73.0	$79.0	$84.0	$113.0	$292.0	$133.0	$158.0	$311.0	$349.0	$343.0	$521.0	$565.0	$818.0	$762.0	$1,318.9
	Income from Other IP licenses	---	---	---	---	---	---	---	---	---	---	---	---	$4.7	$246.0	$651.9
	Number of licenses bearing royalty income in the FY	---	---	---	---	---	---	---	---	---	---	---	---	19	17	114
	Exclusive	---	---	---	---	---	---	---	---	---	---	---	---	---	---	57
	Partially exclusive	---	---	---	---	---	---	---	---	---	---	---	---	---	---	13
	Non-exclusive	---	---	---	---	---	---	---	---	---	---	---	---	---	---	44
	Earned royalty income in the FY (thousand $)	---	---	---	---	---	---	---	---	---	---	---	---	$388.0	$174.8	$521.2
Transportation	Total income, all licenses active in the FY (thousand $)	---	---	---	---	---	---	---	---	---	---	---	---	$0.0	$0.0	$5.5
	Income from invention licenses	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	$0.0	$0.0	$0.0	$0.0	$5.5
	Income from Other IP licenses	---	---	---	---	---	---	---	---	---	---	---	---	$0.0	$0.0	$0.0
	Number of licenses bearing royalty income in the FY	---	---	---	---	---	---	---	---	---	---	---	---	0	0	1
	Exclusive	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0
	Partially exclusive	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0
	Non-exclusive	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1
	Earned royalty income in the FY (thousand $)	---	---	---	---	---	---	---	---	---	---	---	---	$0.0	$0.0	n/a
Veterans Affairs	Total income, all licenses active in the FY (thousand $)	---	---	---	---	---	---	---	---	---	---	---	---	n/a	$1,021.0	$37.6
	Income from invention licenses	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	$0.0	$0.0	n/a	$1,021.0	$23.2
	Income from Other IP licenses	---	---	---	---	---	---	---	---	---	---	---	---	$0.0	$0.0	$14.4
	Number of licenses bearing royalty income in the FY	---	---	---	---	---	---	---	---	---	---	---	---	n/a	n/a	58
	Exclusive	---	---	---	---	---	---	---	---	---	---	---	---	---	---	3
	Partially exclusive	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2
	Non-exclusive	---	---	---	---	---	---	---	---	---	---	---	---	---	---	53
	Earned royalty income in the FY (thousand $)	---	---	---	---	---	---	---	---	---	---	---	---	n/a	n/a	$17.3
Totals	Total income, all licenses active in the FY (thousand $)	---	---	---	---	---	---	---	---	---	---	---	---	$63,831.3	$75,898.4	$80,275.2
	Income from invention licenses	$5,875.0	$6,346.0	$7,141.0	$9,406.0	$18,149.0	$14,070.0	$18,570.0	$26,641.0	$27,964.0	$36,969.3	$49,702.0	$56,902.0	$60,059.5	$68,861.9	$71,100.6
	Income from Other IP licenses	---	---	---	---	---	---	---	---	---	---	---	---	$3,771.7	$7,036.5	$8,018.3
	Number of licenses bearing royalty income in the FY	---	---	---	---	---	---	---	---	---	---	---	---	507	518	2,191
	Exclusive	---	---	---	---	---	---	---	---	---	---	---	---	---	---	481
	Partially exclusive	---	---	---	---	---	---	---	---	---	---	---	---	---	---	187
	Non-exclusive	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1,523
	Earned royalty income in the FY (thousand $)	---	---	---	---	---	---	---	---	---	---	---	---	$41,731.6	$49,818.7	$53,264.9

n/a = requested agency data not available at time of this report. --- = data not requested from agency in reporting for prior years.

NOTES: FY 2001 is the first year for which agency data on federal lab tech transfer is available through the revised reporting process of the Technology Transfer Commercialization Act of 2000. Figures for FY 1987-2000 reflect the Biennial Reporting process established by the Federal Technology Transfer Act of 1986.

As apparent, a few of the agencies could provide only n/a responses to these questions. Nonetheless, federal-wide totals are reported. The extent of bias due to this unavailable information is not fully clear at present, but is likely to be small in most cases.