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Securing America's Future: Realizing the Potential of the Department of Energy's National Laboratories

Final Report of the Commission to Review the Effectiveness of the National Energy Laboratories

Volume 1: Executive Report

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Executive Summary

The Department of Energy (DOE) laboratories are national assets that have contributed profoundly to the Nation's security, scientific leadership, and economic competitiveness. In recognition of the continuing and evolving threats to our security and the dramatic increase in global economic and scientific competition, the laboratories are and will continue to be vitally important.

Yet, the contributions of the National Laboratories are not inevitable, nor have they realized their full potential. This final report of the Commission to Review the Effectiveness of the National Energy Laboratories recommends ways the laboratories could overcome challenges to more efficiently and effectively accomplish the work for which they are uniquely suited. The Commission's unanimous findings and recommendations are grouped around six themes:

- Recognizing value
- Rebuilding trust
- Maintaining alignment and quality
- Maximizing impact
- Managing effectiveness and efficiency
- Ensuring lasting change

Recognizing Value

The National Laboratories provide critical capabilities and facilities in service of DOE's mission, the needs of the broader national science and technology (S&T) community, and the Nation as a whole. They, for example, offer a unique venue for the conduct of major, long-term, high-payoff/high-risk research. The funding for the laboratories has remained flat in constant dollars over the past decade. In addition, the amount of Federal research and development (R&D) support to DOE as a whole has stayed relatively level for the past 40 years, a period during which many other nations have increased their research investments. The Nation should recognize the value of these laboratories and the Administration and Congress should provide the necessary resources to maintain their critical capabilities and facilities.

Rebuilding Trust

The intended relationship between the DOE and the National Energy Laboratories is as trusted partners, working together to carry out critical missions for the Nation. The Federal Government develops important R&D programs and turns to the National Laboratories to provide the expert people, facilities, and management systems to carry them out. Sixteen of the 17 laboratories are run as federally funded research and development centers (FFRDCs), managed through a management and operating (M&O) contract. Under the FFRDC/M&O model, the government is responsible for setting the "*what*" of strategic and program direction to meet the Nation's needs, while the contracted partners, along with the laboratories they manage and operate, are responsible for determining precisely "*how*" to meet the technical and scientific challenges and to carry out programs. Over the years, the relationship between DOE and many of the laboratories has eroded. This has resulted in a less-than-optimal working relationship and reduced efficiency.

DOE and the National Laboratories, with the support of Congress and others, must work together as partners to restore the FFRDC relationship with a culture of trust and accountability. As a foundation for this, the partners should jointly establish annual operating plans that delegate clearly defined authority to the laboratories in exchange for transparency and successful mission performance. Laboratories that earn DOE's trust should enjoy greater freedom to operate, while others will continue to experience heightened DOE oversight and control. DOE should strengthen leadership and management development for its Federal workforce—including multi-directional rotational assignments with the laboratories, field elements, and headquarters—to improve its ability to manage in this mode. DOE should abandon *incentive* award fees in their M&O contracts with the National Laboratories in favor of a fixed fee set at competitive rates. These rates should take into account contractor investments of talent and funds, as well as financial and reputational risk. DOE should also adopt a broader and richer set of incentives and consequences to motivate sound laboratory management and enforce accountability.

Enabling the laboratories to take more responsibility for managing their activities involves rebalancing contract requirements, local oversight, assessments and data calls, and budgeting. For example, for non-nuclear, non-high-hazard, unclassified activities, DOE should allow laboratories to use Federal, State, and industry standards in place of DOE requirements. DOE should also utilize a risk-based model with meaningful stakeholder engagement when developing new requirements and conducting assessments.

While DOE has attempted to shift from transactional compliance to a performance-based oversight model by implementing a contractor assurance system (CAS) at each of the laboratories, systematic improvements to the implementation and utilization of the

CAS must be made at many laboratories. All stakeholders responsible for assessments should reduce duplicative assessments and burden on the laboratories by making maximum use of these local assessments, and DOE should establish a single point of control over data requests to the laboratories. Also the roles and responsibilities of site offices and support centers must be clarified; support centers should not have approval authority.

DOE should give laboratories more flexibility to manage funds with full accountability within legal bounds. This translates to larger funding increments, fewer budgetary buckets, longer timelines with fewer milestones, and in many cases, notification rather than approval for fund transfers.

Maintaining Alignment and Quality

Despite the lack of a Department-wide, comprehensive, in-depth, long-term, strategic planning process, the National Laboratories' research programs and capabilities are generally well-aligned with DOE's missions and strategic priorities. There are robust processes in some program offices (particularly the Office of Science [SC]) that provide strategic oversight, evaluation, and direction to the laboratories. To improve the consistency of those processes across the Department, all DOE offices should adapt the processes of SC for laboratory planning, alignment, and quality to their particular contexts.

To maintain the quality of the technical staff, DOE should proactively encourage laboratory researchers to attend and participate in conferences—both national and international—so they may keep abreast of the latest developments in S&T. The Commission is encouraged by DOE's recently revised guidance on conference-related activities and spending, noting that the laboratories have been given more autonomy on this issue, while at the same time being held accountable for the appropriate use of taxpayer funds.

The ability to adapt, retool, invest in staff and capabilities, and enter new research areas is crucial to laboratory performance and maintenance of high-quality staff and research. Laboratories rely in large part on laboratory directed research and development (LDRD) programs to achieve these goals. Congress should support LDRD by restoring the LDRD cap to an unburdened 6 percent, or its equivalent, of laboratory budget.

To maximize the laboratories combined efforts, DOE should manage them as a system having an overarching strategic plan that gives the laboratories the flexibility to pursue new lines of inquiry so long as the research aligns with mission priorities. Duplicate and competitive laboratory programs add value in the early, discovery phases of a new research initiative, but, once the research has matured to the point that a preferred or most promising approach can be identified, the Department should assert its strategic oversight and guidance to coordinate and potentially consolidate programs to achieve the most effective and efficient use of resources.

Maximizing Impact

A great deal of money and talent has been invested to create scientific and technical capabilities that are crucially important for the Nation's security and economic competitiveness. Realizing the full potential of the laboratories requires a much greater effort to tap their capabilities, especially in support of regional and national economic competitiveness. DOE and the laboratories must work to break down barriers to external collaboration with small and large businesses, academia, and other Federal agencies. Innovative technology transfer and commercialization mechanisms should continue to be pursued, and best practices in other sectors, including academia, should be examined. Congress and DOE should continue to support leading edge S&T user facilities, making sure to continue using scientific community input and peer review processes to determine future priorities for new and upgraded facilities.

Managing Effectiveness and Efficiency

The M&O contractors, in conjunction with DOE, must improve several areas of laboratory management: overhead costs, facilities and infrastructure, and project and program management. The Commission found laboratory overhead rates to be comparable to university-negotiated rates at the science and applied laboratories. The overhead rates at the National Nuclear Security Administration laboratories are understandably higher, due to the unique costs of their national security and nuclear weapons-focused mission. DOE should provide greater transparency into laboratory indirect costs and should publish an annual report of overhead rates for each laboratory.

DOE and the laboratories should continue efforts to improve laboratory facilities and infrastructure by halting the growth in deferred maintenance and speeding up the deactivation and decommissioning of excess facilities. Given the limited budget, DOE, the laboratories, Congress, and the Office of Management and Budget (OMB) should actively work together to agree upon the size and nature of the resources shortfall for facilities and infrastructure, and to develop a long-term plan to resolve it through a combination of increased funding, policy changes, and innovative financing approaches. Such approaches might include third-party financing, enhanced use leases, State funding, gifts, and leveraging partnerships with other Federal agencies.

To better its project management record, DOE and the laboratories should maintain focus on strengthening institutional capability and imposing greater discipline in implementing DOE project management guidance. The Commission also supports the recent Secretary of Energy Advisory Board Task Force recommendation to put more resources into S&T development for the Environmental Management program given the technical complexity of its projects that seriously challenge project performance.

Ensuring Lasting Change

A review of over 50 past reports shows a strikingly consistent pattern of criticism with a repeating set of recommendations for improvement. Despite the extensive examination of the issues, none of these reports has led to the comprehensive change necessary to address the well-documented, persistent challenges confronting the Department and its laboratories. While the current Secretary of Energy has taken a number of steps to improve the relationship between DOE and its laboratories, and thereby the efficiency and effectiveness of the laboratories, these efforts must be institutionalized. A standing review body should be established to track implementation of the recommendations and actions in this report. This body should report regularly to DOE, the laboratories, the Administration, and Congress. Congress should also develop a more orderly and consistent process of reviewing the National Laboratories, in lieu of the past unrelenting pace of studies.

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The Commission wishes to acknowledge that the current Secretary of Energy and the current laboratory directors, and the management teams of both, have made much progress in improving the relationship between DOE and the laboratories. Rebuilding trust is a slow process that requires a sustained culture change that is underway. The Commission encourages future Secretaries and laboratory directors to continue these efforts and Congress and others to continue supporting them.

Today, DOE laboratories face a more complex set of challenges and have a more diverse array of missions than existed when the first National Laboratories were created more than a half-century ago. The recommendations in this report are intended to ensure that the laboratories are able to operate as efficiently and effectively as possible so that the Nation realizes the maximum benefit from this national asset in the years ahead.

Contents

1. Introduction

A. Congressional Charge

Section 319 of the Consolidated Appropriations Act, 2014 (Public Law No. 113-76) directed the Secretary of Energy to establish the Commission to Review the Effectiveness of the National Energy Laboratories. The Commission was charged with reviewing the 17 Department of Energy (DOE) National Laboratories.[1] It was established in May 2014 and held monthly meetings from July 2014 to July 2015. (See Appendix A for the names and biographies of the Commissioners.[2]) Congress directed the Commission to evaluate the laboratories in terms of their alignment with the Department's strategic priorities, duplication, ability to meet current and future energy and national security challenges, size, and support of other Federal agencies. The Commission was also to review the efficiency and effectiveness of the laboratories, including assessing overhead costs and the impact of DOE's oversight and management approach. Lastly, Congress had several specific questions related to the use of laboratory directed research and development (LDRD) such as the effectiveness of the Department's oversight approach and the extent to which LDRD funding supports recruiting and retention of qualified staff.[3] (Appendix B provides the complete text of Section 319.)

Due to the extensive scope of the Commission's task and the aggressive timeline, Secretary of Energy Ernest Moniz and Senator Diane Feinstein, then Chair of the Senate Energy and Water Appropriations Subcommittee, agreed to separate the Commission's charge into two phases. (See Appendix C for a copy of the letter documenting their agreement.) The agreement called for Phase 1 to focus on the mission and strategic planning of the laboratories and for Phase 2 to target the operation and oversight of the laboratory system. LDRD as it relates to the issues outlined above was to be considered

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[1] The 17 laboratories are Ames National Laboratory, Argonne National Laboratory, Brookhaven National Laboratory, Fermi National Accelerator Laboratory, Idaho National Laboratory, Lawrence Berkeley National Laboratory, Lawrence Livermore National Laboratory, Los Alamos National Laboratory, National Energy Technology Laboratory, National Renewable Energy Laboratory, Oak Ridge National Laboratory, Pacific Northwest National Laboratory, Princeton Plasma Physics Laboratory, Sandia National Laboratories, Savannah River National Laboratory, SLAC National Accelerator Laboratory, and Thomas Jefferson National Accelerator Facility.

[2] All appendices can be found in Volume 2.

[3] Consolidated Appropriations Act, 2014 (Public Law No. 113-76).

in both phases of the Commission's task. The Commission issued an Interim Report in February 2015 with its preliminary observations and recommendations.

B. Important Questions about the DOE Laboratories

The Commission reframed the congressional charge in the form of seven important questions about the DOE laboratories.[4] The Commission felt that these questions underlie any evaluation of the National Laboratories and that its work would be incomplete if they were not addressed. The questions are:

- *Why do we need the DOE laboratories?*
- *Does DOE manage its laboratories well?*
- *Are the laboratories properly focused to address mission needs now and in the future?*
- *Is the research carried out at the laboratories of high quality?*
- *Is there too much duplication among the laboratories?*
- *Are the laboratories having an impact?*
- *Do the laboratories cost too much?*

The Commission's answers to these questions, based on the research and analysis described in this report, are summarized in Chapter 8 of this volume.

C. Approach, Scope, and Organization of Report

The findings and recommendations in this report are based on an extensive literature review; visits to all 17 of the National Laboratories; interviews with staff at more than 100 offices across the government and other sectors; and testimony by 85 witnesses at monthly public Commission meetings. The Commission's conclusions are unanimous. A list of organizations represented in interviews and public meetings can be found in Appendix D.

Through its research, the Commission determined that the DOE laboratories are a critical component of our Nation's science and technology (S&T) system (as discussed in Chapter 2). While the DOE laboratories serve our Nation well, they could be even more effective and efficient if they and the DOE improve their relationship. In particular, both parties should focus on the principles of stewardship, accountability, competition, and partnership, upon which the federally funded research and development center (FFRDC)

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[4] Unless otherwise stated, the terms *DOE laboratories* and *National Laboratories* are used interchangeably and are meant to include the National Nuclear Security Administration (NNSA) laboratories. Similarly, *DOE* should be read to include NNSA.

model is based, and DOE should give the laboratories sufficient freedom to operate in line with these principles (as discussed in Chapter 3).

The Commission found that, for the most part, the National Laboratories conduct research and have capabilities that are well-aligned to meet current and future mission needs; that they are conducting high-quality research; that LDRD is crucial to maintaining first-class research and researchers; and that duplication among the laboratories is not excessive. DOE could better manage the National Laboratories as a system using an overarching strategic plan that gives the laboratories the flexibility to pursue new lines of inquiry, so long as their research aligns with mission priorities (as discussed in Chapter 4).

The Commission determined that, in addition to supporting the missions of DOE, the laboratories serve the Nation's needs by operating S&T user facilities, and serving and working with other Federal agencies, the academic community, and industry. While such support is critical to many non-DOE entities, barriers to access need to be minimized. Realizing the full potential of the laboratories requires a much greater effort to tap their capabilities, especially in support of regional and national economic competitiveness. Although the Commission does not judge the laboratories to be inefficient overall, a concerted effort by DOE and the laboratories can improve efficiency and effectiveness of laboratory management in particular areas (as discussed in Chapter 5).

This is the Final Report of the Commission and includes its analysis and findings related to the entire charge; it therefore subsumes the Commission's Interim Report. This report consists of two volumes. The first is the executive volume with a high-level overview of the Commission's findings and recommendations. The second comprises technical chapters that provide detailed analyses and supporting evidence for those findings and recommendations.

2. Recognizing Value

As the Nation has changed, so too have the National Laboratories. Conceived to design and produce the world's first nuclear weapons, the laboratories of today face a vastly broader set of challenges and a more diverse array of missions. Throughout their history, however, it has been the culture of scientific excellence, technical rigor, and mission-focused vision that has defined the DOE Laboratories and served the United States time and again. The laboratories' role may indeed have changed with time, but their ability to rise to meet their charge has remained strong since their founding. From weapons science to clean energy and from legacy cleanup to basic research, the National Laboratories serve the Nation in diverse ways, and recognizing the fullness of the role they play is crucial to understanding their value.

A. DOE Laboratory System

The 17 National Laboratories are categorized by their research focus and DOE stewarding office. There are 10 science laboratories stewarded by the DOE Office of Science (SC), 3 national security laboratories overseen by the National Nuclear Security Administration (NNSA), and 4 applied laboratories stewarded by the applicable DOE program office (one each by the Office of Energy Efficiency and Renewable Energy [EERE], the Office of Environmental Management [EM], the Office of Fossil Energy [FE], and the Office of Nuclear Energy [NE]). Table 1 provides information on each laboratory; including the managing contractor, the DOE stewarding office, and fiscal year (FY) 2014 cost and size data (detailed descriptions of the laboratories can be found in Appendix E). Overall, the National Laboratories employed over 55,000 people and received $11.7 billion of funding from DOE. When other funding sources are included, their total budget in FY 2014 was $14.3 billion.

The National Energy Technology Laboratory (NETL) is the only government-owned, government-operated (GOGO) laboratory among the National Laboratories. The other 16 laboratories are run as FFRDCs and managed through a management and operating (M&O) contract.[5] M&O contractors for the National Laboratories include individual universities, university consortia, nonprofit corporations, industrial firms, and partnerships involving the aforementioned types of organizations.

[5] The Atomic Energy Act of 1946 (Public Law No. 79-585) formalized the M&O contract and established the Atomic Energy Commission, a precursor to the DOE.

Table 1. Characteristics of Department of Energy National Laboratories

Stewarding Office	Laboratory	Managing Contractor	Budget from DOE (FY 2014)*	Total Budget (FY 2014)†	Size (FTE)‡	Year Est.
EERE	National Renewable Energy Laboratory	Alliance for Sustainable Energy, LLC	$290 M	$340 M	1,700	1977
EM	Savannah River National Laboratory	Savannah River Nuclear Solutions, LLC	$204 M	$231 M	800	1951
FE	National Energy Technology Laboratory	N/A	$690 M	$692 M	1,380	1910
NE	Idaho National Laboratory	Battelle Energy Alliance, LLC	$670 M	$800 M	3700	1949
NNSA	Lawrence Livermore National Laboratory	Lawrence Livermore National Security, LLC	$1.2 B	$1.45 B	5,700	1952
	Los Alamos National Laboratory	Los Alamos National Security, LLC	$2 B	$2.2 B	9,500	1943
	Sandia National Laboratories	Sandia Corporation	$1.8 B	$2.75 B	11,000	1949
SC	Ames National Laboratory	Iowa State University	$50 M	$53 M	280	1947
	Argonne National Laboratory	UChicago Argonne, LLC	$600 M	$720 M	3,400	1946
	Brookhaven National Laboratory	Brookhaven Science Associates, LLC	$530 M	$580 M	2,800	1947
	Fermi National Accelerator Laboratory	Fermi Research Alliance, LLC	$430 M	$430 M	1,800	1967
	Lawrence Berkeley National Laboratory	University of California	$640 M	$760 M	3,500	1931
	Oak Ridge National Laboratory	UT-Battelle, LLC	$1.1 B	$1.3 B	4,300	1943
	Pacific Northwest National Laboratory	Battelle Memorial Institute	$580 M	$910 M	4,300	1965
	Princeton Plasma Physics Laboratory	Princeton University	$90 M	$92 M	460	1951
	SLAC National Accelerator Laboratory	Stanford University	$410 M	$420 M	1,400	1962
	Thomas Jefferson National Accelerator Facility	Jefferson Science Associates, LLC	$170 M	$172 M	710	1984

Note: Total budget differs from these values as the laboratories receive funds from external sources through partnerships and work for other agencies.

* DOE figures are from the DOE FY 2016 Budget Justification.

† Total budget figures provided by DOE Chief Financial Officer.

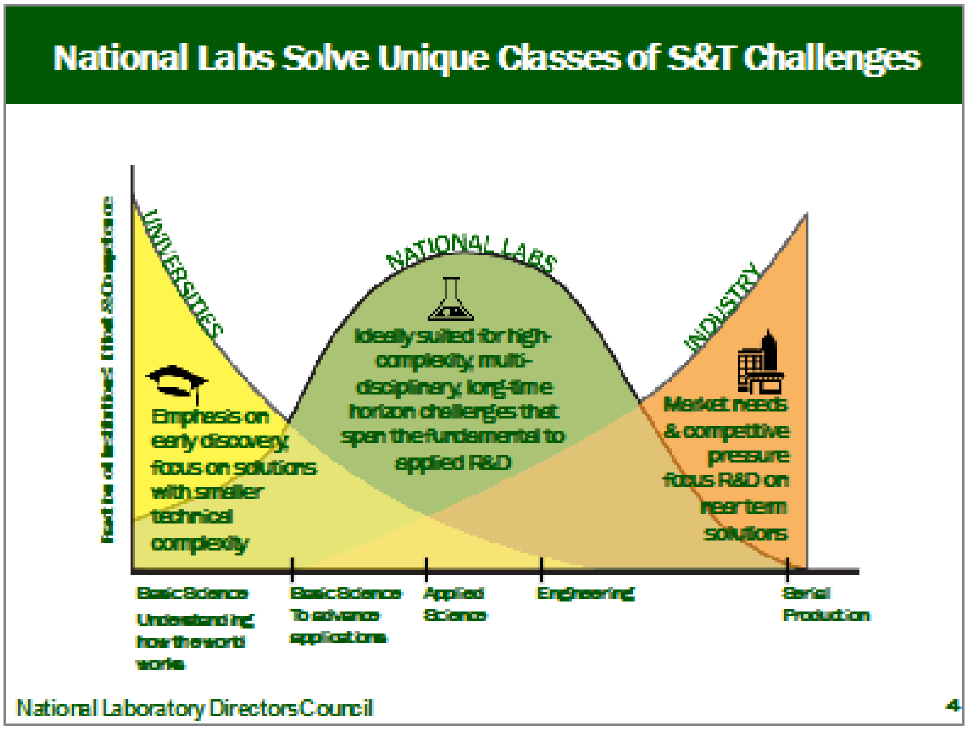
‡ Contractor-submitted calendar year 2014 data to the Office of Management and NNSA. Full time employee (FTE) Definition: the sum of FTEs as of the last calendar day of each month during the calendar year, divided by 12. FTE = straight hours divided by 2080. FTEs may be lower than employee count as a result of part-time employees. This figure does not include temporary employees and contractors.

B. Purpose and Importance of the DOE Laboratories

Most members of the public do not understand what the DOE National Laboratories do, or what a critical role they play in the nation's security and economic vitality. Those people who do know about the National Laboratories often are familiar with only a fraction of what they do, perhaps linked to one of the laboratories in their region.

The DOE National Laboratories occupy a key role in the nation's S&T community that cannot be carried out solely by academic institutions or the business sector. The laboratories are a place where sustained, long-term, complex research and development (R&D) programs can be managed and executed across a range of basic and applied research areas. They are also able to perform sensitive, classified research regarding nuclear weapons and non-proliferation. In addition, they are places where the Federal government has been able to build and operate large-scale user facilities, such as linear accelerators, synchrotron light sources, and high performance computer systems and networks for use by thousands of researchers in academia, the business community and the National Laboratory system.

As illustrated in Figure 1, the National Laboratories exist in cooperation with the university community and with industry, and fill a vital role in the process of scientific exploration and technology innovation. During the early stages of research, university scientists have a greater role than most scientists at the National Laboratories. As the research advances from individual projects to larger scale programs involving large numbers of researchers in highly complex, multi-disciplinary, long-term projects, the DOE laboratories take on a much bigger role and are an ideal location to host research and researchers from other institutions. As the research advances further towards commercialization, industry takes on the lead role, and the involvement of the National Laboratories declines.



Source: DOE National Laboratory Directors Council, "The DOE National Labs: A vital network in the U.S. science and technology ecosystem," November 12, 2014.

Figure 1. The Role of the National Laboratories in the S&T Enterprise.

Broadly stated, the purposes of the DOE National Laboratories are to "solve important problems in fundamental science, energy, and national security…steward vital scientific and engineering capabilities including technology transfer…design, build, and operate unique scientific instrumentation and facilities… [and] promote innovation that advances U.S. economic competitiveness and contributes to our future prosperity."[6] The National Laboratories carry this out across the four mission areas of the DOE, as described briefly below.

1. Nuclear Security Mission

The National Laboratory system began with the Manhattan Project in World War II when the Federal government assembled the Nation's top scientists to design and build the first nuclear weapons. That mission has evolved over the years and for at least the past two decades has focused on stewardship of our nation's nuclear weapons, nuclear nonproliferation, homeland security, support to the intelligence community, and countering weapons of mass destruction. The three NNSA laboratories are primarily devoted to this mission, but several of the other laboratories participate as well.

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[6] DOE, *Strategic Plan 2014–2016* (Washington, DC: DOE, 2014).

To assure the reliability, safety and security of our nation's nuclear deterrent without testing, the laboratories are carrying out science-based stockpile stewardship, including highly complex Life Extension Programs (LEPs) for each of the major nuclear weapons that remain in our arsenal. The primary goals of the W76-1 LEP, for example, are to extend the original warhead service life from 20 to 60 years, address identified aging issues, incorporate nuclear surety enhancements and minimize system certification risk in the absence of underground nuclear testing and refurbish the system in a managed affordable manner. As of last year, the program was over halfway complete. In addition, in support of the nonproliferation programs, the laboratories have converted over 90 research and test nuclear reactors worldwide from highly enriched uranium to low-grade uranium and have removed nuclear material from over 230 sites worldwide. DOE laboratory technology that quickly identifies the chemical makeup of weapons is being used to verify treaties around the world.

To carry out the nuclear weapons work without nuclear testing, the laboratories have worked with the leading computer manufacturers to advance the state of the art in high performance computing and computer codes. Today the DOE laboratories have four of the ten fastest supercomputers in the world at NNSA and SC laboratories. At the SC-managed laboratories, the computers are now also being used by other laboratories and by university and industrial researchers on a wide range of complex computational problems, including human genomic analyses, analyses of chemical structures, climate change modeling, and mapping of energy resources.

The laboratories also serve other Federal agencies in support of their national security missions, by providing capabilities such as nuclear and WMD forensics, special nuclear material detection, and knowledge about foreign S&T capabilities. For example, the National Atmospheric Release Advisory Center at Lawrence Livermore[7] tracked releases from the Fukushima Daiichi Reactors after the nuclear disaster in 2011. The laboratories

[7] "National Atmospheric Release Advisory Center (NARAC)," *Lawrence Livermore National Laboratory*, last modified September 14, 2012. https://narac.llnl.gov/.

also provided critical assistance after the April 2010 Deepwater Horizon oil spill,[8] and during the 2014–2015 negotiations with Iran on its nuclear program.[9]

2. Science Mission

The challenges of new energy sources, energy efficiency, economic competitiveness, and global security ultimately rest on understanding fundamental science in areas such as materials, physics, chemistry, biology and nanoscience. The national laboratories support this science mission through its staff of outstanding scientists and by collaborating with over 30,000 academic and industrial scientists who annually utilize the DOE's large-scale particle accelerators, supercomputers, x-ray light sources, neutron sources and other large user facilities.

DOE's scientists are among the best in the world in these areas of basic and applied R&D. Over 60 researchers affiliated with DOE laboratories have been awarded Nobel Prizes,[10] and DOE laboratories have received over 800 R&D 100 Awards since 1962, when the annual competition began.[11] They have discovered 17 new elements that have been added to the periodic table.

A number of important developments have arisen from the laboratories' cutting-edge scientific work. For example, research in condensed matter physics and materials science led to important discoveries in superconductivity, which is becoming increasingly important in energy storage and transmission, and high performance machines. The emerging field of additive manufacturing, or 3-D printing, is another area in which the National Laboratories are playing a crucial role in developing the basic and applied

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8 Hruby, J., D. Manley, R. Stoltz, E. Webb, and J. Woodward. *The Evolution of Federally Funded Research & Development Centers, Public Interest.* Washington, D.C.: Federation of American Scientists (2011).

9 D. E. Sanger and W. J. Broad, "Atomic Labs across the U.S. Race to Stop Iran," *The New York Times*, April 21, 2015, http://www.nytimes.com/2015/04/22/us/in-atomic-labs-across-us-a-race-to-stop-iran.html?_r=0.

10 See http://www.osti.gov/accomplishments/nobel.html.

11 "The R&D 100 Awards recognize the most promising new products, processes, materials, or software developed throughout the world and introduced to the market the previous year. Awards are based on each achievement's technical significance, uniqueness, and usefulness compared to competing projects and technologies." For a full list of awards from 1993 to 2014, see http://science.energy.gov/about/honors-and-awards/rd-100-awards/.

scientific knowledge needed to produce, in collaboration with industry, complex parts made of high strength materials for aircraft engines and other high performance applications that are important to U.S. industrial competitiveness.

The Human Genome Project, which was begun by the National Laboratories, has transformed biomedical research, diagnosis and treatment. In addition, protein crystallography being carried out at the DOE synchrotron light sources has been used to test nearly all new pharmaceutical drugs introduced over the past 20 years. DOE science has also contributed to the development of MRI machines, now in virtually every hospital in the country, and Los Alamos is developing a portable "battlefield MRI" that can be used in war zones and in underdeveloped countries.

3. Energy Mission

The National Laboratories play a very important role in DOE's development of advanced technologies for the generation, distribution, storage, and use of energy in both stationary and mobile applications. Much of this work is centered at the four applied National Laboratories, but almost all of the other laboratories participate in these programs as well.

The laboratories have worked closely with industry in many of the technology and system developments in this area. For example, they have helped to develop the current breed of high efficiency wind generators and new, high efficiency solar cells. They have also been instrumental in advances in traditional energy sources, such as high efficiency combined cycle natural gas turbines, super critical coal boilers, and nuclear generating plants.

They had a major role in the development of hydro-fracking technology, which has led to the nation's "shale gas revolution" yielding huge increases in oil and gas production. The laboratory scientists helped develop 3-D seismic imaging, directional drilling techniques, diamond drill bits, computer simulation of fracking, pore level analysis, and modeling, monitoring and evaluation.

On the end uses of energy, the laboratories have made major contributions to energy efficiency and conservation. For example, the laboratories developed the solid-state ballast for fluorescent lighting, which has been one of the greatest gains in energy efficiency ever. They continue to work on both construction and design of buildings, as well as on the efficiency of the equipment inside them.

4. Environmental Management Mission

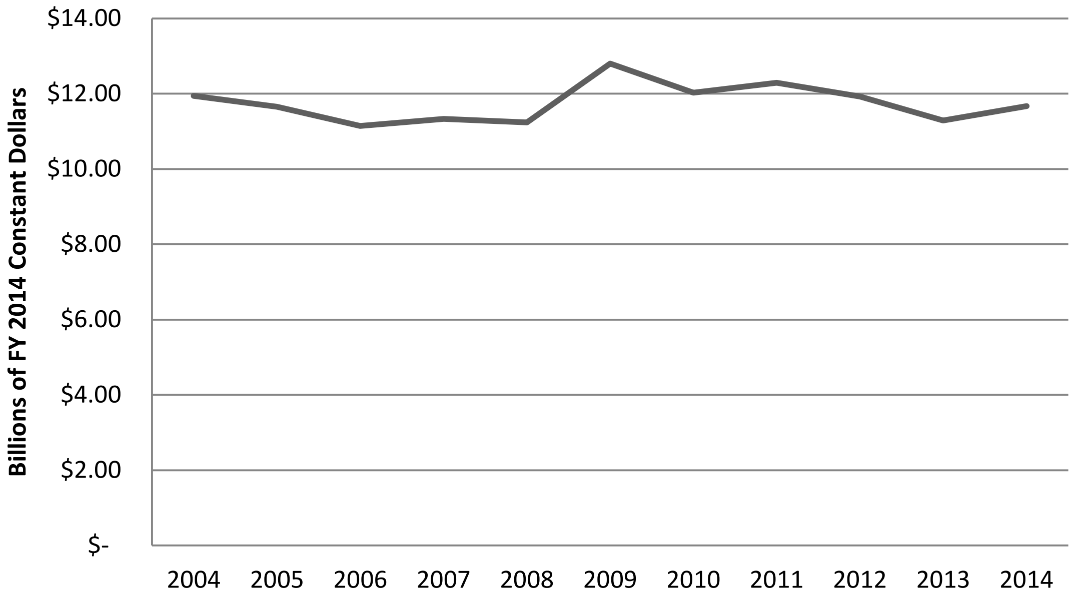
DOE's environmental management mission is a consequence of its responsibility for cleaning-up the legacy environmental wastes generated by the weapons programs from the cold war. In support of that mission, the laboratories provide expertise in areas such as radiology and chemistry, subsurface monitoring, groundwater modeling, and technology development.

The laboratories have developed innovative groundwater remediation methods and long-term monitoring that are saving millions of dollars and providing better information to local communities. In 2014, with the aid of these techniques, DOE completed the cleanup of 90% of Hanford's River Corridor, representing 479 square miles.

The technology development process for treating the legacy wastes in tanks at various facilities has been extremely challenging. Nevertheless, the laboratories lead the world in developing cleanup processes and technologies for these highly radioactive wastes. With that support, in 2014 DOE converted 15 million pounds of liquid waste at Savannah River into glass, enabling the closure of 6 high-level waste storage tanks.

C. The Laboratories' Funding in Perspective

Despite these critical and continuing contributions, DOE's budget for its laboratories has remained relatively flat in constant dollars over the past decade at approximately $12 billion per year (Figure 2).



Source: DOE Budget.

Figure 2. Total DOE Laboratory Budget from DOE in Constant Dollars ($B 2014)

In addition, the constant dollar level of Federal R&D support to DOE as a whole has stayed relatively level since 1976 (Figure 3).[12] However, the percentage of Federal R&D spending bound for DOE has dropped considerably in the same timeframe; the high of 18 percent was in 1979, and it has remained between 6 percent and 9 percent for the past 20 years. This is at a time when some other nations' have increased their share of GDP going into R&D, and the U.S. overall rate of R&D spending as a fraction of GDP has declined. At 8.1 percent of Federal R&D spending and Federal R&D spending at 0.81 percent of the Nation's GDP, DOE's R&D budget is 0.066 percent, or less than one thousandth, of the Nation's GDP.[13]

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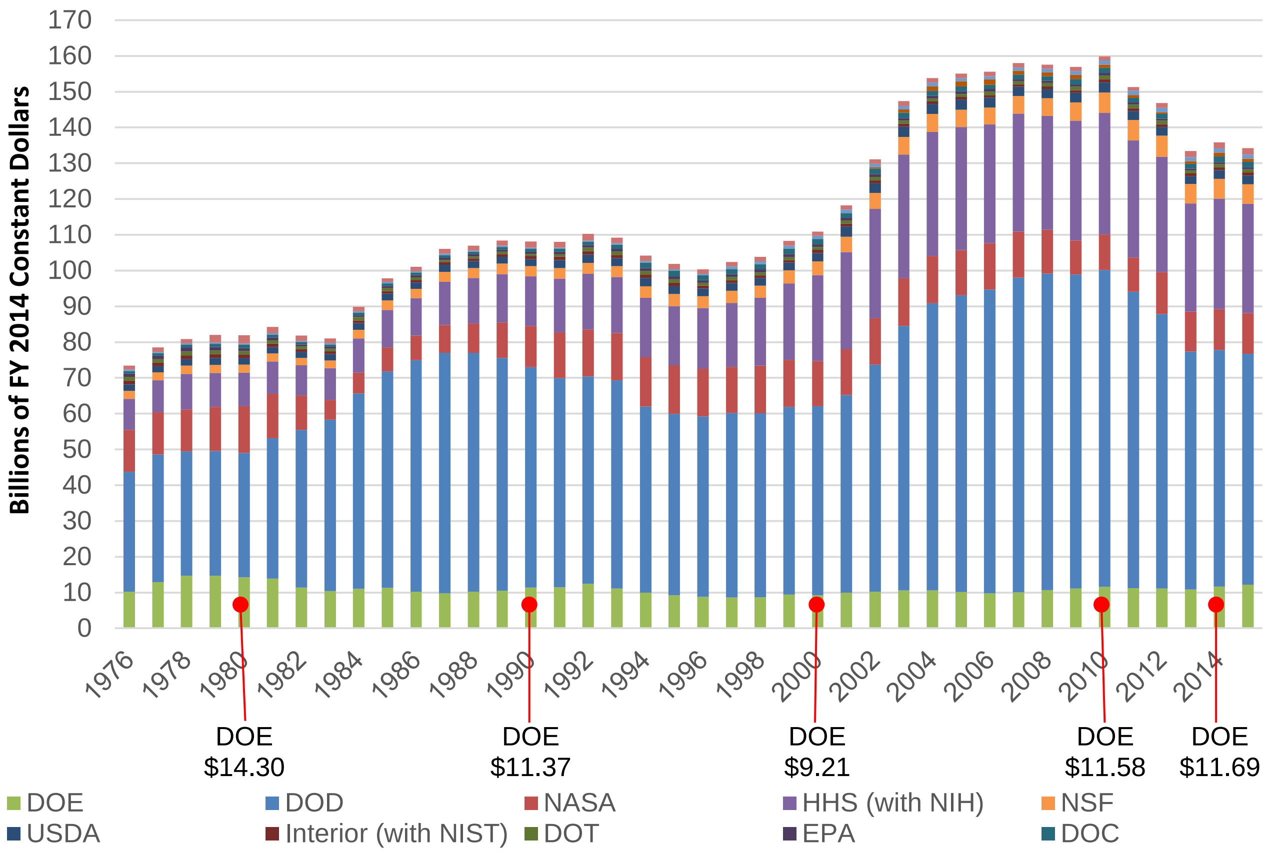
[12] Although the overall budget of the Department has remained relatively stable, specific DOE program funding has varied over the years due to changing strategic priorities within the Department's four missions: energy, science, environmental cleanup, and national security.

[13] DOE percentage of Federal R&D spending from American Association for Advancement of Science (AAS) website, *AAAS Historical Trends in Federal R&D, Total by Agency 1976–2015* (http://www.aaas.org/page/historical-trends-federal-rd). Percentage of Federal R&D of U.S. GDP from AAAS, Intersociety Working Group, *AAAS Report XXXIX: Research and Development FY 2015* (2014). These values are from FY 2013. More recent values (FY 2014 and FY 2015) are estimates. The most recent values for percentage of total national R&D are for 2011. In 2011, DOE R&D funding was 7.39% of Federal R&D funding, and Federal R&D funding was 29.5% of total U.S. R&D funding. Thus, DOE R&D funding was 2.18% of total national R&D expenditures.



Source: AAAS website, *AAAS Historical Trends in Federal R&D, Total R&D by Agency 1976–2015*, http://www.aaas.org/page/historical-trends-federal-rd.

Note: Values for 2015 are latest estimates from the President's budget request.

Figure 3. Trends in R&D by Agency ($B 2014), 1976–2015

Considering the positive impact the laboratories have had and the small size of DOE's funding relative to other Federal R&D expenditures, the Commission concludes that the overall funding level for the DOE laboratories is not too large. In fact, the case can be made for budgetary increases in specific areas. The Commission sees sustained federal support of R&D at the National Laboratories as critical to the future of the national S&T enterprise, as well as the Nation's economy and security. The principal challenges are to make the DOE laboratory system as efficient as possible to enable it to perform the maximum amount of R&D for the available level of Federal funding, and to ensure that it focuses on important endeavors not otherwise being addressed, especially high-payoff (often high-risk) longer-term research.

Prominent among areas for which a real increase in funding should be considered is support for facilities and infrastructure at the laboratory sites. The issue of aging facilities and infrastructure is discussed in detail in Chapter 6 and addressed by Recommendations 31, 32, and 33.

The Commission also notes that Congress and others have repeatedly directed external reviews of the laboratories. In the past four decades, over 50 commissions, panels, reviews and studies of the National Laboratories have been conducted by a multitude of groups. For many of these studies, the undertone of the charge has been to question whether the DOE laboratories should exist at all. The Commission concludes that the unique role and value to the Nation of the National Laboratories clearly justify their continued support.

Recommendation 1: The National Energy Laboratories provide great value to the Nation in their service to DOE's mission, the needs of the broader national S&T community, and the security needs of the Nation as a whole. The Administration and Congress should provide the necessary resources to maintain these critical capabilities and facilities. It would also benefit all stakeholders if the key committees in Congress would develop a more orderly process of reviewing the National Laboratories, to replace the unrelenting pace of studies evaluating the performance of the DOE laboratories. For example, Congress could initiate a comprehensive review of the entire laboratory system in predetermined intervals.

3. Rebuilding Trust

Under the FFRDC/M&O model, government and the contractor should work together as partners in a relationship with clearly understood roles. The government is responsible for setting the "*what*" of strategic and program direction to meet the Nation's needs, while contracted university and industry partners are responsible for determining precisely "*how*" to meet the technical and scientific challenges and to carry out programs. However, over the years, the relationship between DOE and the laboratories has eroded. There is fault on both sides. The National Laboratories, for their part, do not fully trust DOE and therefore maintain secrecy about some of their actions, including contacts with Congress and other agencies; not informing DOE of emerging problems in a timely manner; and taking some actions below the radar to create new programs and compete for turf in new and emerging areas. DOE, for its part, does not trust the laboratories to keep them fully informed about technical and financial progress or safety and security issues. As a result, DOE micromanages work at the laboratories with excessive milestones and budget limitations and other requirements about *how* work should be done. This chapter is focused on steps that can be taken to rebuild trust in order to recapture the advantages of the FFRDC model.

A. Restoring the Partnership between DOE and its Laboratories

Perhaps the greatest strength of the FFRDC/M&O model, when it is working properly, is the freedom it grants to both parties. It allows the M&O contractors to innovate and apply their best practices to meet national needs and it frees the DOE to focus on developing programs and policies, without burdening them with excessive implementation details and responsibilities. This freedom, however, is not granted but rather must be earned, through proven performance and transparency on both sides that develops into mutual trust and respect.

1. Restoring the FFRDC Model

The FFRDC/M&O relationship is designed to get the greatest leverage and results from the combination of government tasking and expert scientific and technical organizations to carry out the DOE missions. Using M&O contractors enables the government to access an exceptionally skilled workforce, to be agile in shifting resources to new R&D areas as needs change over time, and to adopt the best management practices from these experienced organizations.

DOE's role is to provide direction, oversight and funding to the National Laboratories to carry out those programs. The laboratories, as experts and trusted partners, play active roles in supporting DOE in that process. Once programs are defined, DOE is responsible for providing direction to the laboratories to develop and implement the details of those programs. The wording is precise: "direction" is not "management." Similarly, "oversight" should be risk-based and not excessive and intrusive.

Many of the problems cited in earlier reports stem from "broken trust" between DOE and its laboratories because these respective roles are frequently not honored.[14] In contrast with the ideal relationship that is envisioned in the FFRDC model, the laboratories too often act independently in their own perceived self-interests, as described earlier, without keeping DOE properly informed. DOE responds to this lack of transparency with an excessive level of transactional oversight and control over the activities of the laboratories. The Commission recognizes that the issue of trust (or lack thereof) is not experienced uniformly across the system. Some laboratories along with their M&O contractors, especially in SC, have been able to develop much better trusting relationships with their program offices and site offices than others. Two examples are Pacific Northwest and Brookhaven, which today have much stronger and more effective relationships with their site offices and with DOE headquarters than they did a decade ago.

Trust between Congress, DOE, and the laboratories has also deteriorated due to several high profile failures in project management, security, safety, or operations by certain laboratories. This has resulted in both tighter congressional budgetary controls on DOE, and therefore the laboratories, and also more frequent congressionally mandated studies of the laboratories. Congressional confidence in DOE and the laboratories' abilities is another key to restoring an efficient operational environment.

The role of the M&O contractors is important here as well. There is a subtle, but important distinction between the M&O contractor and the laboratory, as an entity in and of itself. While the laboratory is answerable only to the government customer, the M&O contractor, as a separately organized entity, is ideally answerable to its customers, partners, shareholders and the public at large (through the local, state and Federal governments). DOE has created an apparent dichotomy between the laboratory management and their M&O corporate parent(s). The contracts have been structured to ensure great laboratory management but do little to involve the parent organization(s).

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[14] Secretary of Energy Advisory Board (SEAB), *Alternative Futures for the Department of Energy National Laboratories* (Washington, DC: DOE, 1995), 6 (also referred to as the Galvin report); and the National Academy for Public Administration (NAPA), *Positioning DOE's Laboratories for the Future: A Review of DOE's Management and Oversight of the National Laboratories* (Washington, DC: NAPA, January 2013), 13, 23, and 75.

Laboratory management, while extremely important to the day-to-day operation and strategic direction of the laboratory, should not be solely accountable as the M&O contractor. The parent organization can drive improvement and ensure high performance across the enterprise, but only if this involvement is valued. Both the laboratory management and the respective M&O parent organization should aid in the improvement of the laboratory system.

One cannot mandate or legislate trust; it must be earned. Transparency and agreement on scope or scale of laboratory activities and a shared safety and security culture are prerequisites for trust and independent authority. Vital to this is the clear definition of the roles and responsibilities of each partner.

Along with trust comes accountability; there must be consequences to the laboratory and its management if they do not uphold their ends of the agreement. Consequences should be a rich and graduated set of potential responses when performance is inadequate. Incentive fees are, at best, a limited instrument, as discussed later. The most effective incentive can be a greater degree of freedom to operate independently. The corresponding remedy for negligence may be giving a laboratory a shorter leash by withholding or limiting some authorities. Alternatively, DOE could condition funding on more numerous and frequent milestones, at least temporarily until performance improves. It is also important that such consequences be graded, matched to the severity of the situation, and only imposed on the transgressing laboratory rather than on the entire laboratory system.

The Commission notes that there is significant improvement being made in this area under the current Secretary and directors of the National Laboratories, and wishes to support these and other steps in this direction. In particular, reactivating the National Laboratory Directors Council was a very positive step, which has resulted in much more open and effective collaboration between DOE and its laboratories in areas such as strategic planning and overall management. Likewise, reactivating the Laboratory Operations Board and other forums for collaboration of various groups within DOE and the laboratories is having very positive results. It is important that these continue.

Recommendation 2: Return to the spirit of the FFRDC model (stewardship, accountability, competition, and partnership). DOE and the National Laboratories must work together as partners to restore the ideal nature of the FFRDC relationship as a culture of trust and accountability. DOE should delegate more authority and flexibility to the laboratories on *how* to perform their R&D, and hold them fully accountable for their actions and results. For their part, to be trusted partners and advisors, the laboratories must be transparent with DOE about their planned activities ahead of time, as well as about their actions and results as they are carried out.

The mechanism by which this recommendation might be implemented turns on an agreed-upon long-term strategic plan that describes the vision for the laboratory and an annual operating plan for how the strategy will be executed in the coming year. Such strategic and operational planning for both DOE and the laboratories is best accomplished jointly, with DOE and its laboratories working together.

Recent initiatives have led to an increase in laboratory involvement in DOE's strategic planning. The Big Ideas Summits, which involve the laboratories in discussions of ways in which their capabilities can help solve grand challenges, is an example of this commitment. The summits resulted in Crosscuts, or system-wide strategic planning on a series of important topics. One key to the success of the Crosscut initiative has been the treatment of laboratories as partners in the strategic planning exercise.

An annual operating plan for each laboratory can serve as the foundation for an effective working relationship with appropriate roles and responsibilities. The concept is centered on the idea that the laboratories are FFRDCs and that the document would be one between trusting partners, not simply an addendum to the M&O contract. Once an agreement is in place, DOE should give the laboratory the flexibility and authority to carry it out, so long as its activities are consistent with the operating plan and the law. Each laboratory, of course, must also maintain an appropriate degree of transparency with DOE about its activities, and must discuss with the department any new opportunities that are outside the scope of the operating plan. The laboratories will be held accountable not only for performance of technical work, but also for compliance with all applicable requirements, such as financial, environmental, safety and health, and other standards.

In practical terms, the annual operating plan should represent a high-level agreement between DOE and a specific laboratory on the nature and scope of the laboratory's planned major activities for the year ahead, including the major areas of significant program funding, work for other agencies, collaborations with academia and the private sector, hiring plans, facilities and infrastructure plans, and any other activities that the Department and the laboratory deem significant. It is very important in the Commission's view that this NOT become an extensive new planning process. The idea is to draw upon the many detailed planning and budgeting systems that already exist within DOE and its program offices to produce a brief, high-level summary of major activities for the year ahead. Although the Commission does not want to dictate the detailed form and structure of the operating plan, it envisions such plans would be relatively short documents (less than ten pages) containing information such as:

- Major areas of activity in support of DOE programs for the coming year, including general levels of funding, compared to the prior year
- Top priorities for the coming year, including key milestones and goals, and collaborations with other laboratories

- General nature and scope of SPP for Federal agencies, including any major changes from the prior year
- General nature and scope of collaborations with business and others for technology commercialization and regional development, through cooperative research and development agreements (CRADAs) and other vehicles, including any major changes from the prior year
- Levels of activity regarding user facilities compared to the prior year
- Major infrastructure and facilities priorities for the coming year
- Any other major changes, including human resources, and new initiatives not identified above

Looking across existing Department documents, the 10-year plans developed annually by the SC laboratories in collaboration with SC are the closest to what the Commission is envisioning. However, the SC's 10-year plans are much more detailed and contain a mix of strategic (e.g. core capabilities) and tactical (e.g. facilities and infrastructure investments) elements. The new annual operating plans should only focus on a single year's activities and provide a high-level summary, much of which can be drawn from the more detailed plans.

The narrative of the annual operating plan, while brief, can also provide an opportunity for DOE and the laboratory to highlight key priorities, but should not become a "laundry list" of all activities. Strong discipline will be needed to preserve the high-level summary nature of the annual operating plan.

Recommendation 3: DOE and each laboratory should cooperatively develop a high-level annual operating plan, with specific agreements on the nature and scope of activities at the laboratory, and milestones and goals that are jointly established. Within that framework, DOE should provide increased flexibility and authority to the laboratory to implement that plan. This increased flexibility must go hand-in-hand with greater transparency and accountability. The annual operating plan is not intended to be a retrospective evaluation document, such as SC's Performance and Evaluation and Measurement Plan (PEMP) or NNSA's Performance Evaluation Plan (PEP). Instead it can provide high-level perspective for such evaluation plans. In other words, as envisioned by the Commission, the annual operating plan fits between the laboratory's long term strategic plan and its evaluation plan.

The report of the Congressional Advisory Panel on the Governance of the Nuclear Security Enterprise (the Augustine/Mies panel report) and this Commission found that DOE does not have the career development programs needed to build a DOE workforce with the necessary technical and managerial skills.[15] Too little emphasis is placed on technical training, experience, and accomplishments. In addition, too few headquarters personnel have spent time in the field and, as a result, do not have an in-depth understanding of the issues between the field and headquarters. To rectify this, the Department has recently instituted an executive rotator program designed to encourage rotation of DOE staff from headquarters into the field.

After a series of negative reports from DOE's Office of the Inspector General (IG),[16] particularly related to the high cost, personnel rotations in the other direction—laboratory personnel into the Department—have been discouraged. While such programs are expensive, the Commission's view is that the long term benefits are far greater than the costs. The Commission feels while waste and fraud should certainly not be allowed, laboratory rotational programs are important to the Department's effective management of its laboratories and research programs, and the exchange program must be reinvigorated across the Department.

Recommendation 4: To improve DOE's ability to manage the laboratories, DOE should implement greater leadership and management development for its Federal workforce, including multi-directional rotational assignments with the laboratories.

NETL is unique among the 17 National Laboratories in two respects. First, and most obvious, it is the only one that is not contractor-operated; it is both government-owned (as are all of the laboratories) *and* government-operated (unlike the others). Thus, NETL has not enjoyed the flexibility and other benefits that come with management by an M&O contractor.

In addition, NETL also differs from the other laboratories in terms of its structure and missions. In addition to its on-site R&D related to fossil fuels, NETL manages a large contracting operation for FE. In fact, only about 10% of NETL's funding goes to support its own research at the laboratory; the vast majority, about 90%, is sent elsewhere or is used for program management. In effect, FE has co-located its program offices and contracting and other service support functions with its laboratory. In other locations, this contracting and service support activity might be categorized as a "support center", which

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15 Congressional Advisory Panel on the Governance of the Nuclear Security Enterprise, *A New Foundation for the Nuclear Security Enterprise* (also referred to as "the Augustine/Mies panel"), November 2014, 12–14.

16 DOE IG, *Audit Report: The Department of Energy's Management of Contractor Intergovernmental Personnel and Change of Station Assignments* (DOE/IG-0761, March 2007); DOE IG, *Management of Facility Contractors Assigned to the Washington, D.C. Area* (DOE/IG-0710, November 2005); DOE IG, *Summary Audit Report on Contractor Employee Relocation and Temporary Living Costs* (DOE/IG-0400, January 1997).

provides administrative services for the host DOE program office and for other offices as well.

There is nothing inherently wrong with locating service and program office functions in the field, which is done in other locations within DOE. However, placing the program and service functions within the "laboratory" itself and having its director oversee all of it diminishes the attention and emphasis that the director and the "laboratory" bring to the R&D function. Because of this structure, the R&D function at NETL does not enjoy the singular focus seen at the other DOE laboratories. As a result of all of the above, the laboratory has not consistently produced research results or had an impact concomitant with the best of the laboratories in the National Laboratory network.

The Commission is aware of the important national and regional role of the laboratory, and the concern of elected officials and union representatives that any changes in the structure of NETL might jeopardize the continued employment and accomplishments at the laboratory. The Commission takes those concerns very seriously and is making a two-part recommendation that it believes will strengthen NETL and the region in the long run.

The first part of the recommendation concerns the management structure of the laboratory, but would not change the employment status of the personnel – they would continue to be federal government employees, as they are now. This recommended change is for DOE to organize the workforce at NETL into two organizational units: one focused on the R&D work, and the other on the federal program management, contracting and other support functions. The R&D unit, with approximately 10% of the annual funding, would be the "national laboratory" and be called "NETL". The other unit, with about 90% of the funding, would consist of federal employees who provide program management direction for the Office of Fossil Energy, and other federal employees who provide contracting and other inherently governmental services in support of FE and other DOE offices.

The Commission believes that this would yield significantly increased clarity and focus on the R&D mission for the research staff at NETL and for others outside NETL who work with them. The Commission believes those changes would enhance the standing of the R&D programs at NETL and lead to a more consistent level of high quality research. That should also result in even better opportunities for collaboration with researchers in academia and industry, and strengthen the lab's ability to attract and retain top quality professional staff.

In the long run, the Commission believes that portion of NETL's activity that is the R&D work would benefit even more if it were converted to a government-owned, contractor-operated FFRDC. The Commission recognizes the strongly held local views against this idea. Yet in the Commission's view, the other DOE National Laboratories that are structured that way benefit from stronger affiliations with universities and other organizations, have greater success in recruiting and retaining top quality personnel, and have a more consistent record of producing high quality R&D. It is the Commission's view that a careful assessment of the pros and cons of such a possible change should be made by DOE working with NETL and the local and regional governments, academic institutions, and other stakeholders.

In recent years, a collaboration with a group of universities in NETL's region produced significant gains in research quality and productivity—as measured by journal publications—until it was discontinued last year. Apparently, there are plans to resume university collaborations, but at a reduced level.

Recommendation 5: DOE should separate NETL's R&D function from its program responsibilities (and call the R&D portion—not the program activities—NETL). Furthermore, consideration should be given to converting the new, research NETL into a government-owned, contractor-operated FFRDC. Whether or not the above steps are taken, NETL should increase its interactions and collaboration with universities.

2. M&O Contractor Motivations and Performance Incentives

Contracting organizations may be motivated to run laboratories out of a sense of service to the Nation, for reputational enhancement, for access to quality technical staff, or for other reasons, but management fee should not be the primary motivating factor. Incentive fees may be appropriate for some types of production operations, but are not the best mechanism for research programs. Fees must be adequate to cover unallowable costs, such as gaps in salary, community and educational contributions, employee scholarships, and potential risks, but they do not need to be as high as some of the recent NNSA laboratory contracts.[17] The Commissioners find that a high fee perpetuates the stereotype that laboratory managers and M&O contractors are focused only on profit and are merely "contractors" rather than partners. In addition, the process to evaluate performance and award fee has led to excessive box checking and transactional compliance for the laboratories. Both of these have contributed to the breakdown in trust between some of the laboratories and DOE. The Commission agrees with the Augustine/Mies panel finding that the relationship between the NNSA laboratories and the government has been eroded by the fee structure and contract approach that invites

[17] The average available award fee as a percentage of the laboratory budget from DOE is 1.76%. While Sandia's (1.56%) is lower than the average, both Lawrence Livermore's (3.83%) and Los Alamos's (3.17%) are higher. This translates to an available award fee of $28.1M for Sandia, $45.9M for Lawrence Livermore, and $63.4M for Los Alamos. See Appendix F for complete award fee information.

detailed, tactical, and transactional oversight rather than a strategic, performance-based management approach.[18]

The Commission also notes that approximately 6 years ago, the National Aeronautics and Space Administration (NASA) changed its contract for the Jet Propulsion Laboratory (JPL), also an FFRDC, from an incentive fee to a fixed fee. JPL personnel have found the change to be positive in that it has decreased bureaucracy associated with the annual fee awarding process. The primary incentive for the laboratory to perform well is that it will receive more research funding from NASA; the punishment is that it will receive less.

Recommendation 6: DOE should abandon *incentive* award fees in the M&O contracts of the National Laboratories in favor of a fixed fee set at competitive rates with risk and necessary investment in mind. In addition, DOE should adopt a broader and richer set of incentives and consequences to motivate sound laboratory management and enforce accountability.

B. Giving the Laboratories Sufficient Freedom to Operate

The Secretary of Energy Advisory Board (SEAB) Task Force on the DOE National Laboratories described the oversight environment of the laboratories as involving six groups with managing roles: "the laboratory director and the director's leadership team, DOE Headquarters (HQ) sponsoring program offices, DOE site offices (field offices in NNSA), DOE Service Centers, DOE operational oversight offices (e.g., the Office of Independent Enterprise Assessment), [and] the M&O Contractor."[19] The multitude of oversight entities has led "to a highly burdensome operating environment that severely diminishes the effectiveness of this arrangement."[20]

1. Contract Requirements

Previous commissions and studies have highlighted the duplicative and unnecessarily burdensome requirements that govern DOE laboratories. Under the FFRDC model, DOE should provide broad direction for the work performed at the laboratories and hold the laboratories accountable for mission execution and compliance with relevant operational standards. As a result of internal and external criticism of the poor management practices of a few M&O contractors, DOE has become increasingly

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[18] See Congressional Advisory Panel on the Governance of the Nuclear Security Enterprise, *A New Foundation for the Nuclear Security Enterprise*, November 2014, 12–14.

[19] SEAB, *Report of the Secretary of Energy Task Force on DOE National Laboratories* (Washington, DC: DOE, June 17, 2015).

[20] *Ibid.*

prescriptive in its oversight of all the laboratories. This completely undermines the model since the whole point of engaging M&O contractors is for them to bring their best scientific research and business practices to laboratory operation. While it is appropriate for DOE to develop its own unique requirements to cover nuclear, high hazard, and/or classified activities, DOE has often established its own requirements across a wide variety of low-risk areas, such as human resources, business services, and other administrative functions. These requirements add little value to laboratory operation and performance, waste time and resources on unnecessary transactional details, and lead to redundant layers of bureaucracy, adding to laboratory overhead as well. This focus on such requirements has skewed DOE's relationship with its laboratories toward compliance and away from mission.

Another area in which DOE requirements can be overly prescriptive is in construction and related activities on laboratory sites. There are situations in which the Federal, state, local and industry standards are more appropriate than DOE requirements. For instance, the Commission found that some industry standards are more up-to-date than the analogous DOE standards. This situation creates confusion when, for example, sub-contractors that are brought on-site from off-site locations have been trained to follow the more updated industry standards. In fact, when this occurs, the laboratory technically may not be in compliance with their M&O contract.

DOE's requirements often also involve multiple levels of approvals rather than allowing decisions to be made at the lowest possible level. It is sometimes said that virtually anyone in the chain can say "no," but only the highest level has the authority to say "yes." The Commission also notes that the multi-layered approval process at DOE builds a culture of excessive conservatism because a margin of safety is added at every step.

Recommendation 7: DOE should give the laboratories and M&O contractors the authority to operate with more discretion whenever possible. For non-nuclear, non-high-hazard, unclassified activities, DOE should allow laboratories to use Federal, State, and national standards in place of DOE requirements. DOE should review and minimize approval processes.

DOE's processes for developing directives, orders and other requirements provide some opportunities for involvement and input from the functional offices, field elements and laboratories. However, engagement could be improved by increasing participation from subject matter experts, particularly from the field, to maximize input on the relative benefits of the proposed requirements and on their true impact on laboratory operations. In addition, when developing new requirements, DOE does not effectively consider risk.

Recommendation 8: DOE should modify its processes for developing directives, orders and other requirements to more fully engage subject matter experts for input on the benefits and impacts of the proposed requirements. When developing new requirements, DOE should use a risk-based model, ensuring the level of control over an activity is commensurate with the potential risk.

Recently DOE has established an "Evolutionary Working Group" and a "Revolutionary Working Group" to evaluate potential changes to the contractual relationship between DOE and its laboratories. The Evolutionary Working Group reviewed the M&O contracts for single-program laboratories to identify and potentially eliminate relatively low-risk requirements, including human resources, foreign travel approvals, and data requests.[21] The Revolutionary Working Group is evaluating more drastic changes such as either using a cooperative agreement or a more aggressive paring down of an M&O contract.[22] The Commission endorses these efforts.

2. Local Oversight: Contractor Assurance, Site Offices and Support Centers

DOE has attempted to shift from transactional compliance to a performance-based oversight model by installing a contractor assurance system (CAS) at each of the laboratories. Generally, CAS is a system of metrics produced by the laboratories to assure DOE that they are meeting requirements, mitigating risk, and effectively managing the laboratory. CAS also has been used to reduce Federal oversight by focusing on laboratory system approval, verification of system effectiveness, and the use of management information systems. It also emphasizes periodic assessments of high-risk operations, rather than continuous Federal inspection of all operations. One critical aspect of this model is transparency and mutual access to data. CAS implementation increases the use of laboratory-conducted oversight in operational domains such as finance and human resources, thereby prioritizing work at the site office and decreasing the number of external assessments. As a result, site office leadership has been able to reduce the staff size of some site offices by a factor of two to reflect the reduced workload. The status and maturity of CAS vary across laboratories; so too does the extent to which site offices rely

[21] DOE, *Working Groups to Study Modifications to Laboratory M&O Contracts for Single-Program Laboratories* (2015).

[22] DOE has precedence for using cooperative agreements for research and facility operations. For instance, DOE developed a cooperative agreement with Michigan State University for construction of the Facility for Rare Isotope Beams (FRIB), a new national user facility for nuclear science. More broadly, DOE has solicited 387 cooperative agreements since 2009 according to www.grants.gov, of which most are for research rather than for facility construction and management.

on CAS for oversight. Trust between the laboratory and site office staff is important to the site office's willingness to depend on CAS to manage operational risk effectively.[23]

SC has completed a peer review of the CAS across its 10 laboratories that documented the varying degree of adequacy of systems and allowed for dissemination of best practices. The Government Accountability Office (GAO) found that NNSA has not fully established policies or guidance for using information from the CAS, which has led to inconsistency in their field office procedures.[24] NNSA itself has been concerned that the laboratory systems are not sufficiently mature to act as a reliable replacement for site office on-site inspections and transactional reviews.[25] NNSA has a current opportunity to improve oversight at the laboratories by amending its new CAS policy to ensure effective implementation by both its laboratories and field office personnel.

Recommendation 9: DOE should focus on making the use of CAS more uniform across the laboratories. DOE local overseers should rely on information from the CAS systems, with appropriate validation, as much as possible for their local oversight. The quality of CAS can be increased through peer reviews for implementation and effectiveness.

The laboratories execute their missions in the midst of a complicated oversight environment, including significant local or on-site oversight. Particularly important to local oversight is the relationship between the laboratory and its site office.[26] If the relationship is adversarial, then it can seriously impede mission execution. These site offices serve as the local DOE oversight for the laboratory and management of the contract, and a site office (or two) co-locates and oversees each of the 16 FFRDC laboratories.[27] The number of Federal oversight personnel in many site offices is

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[23] NAPA, *Positioning DOE's Laboratories for the Future*.

[24] GAO, *National Nuclear Security Administration: Actions Needed to Clarify Use of Contractor Assurance Systems for Oversight and Performance Evaluation*, GAO-15-216 (Washington, DC: GAO, May 2015).

[25] NAPA, *Positioning DOE's Laboratories for the Future*.

[26] The importance of the site office/laboratory relationship is discussed in previous reports on the National Laboratories, such as NAPA's *Positioning DOE Labs for the Future* report, SEAB Task Force report, Galvin Report, and Augustine/Mies panel report.

[27] The term "site offices" is used to describe the DOE Federal offices located at each laboratory site. These offices are called "site offices" or "field offices" depending on the location, but the roles and responsibilities are consistent even with the differing name. The Golden Field Office, however, serves both as a site office and a support center to EERE and NREL and co-locates NREL in Golden, CO (http://energy.gov/eere/about-us/business-operations/golden-field-office). NETL, as a GOGO, does not have a site office. The Savannah River Site, which includes the Savannah River National Laboratory, has two site offices, one for its stewarding office, EM (http://sro.srs.gov/), and one for NNSA. For more information about each site office at NNSA's eight sites, go to http://nnsa.energy.gov/aboutus/ourlocations. For information on SC's 10 site offices, go to http://science.energy.gov/about/field-offices/.

substantially higher than at other Federal agency FFRDCs. Given the importance of trust in the relationship between the site offices and the laboratories, the site offices impact the laboratories, both positively and negatively, and the character of this impact can affect mission execution.

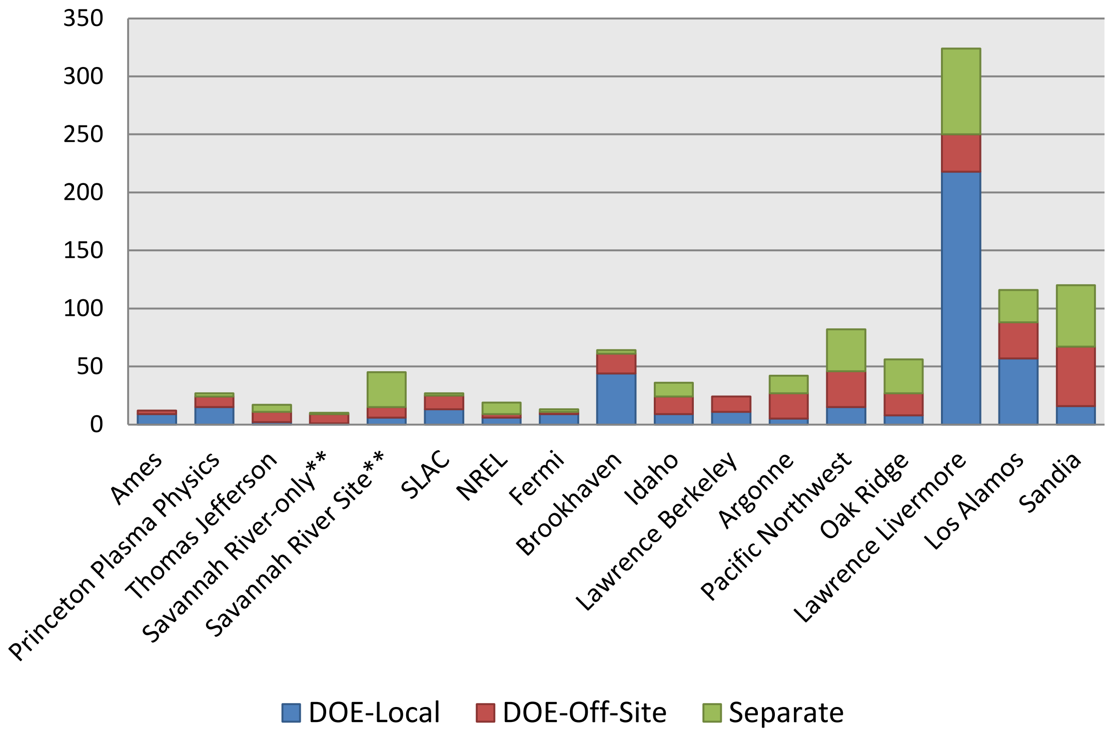
Recommendation 10: The role of the site office should be emphasized as one of "mission support" to the program offices at DOE and to the laboratories. The site office manager should be clearly responsible for the performance of the site office in support of the mission, and all staff in the site office, including the Contracting Officers, should report to the site office manager. Since site office effectiveness is so dependent on site office leadership, DOE should devote more effort to leadership training and professional development of field staff.

The roles, responsibilities, and authority of the support centers are unclear to many in the laboratory network. In certain cases, support centers have approval authority, which confuses and complicates matters. The main rationale for support centers is to provide specialized expertise, such as real estate lawyers, who are not needed full-time at each site office. The Commission accepts that justification. The responsibility for drawing on that expertise and for making decisions ultimately rests in the program, which is responsible for mission execution. The Commission heard complaints from both the field and headquarters that support centers sometimes inappropriately claim approval authority for various decisions and can be unresponsive to mission priorities and schedules.

Recommendation 11: DOE should clarify the role and authority of the support centers. Wherever approval authority resides with a support center, DOE should remove it and reinstate it at either the site office or DOE headquarters, as appropriate.

3. Assessments and Data Calls

Previous reports found that the National Laboratories are subject to too many assessments and data requests, which are time consuming and a distraction from the mission. To develop a greater understanding of the underlying causes and complexities of the issue, the Commission collected data on assessments and data requests from all 17 of the National Laboratories. Though the Commission did find examples of burdensome and duplicative assessments at almost all the laboratories, the problem is more prevalent at the NNSA laboratories (Figure 4).



Source: Data supplied by each laboratory through list of assessments for FY 2014.

Notes: Laboratories are organized by increasing size of operating budget from left to right.

These are assessments that were considered open for at least part of the fiscal year. These values include assessments that started or ended in other fiscal years as some assessments span fiscal years.

** Savannah River National Laboratory is part of the Savannah River Site contract. Thus, the values presented for "Savannah River Site" include assessments of the laboratory. The values presented for "Savannah River-only" are a subset of the site assessments that included only the laboratory, not other parts of the site.

Figure 4. Number of External Assessments at the DOE Laboratories (FY 2014), Operations Only

Other than the site offices and support centers, the primary conductors of assessments at the laboratories within DOE are the Office of Enterprise Assessments (EA) and IG. EA is the independent assessment office for the Secretary within the Department and conducts assessments in safety and security.[28] IG is the auditing organization charged with discovering "waste, fraud, and abuse" across the Department,

[28] The former Office of Health, Safety and Security was divided into two separate organizations on May 4, 2014: EA and the Office of Environment, Health, Safety and Security. According to EA's webpage ("About Us," http://energy.gov/ea/about-us), the office is DOE's "autonomous organization responsible for performance of assessments on behalf of the Secretary and Deputy Secretary, in the areas of nuclear and industrial safety, cyber and physical security, and other critical functions as directed by the Secretary and his Leadership team."

not just at the laboratories.[29] The effective implementation of the CAS has reduced much of the separate oversight and assessment activity at many of the laboratories. Site offices at laboratories with a mature CAS have been more successful acting as gatekeepers by aiding non-DOE external assessors in leveraging assessments conducted by the laboratory or the site office.

Recommendation 12: All stakeholders should make maximum use of local assessments (performed by site offices and laboratories), with appropriate verification, to reduce duplicative assessments and burden on the laboratories.

The Commission found that onerous and lengthy data requests can often arrive at the laboratories without being sufficiently vetted or filtered. Many of the data calls are sent to all of the laboratories and could be answered by one call to a single laboratory, rather than 5 or 17. SC has successfully reduced the number of unfiltered data requests at the laboratories by establishing a single point of contact for data requests for all of its 10 laboratories. This filtering process does not occur at other program offices, and burdensome data requests still arrive at all laboratories. In a previous Administration, all data requests were screened and approved by the Deputy Secretary in order to assure a consistent application across all offices and laboratories.

Recommendation 13: DOE should establish a single point of control—within the Department or each stewarding program office—for all laboratory-directed data requests.

4. Flexible Budgeting

Several past reports have emphasized the laboratories' concern regarding "budget atomization," which refers to ever smaller increments of funds under the laboratory's control for a particular project or program. The result of budget atomization is increased reporting requirements and decreased flexibility, which may reduce the laboratories' effectiveness and efficiency.

Budget flexibility depends on both the legal restrictions imposed by Congress in their allocation of funding and the granularity of management by each DOE program office (Table 2). The pyramid graphic (Figure 5) shows the view from the laboratory's perspective. It demonstrates the different levels of controls placed on the NNSA laboratories' budgets and indicates what legal or institutional requirements pertain at each level.

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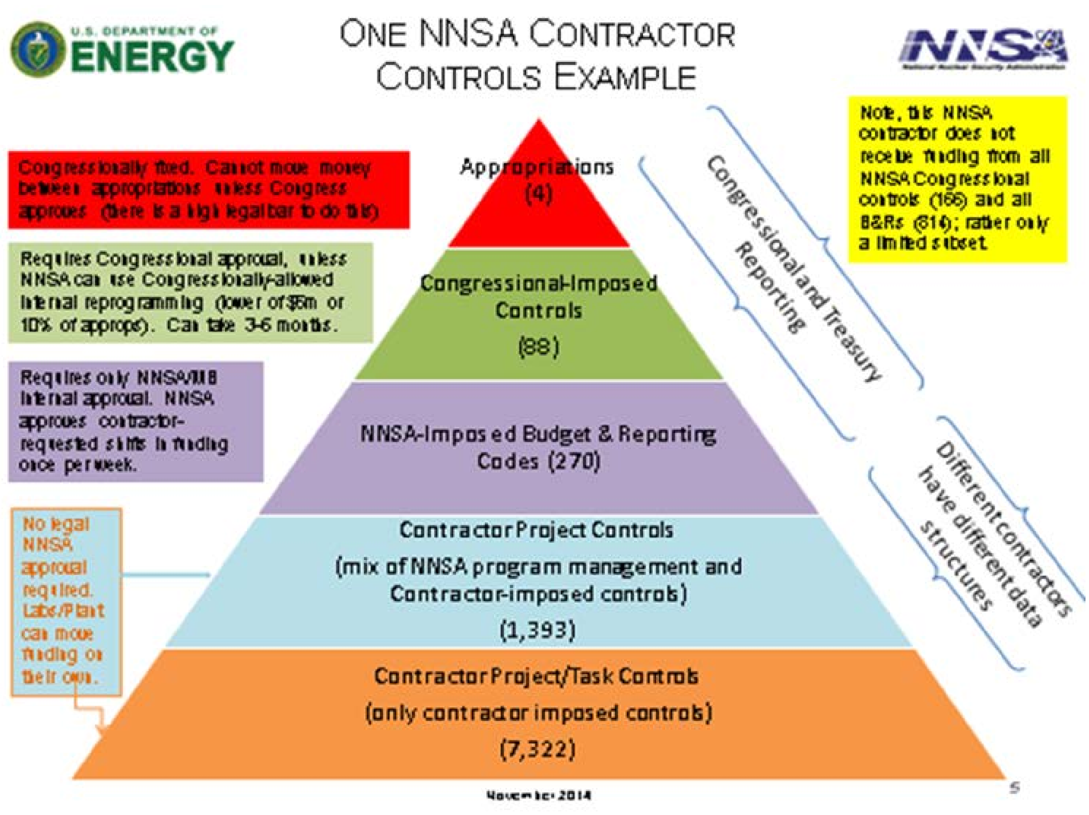
[29] More information is available at the DOE Office of Inspector General's webpage, "About Us," http://energy.gov/ig/about-us.

Table 2. Number and Source of Control Points for Laboratory Budgets

	[-------------Legal Control-------------]		[-----------------------Program Office-----------------------]		
	[-------------------------FY 2014 Appropriations Only----------------------------]				All Years
	Appropriation (year & period of availability)	Program Project Activity (PPA)	9 Digit Budget and Reporting (B&R) Codes	Place	Place
Weapons	1	70	321	1,278	2,369
Defense Programs	*1*	*44*	*161*	*566*	*979*
All other	*1*	*26*	*160*	*712*	*1390*
Defense, EM	2	33	119	609	1,292
SC	3	26	253	1054	2,120
EERE	3	18	84	553	1,253
OE	2	7	14	80	211

Source: DOE Office of the Chief Financial Officer.

Note: The table does not include the Obligational Control Level (OCL).



Note: The figure does not include the PPA level.

Figure 5. One NNSA Contractor Controls Example

Congress is responsible for the first three layers: the Appropriation, the Obligational Control Levels (OCL), and the program, project, and activity (PPA) levels which are established by statute. Within any given OCL, there is some flexibility at the level of a total dollar amount or a percentage of the total funding line, whichever is lower. For example, the ceiling for movement of funds for NNSA is $5 million or less than ten percent of the funding amount, whichever is lower. This permits some movement of funding between OCLs without congressional approval. However, when a movement of funds between OCLs that exceeds the statutorily defined thresholds occurs, NNSA reported that the time required for each congressional approval is between 3 and 6 months.

DOE, in turn, divides each PPA into multiple budget and reporting (B&R) codes. The degree of programmatic control is set forth in the work breakdown structure that corresponds to each B&R code. Table 2 shows the obligations for five appropriations as examples of how these buckets proliferate as funding moves out to the field—from congressional PPAs to individual program offices to individual laboratories. The first four columns show the number of buckets for FY 2014 funding only. The last shows how many buckets each office manages when all years of funding are considered.

The budget atomization problem is not uniform across program offices or laboratories. The 2014 Augustine/Mies panel report called for the Congress, DOE Secretary, and the NNSA Administrator to "adopt a simplified budget and accounting structure" through a reduction of the Obligational Control Levels and to "better align resources" for efficient mission execution.[30] The report went on to say that NNSA should reduce the internal budget control lines to the "minimum number needed to assign funding for major programs and mission-support activities across the sites." The Commission endorses these recommendations and believes they should be extended to other parts of DOE's laboratory system.

The Commission also supports the Office of Energy Efficiency and Renewable Energy's recent move towards larger grants with longer periods of performance and fewer milestones and reporting requirements. In 2014, EERE leadership established a policy for its program managers to assign fewer, larger projects to the laboratories.[31] The guidance was to double the size and halve the number of funding buckets. In addition, the new EERE policy decreased the number of milestones per project to one per quarter. These milestones are to be well-defined, quantitative and rigorous. Accountability is still

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[30] Congressional Advisory Panel on the Governance of the Nuclear Security Enterprise, *A New Foundation for the Nuclear Security Enterprise*, November 2014.

[31] The policy changes are reflected in DOE Energy Efficiency and Renewable Energy (EERE), *EERE – National Laboratory Guiding Principles*, (Washington, DC: DOE, March 9, 2015).

key; every 12 to 18 months, the office makes a go/no-go decision based on the work accomplished to date.

Recommendation 14: To reduce the number of funding buckets and minimize the accompanying transactional burden, DOE and its program offices should adopt and adhere to the following principles:

- Increase the size of funding increments through consolidation of B&R codes at the highest level possible within each program area.
- Extend timelines and minimize milestones for each increment of funding. Work breakdown structures must be formulated to focus on strategic goals rather than tactical milestones and reporting requirements.
- Within legal limits, institutionalize mechanisms for laboratory flexibility via notification, rather than formal approval, to move money between B&R codes on cross-cutting R&D objectives or closely interrelated research areas among DOE program offices.

The recent reliance on continuing resolutions to fund the U.S. Government and a change in law has exacerbated the budget atomization issue. DOE used to be able to control funds at the OCL when operating under a continuing resolution. However, Section 301(c) in the FY 2012 appropriations bill, which was reinstated as Section 301(d) in FY 2014 and FY 2015, changed the legal level of control to the program, project, and activity (PPA) level.[32] In one example cited by DOE personnel, this change expanded the number of control categories from 30 to over 300. This, in combination with other Office of Management and Budget (OMB) apportionment requirements—including quarterly apportionment for SC and other program areas—creates constant turmoil and delay in getting money to the laboratories. Repealing Section 301(d) would allow the laboratories to manage more effectively, while still complying with all new start and other legal restrictions when operating under a continuing resolution.

Recommendation 15: Congress should repeal Section 301(d) of the FY 2015 Consolidated Appropriations Act as soon as feasible to remedy the transactional burden it creates for OMB, DOE Headquarters, and the laboratories when operating under a continuing resolution.

[32] Section 301(d) reads "Except as provided in subsections (e), (f), and (g), the amounts made available by this title shall be expended as authorized by law for the programs, projects, and activities specified in the 'Final Bill' column in the 'Department of Energy' table included under the heading 'Title III—Department of Energy' in the explanatory statement described in section 4 (in the matter preceding division A of this consolidated Act)."

4. Maintaining Alignment and Quality

DOE is responsible for aligning the research performed at its laboratories with the Department's mission priorities, ensuring the quality of the research and research programs, monitoring for duplication, and providing sufficient resources to allow the laboratories to execute effectively. As steward of the 17 National Laboratories, DOE has the important role of providing strategic direction to the laboratory system. Strategic review, planning, and implementation are essential for alignment among the laboratories, the laboratories' sponsors, and the Department's priorities. Currently there are no processes to provide this type of comprehensive strategic direction to the laboratory system as a whole. Recent initiatives, such as the Crosscuts and the Science and Energy Plan, address this objective in part by creating strategic links across DOE programs and between programs and laboratories. They have either focused on a single, albeit broad, topic (in the case of the Crosscuts) or have focused only on pieces of the mission (in the case of the Science and Energy Plan, which excludes the nuclear and environmental management missions).

A. Alignment with DOE's Objectives

Despite the lack of a Department-wide, comprehensive strategic planning process, the National Laboratories' research programs and capabilities are generally well-aligned with DOE's missions and strategic priorities. There are robust processes in some program offices to provide strategic oversight, evaluation and direction to the laboratories. However, those processes are not consistently utilized throughout the Department.

SC has established effective formal processes to ensure proper alignment between its laboratories' research programs, and the Department's missions and strategic priorities. Alignment is assessed annually during the Laboratory Strategic Planning process. During this process, SC requires laboratory leaders to define the long-range visions for their respective laboratories. This information provides a starting point for discussion about each laboratory's future directions, immediate and long-range challenges, and resource needs. DOE and the laboratory leaders settle on new research directions and the expected development or sustainment of capabilities. In addition, external advisory committees provide advice on establishing research and facilities priorities; determining proper program balance among disciplines; and identifying opportunities for inter-laboratory collaboration, program integration, and industrial participation.

By contrast, within the NNSA, each program office reviews its strategic plans with the laboratories separately. For example, Defense Programs coordinates the Stockpile Stewardship and Management Plan, a congressionally mandated 25-year program planning document that is a collaborative effort of all the sites and stakeholders.[33] Semiannually, the Defense Nuclear Non-Proliferation Office (NA-20) uses an Assistant Laboratory Director "science council" with all the laboratories to discuss strategic direction and core capabilities that are critical to the NA-20 mission. Since these reviews are program based and not integrated, their effectiveness in providing strategic direction to the three weapons laboratories remains unclear.

An essential cultural difference also exists between SC and many of DOE's other program offices. That is the principle of stewardship for the laboratories that exists within SC. The basic orientation of SC leadership in its planning processes is one of responsibility to ensure the long-term health and scientific excellence of each of its laboratories. That principle is not consistently embraced to the same degree in the other program offices. In some cases, it depends completely upon the orientation of the political leadership of the program office at the time, and has varied from indifference to a solid commitment.

Recommendation 16: Other DOE program offices should adapt to their contexts the procedures and processes that DOE's Office of Science has in place for guiding and assessing the alignment of the laboratories under its stewardship with DOE's missions and priorities.

B. Ensuring High-Quality Research and Research Programs

Relative to other offices within DOE, SC has mature processes in place for assessing the quality of the research being done by the 10 laboratories under its stewardship. The office also has numerous processes to assess the quality of the research portfolio in each of its major program areas. The processes in place at the other DOE program offices are not as mature.

SC conducts an annual evaluation of the scientific, technical, managerial, and operational performance of its 10 laboratories. This process is coordinated by the Office of Laboratory Policy on behalf of the SC Director. These evaluations provide the basis for determining annual performance fees and the possibility of winning additional years

33 The Stockpile Stewardship and Management Plan's (SSMP) validity as an executable plan remains an issue of debate between the Department of Defense and NNSA. See Congressional Advisory Panel on the Governance of the Nuclear Security Enterprise, *A New Foundation for the Nuclear Security Enterprise*, November 2014, 12–14.

on the contract through an extension. They also serve to inform DOE decisions regarding whether to extend or to re-compete the M&O contracts when they expire.

The current laboratory appraisal process began in 2006 and was designed to improve transparency, increase the involvement of SC leadership, standardize laboratory evaluation, and more effectively incentivize contractor performance by tying performance to fee earned, contract length, and publicly released grades.

SC's laboratory appraisal process uses a common structure and scoring system across all laboratories and is structured around eight performance goals, each of which comprises several objectives. Within each objective, the program offices and site offices further identify notable outcomes that illustrate important features of the laboratory's performance. The performance goals, objectives, and notable outcomes are documented at the beginning of each year in the PEMP, which is appended to the laboratory's M&O contract.

At the conclusion of each fiscal year, the organizations that fund work at a given laboratory evaluate its S&T performance. In addition to managing its science programs, SC solicits input from all organizations that spend more than $1 million at the laboratory. This input is weighted according to the dollars spent. Each site office evaluates the laboratory's performance against the M&O objectives. The program offices and the site office consider the laboratory's performance against the notable outcomes, defined in the PEMP, as well as other sources of performance information that become available throughout the year. These sources might include independent scientific program and project reviews; external operational reviews conducted by GAO, IG, and other parts of DOE; and results of SC's own oversight activities. The evaluation process concludes with a series of meetings, one for each performance goal, during which the various organizations involved report their proposed scores and work to ensure a consistent and fair approach across all 10 SC laboratories.

Other significant assessment activities also occur within SC program offices. These assessments include division-led laboratory management reviews of the research programs and status of each project; discussion of topics for current and proposed white papers and related LDRD activities; and relevant programmatic activities, such as recruitment, infrastructure, equipment, and instrumentation. SC also carries out a triennial science/operational review of its user facilities, which is an essential part of the performance assessment of these facilities.

Each of the programs within SC has established an external Advisory Committee to provide independent advice to the SC Director regarding the scientific and technical issues that arise in the planning, management, and implementation of the program. The recommendations from the Advisory Committees include research and facilities priorities; proper program balance among disciplines; and opportunities for inter-laboratory collaboration, program integration, academic collaboration and industrial participation. The Advisory Committees include representatives of universities, research laboratories, and industries involved in energy-related scientific research.

The SC Director charges the Advisory Committees to assemble Committees of Visitors (COVs) "to assess the efficacy and quality of the processes used to solicit, review, recommend, monitor, and document funding actions and to assess the quality of the resulting portfolio."[34] The national and international standing of the research are part of the evaluation. Every program must be reviewed by a COV at least once every 3 years. Each review panel is made up of scientists and research managers known to have significant expertise in the appropriate field. The COV prepares a report that is reviewed by the Advisory Committee, which may make modifications prior to acceptance. Following acceptance, the report is transmitted to the SC Director and released publicly.

Another type of external review process used by the SC program offices is the Comparative Research Review. These reviews provide independent comparative evaluations of supported research activities as a means of ensuring the quality and impact of the science that SC supports. By providing a critical assessment of all grants simultaneously, the program offices are able to identify those efforts that should be phased out so that funding can be re-competed. In FY 2013, for example, the Comparative Research Review carried out by the SC's Office of Nuclear Physics (NP) resulted in approximately 25 percent of the least competitive grants being phased out. Not only did the review provide important input to NP regarding the quality and balance of its research portfolio, it also helped establish a strategic vision for U.S. nuclear science developed in partnership with the broader research community.

SC's processes for assessing the quality of both the research conducted by their 10 laboratories and of the research portfolio in each SC program have begun to influence other programs. For example, NE adopted a PEMP-like process, but with greater emphasis on safety. NNSA also recently instituted a process similar to the PEMP, but the NNSA process focuses more on operations than on strategic direction. Although some factors necessarily limit the applicability of SC's processes to other programs (e.g., the classified nature of the work at the NNSA laboratories, which affects their use of Advisory Panels and Committees of Visitors), the Commission is encouraged to see other program offices developing similar processes.

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[34] DOE website, "Committees of Visitors," http://science.energy.gov/sc-2/committees-of-visitors/.

Recommendation 17: The processes that the Office of Science has in place for assessing the quality of the research being done by the 10 laboratories under its stewardship, and for assessing the quality of the research portfolio in each of its programs, should be adapted by the other DOE program offices.

In 2012, partly as a result of the 2010 GSA conference scandal, OMB released a memorandum that, among other things, outlined new policies and practices to reduce spending in areas such as travel and conference attendance.[35] Subsequently, the DOE Deputy Secretary released guidance on the implementation of the new OMB requirements.[36] During every laboratory visit, laboratory staff told the Commission that the resulting conference management rules and their implementation have discouraged scientists and engineers from attending technical conferences, thereby hindering the laboratory's ability to maintain contact with researchers at the leading edge. A lengthier approval process for conference attendance had led many laboratory scientists to choose not to submit and/or present papers at scientific conferences for fear they would not be able to attend. According to the National Academy of Sciences, scientific conferences provide a venue for researchers to collaborate with others in their field and allow access to the latest research findings, which may not be published in scientific journals in a timely fashion.[37] The Commission strongly believes that attendance at professional conferences is essential to maintain the highest quality research at the National Laboratories, and to attract and retain the highest quality scientific and technical staff. Very recently DOE, working closely with the laboratories, updated its guidance on conference-related activities and spending. The new guidance "refines the Department's conference management policies and procedures using a risk-based approach."[38] The changes are expected to streamline approval processes and reduce transactional oversight of the laboratories thereby better enabling participation in scientific/technical conferences. Essentially, the revised conference policy provides the laboratories with more autonomy in managing conferences, but makes them responsible for ensuring that tax payer funds are used appropriately. The Commission is encouraged by both DOE's updated guidance and the laboratories' involvement in the revision process.

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[35] J. Zients, *Promoting Efficient Spending to Support Agency Operations* [Memorandum], Office of Management and Budget.

[36] D. Poneman, *Promoting Efficient Spending to Support Agency Operations* [Memorandum], Department of Energy.

[37] National Research Council (NRC), *Strategic Engagement in Global S&T: Opportunities for Defense Research* (Washington, DC: National Academies Press, 2014).

[38] E. Sherwood-Randall, *Updated Guidance on Conference-Related Activities and Spending* [Memorandum] (Washington, DC: DOE, August 17, 2015).

Recommendation 18: There must be a government-wide reconsideration of the conference travel restrictions to enable conference participation at levels appropriate to both the professional needs of the existing scientific staff and to attract the highest quality staff in the future. The Commission is encouraged by DOE's recently revised guidance on conference-related activities and spending, and notes that the laboratories have been given more autonomy on this issue, while at the same time being held accountable for the appropriate use of taxpayer funds.

C. Laboratory Directed Research and Development

The ability to adapt, retool, invest in staff and capabilities, and to enter new research areas is crucial to laboratory performance and the maintenance of high-quality staff and research. Laboratories rely in large part on LDRD programs to achieve these goals. LDRD is the sole source of discretionary research funding under the control of the laboratory director. First authorized in the Atomic Energy Act of 1954, LDRD supports researcher-initiated work of a creative and strategic nature. These projects might serve as proofs of concept in emerging fields, address significant technical challenges facing laboratory programs, or explore innovative concepts to address DOE missions.

LDRD's accomplishments are noteworthy. Multiple programs across the system have often begun through initial LDRD investments in capabilities and expertise, and the investments have often produced significant returns—both scientific and financial. At Lawrence Berkeley, for instance, LDRD-funded projects totaling $484,000 helped establish the technical foundations that allowed the laboratory and its partners to secure both the $250 million DOE Joint Bioenergy Institute program and a $500 million contract for the Energy Bioscience Institute from British Petroleum. Other major programs, such as the Joint Center for Energy Storage Research at Argonne, the Energy Frontier Research Center led by NREL, and early-stage work on the Human Genome Project at the NNSA laboratories, rose out of LDRD investments. In the field of stockpile stewardship, findings of LDRD projects have had a significant impact on stewardship strategy, resulting in dramatic savings to the Nation through a more informed understanding of life extension science. Lastly, a large volume of the scientific output from the laboratories (measured by peer-reviewed publications, patents, and invention disclosures) result from LDRD-funded projects.

Many laboratories also depend on LDRD to support the recruitment and retention of qualified staff. The importance of LDRD for the purpose of workforce development at NNSA laboratories is demonstrated by Table 3, which shows the significant degree to which LDRD is used to support post-doctoral researchers, a crucial source of the NNSA laboratories' scientific workforce. NNSA laboratories must often hire people who have not yet received their security clearance—a process which can take up to a year or longer—so having a flexible unclassified pool of funds is critically important for hires at all levels.

Table 3. LDRD Recruitment/Retention Metrics at NNSA Laboratories (FY 2008–FY 2012)

	Sandia	Lawrence Livermore*	Los Alamos
Post-doctorates supported by LDRD	56%	51%	59%
LDRD post-doctorates converted to full-time staff	77%	74%	49%

Note: Data for Lawrence Livermore provided by NNSA for FY 2010–FY 2013.

All of the laboratories employ competitive, merit-based processes to solicit, review, and select LDRD projects for funding. DOE has interpreted LDRD authorizing legislation to require site office and headquarters staff to separately review and approve each LDRD project for mission alignment and compliance with the Department's statutory requirements.[39] The Commission finds the requirement for individual LDRD review and approval by the Federal Government counter to the tenets of trusted partnership, but both laboratories and DOE HQ report that the process of review and approval are not burdensome. Regardless, Congress should consider amending LDRD authorizing legislation such that the Department conducts periodic audits or reviews a sampling of each year's project pool after a one-time certification that the laboratory's LDRD proposal selection process is rigorous, based on peer review, and includes all necessary criteria.

Laboratories acquire funding for LDRD as part of the overhead on R&D performed at the laboratory. As illustrated in Figure 6, funding levels for LDRD vary widely across the system, reflecting the diversity of the laboratories in size and mission needs. LDRD is especially important at NNSA laboratories, which spend more on LDRD in both percentage and absolute terms.

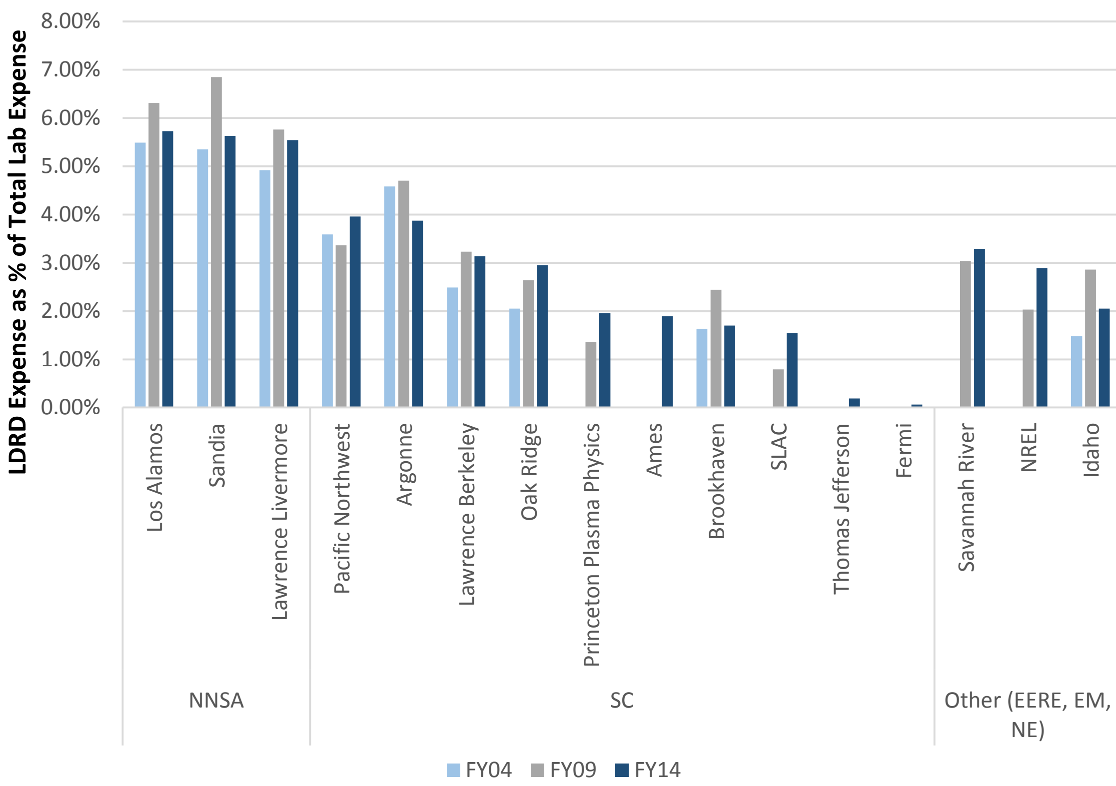
In FY 2006, Congress required the laboratories to burden LDRD, changing the cap from an unburdened 6 percent to a burdened 8 percent.[40] Then in FY 2014, Congress reduced the LDRD cap from 8 percent to 6 percent, still burdened.[41] In 2015 Congress

[39] DOE, Order 413.2B, *Laboratory Directed Research and Development* (January 2011). These requirements prohibit the use of LDRD funds for projects that would require non-LDRD funds to accomplish technical goals, provide for general purpose capital expenditures, and substitute for programmatic projects where funding has been limited by Congress or DOE/NNSA.

[40] Energy and Water Development Appropriations Act, 2006 (Public Law 109-103). "Burdened" means overhead is charged to LDRD projects.

[41] Consolidated Appropriations Act, 2014 (Public Law No. 113-76).

added another restriction, requiring the 6 percent cap to be applied program by program, rather than at the total R&D funding level, further reducing flexibility for the labs. Some laboratories reported that the burdening and reduced cap on LDRD significantly reduced the amount of LDRD work that could be done, while others reported minimal impact. For laboratories with programs closer to the cap—primarily the NNSA laboratories—the decrease from 8 percent to 6 percent resulted in substantial cuts to the size of recruitment and retention programs, number and size of projects, and funding for specific types of projects, such as exploratory research. Non-NNSA laboratories typically elect lower LDRD rates for a variety of reasons—including concern about overhead rates and their reduced reliance on LDRD to attract top talent or maintain scientific creativity due to their more research-focused missions—and the change in cap had less of an effect.



Note: Data derived from DOE Fiscal Year 2004 and Fiscal Year 2014 LDRD Reports to Congress. In FY 2004 and all other fiscal years prior to FY 2006, LDRD-funded projects were unburdened. After FY 2006, Congress mandated the burdening of LDRD, such that LDRD-funded projects pay the appropriate share of overhead. The percent cap on LDRD was also raised to 8 percent during the same year, to be reduced to 6 percent while maintaining the burden in FY 2014. In terms of FTE hours of work, an 8 percent burdened cap enables considerably less research to be conducted than with a 6 percent unburdened cap. Laboratories that did not report LDRD data for specific years did not have LDRD programs during those years. As a GOGO, NETL does not have an LDRD program.

Figure 6. Reported LDRD Spending as a Percentage of Total Laboratory Expenditures, FY 2004, FY 2009, and FY 2014

The quantitative difference between burdening and unburdening LDRD with overhead is significant. To return to the level of real funding provided by a 6 percent unburdened LDRD program under burdening, a laboratory with an 80 percent overhead rate would require a cap of roughly 10 percent burdened.[42] Given the mission importance of LDRD, the Commission strongly endorses a reconsideration of LDRD policy to enable a return to the previous levels of R&D effort.

Recommendation 19: The Commission strongly endorses LDRD programs, both now and into the future, and supports restoring the cap on LDRD to 6 percent unburdened, or its equivalent. The Commission recognizes that, in practice, restoring the higher cap will have the largest impact on the LDRD programs of the NNSA laboratories.

D. Appropriate Level of Duplication of Research

Competition among similar groups—and thus some degree of duplication across the laboratories—is integral to scientific advancement. Scientific progress is made through exploring many avenues of inquiry at the same time and the chance of success increases with the number of people who try different ideas and strategies. The reality of finite resources must, of course, also be recognized—the government simply cannot fund every idea in every field. In addition, spreading resources too thinly across too many researchers is inefficient. A balance must therefore be struck between allowing creativity and innovation to blossom and appropriately managing resources to maximize productivity. Resources should allow several laboratories to participate in a healthy competition, so that different ideas can thrive during the genesis of a new field or technology. Once a specific scheme has proved superior to others, resources should be focused there.

Most "duplication" that occurs within the R&D programs of the laboratories is intentional, managed, and beneficial to the Nation. For example, it may occur during the early stages of new research, when it is appropriate to encourage multiple researchers to carry out small-scale projects and explore different potential avenues. In mature program areas, the Department has processes to provide strategic oversight and guidance. This is healthy and should be supported.

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[42] For 6% unburdened, each $1M of laboratory R&D budget would provide $60K in LDRD funds. Assuming an 80% overhead rate, the same $1M would provide ~$45K in LDRD funds under an 8% burdened cap and only ~$33K under a 6% burdened cap. To reach levels comparable to the historical 6 percent unburdened policy, the cap would need to rise to 10% burdened (i.e., $1M budget would produce $100K LDRD, of which ~$56K would go to R&D while the remainder ~$44K would be collected as overhead).

There is, however, some period of time between the early and more mature stages of a research field during which the laboratories do compete with one another to achieve prominence in new research areas. The Galvin report characterized this in the 1990s, for instance, as "excessive scrambling by the laboratories to establish programmatic activities in new mission areas."[43] If this entrepreneurial stage is allowed to extend for too long, it can seriously inhibit inter-laboratory collaboration and transparency, as the laboratories maintain secrecy and compete aggressively for funding support. DOE has attempted various solutions to this, including the research Hubs that were designed to foster teams of laboratories and other organizations working together. A promising current effort is the Grid Modernization Initiative, in which the 10 laboratories that are currently working on modernization of the electricity grid are forming a collaborative program with differentiated roles for each of them. That is a good step, but should have been initiated by DOE perhaps as much as a decade earlier while the 10 laboratories were working independently.

Because of the significant resources involved, the Department has developed processes for prioritizing user facilities and avoiding duplicative facilities. These processes are often led by external topic-based advisory panels and often involve multiple Federal agencies—for example, the Basic Energy Sciences Advisory Committee (BESAC)[44] and the High Energy Physics Advisory Panel,[45] which report to DOE and the National Science Foundation (NSF) jointly. The success of these processes in planning large user facilities may be best illustrated by recent changes to DOE's thinking about new light sources, which are essential for basic research in many scientific fields, from physics to life sciences, chemistry and materials science. SC significantly amended its strategy for synchrotron light sources as a result of the BESAC report, *Future X-Ray Light Sources*. As a result of this report, SC tasked SLAC to modify its plans for the Linac Coherent Light Source II to integrate new functionality; Argonne to incorporate diffraction limited storage ring technology into its Advanced Photon Source Upgrade; and terminated Lawrence Berkeley's proposed Next Generation Light Source. This strategic restructuring of facility upgrades and termination of a proposed facility has been claimed to have saved between $250 million and $850 million, while simultaneously

43 SEAB, *Alternative Futures for the Department of Energy National Laboratories* (Washington, DC: DOE, 1995); also referred to as the Galvin report.

44 For more information, see "Basic Energy Sciences Advisory Committee (BESAC)," http://science.energy.gov/bes/besac/.

45 For more information, see "High Energy Physics Advisory Panel (HEPAP)," http://science.energy.gov/hep/hepap.

ensuring the U.S. remains at the forefront of light source and storage ring science.[46] It also ensures that the broader S&T community will have the facilities it needs.

> **Recommendation 20:** DOE should manage the National Laboratories as a system having an overarching strategic plan that gives the laboratories the flexibility to pursue new lines of inquiry, so long as the research aligns with mission priorities. Once the research has matured to the point that a preferred or most promising approach can be identified, the Department should provide strategic oversight and guidance, including expert peer review, for the laboratory system to coordinate and potentially consolidate their programs to achieve the most effective and efficient use of resources.

An area in which the question of competition and duplication is more subtle involves the two nuclear weapons physics design laboratories, Los Alamos and Lawrence Livermore. The U.S. has relied on design competition and inter-laboratory peer-reviewed competitive processes to develop and maintain its nuclear deterrent successfully for over 50 years. Los Alamos and Lawrence Livermore have participated in vigorous design competitions for the design of all nuclear explosive packages currently in the stockpile. Sandia has been and continues to be responsible for engineering all parts of the weapons, other than the nuclear explosive package. In contrast to the current policy, which forbids testing of the nuclear explosive package, Sandia components and systems can be tested experimentally.

Now the principal challenge of the three NNSA laboratories is to maintain confidence in the Nation’s smaller nuclear weapons stockpile, while continuing to improve its safety and security, all without nuclear explosive testing. This is an enormous scientific and technical challenge and it is essential that the government continue to have the benefit of two strong, independent physics laboratories responsible for the nuclear explosive package, which use different computational codes and experimental techniques short of nuclear explosive tests.

In the absence of nuclear explosive testing, the Nation's confidence in the stockpile ultimately rests on the technical and scientific judgments of Los Alamos and Lawrence Livermore for the nuclear explosive package and on Sandia for the testable remainder of the weapons systems.

Since the cessation of nuclear weapons explosive testing in the early 1990s, we have relied on science-based stockpile stewardship (SBSS). SBSS requires a redundancy in approach that entails a unique mix of competition, collaboration, and duplication, which has been remarkably successful. It is sometimes argued, however, that since we are

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[46] DOE SC, *FY 2015 Budget Request to Congress for DOE’s Office of Science* (2014).

designing no new nuclear weapons, we no longer need two design laboratories. The basic premise of this argument is flawed. We are still involved in nuclear weapons science and design. Since the start of the Stockpile Stewardship Program, Los Alamos and Lawrence Livermore have continued to discover problems not revealed by the earlier nuclear tests and have occasionally even solved problems that nuclear explosive testing did not. For example, starting with different hypotheses about the aging behavior of plutonium, Los Alamos and Lawrence Livermore, after an intense scientific competition, both eventually came to the conclusion that the plutonium pits in nuclear weapons were much more stable than originally thought, providing greater confidence in the reliability of the pits and the stockpile.

In addition, the current annual assessment process, which is a central element of stockpile stewardship, has included the Independent Nuclear Weapons Assessment Process (INWAP) since 2010. INWAP employs assessment teams from one physics laboratory to independently develop and refine nuclear performance baselines for weapons types that are the responsibility of the other physics laboratory. The technical experts on these teams are uniquely qualified to conduct these assessments because they draw from the only organizations that have the computational and experimental capabilities necessary to conduct such technical evaluations as well as the personnel who possess the required security clearances. The results of these independent annual assessments are reported to the responsible laboratory Director, who uses them as one element of the overall annual assessment process to evaluate the certification basis of the weapons types for which the laboratory is responsible.

Any viable alternative to maintaining two nuclear explosive package design laboratories must provide the same high level of confidence in the nuclear weapons stockpile that is currently ensured by the independent peer review process. This process has been key to U.S. nuclear weapons R&D since the 1950s. Any proposed alternative must also retain key personnel and facilities. The Commission believes that such an independent review process requires the technical capabilities of both Los Alamos and Lawrence Livermore and that these capabilities must remain separate and independent. Since nuclear weapons research is classified, and explores ranges of temperatures, pressures and other physical regimes not usually accessed by the general scientific community, the knowledge, expertise, and experimental capabilities exist only at the nuclear weapon design laboratories. The Commission strongly believes that these capabilities must be maintained.[47]

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[47] For a more in depth look at this subject the reader is referred to the recently released National Academies report entitled "Peer Review and Design Competition in the NNSA National Security Laboratories" which can be found at http://www.nap.edu/catalog/21806/peer-review-and-design-competition-in-the-nnsa-national-security-laboratories.

Recommendation 21: Congress should recognize that the technical capabilities currently housed within the NNSA laboratories are essential to the Nation. Maintaining the nuclear explosive package capabilities in separate and independent facilities has proven effective and should continue, thereby providing senior decision makers the highest possible level of confidence in the country's nuclear weapons stockpile.

5. Maximizing Impact

The National Laboratories represent a national asset of inestimable value. A great deal of money has been invested to create scientific and technical capabilities that are crucially important for the Nation's security and economic competitiveness. Realizing the full potential of the laboratories requires a much greater effort to tap their capabilities, especially in support of economic competitiveness.

Today, the National Laboratories interact with many stakeholders beyond DOE, from other Federal agencies and universities to businesses and industrial partners small and large. Strategic Partnership Projects (SPP)[48] is the performance of work for non-DOE entities, such as other Federal agencies, state or local governments, academia, and industry.[49] Working to encourage these mission-aligned collaborations both invigorates the laboratories with fresh ideas and allows their housed knowledge and expertise to reach beyond the site fence, in service of the public good and national prosperity.

At the same time, more can be done to broaden collaboration and to make the laboratories run efficiently and effectively. By addressing inefficiencies in management and burdensome practices, effectiveness can be improved, and the impact of the laboratories maximized.

A. Support of Other Agencies

Supporting other Federal agencies offers opportunities for the cross-pollination of ideas among the broad scientific and engineering community. It also helps to ensure greater use of existing facilities; enables some Federal agencies to perform work they would not otherwise be able to since they do not possess the capabilities and assets themselves; and sustains S&T capabilities that the DOE budget may not be able to fully support in a given year, but which are important to maintain for the long term.

Of the total $17.2 billion funding for the laboratories in FY 2013, SPP for other Federal agencies accounted for 14 percent ($2.43 billion). The Department of Defense was by far the largest other Federal agency customer, contributing $1.49 billion (61 percent) of

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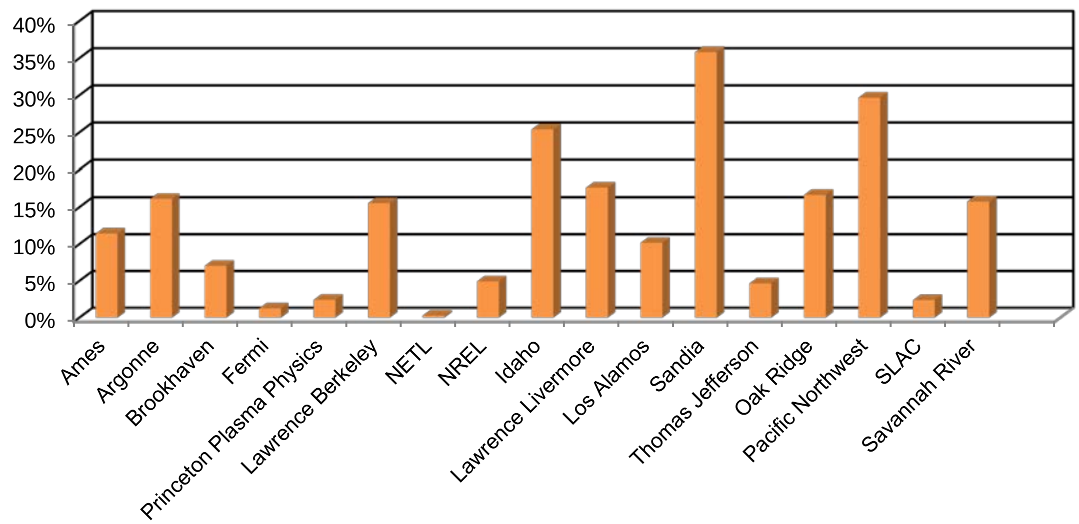
[48] Under DOE Order 481.1, DOE has renamed Work for Others (WFO) as Strategic Partnership Projects (SPP). DOE defines SPP as "work for non-DOE entities that is performed by DOE/contractor personnel and/or utilizes DOE facilities and is not directly funded by DOE appropriations."

[49] Section A of this chapter focuses on the Commission's specific mandate: SPP for other Federal agencies. Sections B, C, and D offer examples of other types of SPP: academic collaboration, industry partnerships and technology transition, and operation of user facilities.

the SPP for other Federal agencies total.[50] The percentage of laboratory work devoted to other agencies varies widely across the laboratories (Figure 7).



Source: Data provided by DOE to the Commission, October 2014.

Figure 7. SPP for other Federal Agencies as a Percentage of Average Total Budgets, FY 2009–FY 2013, by Laboratory

The Commission observes that DOE has policies in place to ensure that work supporting other agencies meets necessary criteria and aligns with the Department's missions. Multiple Federal agencies have identified a range of core DOE mission areas and capabilities that are also part of their mission sets, which the National Laboratories help them address through SPP for other Federal agencies; these include: modeling and simulation; non-proliferation and weapons of mass destruction threat reduction; physical protection of nuclear materials and facilities; nuclear forensics; knowledge about foreign S&T capabilities; energy efficiency; and wide area surveillance technologies.

On the whole, other Federal agency customers are very satisfied with the quality and value of the work performed by the laboratories. However, many find laboratory costs are high relative to other research performers. Satisfaction is much lower with the role that DOE headquarters plays in SPP for other Federal agencies. One source of frustration is the lengthy process required to obtain approvals for SPP, especially within the NNSA laboratories, and the fact that this process is usually the same for a small level of effort as

[50] This figure does not include funding for the existing nuclear weapons and naval reactors programs, nor is Intelligence Community funding fully reported.

it is for a multi-million dollar initiative. While there has been some progress in using standardized umbrella agreements, which identify acceptable areas of work, this has yet to be applied consistently across the system.[51] An additional improvement has been NNSA's creation of the position of Director of Interagency Work, one of the aims of which is to shorten the timeline of the SPP for other Federal agencies approval process. However, absent established relationships with DOE or the laboratories, it is sometimes unclear to SPP customers where to find the needed capability within the National Laboratory system.

Recommendation 22: DOE should establish policies and procedures to make the Strategic Partnership Projects (SPP) for other Federal agencies process more efficient, especially for work that is consistent with the annual operating plans, such as institutionalizing ongoing efforts to streamline the contracting process through more consistent use of umbrella SPP agreements and oversight mechanisms dedicated to shortening the timeline of the approval process; encouraging greater use of personnel exchanges and "customer relationship managers"; and creating a central point of contact in DOE headquarters to field questions from other Federal agency customers about where specific capabilities lie within the laboratory system.

Just as there is a lack of strategic planning across the entire National Laboratory system, so too is there a lack of strategic planning involving other Federal agencies with respect to S&T requirements for the DOE laboratories. The Mission Executive Council (MEC) was established in July 2010 and, consists of the DOE, Department of Defense, Department of Homeland Security, and the Intelligence Community. Its purpose is to match the laboratories' technical capabilities with technical needs of the other agencies, thereby providing long-term strategic planning for capabilities that are unique to the DOE laboratories. However, the MEC has not been as effective a coordination resource as it was intended to be.[52]

Recommendation 23: DOE should support efforts to strengthen the Mission Executive Council.

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51 This issue and recommendations to improve the process have been identified most recently in two other studies: Congressional Advisory Panel on the Governance of the Nuclear Security Enterprise, *A New Foundation for the Nuclear Enterprise*, and NRC, *Aligning the Governance Structure of the NNSA Laboratories to Meet 21st Century National Security Challenges* (Washington, DC: National Academies Press, 2015).

52 NRC, *Aligning the Governance Structure of the NNSA Laboratories*.

B. Collaboration with the Academic Community

It is mutually beneficial for the academic and DOE laboratory communities to be closely linked. The laboratories benefit from university ties as a way to enhance recruitment and retention, and as a means of interacting with academic scientists working at the cutting edge of basic research. Academia also provides opportunities for enhanced external assessment through the academic peer review process. Academics, for their part, benefit from access to DOE's user facilities and involvement in the large, long-term, multidisciplinary projects that are common at the DOE laboratories.

The level of collaboration between the laboratories and universities is high. Based on an analysis of over 300,000 laboratory publications in archival journals over the last decade, the Commission found that roughly 75 percent of them included co-authors from outside the laboratory system. And about 70 percent of these collaborators were at academic institutions.

Recommendation 24: DOE and its laboratories should continue to facilitate and encourage engagement with universities through collaborative research and vehicles such as joint faculty appointments and peer review.

C. Partnering with Industry and Transitioning Technology

Partnering with industry and contributing to the economic development of the Nation is an important part of the mission of the National Laboratories. While every year there are hundreds of patents, invention disclosures, CRADAs and other forms of collaboration with the private sector throughout the laboratory network, support for technology transition is inconsistent across the laboratories and across the DOE program offices. According to interviewees, this is at least partially due to oscillating political pressure that swings from criticisms for favoring industry too much to condemnation for not doing enough to boost the economy.

The barriers to partnership can be significant for many companies, particularly small businesses. These barriers include the early stage of development of many technologies; the financial cost of collaboration with the National Laboratories, including the advance funding requirement; the complexity of many contract terms; the length of negotiation and approval times; and the inability or difficulty of researchers to serve as consultants. Laboratories and DOE have experimented with many innovative mechanisms for engaging industry to make such collaboration easier, faster, less expensive, and more effective. These include centers and institutions, such as the Illinois Accelerator Research Center at Fermi and the High Performance Computing Innovation Center at Lawrence Livermore; legal mechanisms, such as Lawrence Berkeley's umbrella CRADA, CalCharge, and the Agreements to Commercialize Technology pilot; targeted funding, such as Argonne's technology maturation program; and programs to encourage laboratory researchers to engage in technology transfer, such as Sandia's Entrepreneurial Separation to Transfer Technology program. DOE has also focused specifically on addressing barriers to partnership for small businesses through such initiatives as the Small Business Vouchers Pilot.[53]

Recommendation 25: All DOE programs and laboratories should fully embrace the technology transition mission and continue improving the speed and effectiveness of collaborations with the private sector. Innovative technology transfer and commercialization mechanisms should continue to be pursued and best practices in other sectors, including academia, should be examined.

DOE recently established the Fast-Track CRADA Program to streamline the execution of CRADAs by forgoing individual agency approval for each agreement so long as the agency has approved an annual strategic plan.[54] Fast-Track CRADAs can only contain "standard, pre-approved terms and conditions without substantive modification," which do not typically involve long review times under the normal system. Lengthier review times are associated with CRADAs or other agreements that deviate from standard terms and conditions. It would be helpful if DOE could specifically describe the range of acceptable terms and conditions to decrease negotiation and review time.

Recommendation 26: DOE should determine whether the annual operating plans proposed by the Commission in Recommendation 3 could qualify as the "agency-approved strategic plan" under the Stevenson-Wydler Technology Innovation Act of 1980, and the Fast-Track CRADA Program, and, if not, Congress should amend the law accordingly. For CRADAs with non-standard terms and conditions, DOE should define the acceptable range for each term and condition to greatly expedite negotiation and review/approval time.

Universities are natural partners for the laboratories in the pursuit of regional economic development. DOE laboratories with university managers have the option to use the university technology transfer office for many of their patenting and licensing needs. In addition, laboratories have partnered with States and universities to create centers of economic activity.

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53 For more information, see "New National Labs Pilot Opens Doors to Small Businesses," http://breakingenergy.com/2015/07/09/new-national-labs-pilot-opens-doors-to-small-businesses/.

54 The Fast-Track CRADA Program at DOE facilities streamlines the execution of CRADAs by forgoing individual agency approval for each agreement. Under 15 U.S.C. § 3710a (a), directors of Government-owned, contractor-operated laboratories may enter into CRADAs to the extent provided in an agency-approved joint work statement, or if permitted by the agency, in an agency-approved annual strategic plan.

Recommendation 27: Laboratories should pursue innovation-based economic development by partnering with regional universities.

D. Operating User Facilities

The user facilities at the National Laboratories are a unique and enormously valuable national resource to researchers at other Federal agencies, academic institutions, and the private sector here and abroad. These users are often funded through NSF, National Institutes of Health, NASA, Department of Defense, private industry, and other sources.[55] Many of the scientific user facilities run competitive, peer-reviewed processes to allocate time among potential researchers, and all of the SC user facilities designate time in this way. Many key user facilities are oversubscribed, some by as much as a factor of 3.

The strategic planning process for user facilities is strong in some parts of DOE. The best-run processes, such as those of SC, involve extensive work by peer review panels that use experts from the DOE National Laboratories, other Federal agencies, universities, and the private sector. These processes aim to develop long-term technical and funding plans for new and existing user facilities that meet national R&D needs and avoid inappropriate duplication.

Recommendation 28: DOE, the Administration and Congress should continue to support user facilities at the DOE laboratories. Peer review by relevant external advisory groups should continue to be used to decide which facilities to build and where to put all future upgrades and new and replacement user facilities.

[55] Statement of Dr. Antonio Lanzirotti, *Department of Energy User Facilities: Utilizing the Tools of Science to Drive Innovation through Fundamental Research: Hearing before the Subcommittee on Energy and Environment and the Committee on Science, Space, and Technology, United States House of Representatives*. 112th Cong. 21–61 (2012).

6. Managing Effectiveness and Efficiency

A. Overhead

When the National Laboratories are criticized for being too expensive, overhead is often identified as the major source of excessive laboratory costs. All of the National Laboratories are concerned and proactive about managing their overhead costs. During its visits to laboratories, the Commission found how variable factors such as mission scope, age of facilities, and location impacted laboratory costs. These considerations are important context for an analysis of laboratory cost-efficiency.

Figure 8 compares the overhead rates at the National Laboratories with the official overhead, or facilities and administrative rates at twenty of the top major research US universities. Laboratory rates were composed from DOE's Institutional Cost Report (ICR) and adjusted to reflect the direct funding of construction and maintenance and repair at the laboratories. While the NNSA laboratories stand out with higher rates than universities and non-NNSA laboratories, this difference is understandable when the unique costs associated with their national security and nuclear weapons-focused mission are considered. The Commission found rates at non-NNSA laboratories to be slightly higher, but comparable to university negotiated rates.

Two primary factors impact a comparison of laboratory and university rates. First, universities include depreciation and interest expenses associated with facilities in their overhead, while DOE's laboratories do not. The Commission estimates these costs to represent approximately 14.5 percentage points of the mean university rate based on public information available at six major research universities. Second, university administrative costs are capped by OMB policy at 26 percent, whereas actual administrative costs are typically higher by roughly 5 percentage points.[56]

Combining these two sources of error, overhead rates at both NNSA laboratories and non-NNSA laboratories are higher than the values identified in Figure 8, by approximately 10 points. Nevertheless, the Commission finds the rates between non-NNSA laboratories and universities to be comparable, especially when one considers that there are many university indirect costs of research that are lowered by the university's ability to spread those costs over non-research functions. In contrast, laboratories are

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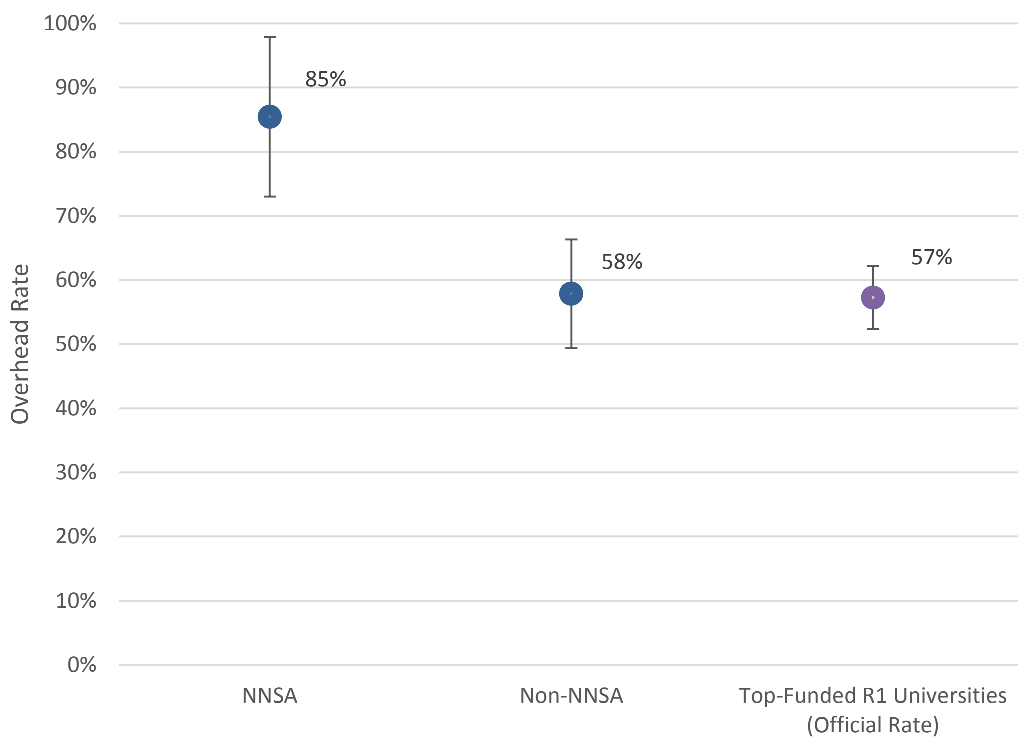
[56] OMB policy limits the government to reimbursing universities for no more than 26% of costs. GAO, *University Research: Policies for the Reimbursement of Indirect Costs Need to Be Updated*, GAO-10-937 (Washington, DC: GAO, 2010).

required by law to fully recover costs for all work, eliminating the possibility of unaccounted expenses. Taking this into account would further reduce the potential error.

The overhead rates at the NNSA laboratories are higher than both the major research universities and the non-NNSA laboratories by about 25 percentage points. That difference is understandable given the special nuclear and classified nature of the missions of the NNSA laboratories. Recall that for purposes of this analysis, the Commission allocated the NNSA costs for safeguards and security to the indirect, rather than the direct, cost categories.



Note: Percentages represent the mean overhead rate for each class of laboratory, as calculated by dividing total indirect costs by total direct costs, and universities. Error bars represent one standard deviation. Laboratory data is derived from the DOE Institutional Cost Report for FY 2014. Two laboratories—NETL and Savannah River—are excluded from the rate calculation. Top-funded Research I (R1) universities include the top twenty single “Research I” universities as designated by the Carnegie Foundation within the NSF Higher Education Research & Development Survey and ranked by total R&D expenditures. Institutions reporting data as an aggregate of multiple campuses were excluded from the rankings. Laboratory data have been adjusted to reflect the direct funding of construction and maintenance/repair at the laboratories.

Figure 8. Adjusted Indirect Costs as a Percentage of Direct Costs at National Laboratories (Grouped by Class) and Top-Funded Research I Universities, Adjusted for Direct Laboratory Construction

Laboratory accounting practices are federally regulated and consistent with the requirements of Federal cost accounting standards, which allow them to conduct business in a way that best matches work at their laboratory. Laboratories report all their costs biweekly into STARS, the DOE-wide cost reporting system. When laboratory financials are audited, auditors use data from STARS and disclosure statements as baselines for assessment.

In partnership with financial leadership from the National Laboratories, DOE established the ICR in 2010 to supply high-level data to the Department and other stakeholders regarding cost drivers at the laboratories. Although the ICR must continue to develop, it promises to be a mechanism by which DOE and other stakeholders can better understand laboratory costs. The ICR will become more useful as data consistency improves with subsequent years, made possible through peer reviews between different laboratories.

Recommendation 29: DOE should continue implementing the ICR as a consistent method for tracking indirect costs across all laboratories, and encourage additional peer reviews to help mature the ICR as a tool for DOE, the laboratories, and other stakeholders.

Today, most of the work at the 17 laboratories is publicly funded. As recipients of Federal funds, it is reasonable to ask, for the purpose of greater accountability and transparency, that laboratory financial data be made available to the public. Public disclosure also provides an additional incentive for laboratories to be mindful of their overhead rates.

Recommendation 30: DOE should provide greater transparency into laboratory indirect costs and publish an annual report of the overhead rates at each National Laboratory.

B. Facilities and Infrastructure

DOE laboratory facilities and infrastructure include a wide range of R&D buildings and fixed capital equipment, such as research centers, laboratories, reactors, and particle accelerators; major equipment and instrumentation for R&D, such as supercomputers, workstations for beamlines, industrial 3-D printing machines, and detectors; and infrastructure associated with the laboratory, such as utility plants and roadways. The scope of laboratory facilities and infrastructure is significant; as a whole it consists of over 800,000 acres, which house over 5,000 buildings and trailers.[57]

Facilities and infrastructure can have a substantial impact on laboratory research and operations in a variety of ways. Laboratory facilities and infrastructure in poor condition can have inadequate functionality for mission performance; negative effects on the environment, safety, and health of the site; higher maintenance costs; and problems with recruiting and retaining high-quality scientists and engineers. There is also a significant cost associated with the upkeep of excess facilities that are no longer used or needed by laboratory staff but that remain at the laboratory due to a lack of funding for disposal.

DOE laboratory facilities and infrastructure construction and renovation are primarily funded through centrally controlled line items or locally controlled General Plant Projects and Institutional General Plant Projects. Unlike universities, industry, and many State and local governments, the Federal Government does not use a capital budget, but instead an operating budget that presents the government's expenditures and revenues for each fiscal year. While facilities and infrastructure planning occurs at multiple levels—at each individual laboratory, within each stewarding office, and across the Department as a whole—the available budget is simply not sufficient to meet the needs of the laboratories to maintain and revitalize the system.

Recommendation 31: The DOE should consider whether a capital budget will better serve its internal facilities and infrastructure budgeting and management needs.

The condition of laboratory facilities and infrastructure across the network is hampered by high levels of deferred maintenance and excess facilities. Deferred maintenance refers to facility and infrastructure repairs that were postponed in order to lower costs, meet budget levels, or liberate funding for research. While all laboratories have deferred maintenance, 3 laboratories hold approximately 64 percent ($1.4 billion) of the total deferred maintenance backlog of $2.2 billion.[58]

Excess facilities have no future mission and the natural conclusion to the facilities lifecycle is deactivation and decommissioning (D&D). Excess facilities that have not yet been deactivated and decommissioned must be stabilized and then surveilled and maintained until their D&D. Laboratories have contaminated and non-contaminated excess facilities that they cannot afford to D&D. The estimated cost for D&D of excess

[57] Data provided by DOE from the Facilities Information Management System (FIMS) database, FY 2014 Snapshot. Numbers do not include Other Structures and Facilities, which account for non-buildings, such as roads, fencing, storage reservoirs, and stacks (when not a part of a building).

[58] Laboratory portion estimate from FIMS database, FY 2014 Snapshot.

facilities at the SC laboratories is $2 billion.[59] DOE established EM in 1989 to oversee cleanup of its weapons research and production legacy. The total cost of cleanup at all DOE sites was estimated to be $280 billion in 2013.[60] As of 2015, EM has determined that 234 additional facilities meet its criteria for transfer to EM, but it does not have the funding to accept them for remediation. In addition to the issue of cost of surveillance and maintenance for the program offices, contaminated excess facilities continue to pose a risk to mission, workers, the public, and the environment.

Recently, the Department and the laboratories have been working together to address the facilities and infrastructure issues, at least initially by accurately assessing the scope of the problems in condition and budget shortfall.

Recommendation 32: DOE and the laboratories should continue efforts to improve laboratory facilities and infrastructure by halting the growth in deferred maintenance and speeding up the deactivation and decommissioning of excess facilities. DOE should work with Congress and OMB to agree upon the size and nature of the resources shortfall for facilities and infrastructure, and to develop a long-term plan to resolve it through a combination of increased funding, policy changes, and innovative financing.

Despite the magnitude of need to maintain and revitalize the system, not to mention the cost to build the next generation of scientific facilities, innovative financing mechanisms have been largely unavailable to the DOE laboratories. Non-contaminated excess facilities could be leased to interested third parties if DOE were granted Enhanced Use Lease (EUL) authority, which it does not currently possess. EULs are long-term leases on agency-owned property in exchange for cash or in-kind consideration. DOD, which does have that authority, has used it to lease excess land at military bases for renewable energy systems, such as solar arrays. If DOE were granted EUL authority, it could generate funds that could be used to address its facilities resource needs, while offloading some of its excess square footage.

Alternative financing through an operating lease is another approach in which the Federal Government contributes the real property or land and a private entity provides the initial capital to develop or renovate it. A lease agreement allows non-Federal entities or contractors to occupy the real property for a defined time period while the agency repays the financed amount through lease payments.

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[59] J. Smith, *The Importance of Core Infrastructure*, presentation to the Commission to Review the Effectiveness of the National Energy Laboratories, February 24, 2015.

[60] DOE IG, *Audit Report: The Department of Energy’s Management of High-Risk Excess Facilities*, (DOE/IG-0931, January 2015).

OMB is responsible for approving these projects, but no DOE R&D facilities projects using alternative financing have moved forward since 2007. Proponents of alternative financing argue that it allows laboratories to pursue construction projects in times of budget austerity. Critics of alternative financing do not approve of DOE committing to a long-term “mortgage” when there is no guarantee the Nation will continue to see a mission need for maintaining a laboratory. However, the Commission is disappointed by the lack of independent analysis of alternative financing, particularly cost benefit analyses.

Recommendation 33: DOE, the laboratories, Congress, and OMB should actively work together to identify appropriate situations and methods for utilizing innovative financing approaches, such as third-party financing, enhanced use leases, and other methods, including State funding, gifts, and leveraging partnerships with other Federal agencies.

C. Project and Program Management

DOE has a decades-old history of project performance problems.[61] While recent DOE efforts to improve project management are enjoying some success, more work must be done. The Department needs to build more project management and cost-estimating capacity. It also needs a more homogenous and disciplined project/program management culture. DOE is moving in this direction with organizational changes and more frequent high-level involvement. DOE has also strengthened its project management guidance and processes by making them binding on all program offices.

SC, in particular, has a good project performance record. NNSA and EM have improved their management of small projects (less than $750 million), a fact which GAO

[61] NAPA, *Positioning DOE’s Laboratories for the Future*; DOE, *Improving Project Management*: *Report of the Contract and Project Management Working Group* (November 2014); GAO, *Department of Energy: DOE Lacks an Effective Strategy for Addressing Recommendations from Past Laboratory Advisory Groups*, GAO/T-RCED-98-274 (Washington, DC: GAO, September 1998); GAO, *Status of Contract and Project Management Reforms,* GAO-03-570T (Washington, DC: GAO, March 20, 2003); GAO, *Actions Needed to Develop High-Quality Cost Estimates for Construction and Environmental Cleanup Projects,* GAO-10-199 (Washington, DC: GAO, January 14, 2010); NRC, *Progress in Improving Project Management at the Department of Energy* (Washington, DC: National Academies Press, 2001); DOE IG, *Management Challenges at the Department of Energy*, DOE-IG-0858 (Washington, DC: DOE, November 2011); GAO, *Department of Energy: Office of Science Has Kept Majority of Projects within Budget and on Schedule, but Funding and Other Challenges may Grow*, GAO-08-641 (Washington, DC: GAO, June 2008); GAO, *Department of Energy: Contract and Project Management Concerns at the National Nuclear Security and Office of Environmental Management* (Washington, DC: GAO, March 2009); DOE, *Department of Energy Contract and Project Management Root Cause Analysis Corrective Action Plan* (Washington, DC: DOE, 2008); DOE IG, *The Department of Energy’s Management of High-Risk Excess Facilities*, DOE-IG-0931 (Washington, DC: DOE, January 2015).

recognized in a 2009 report.[62] Their large projects ($750 million or more), however, have experienced issues. These projects are managed primarily by commercial contractors rather than National Laboratories.

Ironically, DOE actually has very good policies on its books for project management. Its Directive 413.3 has been in place for over 15 years and is now in its third version. This guidance emphasizes the need for clear project accountability, independent analysis of alternatives, better cost estimating practices, more design and technical readiness prior to moving ahead officially on a project, and better project management controls. The problem is that the procedures are too often followed in form but not in substance. Or, where the policy recommends, but does not require, steps such as independent cost analyses, they are too often omitted in the interests of time. The result is that some major projects experience serious cost overruns and delays that could have been avoided by applying the existing policies with greater discipline.

Recommendation 34: DOE should maintain focus on increasing institutional capability and imposing greater discipline in implementing DOE project guidance, which is currently being incorporated into its DOE directive 413.3 B. Expanding on recent DOE efforts, there should be more peer reviews and "red teams" within DOE, among laboratories, other agencies, industry, and academia when appropriate.

In the area of environmental remediation, a recent SEAB Task Force report stated that DOE has spent over $150 billion on environmental management and cleanup and is currently spending roughly $5–6 billion per year in this area.[63] At the same time, the current EM budget for technology development is only $13 million per year, despite the many technical obstacles which remain. The Commission agrees with SEAB that the success of the cleanup effort will require significant new understanding of the science and with this understanding, development of new technology.

Recommendation 35: The Commission supports the recent SEAB Task Force recommendation to put more resources into science and technology development for the EM program given the technical complexity of its projects.

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[62] GAO, *Department of Energy: Contract and Project Management Concerns at the National Nuclear Security and Office of Environmental Management*.

[63] SEAB, *Report of the Task Force on Technology Development for Environmental Management*, December 2014; also, *Presentation to the Task Force by the Office of Environmental Management* (July 15, 2014).

7. Ensuring Lasting Change

Lasting change takes time and work. In the past four decades, over 50 commissions, panels, reviews and studies of the National Laboratories have been conducted. Yet, the true power to implement and realize change rests with the Department, the laboratories, and Congress —those for whom the National Laboratories are more than the object of a year-long study. Where past assessments have sometimes failed to produce meaningful change, this Commission strives to go beyond identifying findings and recommendations by charging the implementation of recommendations to those with the ability to realize them. Table 4 identifies the responsible actors for all of the Commissions' recommendations and provides a cross-reference to where additional information can be found in Volume 2. In doing so, the Commission hopes to assist the key stakeholders—laboratory leadership, DOE, and Congress—in their efforts to improve the impact, effectiveness, and efficiency of the National Laboratories.

A. Lack of Meaningful Change from Past Reports

A review of many past reports shows a strikingly consistent pattern of criticism and a similar set of recommendations for improvement. Despite the extensive examination of the issues, none of these reports has led to the comprehensive change necessary to address the well-documented, persistent challenges confronting the Department and its laboratories.

B. Progress Made during Current Administration

Under the current administration, many steps have been made towards improving the effectiveness and the efficiency of the National Laboratories. Department-led Crosscuts, formation of the Laboratory Operations Board within DOE, and efforts to more actively involve the National Laboratories—primarily through the National Laboratory Directors' Council—with DOE strategic planning are a few noteworthy examples of the progress realized under a thoughtful and proactive administration.

These administration-led changes are significant because they address the relationship between DOE and the National Laboratories which lies at the root of many of the issues raised in this report. With the upcoming change in administration, however, a real fear exists that much of the progress made under the leadership of the current Secretary may be lost due to lack of institutionalization. Lasting, meaningful change is an ongoing process rarely accomplished within a single administration, and recommendations made by past reports have not always led to implementation. To address this concern, the Commission has focused on identifying ways to not only institutionalize the positive changes made recently, but also to assess how recommendations made in this report and numerous others can be carried into the future, for the betterment of DOE and its National Laboratories.

C. How This Commission Can Be Impactful

The Commission notes the absence of a standing body or internal DOE mechanism to advocate for implementation of recommended changes, perform systematic assessments, and evaluate progress over time.

It would be extremely valuable if Congress and the DOE had a credible independent group to turn to for perspective and advice on issues relating to the National Laboratories when questions arise, without having to create a new commission, panel or review each time. Such a group need not be large. It could consist of a few senior people who had previously held responsible positions in DOE, the National Laboratories, industry, academia, or Congress. They might be named to such a board on a part-time basis, as they have been when appointed to commissions such as this CRENEL commission. They would need to be supported by a small staff.

With this in place, not only could Congress get high-quality advice on a faster turnaround time, but also DOE and the National Laboratories could be spared the disruption of as many new review groups as they have experienced in the past. With the right composition and charter, this group could provide brief and insightful perspective on the broad issues regarding the relationship of DOE and the laboratories over time, such as whether changes to restore the FFRDC relationship are truly being made in substance or only cosmetically, by both DOE and the laboratories.

A challenge, of course, is where to locate such a group in order to make it efficient, effective, and independent. One possibility is to ask the National Academies to host it. Another possibility is to have the group report to the President's Council of Advisors on Science and Technology (PCAST). Yet another option is to have the Secretary of Energy establish the group to serve both the Secretary and the Congress. A formal, though larger, example of such a group is the Nuclear Waste Technical Review Board, which was created by Congress as an independent agency of the Federal government to provide independent scientific peer review and recommendations to the Secretary and the Congress regarding DOE's programs for high-level radioactive waste and spent nuclear fuel. That group consists of eleven members who serve on a part-time basis, nominated by the National Academy of Sciences and named by the President. Wherever a new body is located, it would seem appropriate to establish it under a sunset provision, so that the entity's effectiveness would be reviewed and reconsidered at appropriate intervals.

Recommendation 36: A standing body should be established to track implementation of the recommendations and actions in this report, and to report regularly to DOE, the laboratories, the Administration, and the Congress on progress, results, and needed corrective actions. The standing body could assist congressional committees in developing a rational plan for future evaluations of the DOE laboratories.

8. Conclusion

In summation, the Commission has the following answers to the important questions posed in Chapter 1 about the DOE laboratories:

Why do we need DOE laboratories?

The National Laboratories are a unique scientific resource and national security asset, providing a vital experimental infrastructure to the Nation's research community and sustaining the nuclear weapons expertise critical to modern American security. In addition, the laboratories maintain a scientific and technical workforce, as well as a way of working, that fills a key need in the research and development process. Whether through stewardship of open-access scientific user facilities, assessment of the nuclear arsenal, or fostering environments for cutting-edge research in energy, environmental management, and weapons science, the National Laboratories are an important component of the national S&T enterprise. Furthermore, the Nation often calls upon the scientific and technical expertise of the National Laboratories in times of emergent need, as has been done recently in response to the Fukushima Daiichi nuclear reactor accident and during the Iran nuclear negotiations, among others.

Does DOE manage its laboratories well?

While the DOE laboratories are a critical resource that serves the Nation well, they could be better. The relationship between DOE and the laboratories has eroded, leading to ever-increasing levels of micromanagement and transactional oversight, which, in turn, have reduced the efficiency and effectiveness of laboratory operations. DOE and the laboratories must return to the spirit of the FFRDC model, focused on stewardship, accountability, competition, and partnership.

Instead, the National Laboratories are managed at multiple levels: day-to-day operations are overseen by the laboratory director and team in conversation with DOE through either DOE headquarters or site offices, which supply compliance guidance and strategic direction. Elements of departmental management can adversely impact the effectiveness and efficiency of the laboratories. For instance, mounting contract requirements, large numbers of assessments and data calls, and a lack of budgetary flexibility add undue administrative burdens on parts of the laboratory system. Addressing these concerns should be a priority for making the laboratories function better as a whole.

Are the laboratories properly focused to address mission needs now and in the future?

For the most part, the National Laboratories are properly focused to address their mission needs in science, energy, weapons, and environmental management. In some areas, however, shifting the focus should be a priority: managing emerging fields to control for duplication while still allowing the best ideas to compete and flourish is an important strategic planning function that the Department should embrace. There are robust processes in some program offices to provide strategic oversight, evaluation, and direction to the laboratories. However, those processes are not consistently used throughout the Department. With the proper balance of freedom for innovation as new areas emerge, and strategic direction as they mature, the laboratories will be able to continue to evolve to meet the Nation's needs in coming decades.

Is the research carried out at the laboratories of high quality?

During its 17 laboratory visits, the Commission observed that the quality of the R&D at the laboratories is indeed high. For SC and its laboratories, extensive use of external advisory panels, composed of leading subject-matter experts, is a powerful mechanism for maintaining quality, and for assessing the quality of the research portfolio and performance. Partnerships with universities and industry through collaborative work or joint faculty appointments—in the case of universities—further contribute to research quality. The National Research Council (NRC) emphasized in its 2013 report that the quality of science and engineering at the NNSA laboratories was healthy and vibrant.[64] The Commission concurs with this finding. The quality of R&D at all laboratories can be enhanced by further engagement with external peer review groups.

LDRD also plays a critical role in maintaining high-quality talent and research, especially at the NNSA laboratories where fewer opportunities exist for researchers to pursue ideas outside of specific project scope. LDRD helps to generate new ideas and empower research staff to think critically and broadly about the challenges faced. The true value of any institution is its people, and LDRD enables laboratories to develop and invest in its workforce for both the short and long term. In the absence of other discretionary funding for exploratory research, LDRD is vital in providing the freedom laboratories need to innovate and ensure their sustained performance in service of the Nation.

Is there too much duplication among the laboratories?

The Commission does not believe there are too many laboratories, nor is there an undesirable degree of duplication. During its visits to all 17 laboratories, the Commission found each to be unique, conducting work of merit, and becoming of the title "National

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[64] NRC, *The Quality of Science and Engineering at the NNSA National Security Laboratories* (Washington, DC: National Academies Press, 2013).

Laboratory." While work might appear duplicative at a high level, the Commission's closer look revealed that their capabilities and focus areas are diverse, complementary, and well-honed to meeting the missions of the Department. Every laboratory plays a key role: for instance, different synchrotrons address different types of scientific questions, while the existence of two NNSA physics laboratories promotes both competition and a second opinion on high-stakes nuclear weapons work. Having grown out of historic mission decisions, the laboratories of today have evolved to serve not just the Nation but also their home regions and States through the fostering of a scientific community. Many also serve their regional economies.

That said, DOE could do a better job of managing the National Laboratories as a system with an overarching strategic plan that gives the laboratories the flexibility to pursue new lines of inquiry, so long as the research aligns with mission priorities. Once the research has matured beyond a certain threshold, the Department should provide strategic oversight and guidance for the laboratory system to coordinate and potentially consolidate their programs to achieve the most efficient use of resources.

Are the laboratories having an impact?

The National Laboratories interact with many stakeholders beyond DOE, from other Federal agencies and universities to businesses and industrial partners, small and large. These mission-aligned collaborations both invigorate the laboratories with fresh ideas and allow their knowledge and expertise to reach beyond the site, in service of the public good and national prosperity.

Though much has been achieved by supporting other Federal agencies, collaborating with the academic community, partnering with industry, and operating user facilities, barriers to engagement remain. While there are hundreds of CRADAs and other forms of collaboration with the private sector throughout the laboratory system, support for technology transfer is inconsistent across the laboratories and across the DOE program offices. More can be done to increase the effectiveness of the National Laboratories by streamlining their interactions with all external parties.

At the same time, the value of the laboratories has sometimes been poorly communicated or quantified. For example, the Human Genome Project was begun at the laboratories and revolutionized the life sciences, and laboratory accelerator R&D eventually helped to develop MRI technology that is available today in every major hospital. The role of the DOE laboratory system in these advances is not widely recognized. In the interest of greater understanding, both the Department and the laboratories should do more to highlight their achievements.

Do the laboratories cost too much?

Laboratories are indeed costly, but whether they are too expensive is a more nuanced question. The primary business of the National Laboratories—including the operation of large-scale scientific facilities, multidisciplinary research, and weapons science—is costly by nature. How do we determine the appropriate price for these services, a large portion of which cannot or is not conducted elsewhere? This makes the laboratory business model especially difficult to benchmark against other R&D institutions. The Commission focused on overhead as a measure of organizational efficiency. Overhead is a component of cost, but it does not represent an institution's entire cost profile.

When benchmarked to official overhead rates at the 20 research universities with the largest sponsored research expenditures, the cost of doing research at non-NNSA laboratories was found to be comparable. NNSA laboratory rates were higher, but this is understandable due to the additional requirements of their national security mission (heightened safeguards and security, health, and cleanup of legacy facilities). Overall, the Commission believes that laboratory costs are not unreasonable in light of the services they provide.

There is a significant opportunity for increased efficiency in the system if the roles and responsibilities of DOE and the laboratories are returned to the intended FFRDC model. The current degree of micromanagement and oversight impose a "stealth overhead" cost at DOE headquarters, the site offices, and the laboratories by virtue of the extra professional time that those activities require, without yielding corresponding benefits. The Commission believes that there will be significant cost and time savings at each of these levels if its recommendations are implemented.

In addition, there are specific areas of concern, particularly major capital construction projects and facilities and infrastructure. While problematic projects are not always laboratory-related and SC and its laboratories are notable for their strong record of project performance, the Department and all program offices must strengthen their project management capabilities and enforce the processes that are on the books. All laboratories and DOE must also find ways to improve the condition of the facilities and infrastructure. In this time of budget austerity, DOE must work with OMB and the Congress to develop a long-term strategy for dealing with these resource needs, including the appropriate use of innovative financing techniques. The recent joint laboratory-DOE efforts to address the project management and facilities and infrastructure shortcomings have resulted in some improvements.

The National Laboratories are a national treasure with the potential to serve the Nation now and well into the future. This report offers recommendations to make the laboratories more efficient and effective in accomplishing the work for which they are uniquely suited.

Table 4. Responsible Actors for Each Recommendation and Cross-References to Volume 2

Volume 1 Chapter & Section Reference	Rec. No.	Recommendation Text	Responsible Actor(s)	Volume 2 Chapter & Section Reference
2.B	1	Congress and the Administration should recognize the value of the National Laboratories and provide the necessary resources to maintain their capabilities and facilities. Congress should also develop a more orderly process of reviewing the laboratories.	Administration and Congress	1.D
3.A.1	2	Department of Energy (DOE) and the laboratories must work together to restore the ideal Federally Funded Research and Development Center (FFRDC) relationship as one of trust and accountability. DOE should delegate more authority and flexibility to the laboratories and hold them accountable. The laboratories must be more transparent with DOE about their activities.	DOE and Laboratories	2.C
3.A.1	3	DOE and each laboratory should jointly develop an annual operating plan, with agreements on the nature and scope of the laboratory's activities, including goals and milestones. DOE should then provide increased flexibility and authority to the laboratory to implement that plan.	DOE and Laboratories	2.C
3.A.1	4	To improve DOE's ability to manage the laboratories, DOE should implement greater leadership and management development for its Federal workforce, including multi-directional rotational assignments.	DOE	2.C
3.A.1	5	DOE should separate the National Energy Technology Laboratory's (NETL) research and development (R&D) function from its program responsibilities. Consideration should be given to converting the new, research NETL into an FFRDC. NETL should increase its interactions with universities.	DOE and Congress	2.C
3.A.2	6	DOE should abandon *incentive* award fees in favor of a fixed fee set at competitive rates with risk and necessary investment in mind. DOE should also adopt richer set of incentives to motivate sound management.	DOE	2.C
3.B.1	7	DOE should give the laboratories the authority to operate with more discretion whenever possible. For non-nuclear, non-high-hazard, unclassified activities, DOE should allow laboratories to use Federal, State, and national standards in place of DOE requirements. DOE should review and minimize approval processes.	DOE	3.G
3.B.1	8	DOE should modify its processes for developing directives, orders and other requirements to get more input on the benefits and impacts of the proposed requirements. When developing new requirements, DOE should use a risk-based model, ensuring the level of control over an activity is commensurate with the potential risk.	DOE	3.G
3.B.2	9	DOE should focus on making the use of Contractor Assurance System (CAS) more uniform across the laboratories. DOE local overseers should rely on information from the CAS systems, with appropriate validation, as much as possible for their local oversight. The quality of CAS can be increased through peer reviews for implementation and effectiveness.	DOE	4.D
3.B.2	10	The role of the site office should be emphasized as one of "mission support." The site office manager should be responsible for the performance of the site office; all staff, including the Contracting Officers, should report to the site office manager. DOE should devote more effort to professional development of field staff.	DOE	4.D
3.B.2	11	DOE should clarify the role and authority of the support centers. Wherever approval authority resides with a support center, DOE should remove it and reinstate it at the site office or DOE headquarters.	DOE	4.D

Volume 1 Chapter & Section Reference	Rec. No.	Recommendation Text	Responsible Actor(s)	Volume 2 Chapter & Section Reference
3.B.3	12	All stakeholders should make maximum use of local assessments (performed by site offices and laboratories), with appropriate verification, to reduce duplicative assessments and burden on the laboratories.	DOE and External Auditors	§5.C
3.B.3	13	DOE should establish a single point of control within the Department for all laboratory-directed data requests.	DOE	5.C
3.B.4	14	DOE should increase the size of funding increments by consolidating budget and reporting (B&R) codes, extending timelines and minimizing milestones for each funding increment and institutionalizing mechanisms to move money between B&R codes for related research areas.	DOE	6.D
3.B.4	15	Congress should repeal Section 301(d) of the FY 2014 Consolidated Appropriations Act as soon as feasible to remedy the transactional burden it creates for the Office of Management and Budget (OMB), DOE Headquarters, and the laboratories.	Congress	6.D
4.A	16	Other DOE program offices should adapt the processes that DOE's Office of Science has in place for guiding and assessing the alignment of the laboratories under its stewardship with DOE's missions and priorities.	DOE	7.E
4.B	17	The processes that Office of Science has in place for assessing the quality of the research being done by its laboratories and for assessing the quality of its research portfolio should be adapted by the other program offices.	DOE	7.E
4.B	18	There must be reconsideration of the travel restrictions to enable conference participation at levels appropriate to the professional needs of the existing scientific staff and to attract the highest quality staff in the future. The Commission is encouraged by DOE's recently revised guidance on conference-related activities and spending.	DOE and OMB	7.E
4.C	19	The Commission strongly endorses Laboratory Directed Research and Development (LDRD) programs, both now and into the future, and supports restoring the cap on LDRD to 6% unburdened, or its equivalent. The Commission recognizes that, in practice, restoring the higher cap will have the largest impact on the LDRD programs of the National Nuclear Security Administration laboratories.	Congress	8.D
4.D	20	DOE should manage its laboratories as a system having an overarching strategic plan that gives the laboratories the flexibility to pursue new lines of inquiry. Once the research has sufficiently mature, DOE should provide strategic oversight and guidance to coordinate and potentially consolidate their programs.	DOE	7.E
4.D	21	Congress should recognize that the capabilities currently housed within the NNSA laboratories are essential to the Nation. Maintaining these capabilities in separate and independent facilities should continue.	Congress	7.E
5.A	22	DOE should establish techniques to make the Strategic Partnership Projects process more efficient.	DOE	9.E
5.A	23	DOE should support efforts to strengthen the Mission Executive Council.	DOE	9.E
5.B	24	DOE and its laboratories should continue to facilitate and encourage engagement with universities through collaborative research and vehicles such as joint faculty appointments and peer review.	DOE and Laboratories	10.C
5.C	25	DOE and the laboratories should fully embrace the technology transition mission and continue improving the speed and effectiveness of collaborations with the private sector. Innovative transfer and commercialization mechanisms should be pursued and best practices in other sectors should be examined.	DOE and Laboratories	11.E

Volume 1 Chapter & Section Reference	Rec. No.	Recommendation Text	Responsible Actor(s)	Volume 2 Chapter & Section Reference
5.C	26	DOE should determine whether the annual operating plans proposed by the Commission could qualify as the “agency-approved strategic plan” under the Stevenson-Wydler Technology Innovation Act of 1980, and the Fast-Track Cooperative Research and Development Agreement Program. If not, Congress should amend the law accordingly.	DOE and Congress	11.E
5.C	27	Laboratories should pursue innovation-based economic development by partnering with regional universities.	Laboratories	11.E
5.D	28	DOE and Congress should continue to support user facilities at the DOE laboratories. External advisory groups should continue to be used to decide which facilities to build and how to upgrade existing facilities.	DOE, Administration, and Congress	12.C
6.A	29	DOE should continue implementing the Institutional Cost Report (ICR) as a method for tracking indirect costs across the laboratories, and encourage peer reviews to help mature the ICR as a tool for DOE, the laboratories, and other stakeholders.	DOE	13.E
6.A	30	DOE should provide greater transparency into laboratory indirect costs and publish an annual report of the overhead rates at each individual National Laboratory.	DOE	13.E
6.B	31	The DOE should consider whether a capital budget will better serve its internal facilities and infrastructure budgeting and management needs.	DOE	14.D
6.B	32	DOE and the laboratories should continue efforts to improve facilities and infrastructure by halting the growth in deferred maintenance and speeding up the deactivation and decommissioning of excess facilities. DOE should work with Congress and OMB to agree upon the size and nature of the resources shortfall for facilities and infrastructure, and to develop a long-term plan to resolve it through a combination of increased funding, policy changes, and innovative financing.	DOE, Laboratories, Congress, and OMB	14.D
6.B	33	DOE, the laboratories, Congress, and OMB should actively work together to identify appropriate situations and methods for utilizing innovative financing approaches, such as third-party financing, enhanced use leases, and other methods, including State funding, gifts, and leveraging partnerships with other Federal agencies.	DOE, Laboratories, Congress, and OMB	14.D
6.C	34	DOE should maintain focus on increasing institutional capability and imposing greater discipline in implementing DOE project guidance, which is currently being incorporated into its DOE directive 413.3 B. There should be more peer reviews and “red teams” within DOE.	DOE	15.G
6.C	35	The Commission supports the recent Secretary of Energy Advisory Board Task Force recommendation to put more resources into science and technology development for the EM program given the technical complexity of its projects.	DOE, Administration, and Congress	15.G
7.A.3	36	A standing body should be established to track implementation of the recommendations and actions in this report, and to report regularly to DOE, the laboratories, the Administration, and the Congress. This body could assist Congress in developing a rational plan for future evaluations of the DOE laboratories.	DOE, Administration, and Congress	16.D