National Nuclear Security Administration
Sandia National Laboratories

CRADA and Patent License Agreements

NATIONAL ECONOMIC IMPACTS

SAND2021-1328 O

National Nuclear Security Administration
Sandia National Laboratories

CRADA and Patent License Agreements

TABLE OF CONTENTS

National Nuclear Security Administration

Cover Photo: Shutterstock/Alexyz3d

Photo by Senior Airman Daniel Brosam
341st Missile Wing Public Affairs

Airman 1st Class Jackson Ligon, 341st Missile Maintenance Squadron technician, installs parts onto a re-entry system during a Simulated Electronic Launch-Minuteman (SELM) test at a launch facility near Great Falls, Montana.

TABLE OF FIGURES AND CHARTS

National Nuclear Security Administration

Shutterstock / Gorodenkoff

Sandia National Laboratories, through technology transfer, supports a wide array of advanced research and development in the private and government sectors.

EXECUTIVE SUMMARY

This study evaluates the economic outcomes and impacts of 341 Cooperative Research and Development Agreements (CRADAs) and 101 Patent License Agreements (PLAs) between Sandia National Laboratories and outside partners. The purpose was to quantify the extent to which these technology transfer (T2) agreements have contributed to economic activity, job creation, and sustainment in the United States, from the year of the agreement through 2020. Additionally, the study defines the practical value of these technologies to the federal government.

The relevant agreements were executed between 2000 and 2010. Sandia is one of the three national laboratories managed by the National Nuclear Security Administration (NNSA), a semi-autonomous agency within the U.S. Department of Energy (DOE). The time period for the study was defined by Sandia. The technologies developed during this time period were considered likely to have had ample time to mature and reach the commercial markets. The research team successfully surveyed 223 T2 partners. Each was asked a series of questions

regarding sales of new products and services and other outcomes resulting from the technologies associated with the partnerships. In addition, two qualitative questions were asked to determine other benefits from these T2 agreements. Lastly, several additional questions were posed to companies whose agreements explicitly focused on nuclear weapons, stockpile, and non-proliferation.

The results of five outstanding T2 agreements were summarized in a series of success stories published by TechLink, the primary national partnership intermediary of the Department of Defense (DoD). These narratives demonstrate how the projects were used to advance scientific understanding and to support NNSA in achieving its nuclear weapons mission.

The research team was able to obtain full or partial information on the economic outcomes of 410 out of the 442 total PLAs and CRADAs, achieving a response rate of 93%.

The IMPLAN economic impact assessment model was used to estimate the economic impacts related to the sales of products and services enabled by these PLAs and CRADAs. The results of this study are believed to significantly understate the actual economic impacts because of multiple agreements with confidential outcomes, non-responding companies, the effects of inflation, and other factors discussed in the report.

Major findings from the study included the following:

$53.7 billion

In total sales of new products and services resulting from Sandia's PLAs and CRADAs

$21.9 billion

In sales of new products to the government

$95.9 billion

In total economic impact nationwide

$9.9 billion

In new tax revenues (federal, state, and local)

434,464 jobs

(20,689 per year) with average compensation of approximately $69,000

Nearly $1.7 billion

in estimated cost savings

DOE, NNSA and Sandia

The Department of Energy (DOE) is a major engine of innovation in the United States. DOE's 17 national laboratories typically surpass all federal agencies in total numbers of invention disclosures, patent applications, and issued patents. These inventions cover a wide spectrum of technology areas—from electronics, advanced materials, sensors, semiconductors, and various computer-related technologies (including cybersecurity and artificial intelligence) to environmental technology, biotechnology, diverse energy-related technologies, and nuclear weapons development.

The National Nuclear Security Administration (NNSA), a semi-autonomous agency within DOE, manages three of DOE's national laboratories: Lawrence Livermore National Laboratory (LLNL), Los Alamos National Laboratory (LANL), and Sandia National Laboratories. All three of these NNSA labs are government-owned, contractor-operated facilities. They are responsible for maintaining the safety, security, and reliability of the nation's nuclear weapons stockpile, and also for reducing the global threats of nuclear

proliferation and nuclear terrorism. In addition, they develop nuclear propulsion capabilities for the U.S. Navy.

In 1945, Sandia began as the ordnance design, testing, and assembly arm of LANL. In 1949, Sandia separated from LANL to become an independent lab. Seven years later, a second site was opened in California's Livermore Valley. Today Sandia is operated by National Technology and Engineering Solutions of Sandia, LLC, a wholly-owned subsidiary of Honeywell International, and supports a broad spectrum of national security requirements.

NNSA also operates the Kansas City National Security Campus, Nevada National Security Site, Pantex Plant, Savannah River Site, and the Y-12 National Security Complex. These plants and sites have a variety of tasks and objectives, which include but are not limited to manufacturing and obtaining components for nuclear weapons, supporting nuclear deterrence, ensuring the safety and security of the U.S. nuclear weapons stockpile, supplying tritium, and enriching uranium for nuclear weapons. These five NNSA sites and plants closely collaborate with LLNL, LANL, and Sandia to ensure NNSA successfully completes its objectives and mission.

Shutterstock / 4kclips

The James Forrestal building in Washington, DC, serves as headquarters for the Department of Energy.

NNSA and NUCLEAR WEAPONS HISTORY

Nuclear security has been an area of critical importance in the United States since World War II. Following the success of the Manhattan Project in creating the world's first nuclear stockpile, preservation and enhancement of these weapons has been a crucial U.S. national imperative. As its name suggests, the NNSA is tasked with the safety and security of these weapons, using an evolving strategy to combat dynamic threats.

Directed by the *2017 National Security Strategy* and the *2018 Nuclear Posture Review*, NNSA maintains a skilled team of scientists and engineers, pursuing discovery and innovation in the field of nuclear technologies. They work in world class laboratories and facilities, across government agencies, and with trusted industry partners to employ all available knowledge and techniques to further NNSA's mission. These initiatives consistently result in successful and important innovations in the fields of nuclear technology, non-

proliferation, and propulsion. NNSA's versatility and capabilities have also allowed it to successfully explore improvements in areas such as national security infrastructure, cybersecurity, and information technology, providing benefits to the U.S. beyond their core mission.

As nuclear technology continues to rapidly progress, the successful achievement of NNSA's mission becomes increasingly important. Rival powers, rogue nations, and terror groups all threaten the security of the United States as they too pursue nuclear weapons. The U.S. today faces a more diverse and advanced group of nuclear threats than at any other time in the nation's history. With this understanding, the invaluable nature of NNSA's mission to pursue nuclear deterrence and de-escalation cannot be overstated. The ability of NNSA to provide a robust, flexible and functional nuclear deterrence plan is crucial to the overall safety of the nation. However, today's nuclear environment demands that when deterrence fails, the United States be prepared with an advanced, mobile, and effective nuclear stockpile. To accomplish this, NNSA must work to constantly improve and enhance the nuclear stockpile while concurrently ensuring its security. Finally, the perpetual improvement of Navy craft challenges NNSA to provide contemporary and advanced methods of nuclear propulsion to give the U.S. warfighter every possible advantage. The essential nature of these three tasks compound to establish the importance of NNSA operations. Successful completion of its mission allows the NNSA to help provide the bedrock for the safety and security of the warfighter, the federal government, and the American people.

Photo by Airman 1st Class Daniel Brosam

Airman 1st Class Dillan Caceres, 341st Missile Security Forces Squadron response force leader, stands in front of a missile alert facility near Belt, Montana.

PURPOSE OF STUDY

This study quantifies the national economic impacts and other important outcomes of technology transfer (T2) agreements established by Sandia. Sandia is headquartered in Albuquerque, New Mexico, and has a campus in Livermore, California, and a test facility in Waimea, Hawaii. Its origins extend back to the Manhattan Project during World War II, which produced the first nuclear weapons stockpile for the United States. The agreements covered in the study include Patent License Agreements (PLAs) and Cooperative Research and Development Agreements (CRADAs).

DOE and other U.S. government agencies have a legal mandate to transfer their inventions to the private sector in order to benefit the nation's economy and help ensure national technological competitiveness.[1] PLAs are the primary means by which DOE labs transfer their inventions to the private sector for conversion into new commercial and DOE mission-related products. PLAs are legally

1 15 U.S.C. 3701 and 3710, and 35 U.S.C. 207-209, inter alia.

binding contracts that give licensees—usually for-profit corporations—the right to make, use, and sell federal government-owned inventions. CRADAs are unique contractual vehicles that enable federal labs and outside parties to jointly develop new technologies, leveraging each other's expertise and resources.[2] Many DOE CRADAs result in nationally and internationally important products and services.

The **purpose of this study** was to evaluate the extent to which Sandia's PLAs and CRADAs have resulted in new products and services that benefit the national economy, improve the nuclear weapons stockpile for the United States and international allies, and support the NNSA missions. More specifically, its purpose was to determine the extent to which PLAs and CRADAs established by Sandia have (1) contributed to new economic activity and job creation in the United States, and (2) resulted in the transition of new technologies that support the U.S. nuclear security enterprise. This study was jointly sponsored by NNSA and Sandia.

The research team surveyed all outside T2 partners having PLAs and CRADAs active with Sandia during the 2000-2010 period. This survey reached a total of 223 companies[3] with 410 different agreements—97 PLAs and 313 CRADAs. Companies were asked about sales of new products and services and other significant outcomes directly related to their T2 agreements with Sandia. In addition to these quantitative questions, two qualitative questions were asked to determine other benefits from the T2 agreements. Lastly, several additional questions were posed to companies whose agreements focused on nuclear weapons, stockpile, and non-proliferation. The research team used the IMPLAN economic impact assessment model to estimate the total economic impacts related to the company sales. IMPLAN is a leading program used by more than 1,500 organizations nationwide to model economic impacts. IMPLAN analysis yielded estimates of economic output, value added, employment, labor income, and tax revenues.

Photo by Chief Petty Officer Nelson L. Doromal

2 15 U.S.C. 3710a.

3 The term "companies" is used throughout this report to signify DOE's T2 partners. Most of these partners were for-profit companies but five of the CRADA partners were universities. Use of the term "companies" is not only a convenient way to abbreviate the text; it also is appropriate because when the CRADA partners are universities, they typically transfer promising new CRADA-related inventions to the private sector for commercialization.

RESEARCH TEAM and METHODOLOGY

Research Team

This economic impact study was conducted by TechLink in collaboration with the Business Research Division (BRD) of the Leeds School of Business at the University of Colorado Boulder. TechLink is a federally funded technology transfer center located at Montana State University. Since 1999, it has served as the primary national partnership intermediary of the Department of Defense (DoD), helping to develop licensing agreements, CRADAs, and other technology partnerships between DoD labs and U.S. industry nationwide.[4] Conducting economic impact studies is one of its important related activities. TechLink has conducted 15 national economic impact studies of T2 and Small Business Innovation Research programs on behalf of DoD and the National Cancer Institute. The BRD has been analyzing local, state, and national

4 For more information, see *www.techlinkcenter.org*

economies for more than 100 years and specializes in economic impact studies and customized research projects that help companies, associations, nonprofits, and government agencies make informed business and policy decisions.[5]

The principal authors of the study were Dr. Michael Wallner, Jeff Peterson, and Dr. Will Swearingen of TechLink, and Brian Lewandowski of the BRD. Other members of the team included Ray Friesenhahn, Joe Hutton, Jessica Kaplin, Matt Rognlie, Ben Taylor, Chris Van Bockel, and Michelle Zook of TechLink.

Methodology

This study was undertaken in **three major phases** during 2020 and early 2021**:**

(1) Data Gathering. During the data gathering phase, the research team contacted the companies having active CRADAs and PLAs with Sandia during the 2000-2010 time period. This phase began in August and lasted through November.

(2) Data Analysis. During this phase, the evaluation team analyzed the information gathered during the first phase. Analysts at the BRD used the IMPLAN model to estimate the economic multipliers and total economic impacts resulting from the sales of new products and services derived from these agreements. This second phase was accomplished in December.

(3) Final Report. Between December and January, the authors prepared the final report, drawing on the results of the previous two phases.

Research processes conducted during the first two phases are described in the following sections.

Data Gathering

The study was initiated in August 2020, when Sandia staff provided TechLink with essential information on 341 CRADAs and 101 PLAs. TechLink economic research specialists successfully surveyed 223 of the 231 company partners in these agreements, collecting data on 313 CRADAs and 97 PLAs. Respondents were asked a series of questions focusing on the outcomes of these agreements. The main substantive questions are listed below, with follow-up questions on specific category revenues where relevant.[6]

1) Did your company develop any new or improved products or services based on this CRADA or license agreement?

2) To date, what are your total cumulative commercial sales of products or services resulting from this CRADA or license agreement?

5 For more information, see *www.colorado.edu/leeds/centers/business-research-division*

6 Wording of the full survey is included in Appendix 3.

3) To date, what are your total cumulative sales to the U.S. Dept. of Energy/NNSA (either directly or through a contractor) due to this CRADA or license agreement?

4) What are your total cumulative sales to the U.S. government, directly related to this CRADA or license agreement?

5) To date, what is the total cumulative amount of follow-on R&D funding (government or private sector) you've received that is directly related to this CRADA or license agreement?

6) Did your company license or sub-license any of the technology developed from this CRADA or license agreement?

7) Did your company create a spin-off company to commercialize any technology developed under this CRADA or license agreement?

8) Did your company receive any outside investment funding (angel, venture capital, state, or IRAD funding) due to this CRADA or license agreement?

9) Have there been any benefits to your company from this CRADA or license agreement besides sales of new technology or other economic results?

10) Are you aware of any specific benefits to Sandia/NNSA/DOE from this CRADA or license agreement?

The following supplemental questions were posed to companies with CRADAs or PLAs related to nuclear weapons, stockpile, and non-proliferation:

1) Did your CRADA or license agreement result in any products or services that are being used by DOE/NNSA, or the U.S. military for nuclear weapons or non-proliferation purposes? Examples might include but aren't limited to nuclear weapons testing, surveillance, maintenance, security, transportation, or other purposes pertaining to nuclear weapons.

2) Did the technological results you just identified lead to any commercial off the shelf (COTS) products being purchased or used by DOE/NNSA or the U.S. military?

3) What are your estimated cost savings to date for the life cycle of this technology?

4) What are your projected overall cost savings for the life cycle of this technology?

Respondents were also asked if they would be willing to be featured in a success story highlighting the technology transfer process and the outcomes of their projects. Five of the most impressive outcomes were highlighted in success stories published by TechLink.

The company response rate was 97 percent, although some larger firms could not provide data on all of their partnerships. These cases involved large defense contractors with multiple departments, some of which were less cooperative, unreachable, or involved with classified technologies. In all, 223 companies provided information, by email and telephone, about the financial outcomes of 313 CRADAs and 97 PLAs. Only eight companies did not participate in the study, either prohibited by confidentiality agreements, refusing to participate, or proving unresponsive to outreach efforts. This left the outcomes of 28 CRADAs and four PLAs of the 442 total agreements unknown.

For each agreement with sales results, researchers assigned an industry-specific 6-digit North American Industry Classification System (NAICS) code. This was an essential step for analysis of the overall economic impact. NAICS codes are used to assign industry sectors employed by the IMPLAN model. As the federal government's standard industry classification system, NAICS codes allow companies to be aggregated according to the specific activities they undertake. For a list of NAICS codes used in this economic impact study, please refer to Appendix 4. Researchers drew on discussions with respondents to identify the industry most applicable to the product or service resulting from the agreement. During the review process, TechLink's chief data analyst checked each code for accuracy.

TechLink subsequently submitted a final dataset of economic results from its survey to the BRD at the University of Colorado Boulder. The dataset included—for each agreement leading to sales—a code number to identify the agreement and conceal the company's name, the 6-digit NAICS code for the corresponding product or service, and the total sales figures.

Data Analysis

The survey outcomes were compiled into the data report in the next section. Descriptive statistics provide an aggregated picture of the outcomes of the agreements, and economic impact modeling provides an estimate of how they have contributed to growth in the U.S. economy. Furthermore, the qualitative findings briefly explain the non-financial outcomes of these projects for both the private partners and the lab.

The IMPLAN model employed by BRD allows users to estimate the economic contributions resulting from the gathered sales figures. More than 1,500 entities in academia, the private sector, and government use IMPLAN[7] to estimate economic impacts. Estimates can be specified on the state, county, or ZIP code level.

IMPLAN draws on a mathematical input-output framework originally developed by Wassily Leontief, the 1973 Nobel laureate in economics, to study the flow of money through a regional economy. IMPLAN assumes fixed relationships between producers and their suppliers, based on demand, and that inter-industry relationships within a given region's economy largely determine how that economy responds to change. Increases in demand for a certain product or service causes a multiplier effect—a cascade of ripples through the economy. This increased demand affects the producer of the product, the producer's employees, the producer's suppliers, the suppliers' employees, and others, ultimately generating a total impact on the economy that significantly exceeds the initial change in demand.

For example, as a result of a CRADA with Sandia, a company develops an improved nuclear weapons detonation unit (NWDU) to foster more reliable nuclear weapons missile detonation. It subsequently manufactures these NWDUs and sells them to the NNSA and large prime contractors. The company needs to employ factory workers, who spend their earnings on groceries, housing, and other goods. It also must purchase machines, tools, components, and raw materials from other companies, which also employ workers who purchase goods. This ripple of activity extends through the economy.

7 Additional information can be found at *www.implan.com*

In this example, *direct effects* are the sales of the new NWDU, the jobs and payroll required to produce it, and the value created during the production process. *Indirect effects* are the same measures resulting from inter-industry purchases of components and raw materials needed to manufacture the NWDU. *Induced effects* are driven by employees spending their wages across a wide spectrum of the economy. *Total economic impacts* are the sum of direct effects, indirect effects, and induced effects.

Multipliers are ratios of the overall economic impacts to the direct effects and are typically derived from the following equation: (direct effect + indirect effect + induced effect) / direct effect. Multipliers are very specific to industry sectors and regions. The IMPLAN model distinguishes between 536 industry sectors, which are based on NAICS codes. Each sector has an output multiplier based on a unique pattern of purchases from other industries, both inside and outside of the regional economy. IMPLAN is updated annually using data collected by various federal agencies.

Upon receiving the sales data from TechLink, the BRD converted each NAICS code to its corresponding IMPLAN sector. With all of the sales figures properly categorized, the model yielded an estimate of the direct, indirect, and induced effects resulting from the agreements. The overall purpose of this modeling exercise was to estimate the total economic contribution of these sales to the nation's economy, including total economic output, value added, employment, labor income, and tax revenues.

The data presented are aggregated through 2020 and expressed in 2020 dollars. Nearly all company sales occurred prior to 2020, with some dating back to the early 2000s. However, to minimize the burden on respondents, the survey did not ask when sales occurred; therefore, the study assumes a constant year. Using 2020 as the reference year represents a conservative approach, ignoring the higher value of earlier sales figures due to inflation (for example, $100 in 2000 had the same purchasing power as $147 in 2018).

Shutterstock / foxaon1987

The extensive commercial and governmental spending represented by Sandia's CRADAs and PLAs ripple throughout the U.S. economy.

RESULTS REPORTED BY COMPANIES

The answers to the first question establish the fact that these agreements only occasionally result in products or services. As Table 1 shows, only 29 percent (27% of CRADAs and 35% of PLAs) had resulted in new products or services at the time of the survey.

Table 1: New products or services developed as a result of T2 agreements with Sandia

Answer	All Agreements	CRADAs	PLAs
No	70%	72%	64%
Yes	29%	27%	35%
Unknown	1%	1%	1%

A "yes" answer to this question does not necessarily mean these technologies had been sold. Occasionally products resulting from these partnerships are simply turned over to Sandia as a useable tool. The following questions concern the actual sales resulting from the technologies.

Sales from Agreements

The survey questions focus on the outcomes of the T2 agreements, between the signing date and the time of the survey. The numbers reported in this section are aggregated amounts accrued between the start of the relevant agreements (2000-2010) and the date of the survey (2020). The surveyed companies reported that 28 percent of the agreements (113 total) included in the study (25 percent of the 313 CRADAs and 36 percent of the 97 PLAs) had led to sales of new products or services (see Table 2). These rates differ from those in Table 1, because they omit those technologies developed but not sold, and include the receipt of R&D funding, categorized as sales of research services. **Total cumulative sales and revenues reported were nearly $53.7 billion.** The "total sales" category in Table 2 encompasses not only cumulative sales of products and services made by the T2 partner, but also follow-on R&D contracts, sales of directly-related products by a third-party licensee, and sales by spin-out companies.

Table 2: Commercial outcomes resulting from Sandia T2 agreements

	Total Companies	Total Agreements	Percent of Agreements	Total Sales ($ Millions)	U.S. Government Sales ($ Millions)	DOE/NNSA Sales ($ Millions)
Included in Study	223	410	100%	53,691	21,904	78
Achieving Sales	70	113	28%	53,691	21,904	78
No Sales	153	297	72%	0	0	0

Source: TechLink survey, August-November, 2020

The survey found that 72% of agreements—235 CRADAs (75 percent) and 62 PLAs (64 percent)—did not generate sales. This category included newer agreements involving technologies that companies were actively working to commercialize and agreements that, for many reasons, had not resulted in commercialization. A significant portion of the latter includes CRADAs that were never intended to produce commercial outcomes or that were focused only on R&D. These statistics define only the 410 agreements surveyed, not including the 32 agreements for which researchers could find no respondent.

Government Sales. The survey found that **sales to the U.S. government amounted to $21.9 billion**, or 41 percent of the total from all sources (see Table 2). These sales involve CRADA and PLA-developed technology procured by the federal government, and include $78 million in products or services sold to entities within the Department of Energy. This small proportion of sales supports the idea, discussed below in the qualitative outcomes, that the true value of these agreements to DOE lies in the licensing and sharing of technology, rather than creating products for sale to the department. For additional information, Appendix 1 lists sales outcomes from the survey, broken out by agreement type.

Company Size

The survey asked respondents for the size of the company associated with the agreement, both at the time of the survey and at the time the T2 agreement was signed. The purpose of this question was to determine if the T2 agreements had contributed to company growth. Table 3 shows the results. In a small percentage of cases, respondents could not determine the company size, usually because they were not part of the company when either the agreement was signed or when the survey was conducted. In cases where the subject technology was acquired by a different entity, the size at time of survey indicates the size of the current company overseeing the technology portfolio. As Table 3 reveals, approximately two-thirds of the Sandia T2 agreements involved large companies (500+ employees). As the proportions changed very little between the two time periods, the data do not indicate any obvious trends.

Table 3: Size of companies having T2 agreements with Sandia at the times of the survey and agreement execution

Company Size	Time of Survey	Time of Agreement
Unknown	2%	1%
Very Small (1-9)	13%	13%
Small (10-99)	15%	16%
Medium (100-499)	5%	7%
Large (500+)	65%	63%

Table 4 shows how the information collected for product sales breaks down by company size. A notable survey finding was that large businesses (500 or more employees), which were partners on 63 percent of the Sandia T2 agreements, were less likely than smaller companies to commercialize the resulting technologies. In fact, the commercialization rate by company size varies linearly from a low of 24 percent for large companies to a high of 38 percent for both small and very small companies, with an average commercialization rate of 28 percent.

Nonetheless, as Table 4 shows, large companies accounted for approximately 94 percent of the total sales and 99 percent of the sales to government entities. By contrast, very small businesses, which represented 13 percent of the agreements, accounted for only around two percent of the total sales and less than one percent of the government sales.

Table 4: Sales by company size (if known) from the Sandia T2 agreements

Company Size	Agreements with Sales	Commercialization Rate by Company Size	Total Combined Sales ($ Millions)	U.S. Government Sales ($ Millions)
Large 500+ Employees	61	24%	50,561	21,702
Medium 100-499 Employees	7	26%	815	66
Small 10-99 Employees	24	38%	1,329	43
Very Small 1-9 Employees	21	38%	986	93
Total	113	28%	53,691	21,904

Source: TechLink survey, August-November, 2020. Company size at time of agreement.

Other Economic Outcomes

In addition to sales, the companies in the study reported other significant economic outcomes. Companies received *total outside investment funding* (including venture capital and angel funding) directly attributable to these partnerships of slightly over $1 billion. In addition, 10 companies reported that they were *acquired* primarily because of the technologies associated with the T2 partnerships with Sandia. However, because of confidentiality concerns, only six of the companies were able to share the acquisition amounts, a combined total of $88 million. Companies reported that they had licensed nine technologies to other companies for commercialization.

The survey also showed that these projects were responsible for the creation of 33 new companies. Respondents reported that 29 of these start-up companies were created to pursue the T2 partnership with Sandia and an additional four were created to commercialize the technological results of the agreements.

These other economic outcomes and impacts are summarized below:

- Total outside investment funding: $1 Billion
- Number of companies that were acquired: 10
- Number of technologies licensed to other companies: 9
- Number of new companies created: 33

Company CRADA Contributions

Within the survey, the Sandia CRADA partners were asked to estimate the in-kind financial contributions their companies made to the project. Many companies were unable to answer due to lack of cost tracking, a reluctance to share this information, or because they had acquired the technology after the initial research. However, the following descriptive statistics describe the data collected for 164 CRADAs:

- Sum of in-kind contributions: $141,698,999
- Average in-kind contribution: $864,018
- Median in-kind contribution: $250,000
- Maximum in-kind contribution: $10,000,000
- Minimum in-kind contribution: $10,000

Shutterstock / sdecoret

Sandia's CRADAs and PLAs result in extensive commercial and government cooperation, private sector in-kind contributions, and collaboration with our international allies.

ECONOMIC IMPACT ANALYSIS

The product and service sales described in the survey provide the foundation for an estimate of the total economic impact of these Sandia T2 partnerships upon the U.S. economy. The study assumes that sales define the amount of a product produced. The costs of producing these products translate into expenditures that support other industries and households, through the purchase of materials and labor. The value of those expenditures, and subsequent purchases along the many supply chains, result in the total economic impact.

Determining the impact to the U.S. economy requires that sales associated with international manufacturing be removed from the survey total. A large portion of the sales enabled by the T2 partnerships in this study was traced to offshore manufacturing. Through conversations with company representatives and extensive secondary research, TechLink researchers adjusted the sales figures collected by the survey to reflect only the sales that would have a domestic impact through manufacturing within the United States. The result

of these adjustments is an estimated direct impact on the U. S. economy of approximately $33.3 billion, out of the total of $53.7 billion in worldwide sales. Even though there was $20.4 billion in worldwide sales eliminated from our domestic analysis, these foreign sales still have impacts on our international allies and their economies.

The adjusted sales data was anonymized and delivered to the BRD at the University of Colorado Boulder. BRD staff employed the IMPLAN model to estimate the economic activity that was enabled by these partnerships. Results below are presented for *output, value added, employment, labor income*, and *tax revenues*. As previously noted, all dollar figures are reported in 2020 dollars. Note that this section aggregates both agreement types. Impact estimates separated by type are displayed in Appendix 1.

Table 5 displays the output from the IMPLAN model. The outcomes are also discussed below.

Table 5: Total IMPLAN estimates of economic impacts from the Sandia T2 agreements

Impact	Employment	Labor Income ($ Millions)	Value Added ($ Millions)	Output ($ Millions)
Direct	119,367	$10,420	$14,735	$33,345
Indirect	146,877	$10,328	$15,837	$33,278
Induced	168,219	$9,244	$16,642	$29,273
Total	434,464	$29,992	$47,215	$95,896

Total Economic Impact (Output): $95.9 Billion

Output represents the **total economic impact** and is the total value of purchases by intermediate and final consumers—the sum of direct, indirect, and induced sales.[8] Output is closely associated with economic impact analysis and is one of the values most frequently cited by economic impact studies. According to the national IMPLAN model, the $33.3 billion in output, corresponding to the company sales of new products or services, generated an additional $62.6 billion in sales economy-wide. Of this, $33.3 billion was the indirect effect, the result of inter-industry purchases, and $29.3 billion was the induced effect, or increased household spending economy-wide (see Table 5). The total economy-wide output was $95.9 billion. Dividing total economy-wide output by the direct sales of relevant products and services resulting from T2 partnership agreements with Sandia ($33.3 billion) yielded an output multiplier of 2.88. That is, for every dollar spent on U.S.-produced goods and services directly enabled by Sandia's CRADAs and PLAs, an *additional* $1.88 in sales was generated economy-wide.

Value Added: $47.2 Billion

Value added is the difference between industry or company output and the cost of intermediate inputs. Expressed differently, it is the difference between a product's sale price and its production cost (excluding labor). This measure recognizes that companies buy goods and services from other companies and create

8 Technically, it is the total value of purchases, plus or minus inventory adjustments.

products of greater value than the sum of the goods and services used to make these products. This increase in value resulting from the production process is the "value added." As estimated by IMPLAN, value added is equal to the total sales (plus or minus inventory adjustments) minus the cost of the goods and services purchased to produce the products sold.

According to the national IMPLAN model, the $33.3 billion in direct sales added $47.2 billion in value to the national economy. Of this, $14.7 billion was generated by direct sales, $15.8 billion came from the indirect effect, and $16.6 billion resulted from the induced effect (see Table 5).

Employment: 434,464 Jobs (20,689 annual average)

According to the national IMPLAN model, the sales resulting from the agreements and their ripple effects economy-wide supported approximately 434,464 jobs. This includes 119,367 jobs through the direct effect (the sales of new products and services reported by the companies in the study), 146,877 from the indirect effect, and 168,219 from the induced effect (see Table 5). In these estimations, each job is defined as one job supported over one year. This means that, on average, an estimated 20,689 jobs were supported annually between 2000 and 2020, which was the 21-year period in which this study evaluated economic outcomes and impacts.

Photo by MC2 Kelsey Hockenberger

Ohio-class guided-missile submarine USS Ohio transits Apra Harbor in Guam.

Labor Income: $30.0 Billion

Labor income consists of employee compensation (wage and salary payments, including benefits), and proprietor income (income received by self-employed individuals). The national IMPLAN model estimated that labor generated by the direct effect from the $33.3 billion in sales was $10.4 billion, or approximately $87,000 per job (see Table 5).

The indirect labor income was estimated at $10.3 billion, or approximately $70,000 per job. The induced labor income was estimated to be $9.2 billion—nearly $55,000 per job. Average compensation for indirect and induced jobs was substantially lower than for direct jobs because many were in lower-paid manufacturing and service sectors.

The total economy-wide labor income resulting from the agreements was nearly $30.0 billion. The average compensation from the 434,464 jobs supported through these agreements was approximately $69,000. This compares with third quarter 2020 median earnings in the United States of approximately $51,700.[9] The labor income multiplier was 2.88, indicating that for every dollar in wage and salary income directly attributable to NNSA technology partnership agreements, an *additional* $1.88 was generated nationally in employee compensation and proprietor income.

Tax Revenues: $9.9 Billion

Tax revenues were estimated for the $33.3 billion in sales and their economy-wide indirect and induced effects. These tax revenues included social insurance taxes such as Social Security and Medicare (paid by employers, employees, and the self-employed), personal income taxes, motor vehicle licenses, property taxes, corporate profits taxes and dividends, and indirect business taxes, consisting mainly of excise and property taxes, fees, licenses, and sales taxes. Total taxes collected by federal, state, and local government entities were estimated at $9.9 billion (see Table 6). This included $6.4 billion in total federal taxes, and $3.5 billion in total state and local tax revenues. In sum, for every dollar of direct sales generated through all agreements, $0.30 was collected in taxes by federal, state, and local governments.

Table 6: Estimates of the tax collections enabled by Sandia T2 agreements

Source	State and Local Taxes ($ Millions)	Federal Taxes ($ Millions)	Total Taxes ($ Millions)
All Agreements	$3,464	$6,428	$9,892
CRADAs	$3,400	$6,304	$9,704
PLAs	$65	$124	$188

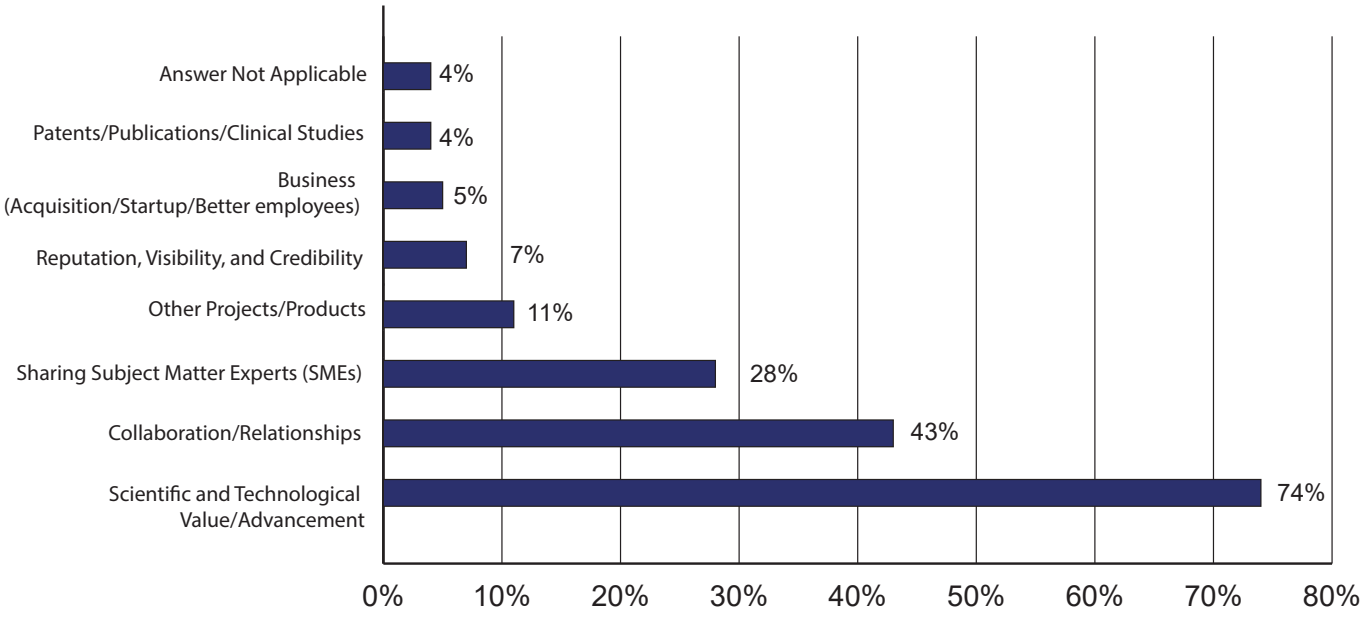
Source: IMPLAN model output based on TechLink survey. Numbers may not add due to rounding.

9 Median national earnings were calculated using the median weekly earnings for the third quarter of 2020 from the Bureau of Labor Statistics (BLS). The average compensation (labor income per job) figures include the earnings of both employees and proprietors, through both work and business profits. Weekly earnings provided by the BLS do not include proprietor income, but are provided here as a general comparison.

As previously mentioned, in addition to the quantitative questions, the survey team asked companies two qualitative questions intended to determine other outcomes and impacts resulting from the Sandia T2 agreements. These questions, and a summary of the results, follow:

> Have there been any benefits to your company from this CRADA or license agreement besides sales of new technology or other economic results?

Over half of the respondents (55%) answered "Yes" to this question, indicating that there were additional benefits for their company. A request for more detail yielded 220 open-ended responses. TechLink staff reviewed these responses and open-coded the results. The open-coding methodology resulted in seven distinct categories that encompassed the research team's findings. Figure 1 below displays these categories and the number of responses falling within each category.



Note: The total number of answers exceed the count of responses (220) because the open-ended answers often covered multiple company benefits.

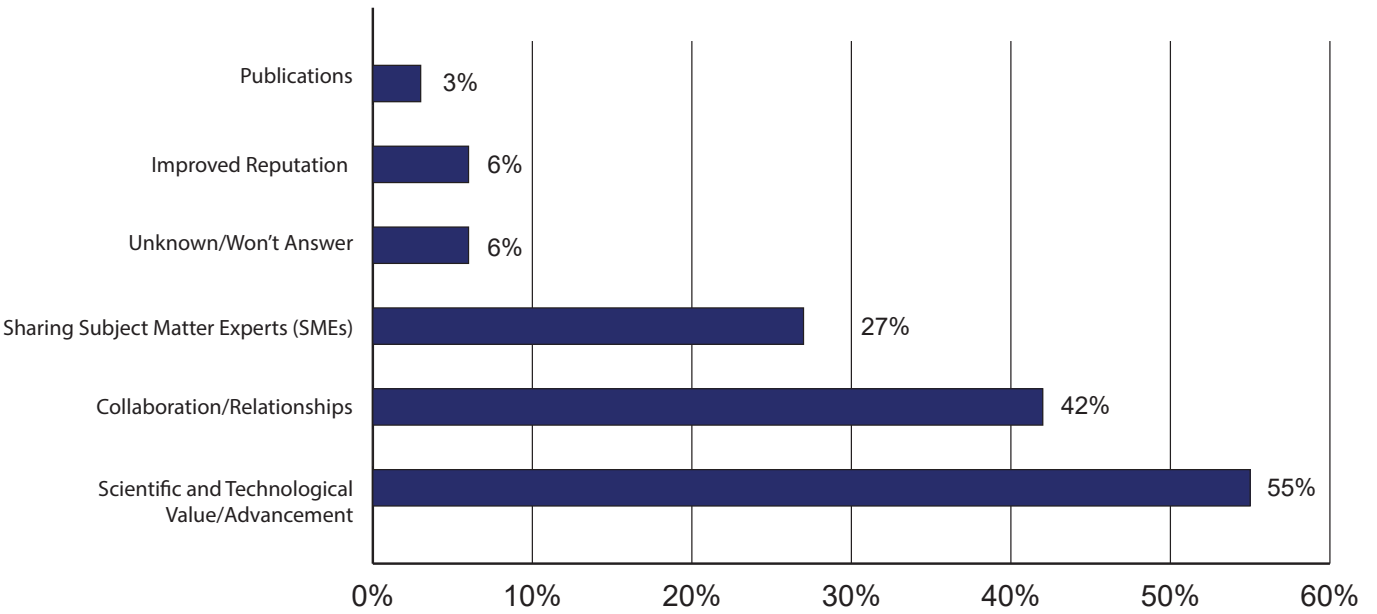
Figure 1. Other company benefits resulting from the T2 agreements with Sandia

The most common answer from respondents (74%) was that the T2 agreement resulted in "Scientific and Technological Value or Advancement," which indicates how important CRADAs and PLAs are for scientific advances for industry, often related to U.S. nuclear weapons and the nation's nuclear stockpile. Additionally, 43 percent of respondents noted the importance of "Collaborations/Relationships" resulting from the agreements. More specifically, 28 percent mentioned the importance of "Sharing Subject Matter Experts (SMEs)" to advance research and development. Less commonly mentioned benefits from the Sandia T2 agreements were that they led to "Other Products/Projects" (11%); improved "Reputation, Visibility,

and Credibility" (7%); business-related benefits such as "Acquisition/Startup/Better Employees" (5%); and Publications/Patents/Clinical Studies (4%).

Are you aware of any specific benefits to Sandia, NNSA, or DOE from this CRADA or license agreement (non-financial)?

Over a third of the respondents, 40 percent, answered "Yes," they were aware of specific benefits to Sandia, NNSA, or DOE. A follow-up question received 157 open-ended responses to elaborate on these specific benefits. These open-ended responses closely mirrored the answers to the previous question about other benefits to the companies from the Sandia T2 agreements. TechLink staff reviewed these findings and open-coded the responses. The open-coding methodology resulted in seven distinct categories that encompassed the research team's findings. Figure 2 below displays these categories and the number of responses falling within each distinct category.



Note: The total number of answers exceed the count of responses (157) because the open-ended answers often covered multiple specific benefits.

Figure 2. Benefits to Sandia, NNSA, or DOE resulting from company T2 agreements with Sandia

The most common answer from respondents (55%) focused on the "Scientific and Technological Value/Advancement" benefits, which indicates how important CRADAs and PLAs are for scientific advances for Sandia and its continued work on nuclear weapons and the nuclear stockpile. Additionally, 42 percent of respondents noted the importance of "Collaborations/Relationships." More specifically, 27 percent mentioned the importance of "Sharing Subject Matter Experts (SMEs)." Less commonly mentioned benefits included "Improved Reputation" (6%) and "Publications" (3%). In six percent of the cases, the benefits were either unknown or the respondents declined to answer.

In addition to the above qualitative questions that all companies were asked, the survey team posed several additional questions to seven large corporations with a total of 112 T2 agreements, most of which focused on nuclear weapons, stockpile, and non-proliferation. The purpose of these questions was to determine how CRADAs and PLAs assist NNSA with maintaining the safety, security, and reliability of the nation's nuclear weapons stockpile while also reducing the global threats of nuclear proliferation and nuclear terrorism.

Although all seven companies surveyed provided answers related to at least some of their T2 agreements, they were unable or unwilling to discuss 17 of them. Of the 95 T2 agreements companies were able to discuss, the specific questions and outcomes included the following:

Question:

Did your CRADA or license agreement result in any products or services that are being used by DOE/NNSA or the U.S. military for nuclear weapons or non-proliferation purposes? If so, how is the technology being used?

Answers:[10]

- Security for nuclear weapons using secure network server with a radiant mercury-based cross domain solution
- Advancement over current NNSA technology and time savings
- Nuclear weapons testing
- Improved computer codes that will be used to solve weapon component design problems that previously were intractable

Question:

Did the technological results you just identified lead to any commercial off the shelf (COTS) products being purchased or used by DOE/NNSA or the U.S. military?

Answers:[11]

- Components were high powered capacitors for COTS dual use
- COTS but not quite there yet
- COTS technology. Laser communication
- Definitely COTS
- If transitioned, would have been COTS
- Low power L&A
- No. Tech was proprietary software
- Power switches
- Software element was COTS

10 Of the 95 responses received, 12 (13%) were "yes," 67 (71%) were "no," and 16 (17%) were "unknown." Among the "no" and "unknown" responses, 11 (13%) were marked as classified.

11 Among the 95 T2 agreements that companies were able to discuss, 18 (19%) were "yes," 68 (72%) were "no," and nine (9%) were "unknown." Among the "no" and "unknown" responses, nine (12%) were marked as classified.

- Technology would have been COTS if developed
- Was developed for COTS

What are your estimated cost savings to date for the life cycle of this technology?

What are your projected overall cost savings for the life cycle of this technology?

For most of the T2 agreements, respondents indicated that either they did not know, that the data was classified and so couldn't be discussed, or that any response would be pure speculation, which they declined to provide. Cost-savings estimates were provided for only four of the T2 agreements. For these four agreements, aggregate life cycle cost savings were estimated at $1.67 billion. This included one estimate of $1.6 billion saved to date, and three others projecting life cycle savings totaling $70 million.

Another measure of cost savings is the in-kind contributions made by the companies themselves. As mentioned on page 22, 164 companies reported investing a total of $142 million in their CRADA projects. Assuming these technologies have value to NNSA, these company contributions can be interpreted as cost savings to the government.

Success Stories

After the survey, five T2 agreements with uniquely successful outcomes were highlighted in a series of success stories developed and published by TechLink. These projects cover a variety of scientific research and serve as case studies of how T2 enhances technological development and supports NNSA in achieving its nuclear weapons mission. They also highlight the impacts these T2 agreements have had on the nation's international allies. The five technologies featured in the success stories focus on advanced software modeling capabilities for nuclear weapons; biological and chemical sensors; simulation codes for nuclear weapons; international simulations and modeling technology used on the Joint Strike Fighter; and technology to quickly and effectively neutralize Improvised Explosive Devices.

SUMMARY

In summary, this study describes the outcomes of PLAs and CRADAs between Sandia National Laboratories and outside partners. The primary goal of the study was to estimate the economic contributions of these T2 agreements to the national economy. The secondary goal was to identify the extent to which CRADAs and PLAs contribute to NNSA's core missions of maintaining the nuclear stockpile, monitoring and promoting non-proliferation, powering the nuclear Navy, and responding to nuclear and radiological emergencies. The findings are clear and succinct: through technology transfer, NNSA and Sandia are important contributors to the United States economy and these T2 agreements have resulted in scientific and nuclear weapons advancements for the safety and security of the United States.

The study team conducted a rigorous survey of companies to determine the total sales of new products and services resulting from these CRADAs and PLAs. Respondents to the survey collectively

attributed $53.7 billion in sales to these agreements. Approximately $33.3 billion of these sales were determined to have a direct impact on the U.S. economy.[12] The team estimated the economic ripple effects of these sales using the IMPLAN model. These estimates define the indirect and induced effects of these sales on the national economy in terms of total economic output, value added, employment, labor income, and tax revenue.

The total economy-wide output over the 21 years (2000-2020) for which this study evaluated economic outcomes and impacts was estimated at $95.9 billion. Value added, representing new wealth creation in the economy, was estimated at $47.2 billion. Employment impact estimates included 434,464 jobs with an average compensation of just over $69,000, and total labor income of $30.0 billion. The $33.3 billion in sales and its economy-wide effects generated approximately $9.9 billion in total tax revenue, including $6.4 billion in federal tax revenues and $3.5 billion in state and local tax revenues.

Photo by Airman 1st Class Jacob Thompson

An Airman with the 841st Missile Security Forces Squadron participates in a recapture and recover exercise.

12 The remainder of the sales, approximately $20.4 billion, was generated from manufacturing outside the United States and did not have a direct impact on the U.S. economy, as explained in the introduction to the Economic Impact Analysis section.

APPENDIX 1

National Economic Impact Estimates by Agreement Type

The following tables provide a more detailed look at the economic impacts resulting respectively from the CRADAs and PLAs in this study. As these tables show, the economic impacts from CRADAs far surpassed those from PLAs. CRADAs generated sales totaling more than $53 billion and total economic impacts (output) exceeding $94 billion. By contrast, PLAs generated less than $700 million in sales and $1.5 billion in total economic impacts.

CRADAs

Sales from CRADAs

Table 7: Sales of products and services resulting from Sandia CRADAs

Sales Type	Amount
Total Combined Sales	$53,005,024,776
Commercial Sales	$30,778,053,015
Sales to the Government	$21,781,428,751
Follow-on R&D Funding	$384,218,010
Sales to the DOE	$65,778,748
Spinoff Sales	$30,500,000
Royalties	$29,725,000
Sales by Licensees	$1,100,000

**Sales to the DOE are also included in Sales to the Government category*

Total Economic Impact from CRADAs

Table 8: Estimates of the economic impacts of Sandia CRADAs

Impact	Employment	Labor Income ($ Millions)	Value Added ($ Millions)	Output ($ Millions)
Direct	117,073	$10,183	$14,425	$32,659
Indirect	144,437	$10,129	$15,534	$32,868
Induced	165,434	$9,082	$16,351	$28,875
Total	426,944	$29,395	$46,309	$94,401

PLAS

Sales from PLAs

Table 9: Sales of products and services resulting from Sandia PLAs

Sales Type	Amount
Total Combined Sales	$686,278,083
Commercial Sales	$400,202,371
Follow-on R&D Funding	$163,470,001
Sales to the Government	$122,555,611
Sales to the DOE	$12,203,466
Royalties	$50,000
Spinoff Sales	$100

**Sales to the DOE are also included in Sales to the Government category*

Total Economic Impact from PLAs

Table 10: Estimates of the economic impacts from Sandia PLAs

Impact	Employment	Labor Income ($ Millions)	Value Added ($ Millions)	Output ($ Millions)
Direct	2,294	$237	$310	$686
Indirect	2,441	$198	$304	$410
Induced	2,785	$161	$292	$399
Total	7,520	$597	$905	$1,495

Photo by Petty Officer 3rd Class Nathan Beard

Marine 1st Lt. Earl Ehrhart exits a T-45C Goshawk on the flight deck of the aircraft carrier USS Dwight D. Eisenhower.

APPENDIX 2

Economic Impact Estimates by State

This appendix estimates the economic outcomes and impacts of the Sandia T2 agreements for the 29 states where the research and manufacturing occurred. There is a ripple effect from these 29 states that impacts the other 21 states. However, because of the difficulty of reliably estimating those ripple effects, breakouts for these other 21 states are not included.

Alabama	Employment	Labor Income	Value Added	Output
Direct	2,790	$233,990,146	$364,620,079	$1,316,577,580
Indirect	6,780	$395,088,851	$654,834,070	$1,521,663,313
Induced	4,488	$233,373,539	$419,437,937	$757,758,350
Total	14,059	$862,452,535	$1,438,892,086	$3,595,999,244

Alaska	Employment	Labor Income	Value Added	Output
Direct	214	$13,060,893	$13,843,495	$30,000,000
Indirect	161	$10,009,856	$14,316,162	$28,092,375
Induced	147	$8,251,940	$14,509,204	$25,331,162
Total	522	$31,322,689	$42,668,860	$83,423,537

Arizona	Employment	Labor Income	Value Added	Output
Direct	15,534	$1,058,392,209	$1,149,059,051	$2,341,000,000
Indirect	26,701	$1,682,864,663	$2,439,297,290	$4,723,078,105
Induced	44,603	$2,518,827,467	$4,436,450,892	$7,950,475,108
Total	86,838	$5,260,084,339	$8,024,807,233	$15,014,553,213

California	Employment	Labor Income	Value Added	Output
Direct	7,381	$684,392,348	$761,316,951	$1,339,081,746
Indirect	4,797	$360,063,316	$512,565,740	$947,442,665
Induced	5,795	$357,876,456	$660,949,626	$1,097,826,855
Total	17,974	$1,402,332,121	$1,934,832,318	$3,384,351,266

Colorado	Employment	Labor Income	Value Added	Output
Direct	4	$249,697	$521,590	$1,283,590
Indirect	5	$380,126	$612,628	$1,404,911
Induced	4	$235,940	$426,109	$751,563
Total	13	$865,762	$1,560,327	$3,440,064

Connecticut	Employment	Labor Income	Value Added	Output
Direct	1,039	$146,055,386	$218,623,765	$759,428,571
Indirect	2,224	$209,977,290	$337,570,887	$750,214,396
Induced	2,265	$135,316,100	$241,185,768	$409,646,234
Total	5,528	$491,348,776	$797,380,421	$1,919,289,202

Florida	Employment	Labor Income	Value Added	Output
Direct	18,185	$1,250,406,351	$1,394,107,765	$3,204,578,571
Indirect	15,865	$976,691,725	$1,453,251,353	$3,033,018,044
Induced	16,710	$843,467,482	$1,544,309,965	$2,778,385,898
Total	50,761	$3,070,565,558	$4,391,669,082	$9,015,982,514

Georgia	Employment	Labor Income	Value Added	Output
Direct	2	$341,345	$645,330	$1,200,000
Indirect	4	$294,447	$437,776	$856,641
Induced	4	$224,806	$415,656	$731,889
Total	10	$860,599	$1,498,761	$2,788,530

Illinois	Employment	Labor Income	Value Added	Output
Direct	189	$21,556,118	$22,547,106	$30,000,000
Indirect	81	$5,031,211	$6,885,357	$11,553,517
Induced	180	$10,226,477	$18,354,065	$31,402,171
Total	449	$36,813,807	$47,786,528	$72,955,687

Kansas	Employment	Labor Income	Value Added	Output
Direct	2,709	$247,071,127	$384,964,143	$1,310,577,580
Indirect	6,307	$385,393,866	$639,506,258	$1,492,170,034
Induced	4,500	$240,829,532	$429,822,067	$774,857,447
Total	13,515	$873,294,525	$1,454,292,468	$3,577,605,061

Massachusetts	Employment	Labor Income	Value Added	Output
Direct	547	$69,720,354	$128,241,266	$255,525,000
Indirect	704	$64,587,612	$97,776,326	$202,535,888
Induced	909	$55,834,578	$95,831,568	$162,409,991
Total	2,160	$190,142,543	$321,849,160	$620,470,878

Maryland	Employment	Labor Income	Value Added	Output
Direct	29,197	$3,313,247,863	$5,934,687,276	$11,284,300,006
Indirect	33,288	$2,953,673,674	$4,491,142,434	$9,427,857,505
Induced	42,305	$2,384,395,017	$4,330,333,776	$7,469,979,350
Total	104,790	$8,651,316,555	$14,756,163,486	$28,182,136,861

Minnesota	Employment	Labor Income	Value Added	Output
Direct	6	$806,652	$1,233,510	$3,300,000
Indirect	13	$1,144,867	$1,673,911	$3,171,082
Induced	15	$816,258	$1,412,137	$2,503,475
Total	34	$2,767,777	$4,319,558	$8,974,556

Missouri	Employment	Labor Income	Value Added	Output
Direct	21	$1,756,750	$2,296,018	$4,599,999
Indirect	22	$1,368,922	$2,107,816	$4,064,245
Induced	24	$1,230,809	$2,172,561	$3,925,441
Total	67	$4,356,481	$6,576,396	$12,589,685

North Carolina	Employment	Labor Income	Value Added	Output
Direct	2,795	$228,205,122	$356,419,892	$1,311,294,027
Indirect	6,515	$394,499,902	$657,940,725	$1,534,677,447
Induced	4,434	$234,068,266	$423,034,972	$754,322,507
Total	13,744	$856,773,290	$1,437,395,589	$3,600,293,981

Nevada	Employment	Labor Income	Value Added	Output
Direct	5,577	$351,913,696	$389,222,751	$810,000,000
Indirect	4,256	$250,961,660	$371,293,856	$739,658,090
Induced	3,644	$192,525,313	$370,477,376	$644,907,919
Total	13,477	$795,400,670	$1,130,993,983	$2,194,566,009

New Mexico	Employment	Labor Income	Value Added	Output
Direct	2,092	$199,110,284	$227,435,545	$1,141,650,101
Indirect	4,366	$369,194,347	$582,269,245	$1,290,230,658
Induced	4,368	$232,276,424	$418,517,093	$752,052,533
Total	10,826	$800,581,055	$1,228,221,883	$3,183,933,291

New York	Employment	Labor Income	Value Added	Output
Direct	4,723	$426,645,212	$631,253,215	$1,277,678,571
Indirect	2,946	$263,852,885	$431,644,074	$921,404,281
Induced	4,365	$269,154,253	$478,798,019	$796,048,799
Total	12,034	$959,652,350	$1,541,695,307	$2,995,131,650

Ohio	Employment	Labor Income	Value Added	Output
Direct	2,168	$159,070,338	$305,889,793	$1,103,059,109
Indirect	4,186	$328,193,673	$540,627,634	$1,221,803,427
Induced	3,805	$204,026,210	$365,613,445	$651,151,475
Total	10,159	$691,290,221	$1,212,130,872	$2,976,014,011

Oklahoma	Employment	Labor Income	Value Added	Output
Direct	2,841	$239,327,691	$339,799,761	$1,310,577,580
Indirect	7,203	$406,628,924	$668,420,053	$1,579,010,966
Induced	4,679	$245,551,253	$435,513,105	$795,763,643
Total	14,723	$891,507,868	$1,443,732,920	$3,685,352,189

Oregon	Employment	Labor Income	Value Added	Output
Direct	59	$4,078,512	$6,126,875	$18,000,000
Indirect	83	$6,593,362	$9,527,210	$18,816,624
Induced	78	$4,245,796	$7,499,450	$13,237,694
Total	220	$14,917,669	$23,153,535	$50,054,318

Pennsylvania	Employment	Labor Income	Value Added	Output
Direct	190	$21,806,822	$25,617,582	$62,000,000
Indirect	187	$15,456,650	$23,543,857	$51,743,139
Induced	277	$15,646,239	$26,870,806	$47,251,928
Total	654	$52,909,711	$76,032,245	$160,995,067

South Carolina	Employment	Labor Income	Value Added	Output
Direct	6,972	$400,774,994	$444,850,484	$971,000,000
Indirect	5,556	$315,128,465	$463,598,569	$950,567,179
Induced	4,803	$232,510,757	$424,043,416	$767,510,026
Total	17,331	$948,414,216	$1,332,492,469	$2,689,077,206

Texas	Employment	Labor Income	Value Added	Output
Direct	3,020	$225,306,536	$265,030,069	$532,400,000
Indirect	2,452	$162,044,245	$233,521,817	$463,560,844
Induced	2,699	$144,265,469	$250,860,212	$453,057,630
Total	8,171	$531,616,249	$749,412,098	$1,449,018,474

Utah	Employment	Labor Income	Value Added	Output
Direct	7,113	$765,617,989	$797,084,176	$1,331,900,000
Indirect	4,935	$327,880,066	$471,371,541	$922,074,704
Induced	7,704	$382,536,943	$705,583,952	$1,286,433,175
Total	19,752	$1,476,034,998	$1,974,039,669	$3,540,407,880

Virginia	Employment	Labor Income	Value Added	Output
Direct	2,649	$235,481,478	$405,194,713	$1,310,577,580
Indirect	6,203	$370,321,609	$624,551,452	$1,420,476,884
Induced	4,147	$225,512,420	$413,704,966	$728,543,062
Total	12,999	$831,315,507	$1,443,451,131	$3,459,597,526

Vermont	Employment	Labor Income	Value Added	Output
Direct	847	$60,361,831	$66,066,908	$130,000,000
Indirect	641	$39,873,021	$56,351,901	$113,068,738
Induced	768	$40,167,439	$70,432,872	$125,768,511
Total	2,256	$140,402,291	$192,851,682	$368,837,249

Washington	Employment	Labor Income	Value Added	Output
Direct	504	$61,644,194	$98,531,877	$153,315,001
Indirect	396	$30,429,905	$50,534,615	$87,068,331
Induced	500	$30,304,347	$55,664,338	$93,326,649
Total	1,399	$122,378,446	$204,730,830	$333,709,981

Wisconsin	Employment	Labor Income	Value Added	Output
Direct	-	$33,698	$37,887	$54,000
Indirect	-	$9,955	$13,655	$23,872
Induced	-	$15,079	$26,624	$46,913
Total	1	$58,732	$78,166	$124,785

APPENDIX 3

Survey Instrument

Demographic and Company Information

Was your company a start-up company specifically created for this CRADA or license agreement?

How many employees did your company have at the time that this CRADA or license agreement was established?

- Unknown
- Large (500+ employees)
- Medium (100-499 employees)
- Small (10-99 employees)
- Very Small (1-9 employees)

How many employees does your company currently employ?

- Unknown
- Large (500+ employees)
- Medium (100-499 employees)
- Small (10-99 employees)
- Very Small (1-9 employees)

Product, Sales, and Funding

Did your company develop any new or improved products or services based on this CRADA or license agreement?

- Yes
- No
- Tech still in development
- Tech was abandoned
- Unknown

To date, what are your total cumulative commercial sales of products or services resulting from this CRADA or license agreement?

To date, what are your total cumulative sales to the U.S. Dept. of Energy/NNSA (either directly or through a contractor) due to this CRADA or license agreement?

What are your total cumulative sales to the U.S. government, directly related to this CRADA or license agreement?

To date, what is the total cumulative amount of follow-on R&D funding (government or private sector) you've received that is directly related to this CRADA or license agreement?

Did your company license or sub-license any of the technology developed from this CRADA or license agreement?

- To date, what are the total royalties received?
- To date, what are the total cumulative sales by the licensee related to this technology?

Did your company create a spin-off company to commercialize any technology developed under this CRADA or license agreement?

- To date, what are the total cumulative sales by the spin-off company?

Did your company receive any outside investment funding (angel, venture capital, state, or IRAD funding) due to this CRADA or license agreement?

- If yes, what was the investment amount?

Regarding the product and service sales previously mentioned, where does the manufacturing or research take place (state)?

Did the manufacturing take place outside the United States?

Weapons, Stockpile, and Non-proliferation

Did your CRADA or license agreement result in any products or services that are being used by DOE/NNSA, or the U.S. military for nuclear weapons or non-proliferation purposes? Examples might include but aren't limited to nuclear weapons testing, surveillance, maintenance, security, transportation, or other purposes pertaining to nuclear weapons.

- If yes, how has the CRADA or license agreement impacted the technological areas you just identified? Please provide specific examples (such as surveillance, maintenance, etc.).

Did the technological results you just identified lead to any commercial off the shelf (COTS) products being purchased or used by DOE/NNSA or the U.S. military?

What are your estimated cost savings to date for the life cycle of this technology?

What are your projected overall cost savings for the life cycle of this technology?

Qualitative Information

Have there been any benefits to your company from this CRADA or license agreement besides sales of new technology or other economic results?

Are you aware of any specific benefits to Sandia/NNSA/DOE from this CRADA or license agreement?

Other

Is your company interested in a possible success story focusing on this CRADA or license agreement?

Can you please estimate the financial value of personnel, supplies, equipment, and other resources your company contributed to this individual CRADA?

Photo by Petty Officer 3rd Class Nathan Beard

Aviation Boatswain's Mate Airman Malik Robinson conducts maintenance on the flight deck of the aircraft carrier USS Dwight D. Eisenhower.

APPENDIX 4

NAICS Codes Assigned for Impacts in the Study

Code	Description
237130	Power and Communication Line and Related Structures Construction
322291	Sanitary Paper Product Manufacturing
325510	Paint and Coating Manufacturing
325998	All Other Miscellaneous Chemical Product and Preparation Manufacturing
326211	Tire Manufacturing
327212	Other Pressed and Blown Glass and Glassware Manufacturing
332993	Ammunition (except Small Arms) Manufacturing
333517	Machine Tool Manufacturing
334118	Computer Terminal and Other Computer Peripheral Equipment Manufacturing
334220	Radio and Television Broadcasting and Wireless Communications Equipment Manufacturing
334413	Semiconductor and Related Device Manufacturing
334511	Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing
334513	Instruments and Related Products Manufacturing for Measuring, Displaying, and Controlling Industrial Process Variables
334515	Instrument Manufacturing for Measuring and Testing Electricity and Electrical Signals
334516	Analytical Laboratory Instrument Manufacturing
334519	Other Measuring and Controlling Device Manufacturing
335931	Current-Carrying Wiring Device Manufacturing
336411	Aircraft Manufacturing
336414	Guided Missile and Space Vehicle Manufacturing
339112	Surgical and Medical Instrument Manufacturing
488190	Aircraft Maintenance and Repair Services
541511	Custom Computer Programming Services
541714	Research and Development in Biotechnology
541715	Research and Development in the Physical, Engineering, and Life Sciences


NNSA
SM
National Nuclear Security Administration

National Nuclear Security Administration
Sandia National Laboratories

CRADA and Patent License Agreements

MAJOR FINDINGS FROM THE STUDY INCLUDED THE FOLLOWING:

$53.7 billion

In total sales of new products and services resulting from Sandia's PLAs and CRADAs

$21.9 billion

In sales of new products to the government

$95.9 billion

In total economic impact nationwide

$9.9 billion

In new tax revenues (federal, state, and local)

434,464 jobs

(20,689 per year) with average compensation of approximately $69,000

Nearly $1.7 billion

in estimated cost savings

Shutterstock/Sean Pavone