

July 2001

TECHNOLOGY TRANSFER

DOE Has Fewer Partnerships, and They Rely More on Private Funding



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United States General Accounting Office
Washington, DC 20548

July 6, 2001

The Honorable Carl Levin
Chairman
The Honorable John W. Warner
Ranking Minority Member
Committee on Armed Services
United States Senate

The Honorable Bob Stump
Chairman
The Honorable Ike Skelton
Ranking Democratic Member
Committee on Armed Services
House of Representatives

Since 1980, the Congress has enacted several laws designed to improve the United States' competitive position in the world economy by facilitating the transfer of technology from federal laboratories to U.S businesses. Specifically, the National Competitiveness Technology Transfer Act of 1989 authorized federal laboratories operated by contractors—including the Department of Energy's (DOE) national laboratories—to enter into cooperative research and development agreements (CRADA) that are consistent with the laboratories' mission. By fiscal year 1995, DOE's three nuclear weapons laboratories—Lawrence Livermore National Laboratory, Los Alamos National Laboratory, and Sandia National Laboratories—were among the leading federal laboratories participating in CRADAs with businesses, universities, and other private partners. In addition, DOE's Kansas City, Pantex, and Oak Ridge Y-12 nuclear weapons production facilities began entering into CRADAs in the mid-1990s. Within DOE, these laboratories and production facilities are managed by the National Nuclear Security Administration. Both the private partner(s) and the DOE laboratory or production facility generally have provided scientists and facilities for CRADA projects, and private partners have also provided funding to cover a portion of the research costs. According to DOE, the laboratories and production facilities have also transferred technology by, for example, providing technical assistance to small businesses and entering into "work-for-other" agreements, in which the private entity pays the laboratory's full costs for performing a research project.

To further encourage DOE's nuclear weapons laboratories and production facilities to enter into partnerships with private entities, the Congress

established the Technology Transfer Initiative in fiscal year 1991 to provide funding specifically designated for supporting CRADAs and other types of partnerships.¹ Technology Transfer Initiative funding increased from about \$1 million initially to \$205 million in fiscal year 1995. However, the Congress began to phase out these dedicated funds in fiscal year 1996 and rely instead on program managers at the laboratories and production facilities to use regular research funding for partnerships that would significantly benefit their programs. While the use of research funds instead of dedicated funds ensures that a CRADA project will have primary benefits to DOE's research mission, it has raised concerns that DOE's laboratories will be less likely to support technology development partnerships.

In response to these concerns, the Floyd D. Spence National Defense Authorization Act for Fiscal Year 2001 directed DOE's Administrator for Nuclear Security to report on (1) the efficiency and effectiveness with which NNSA and its nuclear weapons laboratories and production facilities have implemented technology development partnerships with nonfederal entities and (2) the advantages and disadvantages of CRADAs.² The act also mandated that we provide an assessment of the administrator's report within 30 days of its issuance. In response to this mandate, we briefed your offices on the NNSA report, issued on April 16, 2001.³ (See app. I for the report's highlights.) We also obtained data on technology partnerships at NNSA's laboratories and production facilities in addition to that presented in NNSA's report.

As agreed with your offices, this report provides information on (1) the trends in the technology development partnerships used and funding made available by DOE and private partners for each type of partnership and (2) NNSA's views of the advantages and disadvantages of CRADAs, along with options that NNSA suggested for maintaining or increasing current financial and management support for CRADAs.

¹The Technology Transfer Initiative was renamed the Technology Partnership Program in fiscal year 1998.

²NNSA was established in 2000 to consolidate responsibility for overseeing DOE's nuclear nonproliferation and nuclear weapons missions, including its stockpile stewardship program.

³*Report to Congress on Technology Partnerships With Non-federal Entities Within the National Nuclear Security Administration During Fiscal Year 2000.*

Results in Brief

In recent years, NNSA's laboratories and production facilities have substantially revised their approaches to technology development partnerships: They have reduced their use of CRADAs and the provision of technical assistance to small businesses while entering into more agreements fully funded by private partners. The number of CRADAs at NNSA facilities, which peaked at 639 in fiscal year 1995, subsequently declined by more than 60 percent as dedicated funding for technology partnerships was gradually eliminated. NNSA laboratory managers told us that because the dedicated funding generally has not been replaced with NNSA research program funds, their laboratories have either prematurely terminated many CRADAs or required the private partners to fully fund the work. NNSA facilities also are negotiating fewer new CRADAs—they entered into only 21 CRADAs during the first 6 months of fiscal year 2001; in comparison, they entered into 240 new CRADAs in fiscal year 1995. Similarly, technical assistance for small businesses, funded by the Technology Partnership Program, has declined by more than 70 percent between fiscal years 1995 and 2000. In contrast, NNSA facilities have increased work-for-other and technology licensing activities, which are funded by private businesses. Overall, NNSA's and private partners' support of technology partnerships has dropped from \$390 million in fiscal year 1995 to \$175 million in fiscal year 2000 and to \$81 million in the first 6 months of fiscal year 2001.

NNSA officials and laboratory managers identified various advantages and disadvantages of collaborative research under a CRADA. In particular, CRADAs can leverage NNSA's research funds with additional private funding, scientists, and equipment that extend NNSA's research capabilities. CRADAs also have enabled NNSA's laboratories to maintain core competencies in research and manufacturing and recruit and retain key scientists challenged by interesting research projects. However, CRADAs require NNSA's laboratories to share control over the scope of the research, project time frames, and intellectual property rights; and they may divert research funds to projects with only secondary benefits to NNSA's core mission. NNSA laboratory managers identified two alternatives—establishing an advocate within NNSA to facilitate funding for CRADAs and setting aside a small portion of research funding specifically to provide initial support for mission-related CRADAs—that would increase NNSA's current management and financial support for CRADAs and potentially increase the number of agreements.

Background

Technology development partnerships are key elements of the technology transfer program of each NNSA laboratory and production facility. NNSA laboratory and facility managers told us that they have primarily used the following types of partnerships:

- **CRADAs:** An NNSA laboratory or production facility and private partner(s) agree to collaborate on a research project that is consistent with DOE's mission and has a potential impact on U.S. economic competitiveness. The NNSA laboratory or production facility and its private partner(s) contribute personnel, services, facilities, equipment, intellectual property, and/or other resources to the CRADA project. The private partner(s) may also provide funding, in-kind (noncash) contributions, and other resources directly beneficial and specifically identifiable and necessary in the performance of the project. However, NNSA and its laboratory or production facility are not allowed to transfer funds to the private partner(s). At a minimum, DOE retains a nonexclusive, nontransferable, irrevocable license to use any invention developed under the CRADA on behalf of the U.S. government. The private partner has the option to choose an exclusive license for a pre-negotiated field of use for any inventions developed by the NNSA laboratory or production facility under the CRADA.
- **Technical assistance for small businesses:** In response to section 3135(b) of the National Defense Authorization Act for Fiscal Year 1993, NNSA's laboratories and production facilities have provided technical assistance to small businesses.
- **Work-for-other agreements:** An NNSA laboratory or production facility agrees to conduct a defined scope of work or list of tasks, and the private partner pays for the entire cost of the project. While intellectual property rights are negotiable, the private sponsor typically retains title rights to any inventions.
- **Cost-shared procurement contracts:** An NNSA laboratory or production facility and private partner(s) agree to collaborate to develop technologies or computer codes for Defense Program mission requirements. Lawrence Livermore National Laboratory has used these contracts for the Accelerated Strategic Computing Initiative.
- **Technology licensing agreements:** An NNSA laboratory or production facility grants a business an exclusive or nonexclusive license to use its intellectual property in return for a licensing fee and/or royalties.

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- **User facility agreements:** An NNSA laboratory or production facility permits outside organizations to use its unique research equipment and/or facilities to conduct research. The private organization pays the full cost of using research equipment or facilities and retains title rights to any intellectual property.

NNSA Laboratories and Production Facilities Have Reduced Partnership Activities Not Fully Funded by Private Partners

In response to the phasing out of dedicated funding for partnerships, NNSA's laboratories and production facilities have reduced their CRADAs and technical assistance to small businesses while entering into more agreements that are fully funded by the business partners. The total number of CRADAs at NNSA laboratories and production facilities has declined by more than 60 percent, from a high of 639 in fiscal year 1995 to 244—including only 21 new CRADAs—in the first 6 months of fiscal year 2001. During this period, DOE's funding for CRADAs dropped even more—from \$222 million to \$19 million. Similarly, technical assistance for small businesses dropped from about 1,700 actions that assisted small businesses in fiscal year 1995 to 136—including only 59 new assistance agreements—in the first 6 months of fiscal year 2001. While these types of partnerships have declined, work-for-other agreements and technology licenses, which require no DOE funds, grew substantially. (Table 4 in app. II provides partnership data by fiscal year for each NNSA facility.)

Table 1 shows that the number of active CRADAs at the NNSA laboratories and production facilities grew rapidly in the early 1990s and then dropped by more than half through the first 6 months of fiscal year 2001. This trend reflects a similar pattern in the growth and decline of DOE's dedicated funding for technology partnerships. Sandia National Laboratories has entered into more CRADAs than any other NNSA laboratory. (See table 5 in app. II.) In fiscal year 1995, when CRADA activity peaked, Sandia had 254 active CRADAs—40 percent of all NNSA CRADAs. Sandia participated in 153 CRADAs (44 percent of all CRADAs) in fiscal year 2000 and 120 CRADAs (about 50 percent of all CRADAs) in the first half of fiscal year 2001. The number of CRADAs at Lawrence Livermore National Laboratory has dropped even more—from 159 in fiscal year 1995 to 26 in the first two quarters of fiscal year 2001. Lawrence Livermore has shifted its emphasis from using CRADAs with private partners to using procurement contracts with its contractors to develop new technologies important for its mission, according to laboratory officials.

Table 1: CRADA Activity and Funding at NNSA Laboratories and Facilities, Fiscal Year 1991 Through the Second Quarter of Fiscal Year 2001

Dollars in millions

	Fiscal year										
	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001 ^a
Number of CRADAs											
Newly executed	21	104	177	237	240	137	102	103	113	50	21
Ongoing	6	23	96	211	399	494	380	312	281	298	223
Total	27	127	273	448	639	631	482	415	394	348	244
Source of funding support											
DOE ^b	\$2.8	\$24.4	\$89.5	\$157.6	\$222.4	\$172.0	\$87.1	\$69.7	\$68.5	\$35.4	\$19.4
Private partners	4.4	56.0	94.9	143.2	167.2	147.5	170.5	186.0	175.7	139.6	61.4
Total	\$7.2	\$80.4	\$184.4	\$300.7	\$389.6	\$319.5	\$257.6	\$255.7	\$244.2	\$175.0	\$80.8

^aData are for the first 2 quarters of fiscal year 2001.

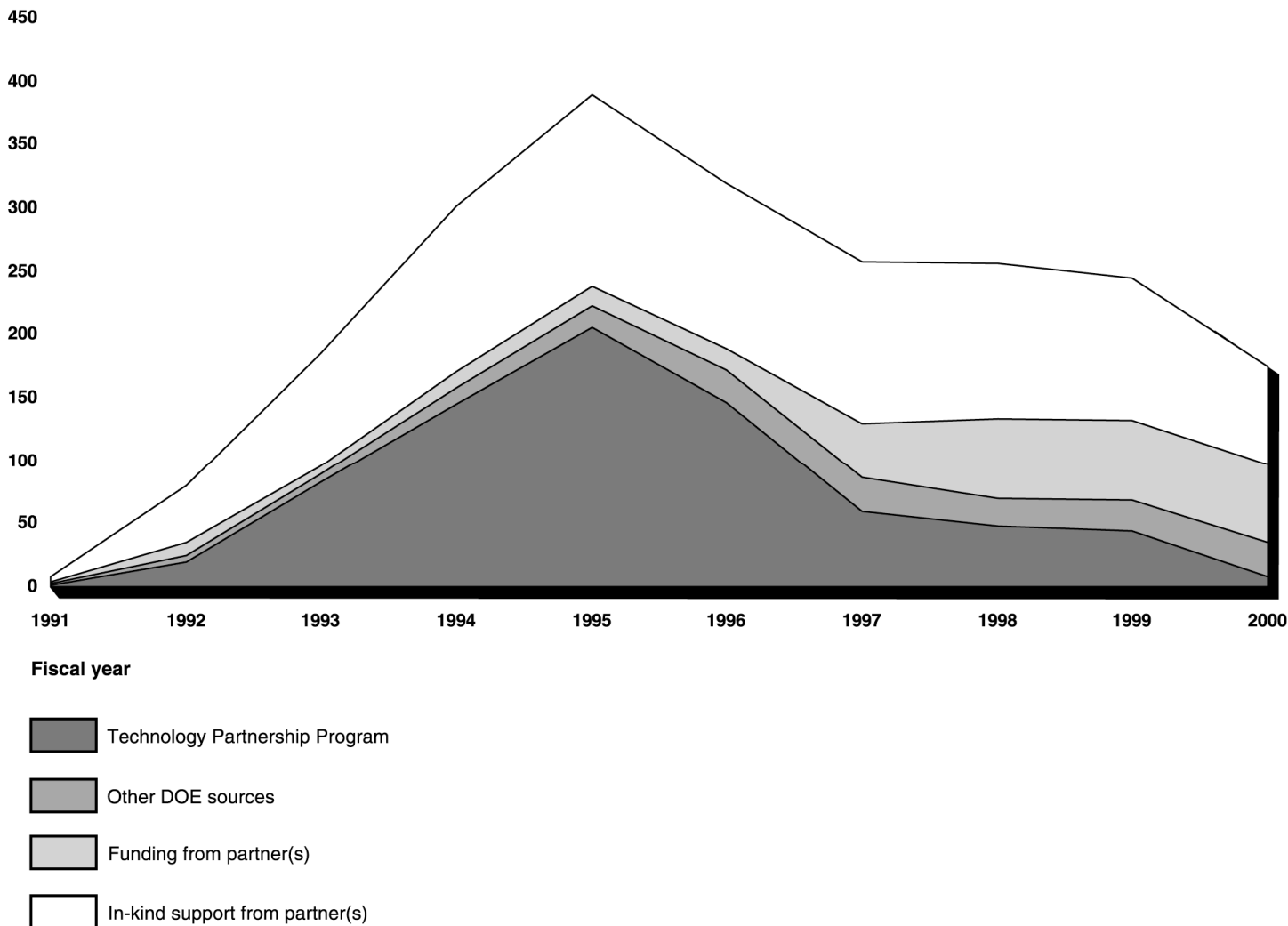
^bDOE funding support includes the Technology Transfer Initiative, the Technology Partnership Program, and research program funds. The fiscal year 2001 funding is DOE's total fiscal year commitment for existing CRADAs.

Sources: NNSA laboratories and production facilities and DOE's Institutional and Joint Programs Division.

Figure 1 shows funding sources for CRADAs at NNSA laboratories and production facilities for fiscal years 1991 through 2000. As figure 1 and table 1 show, CRADA expenditures at NNSA's laboratories and production facilities peaked in fiscal year 1995. In that year, DOE contributed \$222 million, including \$205 million in Technology Partnership Program funding, and private partners contributed \$167 million in direct and in-kind support for CRADA activities. As DOE's dedicated funding for technology partnerships declined, the proportion of private partners' direct and in-kind contributions increased and has constituted more than half of all CRADA funding since fiscal year 1997. In the first two quarters of fiscal year 2001, DOE contributed \$19 million and private partners contributed \$61 million in direct and in-kind support for CRADA activities. (See table 6 in app. II for CRADA funding at individual NNSA facilities.)

Figure 1: Sources of Funding for CRADAs at NNSA Laboratories and Production Facilities, Fiscal Years 1991 Through 2000

Dollars in millions



Note: Lawrence Livermore National Laboratory could not provide data on the value of partners' in-kind support. Other NNSA facilities estimated partners' in-kind support based on their planned contributions.

Source: GAO's analysis of NNSA laboratories and production facilities data.

Table 2 shows the extent to which NNSA's laboratories and production facilities used the other primary types of technology development partnerships. Generally, partnerships that relied on DOE funds have decreased, while those predominantly funded by businesses have grown. For example, technical assistance for small businesses, which was

primarily funded by DOE’s Technology Partnership Program, dropped sharply—from about 1,700 actions that assisted small businesses in fiscal year 1995 to about 500 in fiscal year 2000. In contrast, work-for-other agreements, which are wholly funded by businesses, grew substantially from 209 agreements in fiscal year 1995 to 987 agreements in fiscal year 2000. Similarly, technology licensing agreements have greatly increased during this period. (See tables 7, 8, and 9 in app. II for each NNSA facility’s participation in each of these partnerships.) User facility agreements, which provide access to unique NNSA experimental research equipment and facilities, increased from 103 in fiscal year 1995 to 165 in fiscal year 1998 and then decreased to 96 agreements in fiscal year 2000. Businesses have provided more direct funding for work-for-other agreements than for any of the other types of partnerships. (See table 10 in app. II.)

Table 2: Trends in the Other Primary Types of Partnerships at NNSA Laboratories and Production Facilities, Fiscal Year 1991 Through the Second Quarter of Fiscal Year 2001

Type of partnership	Fiscal year										
	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001 ^a
Technical assistance for small businesses	^b	^b	630	1,622	1,722	1,322	908	669	560	490	136
Work-for-other agreements ^c	94	108	94	154	209	313	569	692	802	987	788
Cost-shared procurement contracts ^d	0	0	0	0	0	0	0	4	4	4	4
Technology licenses	33	52	87	213	300	503	600	669	764	844	938
User facilities agreements	12	17	22	69	103	119	141	165	94	96	51

^aData are for the first 2 quarters of fiscal year 2001.

^bIn response to section 3135(b) of the National Defense Authorization Act for Fiscal Year 1993, DOE’s Defense Programs established the Small Business Initiative to facilitate the transfer of technology to small businesses.

^cIncludes only agreements with nonfederal industrial partners.

^dLawrence Livermore National Laboratory used a cost-shared procurement contract for its Accelerated Strategic Computing Initiative/PathForward program to develop advanced computational capabilities for simulating nuclear weapons testing and predicting the performance, safety, and reliability of these weapons.

Sources: NNSA laboratories and production facilities.

CRADAs Offer Both Advantages and Disadvantages

NNSA officials and laboratory managers identified various advantages and disadvantages of collaborative research under a CRADA. (See table 3.) An advantage of collaborative research under a CRADA is often accompanied by a disadvantage. For example, the ability to leverage research funding, staff, and equipment can be offset by concerns over a CRADA’s relevance to mission objectives and the risk inherent in sharing control over the scope of the research, project time frames, and intellectual property.

Table 3: Advantages and Disadvantages of CRADAs at NNSA Laboratories and Production Facilities

Advantages	Disadvantages
<ul style="list-style-type: none"> • Involves multiple partners and a wider range of technical disciplines to address technical challenges of mutual interest. • Leverages NNSA laboratory resources by using partners' scientists, equipment, and funding to extend research and development capability. • Enables NNSA laboratories and production facilities to maintain core competencies in research and manufacturing. • Aids in the recruitment and retention of talented staff by exposing NNSA scientists to a broader range of technical challenges. • Improves the competitive position of U.S. businesses. • Provides NNSA laboratories with access to companies' proprietary technology. • Results in additional industry requests and funding for laboratory expertise and services and long-term research and development partners. • Can be used to bring laboratory inventions to the marketplace by providing "seed money" to develop commercial applications. 	<ul style="list-style-type: none"> • CRADAs compete with DOE's mission research for funding support and laboratory resources. Without DOE's funding, private partners are reluctant to enter into CRADAs. • NNSA's stockpile stewardship program has established schedules for NNSA's laboratories to complete work on—such as the W76 stockpile life extension program by 2007. Laboratory research managers are hesitant to commit any funding and resources that might be needed to complete critical stockpile stewardship projects. • Some of the CRADAs negotiated in the mid-1990s were primarily designed to improve the competitive position of a U.S. industry with few benefits for the NNSA mission. As a result, they diverted DOE resources away from stockpile stewardship and NNSA's other primary missions. • An NNSA laboratory typically has less control over the scope of work and product delivery time frames for CRADAs than for procurement contracts. • CRADAs generally take more time to execute than other types of agreements or contracts because the statement of work, funding, and intellectual property rights must be negotiated.

Sources: NNSA headquarters and regional officials, NNSA laboratory managers, and *Technology Transfer: Benefits of Cooperative R&D Agreements* (GAO/RCED-95-52, Dec. 16, 1994).

Each of the NNSA laboratories we visited provided examples of successful CRADAs for both the laboratory and the CRADA partner(s). For example, in 1997, Sandia, Lawrence Livermore, and Lawrence Berkeley National Laboratory (a DOE energy science laboratory) entered into a CRADA with a consortium of microelectronics manufacturers to develop extreme ultraviolet lithography equipment for making next-generation computer chips with enhanced speed and memory. Consortium members are providing \$250 million to develop this technology, which is also important for developing advanced computational capabilities that NNSA needs for its nuclear stockpile stewardship program.

Technology transfer officials at the NNSA laboratories noted that CRADAs have enhanced their laboratories' research by, for example, bringing together a wide range of scientific disciplines to address technical problems or providing NNSA scientists with access to advanced

technology or manufacturing processes. Sandia officials generally preferred a CRADA to a work-for-others agreement because CRADA partners actively participate in the research. Sandia officials told us that the Technology Partnership Program had been an important catalyst for initiating CRADAs because it was the laboratories' primary source of financial support in the early stages of the CRADA project before researchers could demonstrate that the CRADA would directly benefit a specific DOE program.

However, some DOE managers have questioned the value of certain CRADAs—particularly some related to the Technology Transfer Initiative in the mid-1990s—stating that those CRADAs had used scarce resources for projects not closely tied to NNSA's mission. Furthermore, negotiating and approving the terms of a CRADA could take more than 1 year to complete in the early 1990s. According to Sandia National Laboratories' data, this time has been substantially reduced—in fiscal year 2000, CRADAs were processed from initiation to final approval in 86 days, on average, including an average of 4 days for DOE's review and approval. Laboratory officials attributed this improved efficiency to the use of a standardized format for these agreements and the common practice of amending existing CRADAs to broaden the scope of work in lieu of negotiating a new agreement. In several cases, Sandia used blanket or "umbrella" CRADAs to combine a number of different projects with the same partner into a single agreement.

NNSA laboratory managers identified three primary options for providing financial and management support for CRADAs:

- Continue to rely primarily on laboratory research managers to determine whether participating in a CRADA effectively supports their mission research. In addition to research funds, NNSA's laboratories have used other DOE funds, including their "laboratory-directed research and development" funds and Accelerated Strategic Computing Initiative funds, to support certain CRADAs.⁴ DOE has contributed \$19.4 million for active CRADAs at NNSA laboratories and production facilities in fiscal year 2001.

⁴Section 3135 of the National Defense Authorization Act of 1993 authorized the use of laboratory-directed research and development funds to support CRADAs, provided they meet certain administrative requirements.

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- Set aside a small portion of research funding specifically to provide initial support for mission-related CRADAs until they show sufficient potential benefits that program managers would be willing to provide financial support.
 - Establish an advocate within NNSA responsible for facilitating funding for CRADAs.

The laboratory managers noted that the advocate's office could be combined with one of the two funding options. A senior official at NNSA headquarters stated that the two funding options were reasonable. However, the senior official preferred to assign responsibility for facilitating CRADAs to a senior office within NNSA without giving it responsibility for advocacy.

Agency Comments

We provided DOE with a draft of this report for its review and comment. NNSA's Institutional and Joint Programs Division generally agreed with the draft report. NNSA also provided comments to improve the report's technical accuracy, which we incorporated as appropriate.

Scope and Methodology

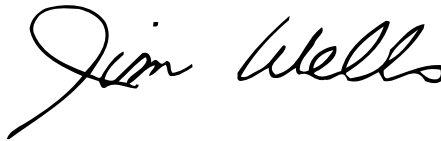
To obtain trend data on technology development partnerships, we asked officials at NNSA and its laboratories to identify the primary types of technology partnerships that they have used with private entities. We then developed a data collection instrument to obtain participation and funding data from NNSA's three nuclear weapons laboratories and three of its production facilities from fiscal year 1991 through the second quarter of fiscal year 2001. To help ensure consistency across locations, we worked with officials from these laboratories and facilities to establish uniform definitions and resolve any discrepancies. In addition, we (1) interviewed NNSA officials at DOE headquarters and DOE's Albuquerque and Oakland Operations Offices and (2) visited Lawrence Livermore National Laboratory, Los Alamos National Laboratory, and Sandia National Laboratories to obtain the views of administrators and scientists about their laboratories' participation in and funding of technology development partnerships.

To identify the advantages and disadvantages of CRADAs, we interviewed NNSA officials at DOE headquarters and obtained the views of laboratory administrators and scientists at Lawrence Livermore National Laboratory, Los Alamos National Laboratory, and Sandia National Laboratories. We also interviewed executives of four businesses that participated in at least

one CRADA with an NNSA laboratory to obtain their perspective about CRADAs. We conducted our review from January 2001 through May 2001 in accordance with generally accepted government auditing standards. We did not independently verify the data provided by NNSA's laboratories and production facilities.

We are sending copies of this report to the Secretary of Energy, the Director of the Office of Management and Budget, and other interested parties. We will make copies available to others on request.

If you or your staff have any questions about this report, please contact me at (202) 512-3841. Key contributors to this report were Richard Cheston, Sandra Davis, and Timothy Minelli.

A handwritten signature in black ink that reads "Jim Wells". The signature is fluid and cursive, with the first name "Jim" and last name "Wells" clearly distinguishable.

Jim Wells
Director, Natural Resources
and Environment

Appendix I: NNSA's Report on Technology Development Partnerships

NNSA's report entitled *Report to Congress on Technology Partnerships With Non-federal Entities Within the National Nuclear Security Administration During Fiscal Year 2000* primarily examined CRADA activities at its laboratories and production facilities. The report stated that with the termination of the Technology Partnership Program's dedicated funding, CRADA partnerships will obtain either financial support from individual DOE research programs—ensuring that the project is more clearly linked to DOE's mission—or full funding from the private sector partner. NNSA stated that more than 200 of its 348 CRADAs supported its core missions in fiscal year 2000 and pointed to CRADA-developed technologies that benefited both NNSA and its private partners. For example, a CRADA used NNSA advanced laser technology to develop an improved laser shot peening process to make indentations that reduce fatigue in critical metal parts, such as jet engine fan blades and nuclear waste disposal containers. According to NNSA, the absence of dedicated funding could also result in fewer CRADAs that provide only secondary, or spinoff, benefits for its core mission. A separate NNSA report discussed technical assistance for small businesses, which also was cut back as the Technology Partnership Program was phased out.⁵

NNSA reported that CRADAs are advantageous because they can leverage its laboratories' resources and bring to bear the expertise of several partners to address technical challenges. CRADAs also allow for more flexibility in the treatment of intellectual property than do other types of partnership agreements. NNSA noted that some laboratory personnel and private sector partners are skeptical about using CRADAs because they believe that negotiations take longer than necessary.

Although the congressional mandate directed NNSA to recommend actions that would make CRADAs more effective in supporting its mission, NNSA made no recommendations.

⁵See *Report to Congress on Small Business Participation in National Nuclear Security Administration Activities* (Feb. 2001).

Appendix II: The Technology Development Activities of NNSA's Laboratories and Production Facilities

Table 4: Active Technology Development Partnerships With Nonfederal Entities at NNSA Laboratories and Production Facilities, Fiscal Year 1991 Through the Second Quarter of Fiscal Year 2001

Facility	Fiscal year										
	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001 ^a
Lawrence Livermore National Laboratory											
CRADAs	0	13	50	96	159	161	118	83	66	47	26
Technical assistance for small businesses	^b	^b	0	3	15	41	19	10	2	0	0
Work for others ^c	74	75	55	80	104	110	192	192	276	299	309
Cost-shared procurements ^d	0	0	0	0	0	0	0	4	4	4	4
Technology licenses	^e	^e	^e	100	158	239	260	290	312	324	331
User facilities	0	0	0	0	0	0	0	1	1	0	0
Los Alamos National Laboratory											
CRADAs	11	37	65	124	175	165	132	134	130	116	83
Technical assistance for small businesses	^b	^b	22	75	180	85	29	0	0	0	0
Work for others ^c	20	20	25	21	14	39	50	61	74	81	83
Technology licenses	13	21	34	38	41	49	58	65	97	115	140
User facilities	12	17	22	45	60	47	58	54	31	43	19
Sandia National Laboratories											
CRADAs	11	55	123	195	254	253	193	150	154	153	120
Technical assistance for small businesses	^b	^b	0	302	393	322	292	233	257	210	93
Work for others ^c	0	0	0	22	42	80	126	183	263	351	327
Technology licenses	8	16	32	49	77	178	240	273	313	362	424
User facilities	0	0	0	3	24	56	66	89	45	33	29
Kansas City Plant											
CRADAs	0	0	0	5	21	32	30	24	26	24	12
Technical assistance for small businesses	^b	^b	0	297	269	140	128	92	74	60	42
Work for others ^c	0	0	0	0	4	12	25	27	16	14	11
Technology licenses	0	0	0	1	1	3	6	6	6	6	5
User facilities	0	0	0	0	1	3	2	3	4	4	3
Oak Ridge Y-12 Plant											
CRADAs	5	22	35	28	29	18	8	23	17	7	2
Technical assistance for small businesses	^b	^b	608	943	860	730	433	334	225	217	0
Work for others ^c	0	13	14	31	40	66	167	221	169	240	57
Technology licenses	12	15	21	25	23	34	36	35	36	37	38
User facilities	0	0	0	21	18	13	15	17	12	16	0
Pantex Plant											
CRADAs	0	0	0	0	1	2	1	1	1	1	1
Technical assistance for small businesses	^b	^b	0	2	5	4	7	0	2	3	1
Work for others ^c	0	0	0	0	5	6	9	8	4	2	1
User facilities	0	0	0	0	0	0	0	1	1	0	0

**Appendix II: The Technology Development
Activities of NNSA's Laboratories and
Production Facilities**

Facility	Fiscal year										
	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001 ^a
All NNSA facilities											
CRADAs	27	127	273	448	639	631	482	415	394	348	244
Technical assistance for small businesses	^b	^b	630	1,622	1,722	1,322	908	669	560	490	136
Work for others^c	94	108	94	154	209	313	569	692	802	987	788
Cost-shared procurements^d	0	0	0	0	0	0	0	4	4	4	4
Technology licenses	33	52	87	213	300	503	600	669	764	844	938
User facilities	12	17	22	69	103	119	141	165	94	96	51

^aData are for the first 2 quarters of fiscal year 2001.

^bIn response to section 3135(b) of the National Defense Authorization Act for Fiscal Year 1993, DOE's Defense Programs established the Small Business Initiative to facilitate and encourage the transfer of technology to small businesses.

^cIncludes only agreements with nonfederal industrial partners.

^dIncludes contracts for the Accelerated Strategic Computing Initiative/PathForward Program. Cost-shared procurement agreements under the Federal Acquisition Regulation were used to expedite research and development contracts.

^eData were not readily available.

Source: NNSA laboratories and production facilities.

**Appendix II: The Technology Development
Activities of NNSA's Laboratories and
Production Facilities**

Table 5: Active CRADAs at NNSA Laboratories and Production Facilities, Fiscal Year 1991 Through the Second Quarter of Fiscal Year 2001

Facility	Fiscal year										
	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001 ^a
Lawrence Livermore National Laboratory											
Newly executed CRADAs	0	13	40	52	66	28	30	11	14	5	2 ^b
Continuing CRADAs	0	0	10	44	93	133	88	72	52	42	24
Subtotal	0	13	50	96	159	161	118	83	66	47	26
Los Alamos National Laboratory											
Newly executed CRADAs	8	31	33	69	68	39	26	45	36	14	1
Continuing CRADAs	3	6	32	55	107	126	106	89	94	102	82
Subtotal	11	37	65	124	175	165	132	134	130	116	83
Sandia National Laboratories											
Newly executed CRADAs	8	38	69	83	65	45	33	30	52	27	17
Continuing CRADAs	3	17	54	112	189	208	160	120	102	126	103
Subtotal	11	55	123	195	254	253	193	150	154	153	120
Kansas City Plant											
Newly executed CRADAs	0	0	0	5	16	11	8	7	10	4	1
Continuing CRADAs	0	0	0	0	5	21	22	17	16	20	11
Subtotal	0	0	0	5	21	32	30	24	26	24	12
Oak Ridge Y-12 Plant											
Newly executed CRADAs	5	22	35	28	24	13	5	10	1	0	0
Continuing CRADAs	0	0	0	0	5	5	3	13	16	7	2
Subtotal	5	22	35	28	29	18	8	23	17	7	2
Pantex Plant											
Newly executed CRADAs	0	0	0	0	1	1	0	0	0	0	0
Continuing CRADAs	0	0	0	0	0	1	1	1	1	1	1
Subtotal	0	0	0	0	1	2	1	1	1	1	1
All NNSA facilities											
Newly executed CRADAs	21	104	177	237	240	137	102	103	113	50	21
Continuing CRADAs	6	23	96	211	399	494	380	312	281	298	223
Total	27	127	273	448	639	631	482	415	394	348	244

^aData are for the first 2 quarters of fiscal year 2001.

^bLawrence Livermore subsequently entered into three more CRADAs in the first 3 days of April 2001.

Source: NNSA laboratories and production facilities.

**Appendix II: The Technology Development
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Table 6: Sources of Funding for CRADAs at NNSA Laboratories and Production Facilities, Fiscal Year 1991 Through the Second Quarter of Fiscal Year 2001

Dollars in millions

Facility	Fiscal year										
	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001 ^a
Lawrence Livermore National Laboratory											
Technology Partnership Program	\$0	\$1.6	\$22.8	\$30.9	\$40.5	\$34.9	\$13.6	\$2.1	\$1.0	\$0	\$0
Other DOE sources ^b	0	0	0.6	2.2	2.1	2.7	1.8	2.2	2.2	2.3	1.0
Funding from partner(s)	0	0	0	1.9	3.2	2.4	12.4	28.6	31.3	20.9	2.8
In-kind support from partner(s) ^c	d	d	d	d	d	d	d	d	d	d	d
Subtotal	\$0	\$1.6	\$23.4	\$35.0	\$45.8	\$40.0	\$27.8	\$32.9	\$34.5	\$23.2	\$3.8
Los Alamos National Laboratory											
Technology Partnership Program	\$0.2	\$4.3	\$10.3 ^e	\$25.0 ^e	\$41.7	\$32.9	\$13.2	\$14.0	\$15.6	\$2.6	\$0
Other DOE sources (planned) ^b	1.4	2.2	1.8	4.7	7.3	12.0	13.4	10.4	12.2	10.9	5.7
Funding from partner(s)	1.2	6.1	0.3	0.6	1.5	1.9	1.9	2.3	2.3	2.6	0.5
In-kind support from partner(s) ^c	1.2	5.7	14.1	36.0	42.7	46.6	43.4	42.5	46.2	35.1	20.4
Subtotal	\$4.0	\$18.3	\$26.5	\$66.3	\$93.2	\$93.4	\$71.9	\$69.2	\$76.3	\$51.2	\$26.6
Sandia National Laboratories											
Technology Partnership Program	\$0	\$8.0	\$32.0	\$71.0	\$94.0	\$65.0	\$25.0	\$24.0	\$21.0	\$3.4	\$0
Other DOE sources ^b	0.2	2.5	4.0	6.5	8.0	11.3	12.3	9.5	9.9	11.8	11.6
Funding from partner(s)	0	4.4	5.8	10.6	10.6	12.1	27.2	32.8	30.1	38.2	13.6
In-kind support from partner(s) ^c	0.5	13.2	44.1	79.0	94.6	76.9	77.9	73.3	61.9	41.4	23.0
Subtotal	\$0.7	\$28.1	\$85.9	\$167.1	\$207.2	\$165.3	\$142.4	\$139.6	\$122.9	\$94.8	\$48.2
Kansas City Plant											
Technology Partnership Program	\$0	\$0	\$0.5	\$1.6	\$3.0	\$3.9	\$3.5	\$2.2	\$3.1	\$1.2	\$0
Other DOE sources ^b	0	0	0	0	0	0	0	0	0.7	2.9	1.1
Funding from partner(s)	0	0	0	0	0	0	0	0.2	0.1	0.2	0
In-kind support from partner(s) ^c	0	0	0	1.6	3.0	3.9	3.5	2.2	3.1	1.2	1.1
Subtotal	\$0	\$0	\$0.5	\$3.2	\$6.0	\$7.8	\$7.0	\$4.6	\$7.0	\$5.5	\$2.2
Oak Ridge Y-12 Plant											
Technology Partnership Program	\$1.0	\$5.8	\$17.5	\$15.7	\$25.8	\$8.9	\$4.2	\$5.3	\$2.8	\$0.3	\$0
Other DOE sources	d	d	d	d	d	d	d	d	d	d	d
Funding from partner(s)	0	0.3	0	0.1	0.6	0	0.1	0.1	0	0	0
In-kind support from partner(s) ^c	1.5	26.3	30.6	13.3	10.7	3.4	4.1	4.0	0.7	0	0
Subtotal	\$2.5	\$32.4	\$48.1	\$29.1	\$37.1	\$12.3	\$8.4	\$9.4	\$3.5	\$0.3	\$0

**Appendix II: The Technology Development
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Facility	Fiscal year										
	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001 ^a
Pantex Plant											
Technology Partnership Program	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Other DOE sources ^b	0	0	0	0	0	0.3	0	0	0	0	0
Funding from partner(s)	0	0	0	0	0	0	0	0	0	0	0
In-kind support from partner(s) ^c	0	0	0	0	0.3	0.3	0	0	0	0	0
Subtotal	\$0	\$0	\$0	\$0	\$0.3	\$0.6	\$0	\$0	\$0	\$0	\$0
All NNSA facilities											
Technology Partnership Program	\$1.2	\$19.7	\$83.1	\$144.2	\$205.0	\$145.6	\$59.5	\$47.6	\$43.5	\$7.5	\$0
Other DOE sources ^b	1.6	4.7	6.4	13.4	17.4	26.3	27.5	22.1	25.0	27.9	19.4
Funding from partner(s)	1.2	10.8	6.1	13.2	15.9	16.4	41.6	64.0	63.8	61.9	16.9
In-kind support from partner(s) ^c	3.2	45.2	88.8	129.9	151.3	131.1	128.9	122.0	111.9	77.7	44.5
Total	\$7.2	\$80.4	\$184.4	\$300.7	\$389.6	\$319.4	\$257.5	\$255.7	\$244.2	\$175.0	\$80.8

^aData are for the first 2 quarters of fiscal year 2001.

^bPrimarily includes research funds. Some CRADAs at NNSA laboratories have used laboratory-directed research and development funds.

^cPlanned in-kind contribution by nonfederal partner(s).

^dData were not readily available.

^ePlanned Technology Partnership Program funding. Actual data were not readily available.

Source: NNSA laboratories and production facilities.

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Table 7: Active Agreements to Provide Technical Assistance to Small Businesses at NNSA Laboratories and Production Facilities, Fiscal Year 1993 Through the Second Quarter of Fiscal Year 2001

Facility	Fiscal year								
	1993	1994	1995	1996	1997	1998	1999	2000	2001 ^a
Lawrence Livermore National Laboratory									
Newly executed agreements	0	3	15	41	19	10	2	0	0
Continuing agreements	0	^b	^b	^b	^b	^b	^b	0	0
Subtotal	0	3	15	41	19	10	2	0	0
Los Alamos National Laboratory									
Newly executed agreements	22	65	129	36	18	0	0	0	0
Continuing agreements	0	10	51	49	11	0	0	0	0
Subtotal	22	75	180	85	29	0	0	0	0
Sandia National Laboratories									
Newly executed agreements	0	280	287	232	198	153	175	131	29
Continuing agreements	0	22	106	90	94	80	82	79	64
Subtotal	0	302	393	322	292	233	257	210	93
Kansas City Plant									
Newly executed agreements	0	297	269	140	128	92	74	60	29
Continuing agreements	0	0	^b	^b	^b	^b	^b	^b	13
Subtotal	0	297	269	140	128	92	74	60	42
Oak Ridge Y-12 Plant									
Newly executed agreements	513	747	600	454	362	248	156	180	0
Continuing agreements	95	196	260	276	71	86	69	37	0
Subtotal	608	943	860	730	433	334	225	217	0
Pantex Plant									
Newly executed agreements	0	2	5	4	7	0	2	3	1
Continuing agreements	0	0	0	0	0	0	0	0	0
Subtotal	0	2	5	4	7	0	2	3	1
All NNSA facilities									
Newly executed agreements	535	1,394	1,305	907	732	503	409	374	59
Continuing agreements	95	228	417	415	176	166	151	116	77
Total	630	1,622	1,722	1,322	908	669	560	490	136

Note: In response to section 3135(b) of the National Defense Authorization Act for Fiscal Year 1993, DOE's Defense Programs established the Small Business Initiative to facilitate and encourage the transfer of technology to small businesses.

^aData are for the first 2 quarters of fiscal year 2001.

^bData were not readily available.

Source: NNSA laboratories and production facilities.

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Table 8: Active Work-for-Others Agreements at NNSA Laboratories and Production Facilities, Fiscal Year 1991 Through the Second Quarter of Fiscal Year 2001

Facility	Fiscal year										
	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001 ^a
Lawrence Livermore National Laboratory											
Newly executed agreements	b	b	b	b	b	b	b	b	b	b	b
Continuing agreements	b	b	b	b	b	b	b	b	b	b	b
Subtotal	74	75	55	80	104	110	192	192	276	299	309
Los Alamos National Laboratory											
Newly executed agreements	14	11	13	8	8	22	38	39	42	35	16
Continuing agreements	6	9	12	13	6	17	12	22	32	46	67
Subtotal	20	20	25	21	14	39	50	61	74	81	83
Sandia National Laboratories											
Newly executed agreements	0	0	0	13	21	39	54	93	152	155	68
Continuing agreements	0	0	0	9	21	41	72	90	111	196	259
Subtotal	0	0	0	22	42	80	126	183	263	351	327
Kansas City Plant											
Newly executed agreements	b	b	b	b	3	10	18	18	12	11	2
Continuing agreements	b	b	b	b	1	2	7	9	4	3	9
Subtotal	b	b	b	b	4	12	25	27	16	14	11
Oak Ridge Y-12 Plant											
Newly executed agreements	b	b	b	b	b	b	b	b	b	b	b
Continuing agreements	b	b	b	b	b	b	b	b	b	b	b
Subtotal	0	13	14	31	40	66	167	221	169	240	57
Pantex Plant											
Newly executed agreements	0	0	0	0	5	4	9	4	3	2	1
Continuing agreements	0	0	0	0	0	2	0	4	1	0	0
Subtotal	0	0	0	0	5	6	9	8	4	2	1
All NNSA facilities											
Newly executed agreements	b	b	b	b	b	b	b	b	b	b	b
Continuing agreements	b	b	b	b	b	b	b	b	b	b	b
Total	94	108	94	154	209	313	569	692	802	987	788

Note: Includes only agreements with nonfederal industrial partners.

^aData are for the first 2 quarters of fiscal year 2001.

^bData were not readily available.

Source: NNSA laboratories and production facilities.

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Table 9: Active Licenses of NNSA Laboratory and Production Facility Technology, Fiscal Year 1991 Through the Second Quarter of Fiscal Year 2001

	Fiscal year										
Facility	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001 ^a
Lawrence Livermore National Laboratory											
Newly executed licenses	b	b	b	36	57	81	64	49	35	33	13
Continuing licenses	b	b	b	64	101	158	196	241	277	291	318
Subtotal	b	b	b	100	158	239	260	290	312	324	331
Los Alamos National Laboratory											
Newly executed licenses	6	9	12	6	5	15	11	11	38	30	11
Continuing licenses	7	12	22	32	36	34	47	54	59	85	129
Subtotal	13	21	34	38	41	49	58	65	97	115	140
Sandia National Laboratories											
Newly executed licenses	2	8	17	17	27	102	64	38	49	57	38
Continuing licenses	6	8	15	32	50	76	176	235	264	305	386
Subtotal	8	16	32	49	77	178	240	273	313	362	424
Kansas City Plant											
Newly executed licenses	0	0	0	1	0	2	3	1	0	1	1
Continuing licenses	0	0	0	0	1	1	3	5	6	5	4
Subtotal	0	0	0	1	1	3	6	6	6	6	5
Oak Ridge Y-12 Plant											
Newly executed licenses	4	4	9	7	7	14	3	7	2	4	1
Continuing licenses	8	11	12	18	16	20	33	28	34	33	37
Subtotal	12	15	21	25	23	34	36	35	36	37	38
All NNSA facilities											
Newly executed licenses	12	21	38	67	96	214	145	106	124	125	64
Continuing licenses	21	31	49	146	204	289	455	563	640	719	874
Total	33	52	87	213	300	503	600	669	764	844	938

Note: Pantex did not have any technology licenses in effect between fiscal years 1991 and 2001.

^aData are for the first 2 quarters of fiscal year 2001.

^bData were not readily available on the number of continuing licenses.

Source: NNSA laboratories and production facilities.

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Table 10: Funding Provided by Nonfederal Entities for Technology Development Partnerships With NNSA Laboratories and Production Facilities, Fiscal Year 1991 Through the Second Quarter of Fiscal Year 2001

Dollars in millions

Facility	Fiscal year										
	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001 ^a
Lawrence Livermore National Laboratory											
CRADAs	\$0	\$0	\$0	\$1.9	\$3.2	\$2.4	\$12.4	\$28.6	\$31.3	\$20.9	\$2.8
Work for others	4.1	4.6	4.0	15.5	31.8	20.6	16.4	43.8	70.5	19.6	9.2
Cost-shared contracts	0	0	0	0	0	0	0	8.1	11.2	12.8	4.0
Technology licenses	0.4	0.4	0.4	0.6	1.1	1.3	2.3	2.6	2.2	3.6	^b
User facilities	0	0	0	0	0	0	0	0	0	0	0
Los Alamos National Laboratory											
CRADAs	1.2	6.1	0.3	0.6	1.5	1.9	1.9	2.3	2.3	2.6	0.5
Work for others	^b	^b	8.8	4.1	8.6	12.7	16.8	13.3	16.7	14.8	4.3
Technology licenses	0.1	0.2	0.1	0.2	0.1	0.3	0.4	0.7	0.9	1.3	1.0
User facilities	0	0.2	1.6	1.6	1.1	0.7	2.3	0.8	1.0	0.6	0
Sandia National Laboratories											
CRADAs	0	4.4	5.8	10.6	10.6	12.1	27.2	32.8	30.1	38.2	13.6
Work for others	0	0	0	0.2	14.0	14.3	17.1	22.7	24.6	29.7	15.4
Technology licenses	0	0.1	0	0.1	0.4	0.7	1.7	0.9	1.2	2.3	1.6
User facilities	^b	^b	^b	^b	^b	^b	^b	^b	^b	^b	^b
Kansas City Plant											
CRADAs	0	0	0	0	0	0	0	0.2	0.1	0.2	0
Work for others	^b	^b	^b	^b	0.4	0.4	0.5	0.9	1.0	0.9	0.1
Technology licenses	0	0	0	0	0	0	0.1	0.1	0	0.1	0
User facilities	0	0	0	0	0	0	0	0	0	0	0
Oak Ridge Y-12 Plant											
CRADAs	0	0.3	0	0.1	0.6	0	0.1	0.1	0	0	0
Work for others	0	1.2	0.5	0.9	0.5	2.2	7.0	10.9	8.0	2.7	0.4
Technology licenses	0	0	0	0	0	0	0	0.1	0.1	0	0
User facilities	^c	^c	^c	0.1	0	0	0	0.1	0	0	0
Pantex Plant											
CRADAs	0	0	0	0	0	0	0	0	0	0	0
Work for others	0	0	0	0	0	0.1	0.2	0.2	0.1	0	0
User facilities	0	0	0	0	0	0	0	0	0	0	0
All NNSA facilities											
CRADAs	\$1.2	\$10.8	\$6.1	\$13.2	\$15.9	\$16.4	\$41.6	\$64.0	\$63.8	\$61.9	\$16.9
Work for others	\$4.1	\$5.8	\$13.3	\$20.7	\$55.3	\$50.3	\$58.0	\$91.8	\$120.9	\$67.7	\$29.4
Cost-shared contracts	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$8.1	\$11.2	\$12.8	\$4.0
Technology licenses	\$0.5	\$0.7	\$0.5	\$0.9	\$1.6	\$2.3	\$4.5	\$4.4	\$4.4	\$7.3	\$2.6
User facilities	\$0	\$0.2	\$1.6	\$1.7	\$1.1	\$0.7	\$2.3	\$0.9	\$1.0	\$0.6	\$0

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Note: Technical assistance for small businesses is excluded because small businesses do not contribute funding.

^aData are for the first 2 quarters of fiscal year 2001.

^bData are not available.

^cNot applicable.

Source: NNSA laboratories and production facilities.

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