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

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

Volume 2: Technical Chapters and Appendices

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1. Value of the Department of Energy National Laboratories

Broadly stated, the purposes of the Department of Energy (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.”[1]

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 different 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 Laboratories and served the United States time and again. The role of the National Laboratories may indeed change with time, but the ability of laboratories to rise to meet their charge remains a constant since their founding. From weapons science to clean energy, legacy cleanup to basic research, the National Laboratories serve the Nation in diverse ways, and recognizing the fullness of the role they play is critical to an understanding their value.

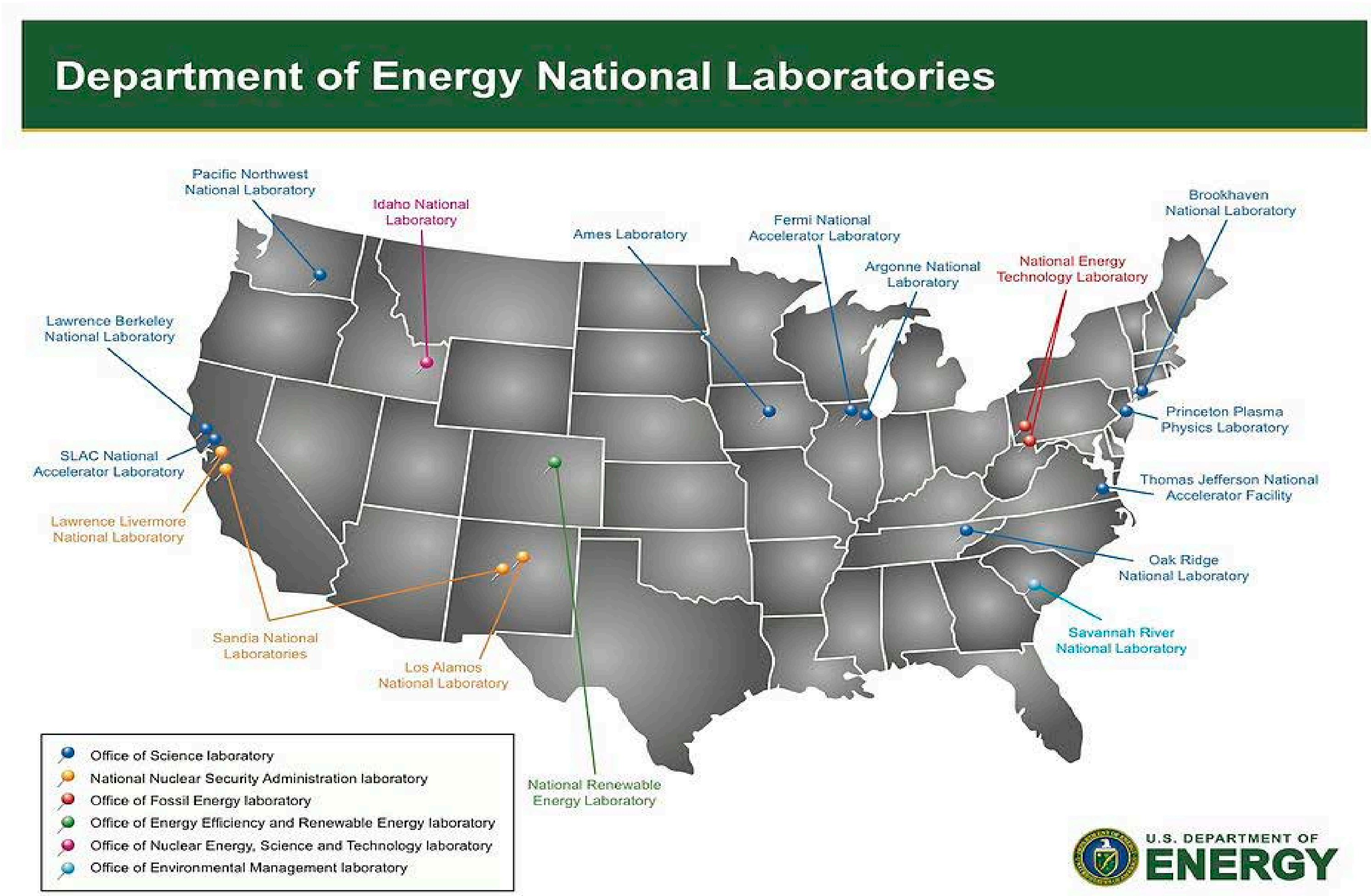
A. DOE Laboratory System

Figure 1 shows the locations across the country of the 17 laboratories in DOE’s laboratory system. When 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 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. As a whole, the laboratories received $11.7 billion in funding from DOE and employed over 55,000 staff.

[1] Department of Energy (DOE), *Strategic Plan 2014–2018* (Washington, DC: DOE, 2014).

Sixteen of the 17 laboratories are Federally Funded Research and Development Centers (FFRDCs), managed through a management and operating (M&O) contract.[2] M&O contractors for the National Laboratories include individual universities, university consortia, nonprofit corporations, industrial firms, and partnerships involving the aforementioned types of organizations. The National Energy Technology Laboratory (NETL) is the sole government-owned, government-operated (GOGO) laboratory.

[2] The Atomic Energy Act of 1946 (P.L. 79-585) formalized the M&O contract and established the Atomic Energy Commission, a precursor to the DOE.



Source: Map provided by DOE.

Figure 1. Locations of the Department of Energy National Laboratories

Table 1. Characteristics of Department of Energy National Laboratories

Laboratory	Managing Contractor	Stewarding Office	Budget from DOE (FY 2014)*	Total Budget (FY 2014)†	Size (FTE)‡	Year Est.
Ames National Laboratory	Iowa State University	SC	$50 M	$53 M	280	1947
Argonne National Laboratory	UChicago Argonne, LLC	SC	$600 M	$720 M	3,400	1946
Brookhaven National Laboratory	Brookhaven Science Associates, LLC	SC	$530 M	$580 M	2,800	1947
Fermi National Accelerator Laboratory	Fermi Research Alliance, LLC	SC	$430 M	$430 M	1,800	1967
Idaho National Laboratory	Battelle Energy Alliance, LLC	NE	$1.1 B	$1.2 B	3700	1949
Lawrence Berkeley National Laboratory	University of California	SC	$640 M	$760 M	3,500	1931
Lawrence Livermore National Laboratory	Lawrence Livermore National Security, LLC	NNSA	$1.2 B	$1.45B	5,700	1952
Los Alamos National Laboratory	Los Alamos National Security, LLC	NNSA	$2 B	$2.2 B	9,500	1943
National Energy Technology Laboratory	N/A	FE	$690 M	$692M	1,380	1910
National Renewable Energy Laboratory	Alliance for Sustainable Energy, LLC	EERE	$290 M	$340 M	1,700	1977
Oak Ridge National Laboratory	UT-Battelle, LLC	SC	$1.1 B	$1.3 B	4,300	1943
Pacific Northwest National Laboratory	Battelle Memorial Institute	SC	$580 M	$910 M	4,300	1965
Princeton Plasma Physics Laboratory	Princeton University	SC	$90 M	$92 M	460	1951
Sandia National Laboratories	Sandia Corporation	NNSA	$1.8 B	$2.75 B	11,000	1949
Savannah River National Laboratory	Savannah River Nuclear Solutions, LLC	EM	$15 M	$215 M	800	1951
SLAC National Accelerator Laboratory	Stanford University	SC	$410 M	$420 M	1,400	1962
Thomas Jefferson National Accelerator Facility	Jefferson Science Associates, LLC	SC	$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.

* Budget from DOE from Budget from 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. 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. DOE's Mission and Strategic Goals

DOE is a conglomerate Department (as were its precursor agencies) that includes responsibility for energy, science, nuclear weapons, and environmental cleanup.[3] Over time its strategic priorities have shifted in response to specific needs but the three goals outlined in DOE's 2014–2018 Strategic Plan—science and energy, nuclear security, and management and performance—are consistent with these historic mission areas.[4]

In many cases, the mission of the Department and the corresponding roles of the National Laboratories serve the Nation more broadly than one might expect if one thinks DOE's only purpose is "energy." Of course, advancing the state of energy technology is critically important to the Department's core mission. But the Department is also the primary Federal funding agency for physical science research and large-scale scientific capabilities.[5] In addition, DOE is responsible for the U.S. nuclear stockpile, nuclear non-proliferation and counter proliferation, and the environmental cleanup required as a consequence of nuclear manufacturing and storage. This aspect of DOE's mission has far reaching implications for national security and environmental science, among other issues.

DOE is unique among Federal agencies in how it funds research. Rather than focusing solely on proposals driven by a single principal investigator, the Department also funds both large-scale multidisciplinary research and large expensive facilities that universities and industry are unable or unwilling to invest in. These facilities are essential to the advancement of science in areas beyond DOE's core mission, such as the life sciences. Through its laboratories, DOE supports the technical staff to maintain the facilities and enable access to the facility for the broader S&T community.

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[3] Certain of the laboratories serve not only to pursue the DOE nuclear weapons mission, but also to advance the national-security interests of the U.S. by serving other agencies in addition to DOE, principally Department of Defense, Department of Homeland Security, and the Intelligence Community.

[4] DOE, *Strategic Plan, 2014–2018*.

[5] In FY 2011, DOE was responsible for $2.61 billion of the total $5.53 billion of Federal funding for physical sciences research. National Science Foundation (NSF), National Center for Science and Engineering Statistics, *Federal Funds for Research and Development (FY 2010– FY 2012)* (Arlington, VA: NSF, 2014), Appendix Table 4-37.

C. Purpose and Importance of the National Laboratories

1. Support of DOE

DOE relies on its laboratories to perform mission-driven science and technology. DOE laboratories have received over 800 R&D 100 Awards since 1962, when the annual competition began,[6] and over 60 researchers affiliated with DOE laboratories have been awarded a Nobel Prize.[7] The research at each laboratory generally extends beyond the primary mission of its DOE stewarding office. Most laboratories obtain funding from multiple offices to perform research in support of multiple mission areas. In performing research for the national security mission, the laboratories often conduct projects that are classified. Also in support of mission-driven science and technology, the National Laboratories are able to pursue high-risk, potentially-high-reward research which often begins with laboratory directed research and development (LDRD) projects. Researchers housed within one National Laboratory collaborate on large, long-term, multidisciplinary projects with relative ease due to co-location and the mission-driven nature of their work.

> The Advanced Simulation and Computing (ASC) Program instituted by DOE's Defense Programs in the mid-1990s is a cornerstone of the science-based nuclear stockpile stewardship program. As part of the mission to extend the lifetime of nuclear weapons in the stockpile, ASC simulations are central to national security and allowed the shift to computational surrogates for nuclear testing. This development drove substantial acceleration in advancing high-performance computing, modeling, and simulation well beyond the weapons program and DOE. NNSA laboratories now house some of the world's fastest supercomputers. ASC tools are currently used for other vital missions, including nuclear nonproliferation, emergency response, and nuclear forensics, as well as purely civilian applications that require high-speed computation. (http://nnsa.energy.gov/asc)

The DOE laboratories are able to conduct coordinated efforts in support of national needs through their networked structure and integrated research platform. In addition, large collaborative projects also occur across the laboratory system, either organized by the DOE offices or by individual laboratories. For example, Lawrence Berkeley, Brookhaven, Jefferson, and Fermilab have played major roles in guiding and

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[6] "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/

[7] See http://www.osti.gov/accomplishments/nobel.html.

> After the April 2010 Deepwater Horizon oil spill, more than 200 researchers from multiple DOE laboratories provided support through real time analysis, technical input, and oversight. The laboratory personnel shared expertise in stress analysis, fluid flow, advanced diagnostics, and geologic modeling, and assisted in determining the best method for containing the spill. (Hruby 2011)

assisting the technical development of the upgrade to the Linac Coherent Light Source (LCLS) at SLAC.

As a national S&T asset, the government can call upon the National Laboratories to employ their capabilities to respond to emerging threats in addition to the mission-driven nuclear response teams operated out of the national security laboratories. For example, the National Atmospheric Release Advisory Center[8] tracked releases from the Fukushima Daiichi Reactors after the nuclear disaster in 2011. The laboratories also provided critical assistance during the recent negotiations with Iran on their nuclear program.[9]

The Commission endorses DOE's current strategic objectives to coordinate and improve its emergency response capabilities.[10] The Commission urges the DOE to continue to sustain these efforts and to better communicate the laboratories' successes.

2. Support of the Broader Science and Technology Community

The purpose of the laboratories extends beyond solely serving the needs of the DOE. The assets and capabilities at the National Laboratories benefit the entire science and technology community. The laboratories perform critical tasks in support of other Federal agencies, collaborate extensively with academia, partner with industry, and maintain user facilities for the entire S&T community.

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

[9] David E. Sanger and William J. Broad, "Atomic Labs Across the U.S. Race to Stop Iran," New York Times, April 21, 2015.

[10] By the end of FY 2015, DOE expects to create an "Energy Incident Management and Response Council" to coordinate the Department's emergency response capabilities.

The National Laboratories support a broad range of Federal agency missions, beyond their core activities for DOE. For example, they serve a vital role enabling the Department of Defense, Department of Homeland Security, Department of State, the Intelligence Community, and others to meet their missions. Multiple Federal agencies identified a range of laboratory mission areas and capabilities that are also part of their agency mission sets; 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. DOE also reports that work for other agencies at the laboratories has historically been synergistic with DOE core mission work, and that it has "frequently resulted in cost avoidance at DOE, improved capability for core mission work, and/or workforce development."[11]

> Lawrence Berkeley developed solid nanostructured polymer electrolyte for rechargeable lithium batteries and licensed the technology to start-up company Seeo, Inc. The technology is enabling development of a solid-state rechargeable lithium battery with the potential to improve the storage capability, safety and lifetime of rechargeable batteries for use in electric and hybrid vehicles, cell phones, laptops, and medical devices. These batteries are much safer because they lack the reactive and flammable materials of conventional lithium ion batteries, and they resist dendrite growth, a factor that has stalled commercialization of rechargeable batteries. Seeo was founded in 2007 and now has funding from several top Silicon Valley venture firms, including $17 million from Samsung Ventures. (Tilley 2014)

> NREL is developing a transportable system prototype for the Consolidated Utility Base Energy (CUBE) project for the U.S. Army. The power interface unit offers a containerized and highly mobile energy system that integrates standard generators, photovoltaics, and battery and grid power, which can be deployed at forward operating bases. CUBE is in the prototype phase and being fully tested to validate its performance, reliability, and projected fuel savings. (http://www.nrel.gov/esi/research_integration_wyle.html)

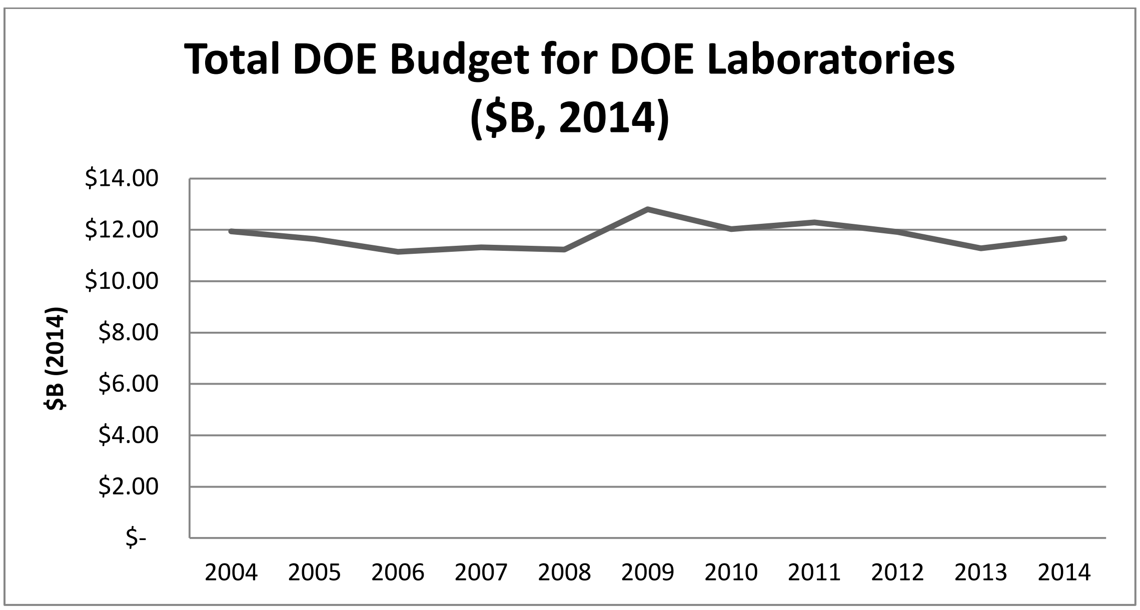
Through research collaborations, academics can connect to mission-oriented projects and work with interdisciplinary research teams. National Laboratories provide university researchers access to scientific facilities and unique equipment that are not available elsewhere. In 2014 alone, more than 100,000 academic, government and industrial researchers utilized DOE user facilities, which include high performance computers, accelerators, colliders, light sources, neutron sources, and nanocenters. The laboratories also serve an important educational function through advanced training and continuing education of students and faculty.

[11] Written document prepared by DOE, "Work for Others Program: Interagency Work," 3.

As national centers for large scale, multidisciplinary research and development, the National Laboratories often advance objectives the private sector is unwilling or incapable of addressing. To facilitate adoption of these technological advancements by the market, the laboratories disseminate their knowledge to industry through research partnerships or direct transfers of intellectual property, though it could be more effective.

> In 2014 researchers led by Ilme Schlichting of the Max Planck Institute for Medical Research in Heidelberg, Germany, used the Linac Coherent Light Source X-ray free-electron laser at SLAC to generate a complete three-dimensional model of the protein lysozyme without any prior knowledge of its structure. This was a successful demonstration of a new technique for determining, from scratch, biological structures form crystals much too small for analysis with conventional X-ray sources. This advance has far-reaching implications by potentially providing new targets for drug development. (http://science.energy.gov/bes/highlights/2014/bes-2014-10-k/)

Despite these critical and continuing contributions, DOE's budget for its laboratories has remained relatively flat in constant dollars over the past decade (see Figure 2).



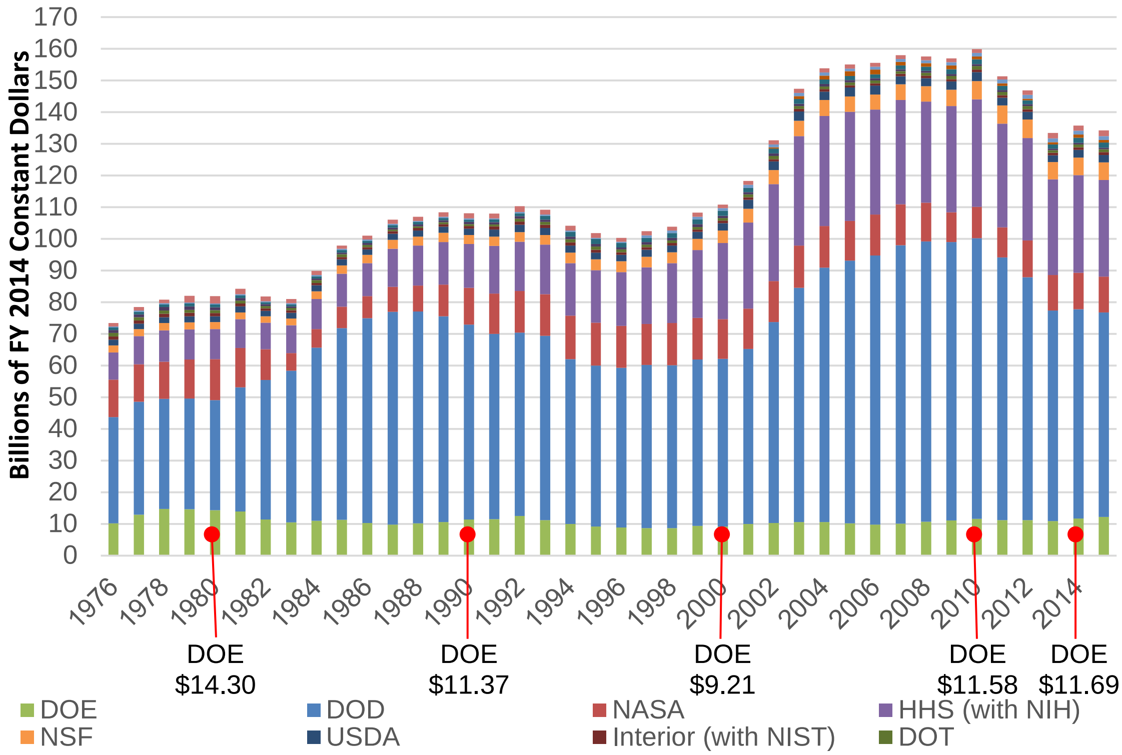
Source: DOE budget.

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

In addition, the amount of Federal R&D support to DOE as a whole has stayed relatively level since 1976 in constant dollars (Figure 3).[12] The percentage of Federal R&D

[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.

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. At 8.1 percent of Federal R&D spending and Federal R&D spending at 0.81 percent of the Nation's GDP,[13] DOE's R&D budget is 0.066 percent, or less than one thousandth, of the Nation's GDP.[14]



Source: AAAS Historical Trends in Federal R&D, Total R&D by Agency 1976–2015.

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

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

The Commission sees continued Federal support of R&D as critical to the future of the national S&T enterprise and the nation's economy and security. The most recent report of the American Association for the Advancement of Science (AAAS) on U.S. R&D funding notes that S&T are "key drivers of economic growth, improved human

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[13] U.S. Federal R&D spending accounts for the lowest percentage of GDP among major industrialized nations.

[14] DOE percentage of Federal R&D spending from American Association for the Advancement of Science (AAAS), *AAAS Historical Trends in Federal R&D, Total by Agency 1976-2015* (Washington, DC: AAAS, 2014). Percentage of Federal R&D of U.S. GDP from AAAS, *AAAS Report XXXIX: Research and Development FY 2015* (Washington, DC: AAAS, 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.

health, and increasing quality of life," and that "economists estimate half or more of economic growth over the past several decades is due to technical progress."[15]

Because of its importance, several reports have called for maintained, if not increased, funding to all types of Federal R&D. One such report released in September 2014 details how R&D, especially basic research, funding is an investment in future success and that sustained funding is necessary for maximum benefit from this research.[16] While total funding to R&D as a percentage of gross domestic product (GDP) has increased slightly over the past 30 years, Federal R&D funding as a percentage of GDP has decreased at roughly the same rate that non-Federal funding has increased (Figure 4). Simultaneously, the United States has fallen from first to tenth in the world for R&D investment as a percentage of GDP.[17] *Restoring the Foundation* recommended the President and Congress increase R&D and provide a long-term investment strategy in order to reestablish dominance internationally.[18] Such calls for sustained R&D funding are not new, [19] but with current budget realities, the Commission is concerned that the United States is at risk of losing critical capabilities and its competitive advantage. This risk is especially worrisome as it also pertains to national security.[20]

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[15] M. Hourihan, et al. *AAAS Report XXXIX: Research and Development FY 2015* (Washington, DC: American Association for the Advancement of Science, 2014), 20.

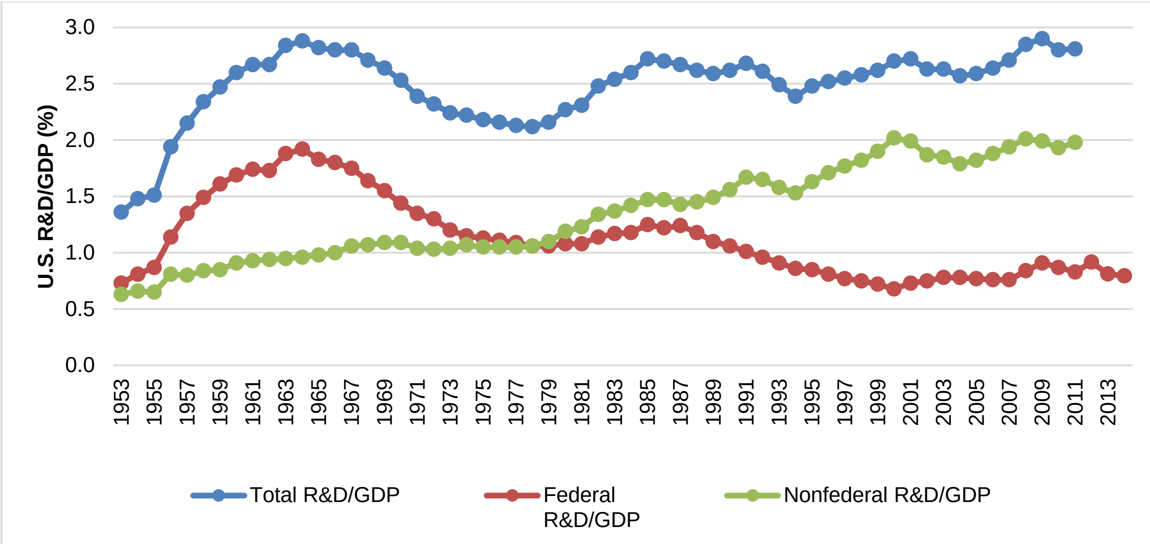
[16] Committee on New Models for U.S. Science & Technology Policy, *Restoring the Foundation: The Vital Role of Research in Preserving the American Dream* (Cambridge, MA: American Academy of Arts & Sciences, 2014).

[17] According to Organisation for Economic Cooperation and Development (OECD), *Main Science and Technology Indicators*.

[18] Recommendations in *Restoring the Foundation* include strong reauthorization bills like the America COMPETES Acts of 2007 and 2010, and for the President and Congress to "adopt multiyear appropriations for agencies." Without these changes, the authors calculate a $639 billion shortfall in funding of basic research by 2032 when compared to sustained funding from 1975–1992.

[19] Two National Academies reports *Rising above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future* (2007) and its update (2010), thoroughly detail how a decrease in support to R&D would negatively impact the nation. Additionally, in remarks at a National Academy of Sciences Annual Meeting, the President called for the United States to spend 3% of GDP on science and technology in a 2009 speech, a goal the United States has not attained (http://www.whitehouse.gov/the_press_office/Remarks-by-the-President-at-the-National-Academy-of-Sciences-Annual-Meeting/).

[20] N. R. Augustine, "The Eroding Foundation of National Security," *Strategic Studies Quarterly*, 8 (4, Winter 2014).



Source: Science and Engineering Indicators 2014 (1953–2011), AAAS Report XXXIX (2012–2014 Federal R&D), OMB GDP and Deflators (2012–2014 GDP values).

Notes: Values for Federal R&D/GDP in 2012–2014 were calculated with Federal R&D values from AAAS Report XXXIX: Research and Development FY 2015 and with GDP values from OMB Gross Domestic Product and Deflators Used in the Historical Tables: 1940–2019. Values for 2014 Budget and 2013 and 2014 GDP are estimates. Absent from this figure are values for total and non-Federal R&D 2012–2014.

Figure 4. Ratio of U.S. Research and Development to Gross Domestic Product (Percent), 1953–2014

Considering the impact the laboratories have had and the size of DOE's funding relative to other R&D expenditures, the Commission does not feel that the overall funding level for the DOE laboratories is too large. In fact, a strong case can be made for budgetary increases in specific areas. The Commission sees sustained Federal Government 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 true challenge is to make the DOE laboratory system as efficient as possible, in order to perform the maximum amount of R&D for the available level of Federal funding.

The Commission also notes that Congress has repeatedly directed external reviews of the laboratories. In the past two decades alone, 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.

D. Recommendation

The Commission has the following recommendation for Congress related to recognizing the value of the DOE Laboratories:

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 continue to 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.

2. Partnership between DOE and the Laboratories

While the relationship between DOE and its laboratories varies depending on the different program office stewards, processes, and mission objectives, the FFRDC/M&O model is the central element for 16 of the 17 laboratories. Under the FFRDC/M&O model, government and the industrial or university contractor work together as partners in a relationship with clearly understood roles and responsibilities. The government should set the "*what*" of strategic direction and provide necessary funding, while the contracted university and industry partners along with the laboratories they manage should have the flexibility to determine precisely "*how*" to meet the technical and scientific challenges confronting the Nation. Unfortunately, this relationship has eroded significantly for many in the laboratory network, leading to ever increasing levels of micromanagement and transactional oversight, which, in turn, have significantly reduced the efficiency of laboratory operations and so hindered the ability of the National Laboratories to support DOE missions.

Perhaps the greatest strength of the FFRDC/M&O model is the freedom it provides contractors to innovate and apply their best practices to meet national need. This freedom, however, must be continually earned, through proven ability to deliver and time-fostered trust with the Federal government.

A. Restoring the FFRDC Model

All of the National Laboratories, save one, are run by non-governmental organizations as FFRDCs under an M&O contract. That relationship is designed to allow expert organizations to manage the laboratories and to be accountable for laboratory performance under the overall direction of DOE. When the FFRDC/M&O model functions properly, it provides significant technical and management benefits to both the DOE and the laboratories. The M&O contracting approach, as originally developed, is designed to enable the National Laboratories to retain an exceptionally skilled workforce, to be agile in shifting resources to new areas as needs change over time, and to utilize the best scientific and operational management practices from the contracting organizations.

The Federal Acquisition Regulation (FAR) and Department of Energy Acquisition Regulation (DEAR) outline the requirements of an FFRDC, which sets the foundation for the relationship between the FFRDC and its sponsor.[21] FFRDCs must:

- meet a special long-term government R&D need that cannot be met as effectively by the government or the private sector;
- work in the public interest with objectivity and independence, and with full disclosure to the sponsoring agency;
- operate as an autonomous organization or identifiable operating unit of a parent organization;
- preserve familiarity with the needs of its sponsor(s) and retain a long-term relationship that attracts high-quality personnel; and
- maintain currency in field(s) of expertise and provide a quick-response capability.

The FFRDC construct is especially important to the laboratories' operation and success because its exemption from civil service regulations provides the flexibility necessary to attract leading technical and scientific talent; enables the ability to work closely with the government sponsor on future plans to create, align, and ensure the current and long-term relevancy of the laboratory; and provides the ability to work with others beyond DOE, on a non-interference basis, thereby leveraging knowledge and resources to advance missions and increase impact. FFRDCs are still subject to budgetary controls from both the sponsoring agency and Congress.

In general, FFRDCs must provide continuity, adaptability, and objectivity. Table 2 details how these benefits to the sponsoring agency translate to FFRDC capabilities.

Table 2. Value of the FFRDC Relationship

Benefit to Sponsor	Definition	FFRDC Capability
Continuity	Uninterrupted, consistent support based on a continuing relationship	Comprehensive knowledge of sponsoring organization's needs
		Institutional memory regarding mission, culture, expertise, and issues of enduring concern to the sponsor
Adaptability	Response to emerging needs of sponsors and anticipation of future	Quick response for short-term assistance to sponsors for urgent and high-priority

[21] Federal Acquisition Regulation, 48 C.F.R. § 35.017 (2014); Department of Energy Acquisition Regulation, Subpart 970.35 (2013).

	critical issues	requirements
		Personnel flexibility for workforce scale-ups or reductions on short time scale
		Link between sponsor offices and programs*
Objectivity	Thorough, independent analyses to address complex technical and analytical problems	Freedom from conflicts of interest and dedication to the public interest
		Independence from commercial, shareholder, political, or other associations
		Broad access to sensitive government information
		Absence of institutional interests that could lead to misuse of information

*For example, Argonne's battery program receives funding from both SC and EERE. Argonne has created a cohesive research program linked funding from SC for basic science and from EERE for applied science.

The M&O contract enables a sponsoring agency to enter into agreements with non-government entities that use their own capabilities for day-to-day operations and support functions, while drawing upon the parent organization's expertise when appropriate. In theory, the Federal sponsor uses oversight, annual evaluation, award fees, and potential recompetition of the contract as mechanisms for ensuring that the performance by an FFRDC meets the needs of the government sponsor and that the capabilities continue to align with the sponsor's mission. The model relationship is not intended to involve many stages of approval or control of the laboratory by the sponsoring agency. Other variations of the contract, such as a Cooperative Agreement or a hybrid approach, are under evaluation by DOE and the laboratories and may prove valuable in restoring the DOE-laboratory relationship to its intended ideal.[22]

In addition to the provisions that govern FFRDCs, there are other regulations that specifically govern DOE M&O contracts found in the FAR and the DEAR. The FAR, at Subpart 17.6 covers M&O contracts for DOE and any other agency having the requisite statutory authority. This subpart recognizes the unique characteristics of the M&O contract, namely the requirement that "the Government must maintain a special, close relationship with the contractor,"[23] and [t]he work is closely related to the agency's mission and is of a long-term or continuing nature, and there is a need (1) to ensure its continuity and (2) for special protection covering the orderly transition of personnel and work in the event of a change in contractors."[24] The FAR also describes the special

[22] Department of Energy (DOE). 2015. "Working Groups to Study Modifications to Laboratory M&O Contracts for Single-Program Laboratories."

[23] Title 48 CFR § 17.604(b).

[24] Title 48 CFR § 17.604(d).

extend/compete process and authorizes agency acquisition regulations that reflect the distinctive nature of the M&O contracts. DEAR Part 970 supplements the FAR and governs solicitation, award, and administration of DOE's M&O contracts.[25]

Ideally, the laboratory as an FFRDC/M&O should function as an independent, long-term, trusted advisor and honest broker. This construct is important because it provides for the long-term continuity of missions and core capabilities that enable DOE to address major national challenges. Laboratories are able to serve as strategic advisors and partners to government, with access beyond that of a typical contractor, to bring the best ideas forward to inform program directions and therefore strengthen the plans for national programs. The laboratory is answerable only to the government customer and has no vested interest in particular technologies or solutions. To achieve this ideal, the FFRDC/M&O must trust that the sponsoring organization values its role. In turn, the government must trust that the FFRDC/M&O is acting as a disinterested, supportive party. These behaviors make it possible to build a partnership based on mutual trust.

Many of the problems cited in earlier reports stem from a "broken trust" in the relationship between DOE and the National Laboratories.[26] In conflict with the ideal relationship that is envisioned in the FFRDC/M&O model, the laboratories are not treated as partners and so, for example, are not engaged by the Department in its top level strategic planning. In day-to-day operations this broken trust engenders an excessive level of transactional oversight and control by DOE over the activities of the laboratories. The SEAB Task Force on the DOE 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 sponsoring program offices, DOE Site Offices (called Field Offices in NNSA), DOE Service Centers, DOE operational oversight offices (e.g. the Office of Independent Enterprise Assessment), [and] the M&O Contractor." The multitude of oversight entities has led "to a highly burdensome operating environment that severely diminishes the effectiveness of this arrangement."[27]

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

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[25] Title 48 CFR Part 970.

[26] SEAB, *Alternative Futures for the Department of Energy National Laboratories* (Washington, DC: DOE, 1995), 6; 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, 2013), 13, 23 and 75.

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

studies auditing the laboratories. Congressional confidence in DOE and the M&O contractors' abilities is another key to restoring an efficient operational environment.

One cannot mandate or legislate "trust", it must be earned. Transparency and agreement on scope of scale of laboratory activities are prerequisites for trust and independent authority. Along with this, however, must come accountability, with consequences to the laboratory and its management if they do not uphold their end of the agreement. Essential to all of this is the clear definition of the roles and responsibilities of each partner.

Both the FFRDC/M&O and the oversight agency have certain responsibilities to ensure a successful relationship. As oversight agency of the National Laboratories, the DOE must define its own missions, provide work tasking and funding to laboratories, determine desired outputs, oversee the laboratories, and communicate successes (or failures) to external stakeholders, including Congress. The FFRDC/M&Os, in turn, have a responsibility to execute scientific and technical work and manage the day-to-day business operations of the laboratories. Certain tasks fall under the purview of both parties; strategic planning for the laboratories and the DOE is best accomplished jointly.

One of the Department's most critical roles as a steward is to develop strategic plans in consultation with the laboratories. Strategic direction must be developed for the DOE, the laboratory system as a whole, and for individual laboratories. Strategic review, planning and implementation ensures alignment between laboratory and Department priorities, appropriate assignment of responsibilities across research programs and National Laboratories, and sufficient levels of collaboration with external parties, including academia and industry. As a steward of the 17 National Laboratories, the DOE is also responsible for evaluating the quality of research programs and ensuring each laboratory receives sufficient resources to maintain its capabilities. These issues will be discussed further in Section 4 of this report.

Strategic planning for both the Department and the laboratories is best accomplished jointly, with DOE and its laboratories working together. The current level of laboratory involvement in DOE strategic planning varies by office. For example, SC's laboratories are involved in the office's Laboratory Strategic Planning process, but they are often absent from broader discussions involving SC's overall direction, priorities, and funding levels. In contrast, the Office of Nuclear Energy (NE) recently updated its R&D roadmap through a process that involved the deputies and representatives from all the relevant National Laboratories. Idaho National Laboratory was responsible for collecting this input, which NE used to make its final decisions on the R&D strategic plan. In this case the laboratories were still – appropriately – excluded from the budgeting process.

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. More effective remedies 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.

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 can serve as the foundation for an effective working relationship with appropriate roles and responsibilities throughout the year. The annual plan should represent an agreement between DOE and a specific laboratory on the nature and scope of the laboratory's planned activities for the year ahead, including the estimated levels of program funding and milestones, work for other agencies, collaborations with academia and the private sector, hiring plans, infrastructure plans, etc. Once that agreement is in place, then the DOE offices should give the laboratories the flexibility and authority to manage their activities, so long as they are consistent with the law and their operating plans. Each laboratory, of course, must also have an appropriate degree of transparency with DOE about what it is doing, and must discuss any activities that are outside the scope of the plan with DOE. The laboratories will be held accountable for their performance not only of the technical work, but also for compliance with all applicable requirements, such as financial, environmental, safety and health, and other standards.

1. DOE Federal Workforce Development

As discussed in the Augustine/Mies panel report, this Commission found that DOE does not have the career development programs needed to build a Federal DOE workforce with the necessary technical and managerial skills.[28] 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 lack an in depth understanding of the issues. To rectify this, the DOE has recently instituted an executive rotator program designed to encourage rotation of DOE staff into the field. After a series of negative IG reports,[29] particularly related to the high cost, rotations in the other direction—laboratory personnel into the Department—have been discouraged. The Commission feels while waste and fraud should certainly be avoided and punished, laboratory rotators are important to the Department's effective management of its laboratories and research programs, to provide expertise and understanding of the issues between headquarters and the field and to engender communication and trust both ways. The exchange program must be reinvigorated across the Department.

2. National Energy Technology Laboratory (NETL)

NETL is unique among the 17 National Laboratories. It is the only one that is not contractor-operated; it is 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.

NETL also differs from the other laboratories in terms of its structure and missions. In addition to its onsite R&D related to fossil fuels, NETL manages a large contracting operation for DOE's Office of Fossil Energy (FE). In fact, relatively little of NETL's funding supports its own research; the vast majority is sent elsewhere. In effect, FE has co-located its program offices with its laboratory. There is nothing inherently wrong with that, but placing the program functions within the laboratory itself and having its director oversee all of it does seem unusual, at least compared to how the other 16 laboratories are structured and how they relate to DOE. Furthermore, as a result 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.

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

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[28] See Augustine/Mies panel, *A New Foundation for the Nuclear Security Enterprise*, 12–14.

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

publications—until it was discontinued last year. Apparently, there are plans to resume university collaborations, but at a reduced level.

B. 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, and for other reasons, but management fee should not be the primary motivating factor. Fee must be adequate to cover unallowable costs, such as gaps in salary, community and educational contributions, employee scholarships, and potential risks, but it does not need to be as high as some of the recent NNSA laboratory contracts.[30] The Commissioners find that a high fee perpetuates the stereotype that laboratory managers are focused only on profit. In addition, the process to evaluate performance and award fee has led to box checking and transactional compliance for the laboratories. Both of these have resulted in a breakdown in trust between 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 a fee structure and contract approach that invites detailed, tactical, and transactional oversight rather than a strategic, performance-based management approach.[31]

C. Recommendations

The Commission has the following recommendation for the Department and the laboratories to improve their partnership:

> **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.

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30 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' (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.

31 See Augustine/Mies, *A New Foundation for the Nuclear Security Enterprise*, 12–14.

Recommendation 3: DOE and each laboratory should cooperatively develop a robust 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 give greater flexibility and authority to the M&O contractor to implement that plan. This greater flexibility must go hand-in-hand with greater transparency and accountability from the laboratory to DOE.

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.

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.

Recommendation 6: DOE should abandon *incentive* award fees 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.

3. Contract Requirements

A. Background

Previous Commissions and other independent studies have highlighted the need for DOE to address duplicative and excessively burdensome requirements in M&O contracts. The present Commission examined studies since 1995 and found the same issues are echoed, including excessive oversight, prescriptive compliance, burdensome bureaucracies, diffused and misaligned accountability and authority, and ineffective consideration of risk in policy decisions. These studies include recommendations to reform contract requirements and their implementation to gain efficiencies in operations and to reprioritize resources towards the performance of missions. Recommendations range from providing laboratories with greater flexibility to restructuring and creating new agencies and governance models for oversight. Refer to Appendix G for a summary of previous studies' findings and recommendations.

DOE has received much public attention and high levels of scrutiny due to incidents in safety and nuclear operations across the complex. Local events often trigger enterprise-wide attention and affect operations across all laboratories and sites. As a result of these events, the public, Congress, groups within the Department, and other stakeholders have been highly critical of the laboratories' management, particularly management related to safety and security. Public perception remains an important aspect of oversight and enforcement and, over time, has led to a Departmental culture of risk aversion and over-compliance with requirements.

DOE's roles as self-regulator and mission performer can either reinforce each other or be at odds. The struggle to maintain balance between these two duties is at the heart of DOE's present oversight culture. Major safety or security incidents, politics, and mission needs can also influence the degree of flexibility or stringency in oversight. In circumstances when tides shift toward stringency, trust across the entire DOE complex declines, increasing risk aversion and overly conservative interpretations of requirements.

This history has caused a great deal of confusion about the roles and responsibilities of staff across DOE headquarters, field elements, M&O contractors, and the laboratories. The laboratories experience at minimum five layers of oversight from entities within the Department: the field and site offices, service centers, programmatic offices, functional offices, and auditing and enforcement groups.

Under the FFRDC concept, DOE should operate in an oversight role, providing direction for the work performed at the laboratories and holding the laboratories accountable for execution of mission, health, safety, and environmental performance while complying with Federal regulations and other appropriate standards to support these activities. Over the years, partially as a result of external criticism of the management practices of some of the M&O contractors and laboratories, DOE has become increasingly prescriptive about how these activities should be carried out. As a result, more time and resources are spent on transactional details, including approvals, than is necessary, and DOE relies less on accountability of the M&O contractor and laboratories.

Against this backdrop, the Commission explored how contractor requirements affect laboratory operations and mission fulfillment. The Commission sought evidence to validate or refute previous report findings. This information was then used to determine ways to improve development and implementation of contractor requirements.

B. Description and Drivers of Requirements

We use the term “requirements” to represent a broad set of DOE internal documents and Federal, State, and other regulations that appear in M&O contracts.

1. Description

Requirements that apply to contractors are typically incorporated in DOE policies as a contractor requirements document (CRD).[32] DOE has two main programs to establish enterprise-wide contractor requirements and CRDs:

- DOE Directives Program—policies, orders, guides, manuals, and notices—managed by the DOE Office of Management
- DOE Technical Standards Program—standards, handbooks, and specifications—managed by the DOE Office of Environment, Health, Safety and Security[33]

A primary means of establishing CRDs is through departmental orders. In 2015, 87 of 129 DOE orders (67 percent) had CRDs (Table 3).[34] Generally, directives have been

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[32] Some directives in M&O contracts predate the creation of CRDs in 1995, *see* DOE Manual 251.1-1, *Directives System Manual*, October 16, 1995. In 2015, 86 directives included CRDs while 14 did not. The analysis included requirements that contain CRDs and that do not have CRDs but are considered contractor requirements.

[33] The Office of Management and Office of Environment, Health, Safety and Security are under the Office of the Under Secretary for Management & Performance, which was created in 2013 by the Secretary of Energy.

[34] This does not include any exemptions or equivalencies to DOE orders and other clauses that individual M&O contracts may incorporate.

steadily increasing since the DOE Directives Program was created in 1995 and accelerated starting in the 2000s when NNSA was established (Figure 5). The Commission obtained data for directives since 1980, the earliest date for which DOE had records. (DOE was established in 1977).

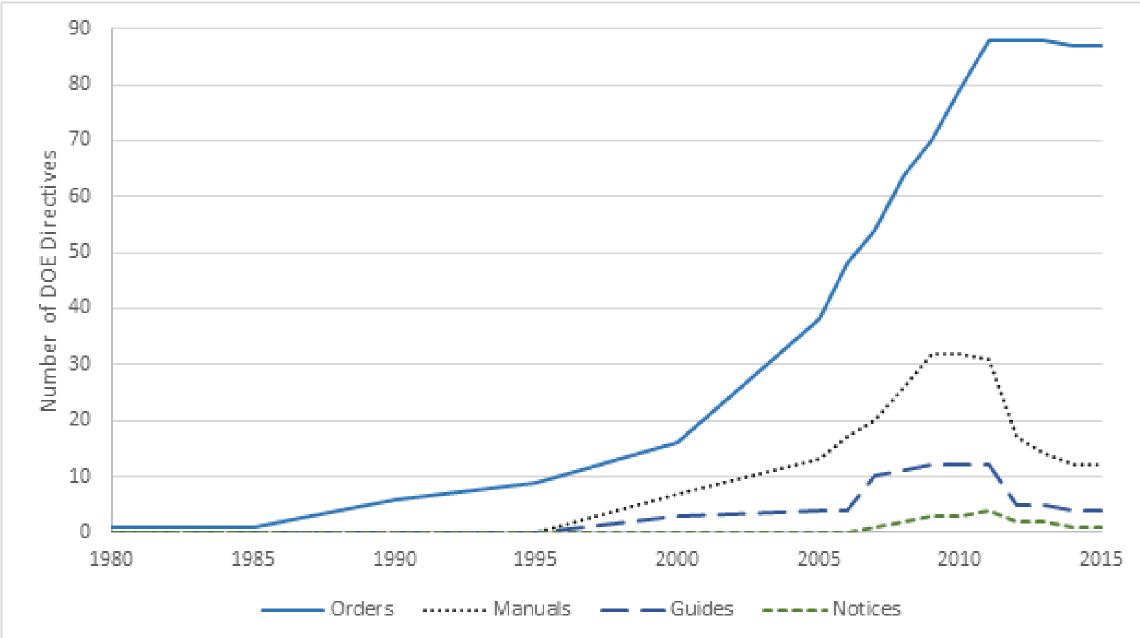
Table 3. Numbers of DOE Directives with Contractor Requirements by DOE Office in 2015

Office	Orders	Guides	Manuals	Notices	Total
Office of Environment, Health, Safety and Security	26		5		31
Office of the Chief Financial Officer	4				4
Office of Congressional and Intergovernmental Affairs	1				1
Office of Economic Impact and Diversity	1				1
Office of Energy Efficiency and Renewable Energy	1				1
Office of Environmental Management	3	1	2	1	7
Office of General Counsel	1				1
Office of the Chief Human Capital Officer	3				3
Office of Inspector General	2				2
Office of the Chief Information Officer	7				7
Office of Intelligence and Counterintelligence	3				3
Office of Management	8	3	1		13
National Nuclear Security Administration	22		3		25
Office of Scientific and Technical Information	1				1
Office of Science	4		1		5
Total	**87**	**4**	**12**	**1**	**104**

Source: Data provided by the DOE Office of Management.

Notes: The analysis included directives that either contain CRDs or are themselves considered contractor requirements. Directives include policies, orders, guides, manuals, and notices. No policies contained CRDs. Guides do not contain CRDs, but they reference mandatory requirements in orders and other documents and can be incorporated into M&O contracts. Some requirements in M&O contracts predate the creation of CRDs in 1995, *see* DOE Manual 251.1-1, *Directives System Manual*, October 16, 1995.

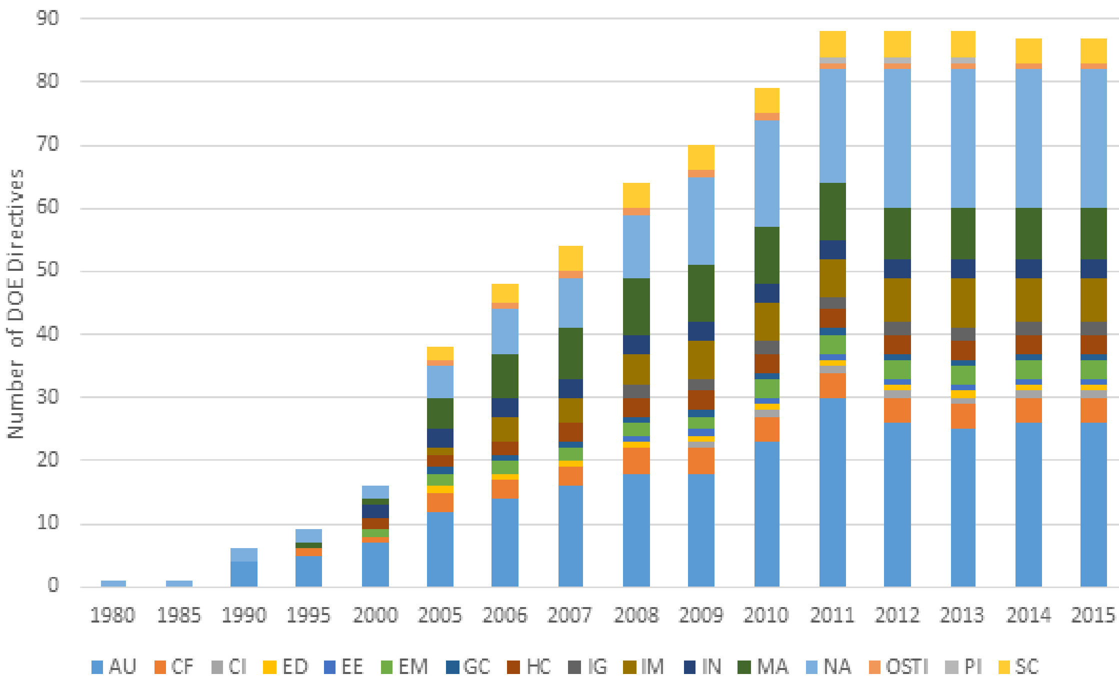
Since 2010, the numbers of guides, manuals, and notices have decreased while the number of orders has remained fairly stagnant (Figure 5). In fact, the Department initiated an enterprise-wide effort to phase out manuals altogether in favor of appending them to directives that reference them. These trends suggest that requirement reforms implemented over the past several years, have been effective in controlling the number of contract requirements from directives. (For further discussion of requirement reforms, refer to Section E of this chapter.) The most prolific DOE offices that have issued M&O contractor requirements include the Office of Environment, Health, Safety and Security and NNSA (Table 3 and Figure 6). The rise in safety and security requirements from these offices over the past several decades indicates DOE's promulgation of enterprise-wide contract requirements in response to public scrutiny of laboratory performance in these areas.



Source: Data provided by the DOE Office of Management.

Note: The analysis included directives that contain CRDs and that are themselves considered contractor requirements. DOE did not have records of directives prior to 1980. . Directives include policies, orders, guides, manuals, and notices. No policies contained CRDs. Guides do not contain CRDs, but they reference mandatory requirements in orders and other documents and can be incorporated into M&O contracts. Some requirements in M&O contracts predate the creation of CRDs in 1995, *see* DOE Manual 251.1-1, *Directives System Manual*, October 16, 1995.

Figure 5. DOE Directives with Contractor Requirements Documents (CRDs), 1995 to 2015



Source: Data provided by the DOE Office of Management.

Note: Refer to the Abbreviations appendix for DOE Office abbreviations.

Figure 6. DOE Directives with Contractor Requirements Documents (CRDs) by Authoring Office, 1980 to 2015

NNSA establishes additional contractor requirements specific to its sites as NNSA policies (NAPs) and supplemental directives (SDs), of which currently 7 and 12 exist, respectively.[35] Department of Energy Acquisition Regulation (DEAR), which is codified in the Federal Acquisition Regulation System (Title 48 CFR), Acquisition Letters (of which currently 49 exist), and General Counsel Letters are other means by which DOE can issue requirements to contractors.

Not all of these policies are included in M&O contracts and some may be applicable only to Federal employees. (Refer to Table 4 for further descriptions of these requirements.)

Table 4. Examples of M&O Contract Requirements and Descriptions

DOE or NNSA	Requirement	Description
DOE-Wide	Secretarial Memorandum	**Mandatory** requirements written by the Secretary of Energy for the Department
	DOE Acquisition	**Mandatory** requirements that supplement regulatory

[35] Section 3212(d) of Public Law 106-65, the National Defense Authorization Act for Fiscal Year 2000, as amended, provides the NNSA Administrator with authority to establish Administration-specific policies.

DOE or NNSA	Requirement	Description
	Regulation (DEAR)	requirements for the acquisition process under the Federal Acquisition Regulation System (Title 48 CFR Parts 901–970)
Directive	Policy	**High-level expectations** for the Department that may not directly contain requirements, although mandatory contractor requirements may flow down
	Order	**Mandatory** requirements that establish management objectives and assign responsibilities throughout the DOE complex; orders must be unique to DOE and must avoid duplicating information from other directives or any existing legal source
	Notice	**Mandatory** requirements that have the same effect as orders but are issued in response to departmental matters requiring prompt action to establish short-term management objectives; must be incorporated into an order within 1 year of effective date; may reference other requirements from existing directives
	Manual	**Mandatory** requirements that supplement other requirements, including directives, laws, and regulations, by providing procedural instructions to carry out requirements provisions
	Guide	**Non-mandatory** guides that provide acceptable means for complying with requirements; Guides do not impose but may reference requirements from existing directives
Technical Standard	Standard	**Non-mandatory** standards, but can be made mandatory when invoked by other requirements; provide specific standardized approaches, methodologies, technical criteria, or other information
	Handbook	**Non-mandatory** handbook that provide a compilation of good practices and lessons learned
	Specification	**Non-mandatory** specifications that describe detailed technical guidance
Other	Letters (e.g., Contract Officer, General Counsel)	**Non-mandatory** guidance that can be sent to contracting officers to modify M&O contracts and provide guidance on a number of areas, including DOE requirements
NNSA-Specific	Policy (NAP)	**High-level expectations** that are specific to NNSA and may not directly contain requirements, although mandatory requirements may flow down and must be aligned with policy
	Supplemental Directive (SD)	**Mandatory** requirements that supplement DOE directives to indicate how NNSA will implement mandatory requirements

Sources: NNSA website, "NNSA Policy System," http://nnsa.energy.gov/aboutus/ouroperations/managementandbudget/policysystem; DOE website, "Acquisition Letters," http://energy.gov/management/acquisition-letters, "Directives," https://www.directives.doe.gov, and "DOE Technical Standards Program," http://energy.gov/ehss/services/nuclear-safety/department-energy-technical-standards-program ; Title 48 CFR, and Chapter 9—Department of Energy

Notes: DEAR includes stipulations for contract management, additional clauses and forms (Subchapter H—often referred to as H-clauses), and agency supplementary regulations (Subchapter I—often referred to as I-clauses). Directives include: policies, orders, guides, manuals, and notices. Technical standards include: standards, handbooks, and specifications.

For instance, guides and technical standards are considered consensus standards and best practices that are voluntarily applied to comply with requirements. Directives often reference these documents, creating confusion in their application in oversight and laboratory operations. For example, there are currently 173 active technical standards and 21 are invoked by orders that apply to DOE M&O contractors.[36] Guides and other non-mandatory documents invoked as references are viewed by DOE oversight staff and the M&O contractors as DOE's preferred way to comply with a requirement. Their insertion into the M&O contracts may make it difficult for M&O contractors to use alternative methods.

In addition to Federal, State, and local regulations, M&O contractors must also comply with regulations established by other government offices, such as the Office of Management and Budget. For example, after Executive Order No. 13589, *Promoting Efficient Spending*, was issued in November 2011, DOE instituted new requirements for conference data management systems with a multi-layer management and approvals process. In this case, a DOE order on conference management does not exist, but actions to be taken by the complex as a whole, including contractors, are outlined in a Secretarial Memo.[37] These additional requirements are difficult to capture since they manifested outside of DOE's internal directives system. Other requirements that are not fully documented in M&O contracts include programmatic or functional direction from DOE offices in their oversight role and M&O contractor practices (e.g., corporate or university rules).

2. Inclusion of Requirements into M&O Contracts

The inclusion of requirements into M&O contracts is not uniform across the laboratories. In reviewing the prime M&O contracts for 16 of the 17 national

[36] Invoked technical standards are available at DOE's website, "Other Requirements," https://www.directives.doe.gov/other_requirements#b_start=0&c9=Invoked+Technical+Standards.

[37] DOE, Updated Guidance on Conference Related Activities and Spending, (Washington, DC: DOE, 2012).

laboratories, the Commission observed that DOE applied clauses for the FAR, DEAR, and other departmental policies in varied ways across the M&O contracts (Table 5).[38]

The varied application of certain clauses is not out of the ordinary considering clauses may be specific to the nature of the work performed at each laboratory.[39] However, there is a relatively large variation in the application of Department enterprise-wide policies, such as DEAR clauses and directives. A comparison of the number of DOE requirements across the laboratories shows that higher risk laboratories, including the NNSA laboratories as well as Idaho and certain Office of Science laboratories, have relatively more DOE requirements than lower-risk or single-program laboratories, such as Ames, Princeton Plasma, and SLAC.

[38] NETL is a government-operated laboratory and does not have an M&O contract. Contracts reviewed as of July 2015.

[39] These special contract requirements are referred to as H-clauses.

Table 5. Number of Contract Clauses for 16 Contractor-Operated National Laboratories

Office	Laboratory	H-Clauses	I-Clauses	DEAR	Directives
SC	Ames	40	95	61	50
	Argonne	44	99	62	78
	Brookhaven	42	99	62	85
	Fermi	47	98	60	51
	Lawrence Berkeley	50	92	71	50
	Oak Ridge	45	101	63	70
	Pacific Northwest	44	67	57	72
	Princeton Plasma	51	94	60	58
	SLAC	37	84	61	41
	Thomas Jefferson	47	73	61	79
EERE	NREL	42	104	55	41
EM	Savannah River	62	25	33	40
NE	Idaho	52	14	48	88
NNSA	Los Alamos	47	91	60	97
	Lawrence Livermore	44	79	58	84
	Sandia	44	74	58	85

Notes: SC: Office of Science, EERE: Office of Energy Efficiency and Renewable Energy, EM: Office of Environmental Management, NE: Office of Nuclear Energy, NNSA: National Nuclear Security Administration, FAR: Federal Acquisition Regulation, and DEAR: Department of Energy Acquisition Regulation. Of the 17 national laboratories, NETL is the only government-operated laboratory and does not have an M&O contract. H-clauses are special contract requirements inserted by DOE; I-clauses stem from FAR clauses; and DOE directives include policies, orders, guides, manuals, and notices. Contracts reviewed as of July 2015 and may not include pending modifications to contracts based on more recent DOE revisions of requirements.

3. Drivers

Internal and external entities that can drive requirements include DOE headquarters, Office of the General Counsel, and Inspector General (IG); independent oversight groups, including the Defense Nuclear Facility Safety Board (DNFSB) and the Government Accountability Office (GAO);, advisory groups, such as the Secretary of Energy Advisory Board (SEAB); and the Congress, media, and general populace (Figure 7). These drivers may provoke DOE to take on strong actions in response to violations or incidents at individual sites. These actions can often impact expectations or requirements across the entire DOE enterprise.

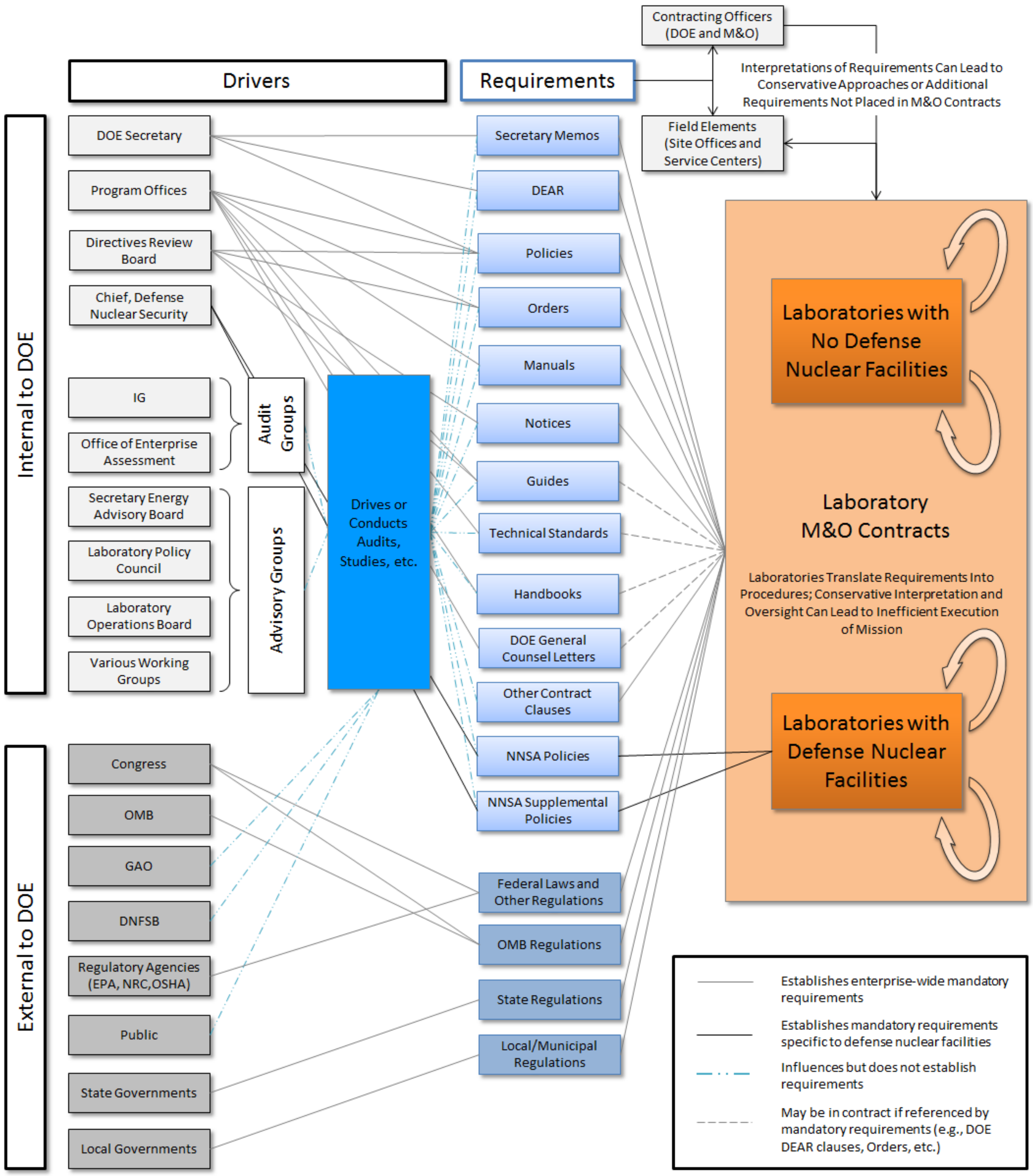


Figure 7. Complexity of Drivers Influencing Establishment and Implementation of Contractor Requirements

Auditors may assess deficiencies in compliance with M&O contract requirements. (Refer to Chapter 5 for further discussion on impacts of assessments and data requests). NNSA's laboratories are under close examination by external auditing groups, including the DNFSB and GAO, due to the relatively higher operating risks at defense nuclear facilities.[40] The DNFSB oversees safety by evaluating DOE's directives and processes for safety and how well DOE's facilities are complying with those requirements. In fact, of the 104 orders with contract requirements, 29 orders (about 28 percent) are subject to review by DNFSB.[41] Although DNFSB's scope is limited to defense nuclear facilities, it is perceived among defense and non-defense laboratories as a continuous driver of overly strict interpretation and rigidity to tailoring safety requirements across the DOE complex. In fact, studies have recommended that NNSA transition regulation to the Nuclear Regulatory Commission and cease oversight by the DNFSB to address the seemingly burdensome impacts to NNSA's missions, among other reasons.[42] The issues seem to stem from DOE's lack of clarity on guidance versus mandatory requirements, the DNFSB's conservative application of DOE requirements in assessing compliance of DOE facilities, and the lack of risk-based policy-making and practice from Federal oversight at headquarters and field elements. These elements are further discussed in the Section C of this chapter.

At the root of the perception of the DNFSB and the drive to development of new requirements may be the adjudication process and over-reaction to the safety issues DNFSB identified. While the number of recommendations from the DNFSB was high during the days of Rocky Flats, a heavily contaminated nuclear weapons production site in operation from 1952 until 1992,[43] since 1995, the DNFSB has issued less than 1.5 recommendations per year on average (Figure 8).

DNFSB recommendations are formal written recommendations to the Secretary of Energy to advise the Department with regard to safety, and they require an acceptance or rejection of the recommendation. In making its recommendations, the DNFSB should

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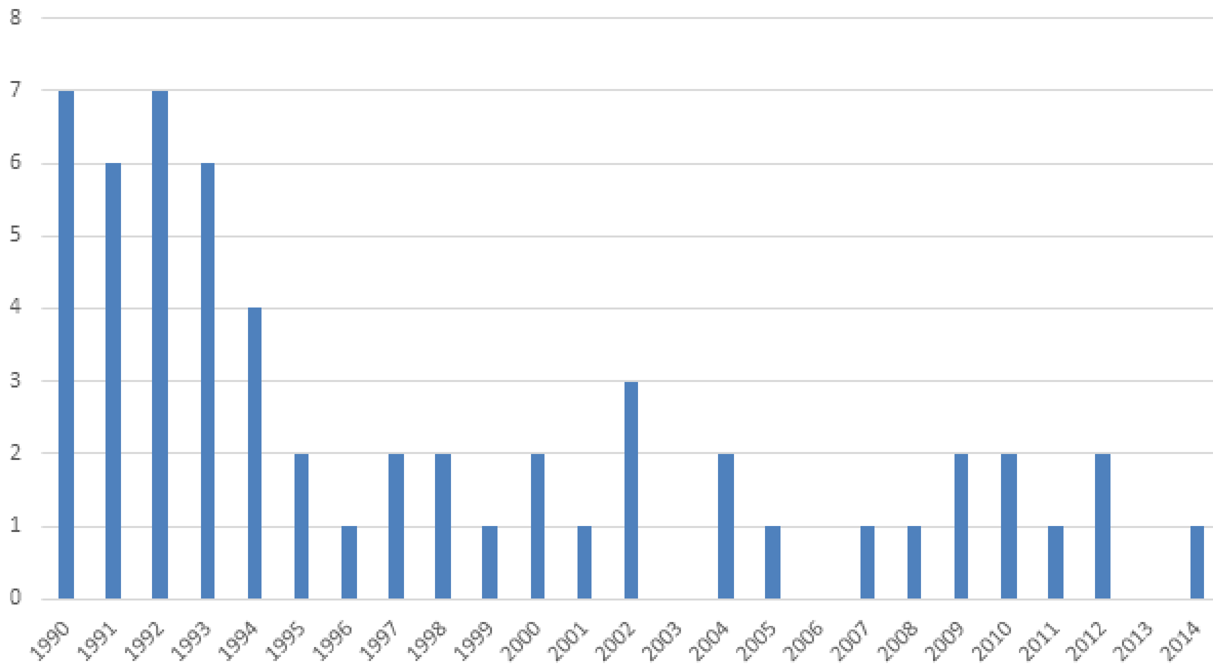
[40] The DNFSB is a board of Senate-confirmed safety experts and was established in the 1990s to provide oversight of safety in defense-related DOE facilities. The role of the DNFSB is to "provide independent analysis, advice, and recommendations to the Secretary of Energy to inform the Secretary, in the role of the Secretary as operator and regulator of the defense nuclear facilities of the Department of Energy, in providing adequate protection of public health and safety at such defense nuclear facilities." See 42 U.S.C. § 2286a(a), Defense Nuclear Facilities Safety Board, Functions of Board.

[41] DOE website, "Directives," https://www.directives.doe.gov.

[42] L. F. Brooks, "Alternatives to the Current NNSA Model," in T. Bolz (ed.), *In the Eyes of the Experts: Analysis and Comments on America's Strategic Posture*, (Washington, DC: U.S. Institute of Peace, 2009), 114–125.

[43] Rocky Flats was the target of major scrutiny from the public due to incidents related to plutonium fires, radioactive waste leaks, and risks for public contamination.

assess the risk and consider the technical and economic feasibility of implementing the recommended measures.[44] The Secretary of Energy has historically accepted every DNFSB recommendation made, although three were accepted with conditions. In one of the conditional cases, NNSA effectively communicated the rationale for disagreeing with part of DNFSB's recommendation (see box).



Source: DNFSB website. "Recommendations to DOE," http://www.dnfsb.gov/board-activities/recommendations.

Figure 8. Number of DNFSB Recommendations, 1990 to 2014

NNSA Rationale and Risk-Based Approach In Response to a DNFSB Recommendation

In October 2010, the DNFSB issued a recommendation, "Safety Analysis Requirements for Defining Adequate Protection for the Public and the Workers." The DNFSB asserted that NNSA laboratories were at risk for not meeting radiation exposure level standards by departing from accepted evaluation methodologies in DOE's technical standard DOE-STD-3009-94, "Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Documented Safety Analyses." The technical standard is invoked in M&O contracts and is also referenced in Federal regulations (10 CFR Part 830, Nuclear Safety Management).

As a result, the DNFSB recommended that DOE develop a plan to reduce exposure at defense nuclear facilities to meet the referenced technical standard. DOE's response stated that the technical standard "was not written as a prescriptive item-by-item requirements document; rather it provides an overall approach and guidance." NNSA was able to provide evidence that its interpretation of the standard had not changed and that NNSA was using it as a guideline. NNSA

[44] Title 42 U.S.C. § 2286a(b)(5), Defense Nuclear Facilities Safety Board, Functions of Board.

rationalized their risk-based approach and argued that the few defense nuclear facilities that have the potential to exceed the standard's safety threshold provided adequate protection through multi-layered controls to mitigate potential risks and consequences.

Source: Based on interviews and DNFSB, "Safety Analysis Requirements for Defining Adequate Protection for the Public and the Workers," Recommendation 2010-1 to the Secretary of Energy, 2010.

C. Processes for Developing and Implementing Requirements

1. Development

The main processes for developing and implementing contract requirements are outlined in DOE's Departmental Directives Program, Technical Standards Program, and NNSA's policies to establish NAPs and SDs. (Refer to Table 6 for a summary of DOE and NNSA processes to establish requirements.)

Table 6. Summary of DOE and NNSA Processes to Establish Requirements

Program	Chair	Timeline	Approvals	Comment Process	Review Board Members	Recertify
Departmental Directives Program	Director, Office of Management	~150 days	Secretary (policy) Deputy Secretary (orders & notices) Director, Office of Management (guides)	Yes, RevCom*	Voting: Under Secretarial offices, Office of the General Counsel, and Office of Environment, Health, Safety and Security Non-voting: National Laboratory Director's Council and Field Management Council	4 years
Technical Standards Program	Manager assigned by the Office of Environment, Health, Safety and Security	~90-120 days	Senior program official in the Office of Environment, Health, Safety and Security	Yes, RevCom*	No	5 years
NNSA Policies	Associate Administrator for Management and Budget	~120 days	NNSA Administrator	Yes	Management Council comprising of head of each NNSA program office to resolve impasses	2 years

* RevCom is a web application that maintains comments on draft requirements.

The principles for developing directives in the Departmental Directive Program include (Table 7) are ideals and do not always apply in practice. For instance, fire protection requirements in DOE Order 420.1, "Facility Safety," duplicate requirements in DOE's health and safety regulations under 10 CFR 851, "Worker Safety and Health Program." In addition, although DOE established requirements in areas in which other standards may not apply or exist, such as protection from exposure to beryllium, additional DOE requirements that exceed other standards may not be necessary.[45] In general, duplication and excessive requirements above Federal regulatory or industry standards can create confusion and inefficiencies in operations, particularly for low-risk activities such as human resources.

Table 7. DOE Directives Program Principles

Principle	Description
What versus How	Directives should specify goals and refrain from mandating how to fulfill requirements, although establishing the "how" may be necessary to cover high-risk functions.
Duplication of Laws, Regulations, or National Standards	Departmental directives shall not duplicate or be inconsistent with applicable laws or regulations. To the extent possible, directives also should be written so that they are consistent with or incorporate widely accepted national standards.
Improved Planning	Office of primary interest (office authoring a directive) will assess risk, degree of prescription. If appropriate, an estimated financial impact will be determined and factored into decision making When contractors are affected their views will be solicited early.
Applicability	Do not approach directives with a one-size-fits-all perspective. Those covered by a directive should make full use of exemptions and equivalencies to avoid unnecessary burden.
Impasse Process	An impasse process will be used to resolve differences.
Unofficial Guidance	Existing requirements that cross organizational lines and apply to contractors but were not developed and promulgated through the formal directives process are to be considered invalid unless/until they have been reviewed and adopted through that process. To the extent possible, program offices, including field offices, should limit supplementing directives with additional guidance.

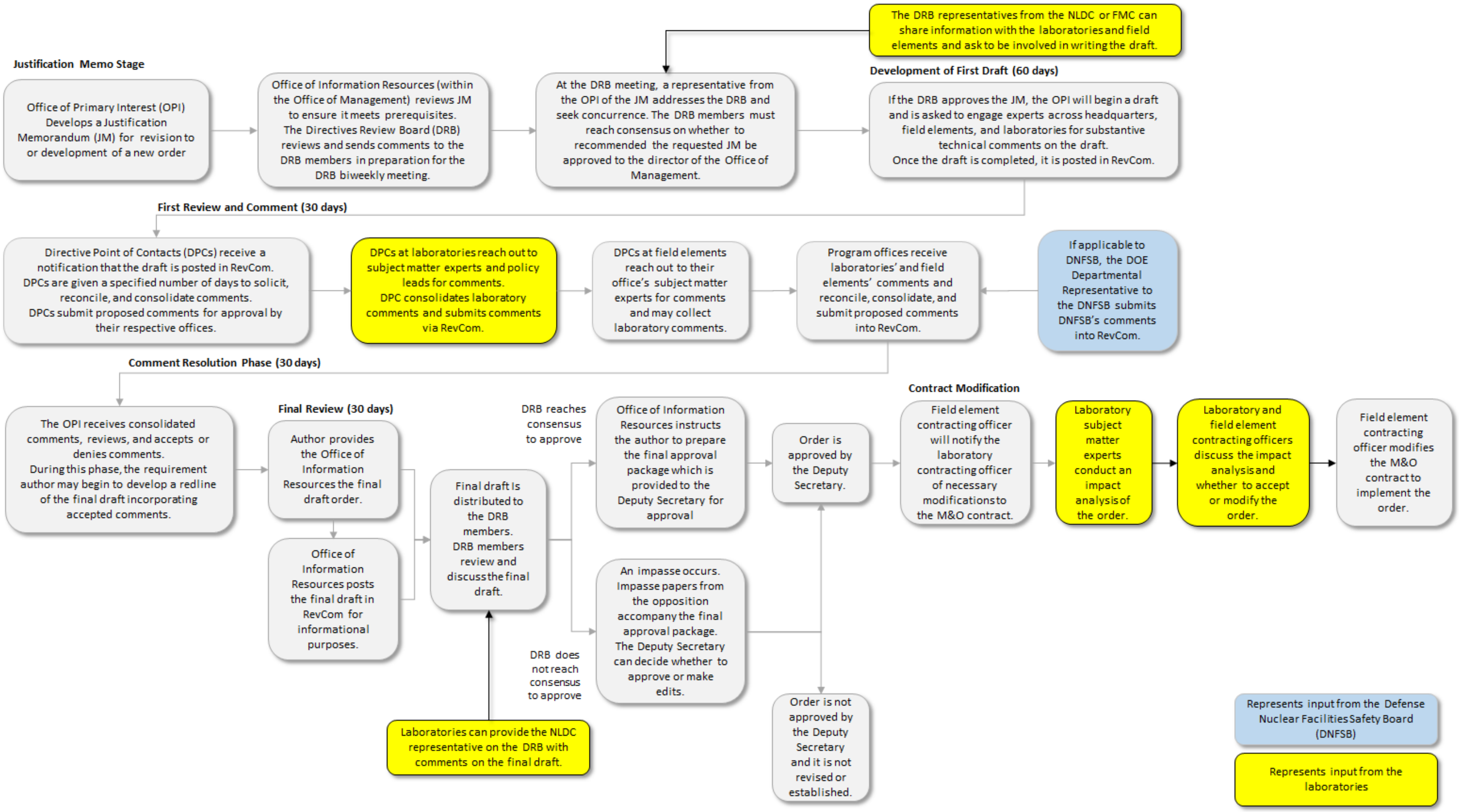
Source: DOE Order 251.C, Departmental Directives Program.

[45] Chronic Beryllium Disease Prevention Program under 10 CFR 850, Worker Safety and Health Program.

Directives are developed by a process governed by the Directives Review Board (DRB). (Refer to Figure 9 for a description of the process to review and approve an order.) Generally, the DRB reviews directives before their release for DOE-wide comment and approves the final directive draft before submitting it to the Deputy Secretary for approval. The DRB involves senior representative from DOE's Under Secretarial offices, the Office of the General Counsel, and the Office of Environment, Health, Safety and Security. Representatives from the National Laboratory Director's Council (NLDC) and the Field Management Council (FMC), which represent the laboratories and field elements, respectively, also serve advisory roles and are non-voting members.

The DRB is ideally a platform where the effect of directives from various perspectives can be considered before approval, but efforts to involve appropriate stakeholders and experts in the process can break down. Members of the DRB commented on the variability in the quality of the input provided by DRB representatives. For instance, there is one non-voting representative each for the national laboratories and field management council. Additional participation across the stakeholders, such as program offices and laboratory representatives, could better inform the process.

In addition, the DRB process includes many opportunities to solicit views from individuals at headquarters, field elements, and laboratories. Enterprise-wide input is managed through RevCom, a web application that maintains comments on draft DOE requirements. Federal and laboratory employees can access RevCom by creating an account online and directly input their comments on draft requirements. The information submitted by representatives in the laboratories and the field elements can be filtered at various points in the process. Directives Points of Contacts (DPCs), which are designated officials across the laboratories, field elements, and headquarters, may modify the comments from their respective offices and institutions to address conflicting input and a requirement author's office (referred to as the office of primary interest) serves as the final arbiter of which comments are eventually presented to a requirement's author. Although the RevCom process provides transparency into the office of primary interest's decisions to accept or reject a comment, the original author of the comment may or may not access the RevCom system to review this feedback.



Source: Based on interviews and DOE Order 251.1C, Departmental Directives Program.

Figure 9. Process to Develop a DOE Order

DOE's current enterprise-wide process for directives is commendable, but limited in that it addresses only the set of requirements communicated via directives. In addition to the Departmental Directives Program, the Technical Standards Program promotes the use of voluntary consensus standards (VCSs) where applicable.[46] Technical standards may be developed only in the absence of appropriate VCSs. Technical standards are written as a means of implementing DOE requirements when a technical methodology is needed. Technical standards are developed in a process similar to directives but without a review board. Comments from stakeholders are similarly managed through RevCom.

Although technical standards are suggested ways of accomplishing tasks, they can be interpreted by risk averse or oversight staff as a separate set of requirements. DOE's Office of Management has explored ways to bring technical standards and other requirements into the DRB development process. A review platform for all contractor requirements could improve the strategic basis from which new requirements are introduced. Such attempts have been met with mixed reactions due to the complexities of bringing the processes together.

A third set of requirements is created by NNSA's policy system, which allows NNSA to administer requirements specific to NNSA laboratories through NAPs and SDs.[47] NAPs and SDs go through a separate review and comment process directed by an NNSA management council before they are approved by the NNSA administrator.

Because DOE requirements come in so many forms and are driven by both internal and external interests, DOE has a limited ability to control all the requirements the laboratories may face. Rather than conducting a systematic and strategic review of how new requirements affect laboratory operations and performance, DOE is reacting to the numerous reviews and audits conducted by oversight groups, or to specific incidents that bring the attention from media, Congress, and the public. New requirements that stem from these reactions and their associated pressures may be at the root of DOE's culture of conservatism in the implementation of requirements.

But strategic leadership decisions could be improved for the requirements over which DOE has greater control as a self-regulator, including DEAR clauses and directives. This suite of requirements are not addressed holistically to identify how new requirements may impact operations and mission performance as a whole. The cumulative impacts of numerous contract modifications amounts to significant work and is not considered in the overall funding for the M&O contract. DOE also does not

[46] DOE Order 252.1A, Technical Standards Program.

[47] Established under the authority of the National Defense Authorization Act for Fiscal Year 2000, Section 3212(d), as amended (Public Law 106-65).

comprehensively assess tradeoffs and costs during the development of new requirements. New contractor requirements can add significant costs in review, adjudication, and implementation. (Refer to the box below for examples.) The laboratory's mission support activities and overhead largely bear the brunt of this cost. Performance can suffer over time as additional requirements are added to M&O contracts and programmatic resources are used to support these activities.

Examples of Laboratory Costs to Review and Implement Contract Modifications

According to staff at Sandia National Laboratories, in the period January to June 2015, NNSA sought the following changes to Sandia's M&O contract:

- Added two DEAR clauses in lieu of a DOE directive,
- Added or modified 55 FAR or DEAR clauses, and
- Added or modified 14 DOE directives.

Review of NNSA's request to replace the primary DOE human resources directive (DOE Order 350.1, Change 3, Contractor Human Resource Management Programs) with two DEAR clauses, required approximately 20 hours of contract administration time and about 130 hours of combined labor from Sandia's Labor Relations, Staffing, Compensation, Benefits, and Pension departments. Ultimately, the proposed changes were not made to Sandia's contract. Although Sandia and NNSA reached a mutually agreeable solution, the cumulative time spent preparing information, engaging with Federal and laboratory staff, and negotiating proposed changes to the M&O contract was significant.

Laboratories may also experience costs in implementing contract changes that are not supported by increased funding to the M&O contract. According to staff of Thomas Jefferson National Accelerator Facility, it would cost $75 thousand for a consultant and 2 person-weeks of effort to document and implement the fire protection requirements (DOE-STD-1066-2012) for facility safety (DOE Order 420.1, Facility Safety). In fact, a full-time equivalent was added to the Thomas Jefferson's staff to complete documentation and maintain the program. Lawrence Livermore recently tracked the amount of time in full-time-equivalents (FTEs) to review draft requirements, internally assess impacts, provide comments through RevCom, and jointly discuss modifications to the M&O contract with the field elements. The estimate for an average contract modification is about 35 full-time equivalent employees.

Source: Based on interviews and data provided by the respective laboratories.

Requirement authors may not adequately assess the value, impacts, and risks of requirements before they are developed and approved. The laboratories typically perform impact assessments after a requirement is approved and information from the assessments may be used to negotiate implementation between DOE and the laboratory's contracting officers. The review of impact assessments after a directive is approved is inefficient at best; it is difficult to modify or eliminate the requirement once it has been inserted into M&O contracts.

The DRB and other DOE staff recertify requirements by reviewing their relevance, but a requirement's author must initiate a formal review and an author can delay the process indefinitely without enforcement. According to the Departmental Directives

Program policy, the director of DOE's Office of Management has the authority to cancel directives that have passed their 4-year recertification date. This process is rarely used. Out of the 87 orders containing contractor requirements, 60 have not been recertified in the last 4 years, some going back as far as 1992.[48] This backlog may make it difficult for leadership and laboratories to identify opportunities to improve operations and performance. In the past, the Office of Management considered sun-setting directives, but there were internal concerns about sun-setting long-lasting safety directives.[49] There are opportunities to apply sun-setting requirements in lower-risk functional areas, such as human resources and business and financial services.

The 2014 pilot of the Enterprise Risk Management (ERM) Model for human resources requirements suggests that DOE is making efforts to move towards a risk-based framework. DOE staff stated that outcomes from the pilot indicated that the human resource requirements were associated with Federal regulations and the results from the pilot did not support scaling up the model to all DOE requirements. In a more recent effort, on August 17, 2015, the Secretary of Energy established a Chief Risk Officer responsibility announced as part of the role of the Associate Deputy Secretary. The Chief Risk Officer is responsible for "advancing an analytical approach to systematically identifying, assessing and managing strategic, project, financial and reputational risks across the Department."[50] This initiative appears to be a step in the right direction towards institutionalizing risk management approaches throughout DOE.

DOE could also apply lessons learned in risk management and adapt frameworks from other regulatory agencies, such as the Nuclear Regulatory Commission, to inform the development and institutionalization of an enterprise-wide risk management model (see the following box).

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[48] DOE, "Directives for Review by EO FY 2015," DOE Directives, Delegations, and Requirements. DOE, n.d. Web. 22 June 2015.

[49] Based on interviews with staff from the DOE Office of Management.

[50] Secretary of Energy letter announcing Associate Deputy Secretary, August 17, 2015.

Lessons Learned from Risk Management Frameworks at the Nuclear Regulatory Commission

A review of the Nuclear Regulatory Commission risk management framework suggests several lessons learned that could be applied to the management of DOE requirements:

- Establish a dichotomy between (1) requirements that absolutely must be met to achieve reasonable assurance that the site will provide adequate protection of public health and safety and in which there is no cost relation (described under 10 CFR Part 50) and (2) requirements in which a risk justification is appropriate.
- Develop a timely and transparent process to inform decisions on new requirements, including a robust benefit and cost assessment framework, training, and guidance to conduct assessments in a participatory manner.
- Promote an effective safety and security culture in which new requirements are made only if a safety significance threshold is met to ensure that issues receive the attention warranted by their significance.
- Facilitate training and guidance for dealing with situations in which an accurate probabilistic estimate is lacking and individual judgment may be necessary, particularly for high-probability/low-consequence events.
- Employ and encourage effective communication strategies to inform others and assess the pervasiveness of potential risks from new incidents or events across sites, including the use of bulletins or notices, requests for formal and informal responses regarding mitigation activities, and independent communications from industry groups.

Sources: National Research Council reports, “Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission,” NUREG/BR-0058; “A Proposed Risk-Management Regulatory Framework” 2012; and “Probabilistic Risk Assessment (PRA).” Also National Research Council website, “Probabilistic Risk Assessment (PRA),” http://www.nrc.gov/about-nrc/regulatory/risk-informed/pra.html.

2. Implementation

Requirements must be incorporated into M&O contracts, typically in the form of a CRD, to enforce their implementation. When a requirement with a CRD is issued, it is sent to the applicable field element’s contracting officers who will reach out to the laboratory’s contracting officer to coordinate its review with subject matter experts. These experts conduct an impact analysis of the CRD. After reviewing the impact analysis, the contractor and site office contracting officers will discuss whether it is appropriate to implement the CRD as written or to modify it due to evidence of burdensome impact and tailor it to the laboratory’s work environment. After the M&O contract is modified, the contractor works to implement the CRD.

There is a formal process to claim exemption or equivalency to DOE requirements. Examples vary across the enterprise (Table 8). Exemptions or equivalencies obtained at one laboratory may not necessarily set precedence for another laboratory. Some laboratories that have obtained third-party certifications, such as those from the International Standards Organization (ISO), have received equivalencies for DOE requirements while others have not. For example, many laboratories maintain ISO Standard 14001:2004, Environmental Management Systems, but most of these laboratories have either not sought equivalency on the environmental management systems clause in DOE Order 436.1, Departmental Sustainability, or were not approved for the equivalency (by local or headquarters oversight staff). DOE staff suggested that the equivalency process is not widely used and could be better leveraged by M&O contractors, while laboratory staff indicated that DOE's conservative views on what may be considered equivalent or valid as an exemption makes the process laborious. Equivalencies granted for all SC laboratories show how program offices can strategically manage the relevancy of requirements.

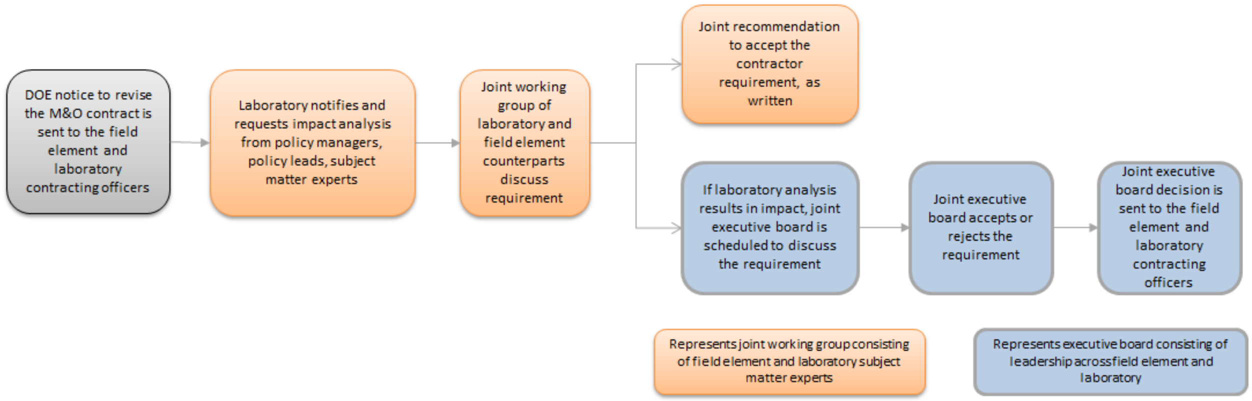
Table 8. Examples of Equivalencies and Exemptions to Contractor Requirements

Scope	DOE Requirement	Exemption or Equivalency
All SC Laboratories	DOE O 413.3B, Program and Project Management for the Acquisition of Capital Assets	Order revised to delegate authority for project approval and other activities to SC rather than the Office of Management
	DOE O 226.1B, Implementation of Department of Energy Oversight Policy	Order can be replaced with an H-clause, Contractor Assurance System
Sandia	DOE O 414.1C, Quality Assurance	Order replaced by ISO 9001-2008, Quality Management Systems
Idaho, Pacific Northwest, Sandia	DOE O 436.1, Departmental Sustainability	Order replaced by ISO 14001:2004, Environmental Management Systems
FERMI	DOE O 350.3, Labor Standards Compliance, Contractor Labor Relations, and Contractor Workforce Restructuring Programs	Order replaced by H-clause, Employee Compensation: Pay and Benefits

SC: Office of Science, SC Laboratories are Ames, Argonne, Brookhaven, Fermilab, Lawrence Berkeley, Oak Ridge, Pacific Northwest, Princeton Plasma, SLAC, and Thomas Jefferson.

Requirements also allow for a graded approach, which provides flexibility to avoid inefficiencies of a one-size-fits-all approach. The success of a graded approach depends on the relationship between the laboratories and the field element, as well as on individual willingness to accept risk and accountability for taking on those risks. Some field elements and laboratories collaborate effectively to understand the relevance of new requirements in the context of the laboratory's operations. Working together, the field elements and laboratories tailor implementation strategies for those requirements that are relevant.

At some sites, joint review teams involving field element and laboratory staff have been established to facilitate joint discussion on the local implementation of contractor requirements and modifications. These joint review teams typically consist of two groups: (1) a working group made up of laboratory subject matter experts that meet with the field element counterparts to discuss accepting a requirement as written or, if agreement cannot be reached, to raise the decision to an executive board, and (2) an executive board consisting of field element and laboratory leadership that considers the laboratory's impact analysis and votes whether to accept or reject the requirement (Figure 10).



Source: Laboratory interviews.

Figure 10. Example of Joint Working Groups and Executive Boards to Review Requirements Established by Field Elements and Laboratories

A well-implemented contractor assurance system (CAS) can facilitate effective collaboration and discussion between the field elements and laboratories. A CAS is a system to measure, improve, and demonstrate performance in meeting mission objectives and contract requirements.[51] Elements of a CAS include mechanisms to increase transparency across the laboratories and DOE including developing effective governance structures of the laboratory and M&O contractor, risk management processes, requirements flow-down, performance assessments, worker feedback, issues management, analysis and reporting, lessons learned, metrics and indicators, training and qualifications, and continuous improvement programs. A CAS presents increased responsibilities and accountability at the field elements and laboratories with increased focus on performance and risk-informed oversight. (Refer to Chapter 4 for further discussion of a CAS's effect on oversight.)

Efforts are underway to leverage a strong CAS with the goals to improve performance and accountability, reduce costs, and use industry standards for non-nuclear activities. For example, NNSA established an SD to establish a Line Oversight and Contractor Assurance System, which added line oversight by the field elements to include operational awareness, onsite reviews and assessments, and other activities involving evaluations of the M&O contractor.[52] Line oversight activities are risk-

[51] DOE Policy 226.1B, Department of Energy Oversight Policy, DOE Order 226.1B, Implementation of Department of Energy Oversight Policy.

[52] NNSA NA-1 SD 226.1A, *NNSA Line Oversight and Contractor Assurance System Supplemental Directive*.

informed and focus on the areas of weakness in the contractor's program and performance. The process includes reviews of line oversight by a headquarters review team. The effectiveness of a CAS varies across the laboratory system, so, there is an opportunity to improve consistency by sharing best practices on the use of a CAS and successes in applying oversight frameworks.

Accountability is essential to efficient and effective implementation of requirements. Responsibilities for managing risks are distributed and diluted across DOE program offices, field elements, including oversight staff at field offices and service centers, M&O contractors, and laboratories. Authority and responsibility are not always aligned, which blurs the lines of accountability. Improper placement of accountability can promulgate conservative interpretations, which is observed through the duplication of responsibilities across the DOE enterprise. For example, reporting and approvals for various requirements could be streamlined if authority to engage in activities, such as WFOs and CRADAs, could be controlled in the field, by field elements or the laboratory, as appropriate. The Commission observes that the implementation of a CAS is a step forward in restoring the "trust but verify" oversight role and eliminating unnecessary bureaucracies that obstruct the focus on obtaining high levels of performance from the laboratories.

D. Characteristics of Burdensome Requirements

Interviewees across the DOE system mentioned various burdensome requirements, many repeating similar concerns documented in past reform efforts. (Refer to Appendix H for summaries of burdensome requirements identified in past reforms.) The Commission identified four characteristics of these requirements that impact the level of burden experienced by the laboratories.

1. Prescriptive and Transactional

Requirements can include language that is overly prescriptive, which leads to transactional oversight. Overly prescriptive language includes references to specific industry standards and DOE guides, technical standards, handbooks, manuals, and the like. DOE guides and handbooks, for instance, are intended to share best practices rather than be used for enforcement. References to non-mandatory DOE documents have caused confusion in interpretation of mandatory requirements and their implementation in the field. An example of overly prescriptive language appears in the DEAR—a clause to acquire vending machines that are fully capable of accepting and dispensing $1 coins and to ensure that signs and notices are displayed denoting these capabilities.[53] DOE

[53] FAR 52.237-11, Clause I.71, Accepting and Dispensing of $1 Coins.

contracting officers have some latitude on which DEAR clauses and directives to include into the M&O contracts. However, laboratories indicated that similarly prescriptive clauses are increasingly being inserted into the M&O contracts.

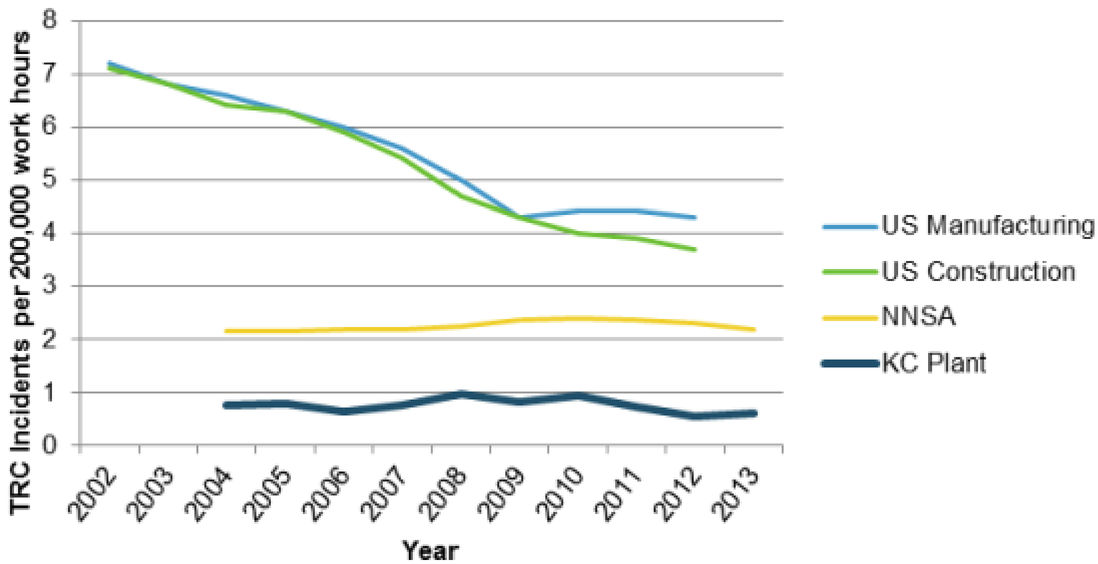
2. Redundant and Outdated

Requirements in areas in which applicable Federal, State, or local regulations and national standards exist cause confusion in implementation. Of these, requirements that reference outdated standards potentially open the laboratories to risk when subcontracting or procuring necessary items. A notable example of references to outdated requirements includes 10 CFR 851, DOE's safety standard issued in 2006 (Table 9). Two of the DOE standards have not been revised, while the standard industry codes have been updated 3 times, and a third standard is based on designs that are no longer manufactured.

Table 9. Examples of Requirement References to Outdated Standards

Outdated Standards	Description
National Electrical Code/NFPA 70	10 CFR 851 invokes the 2005 edition of the code. The code has been updated 3 times since 2006 (2008, 2011, and 2014). Electrical designs are typically performed to the latest edition of the NEC to ensure lessons learned and emerging technologies are incorporated; however, this practice outpaces the regulation and designs are not in compliance.
Standard for Electrical Safety in the Workplace (NFPA 70E)	10 CFR 851 invokes the 2004 edition of the NFPA 70E, which has been updated 3 times (2009, 2012, and 2015). Lessons learned and improved guidance and criteria have been incorporated into the newer editions of the Standard. These provide for enhanced worker safety above what is required.
American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code	10 CFR 851.27(b)(7) and Appendix A(4)(b)(1) invoke the 2004 edition of the ASME Boiler and Pressure Vessel Code. ASME codes are periodically revised and updated, making previous editions either obsolete or not applicable. Pressure vessels are not manufactured or certified to the referenced obsolete code editions. DOE contractors/subcontractors use alternate editions of the code at the risk of enforcement of non-compliance.

DOE's highly active role in enforcing health and safety violations drives M&O contractors to become risk averse in implementing these and other requirements. Implementing outdated safety standards can cause confusion, reduces protection, and increases risk for the M&O contractors and its subcontractors whose crews are trained on the current standards and who may be brought onsite at DOE facilities from offsite projects where they follow current standards. If they follow the current standards at the DOE facilities, the M&O contractors would technically not in in compliance with the DOE standards. In fact, a comparison of the safety record for NNSA laboratories, the Kansas City Plant (KCP), and the U.S. manufacturing and construction industries shows that DOE's increasing promulgation of safety-related contract requirements starting in the early 2000s did not necessarily lead to significant decreases in safety incidents (Figure 11). KCP's experience shows that safety performance can be improved (although marginally) by reforming contract requirements and transitioning safety standards to third-party certifications and industry standards (such as through ISO). KCP's reform effort is described in the Section E of this chapter.



Source: Congressional Advisory Panel on the Governance of the Nuclear Security Enterprise (Augustine/Mies panel) A New Foundation for the Nuclear Enterprise: Report of the Congressional Advisory Panel on the Governance of the Nuclear Security Enterprise. DOE Office of Environment, Health and Safety (formerly the Office of Health, Safety and Security), presentation to the Congressional Advisory Panel on the Governance of the Nuclear Security Enterprise, 22 January 2014, Figure 7. U.S. manufacturing and construction data are from the Bureau of Labor Statistics.

Figure 11. Comparison of Safety Trends (Total Reportable Cases), 2002 to 2013, for Kansas City Plant, NNSA Laboratories, and the U.S. Manufacturing and Construction Industries

In addition, laboratories claim that burdensome requirements for project management have resulted in relatively higher costs to develop a Government-owned facility than in the private sector (See Chapter 15).[54] Comparison of construction costs with the private sector has been the topic of several DOE working groups and studies.[55]

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[54] DOE Orders 430.1B Change 2, "Real Property and Asset Management," and the 18 associated Guides, 9 Handbooks, and 12 Secretarial Memorandums, see DOE, "DOE Project Management Policy and Guidance," available at http://energy.gov/management/office-management/operational-management/project-management/policy-and-guidance.

[55] DOE, *Operations Improvement Committee Workshop Committee Report on Construct Cost at National Laboratories*, (Washington, DC: DOE, 2012). Government Accountability Office (GAO), *Capital*

These studies noted factors that could lead to higher costs to the government, including excessive oversight for worker safety and project management requirements. Other factors that could contribute to higher costs extend beyond DOE requirements, such as the Davis-Bacon Act to provide local prevailing wages to subcontractors.[56] Incremental funding and uncertainties in the Federal budgeting process also affect long-term investments necessary throughout a facility's life-cycle. In addition, some laboratories are required to use project labor agreements (PLAs), which are negotiated plans for the use of union employees on projects. The effects of these factors have not been rigorously studied and the evidence base for their burden is anecdotal.

Interviewees mentioned that, despite their potential for additional costs, DOE requirements in the area of worker and nuclear safety, however inconsistent with industry standards they are, provide the reassurance of safety to contractor and subcontractor employees. For instance, officials at Lawrence Berkeley stated that its M&O contractor, the University of California at Berkeley, opted to implement some of DOE's safety requirements for construction of their own facilities, such as university campus buildings.

3. Spillover of Nuclear Requirements to Non-Nuclear Operations

Nuclear facility operations and laboratories are subject to a more rules and requirements than non-nuclear laboratories. This is to be expected, given that managing nuclear operations is more complex and higher risk than managing non-nuclear operations, particularly when it comes to safety and security. The difficulty lies in the interpretation of requirements at laboratories that may manage both nuclear and non-nuclear facilities. Only three laboratories—Ames, Fermi, and NREL—manage only non-hazardous facilities. For the other 14 laboratories, from 3–25 percent of the facilities are classified as nuclear facility Hazard Category 1, 2, or 3 or radiological facility (Table 10)[57]. Inefficiencies occur when field elements and laboratories do not apply a graded

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Financing: Partnerships and Energy Savings Performance Contracts Raise Budgeting and Monitoring Concerns, (Washington, DC: GAO, 2004). Contractor Financial Management Alliance, *Economics of an Alternatively Financed Facility: Four Case Studies*, (Idaho National Laboratory, 2013). Available at https://inlimages.inl.gov/imageserver/appfiles/INLCM/portalcm_newsltr_feature_portlet_11983_page_8205/file_2013_11_5_18_9_49_393.pdf.

[56] Davis-Bacon Act of 1931 was established to pay local prevailing wages for public works projects, see Department of Labor, "Wage and Hour Division: Davis-Bacon and Related Acts," available at http://www.dol.gov/whd/govcontracts/dbra.htm.

[57] DOE categorizes nuclear facilities by hazard category codes that represent the hazards associated with a building. Nuclear facility hazard category 1 represents a facility with a hazard analysis that shows the potential for significant off-site consequences during an accident. An example is the Advanced Test Reactor at INL. Nuclear facility hazard category 2 represents a facility with a hazard analysis that shows the potential for significant on-site consequences during an accident. An example is the Defense Waste Processing Plant at Savannah River. Nuclear facility hazard category 3 represents a facility with a hazard analysis that shows the potential for significant localized consequences during an accident. An example

approach, as intended by requirements, based upon the hazards present as well as the risk associated with those hazards.

Non-nuclear laboratories that also operate nuclear and other hazardous facilities are concerned that nuclear operating requirements will extend to their non-nuclear operations. Some laboratories have begun efforts to consolidate their nuclear work to gain efficiencies in operations.

Table 10. Type and Number of Facilities for Laboratories Operating Nuclear and Non-Nuclear Facilities at 17 National Laboratories in FY 2014

		Assets without Nuclear or Radiological		Assets with Nuclear or Radiological		Total Assets
Office	Laboratory	# Assets	% Assets	# Assets	% Assets	
SC	AMES	14	100%	0	0%	14
	ANL	159	76%	49	24%	208
	BNL	408	88%	55	12%	463
	FERMI	466	100%	0	0%	466
	JLAB	103	85%	18	15%	121
	LBNL	201	91%	21	9%	222
	NETL	239	100%	0	0%	239
	ORNL	580	83%	116	17%	696
	PNNL	97	90%	11	10%	108
	PPPL	56	97%	2	3%	58
	SLAC	220	83%	45	17%	265
EERE	NREL	67	99%	1	1%	68
EM	Savannah River	100	87%	15	13%	115
NE	Idaho	724	81%	172	19%	896
NNSA	Los Alamos	1481	92%	136	8%	1617

is the Transuranium Research Lab at ORNL. A Radiation facility handles or contains nuclear materials, but at levels below the threshold for Nuclear Category 3 facilities. An example is the National Tritium Labeling Facility at LBNL. Thresholds are defined in DOE-STD 1027-92, Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports.

Lawrence Livermore	507	74%	175	26%	682
Sandia	1223	99%	16	1%	1239

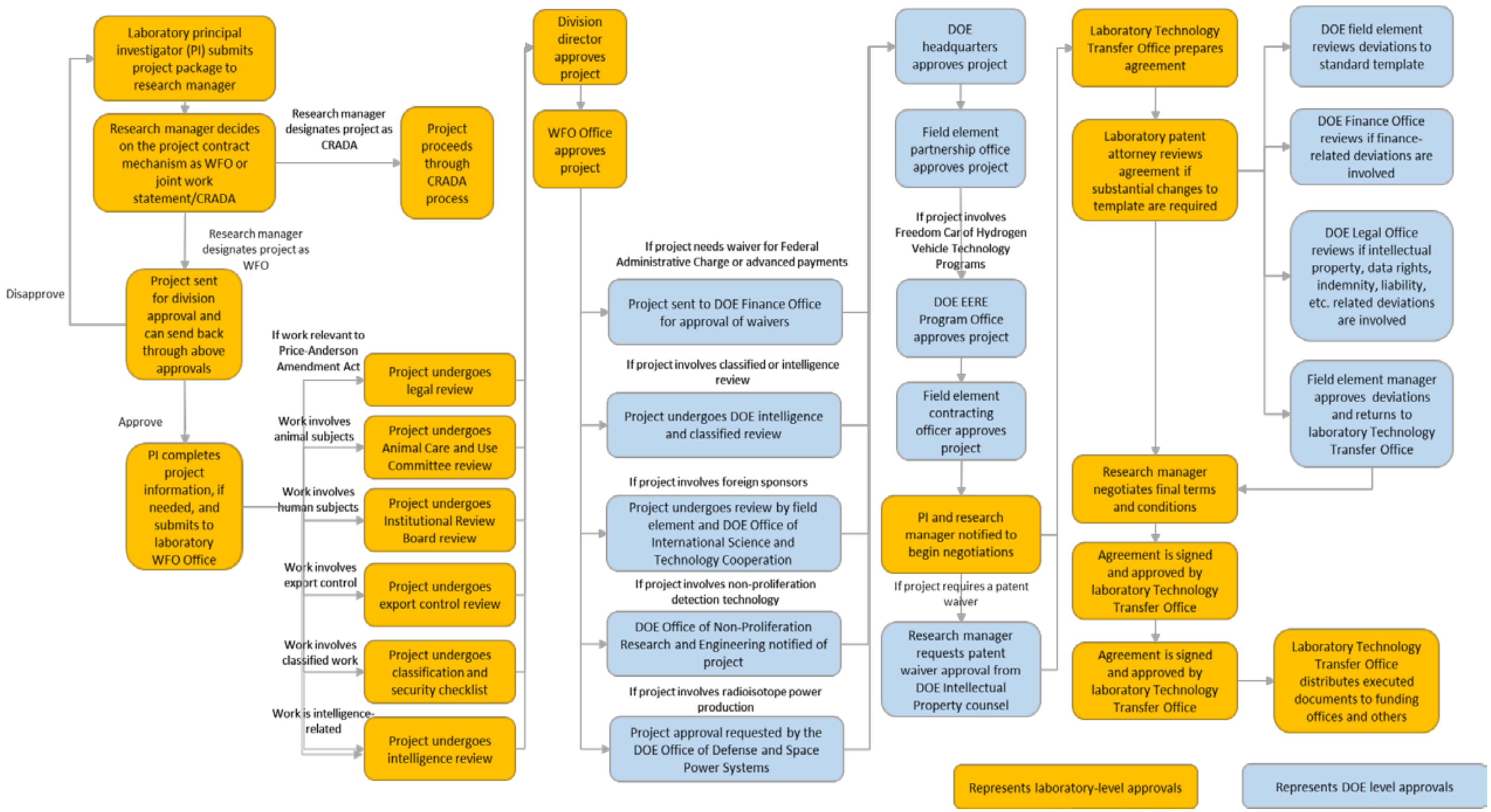
Source: Data provided by the DOE Office of Management.

SC: Office of Science, EERE: Office of Energy Efficiency and Renewable Energy, EM: Office of Environmental Management, NE: Office of Nuclear Energy, NNSA: National Nuclear Security Administration

Note: Assets include buildings, trailers, and other structures, such as radioactive waste storage tanks and pits. Classification of hazard categories for assets are recorded in DOE's Facility Information Management System.

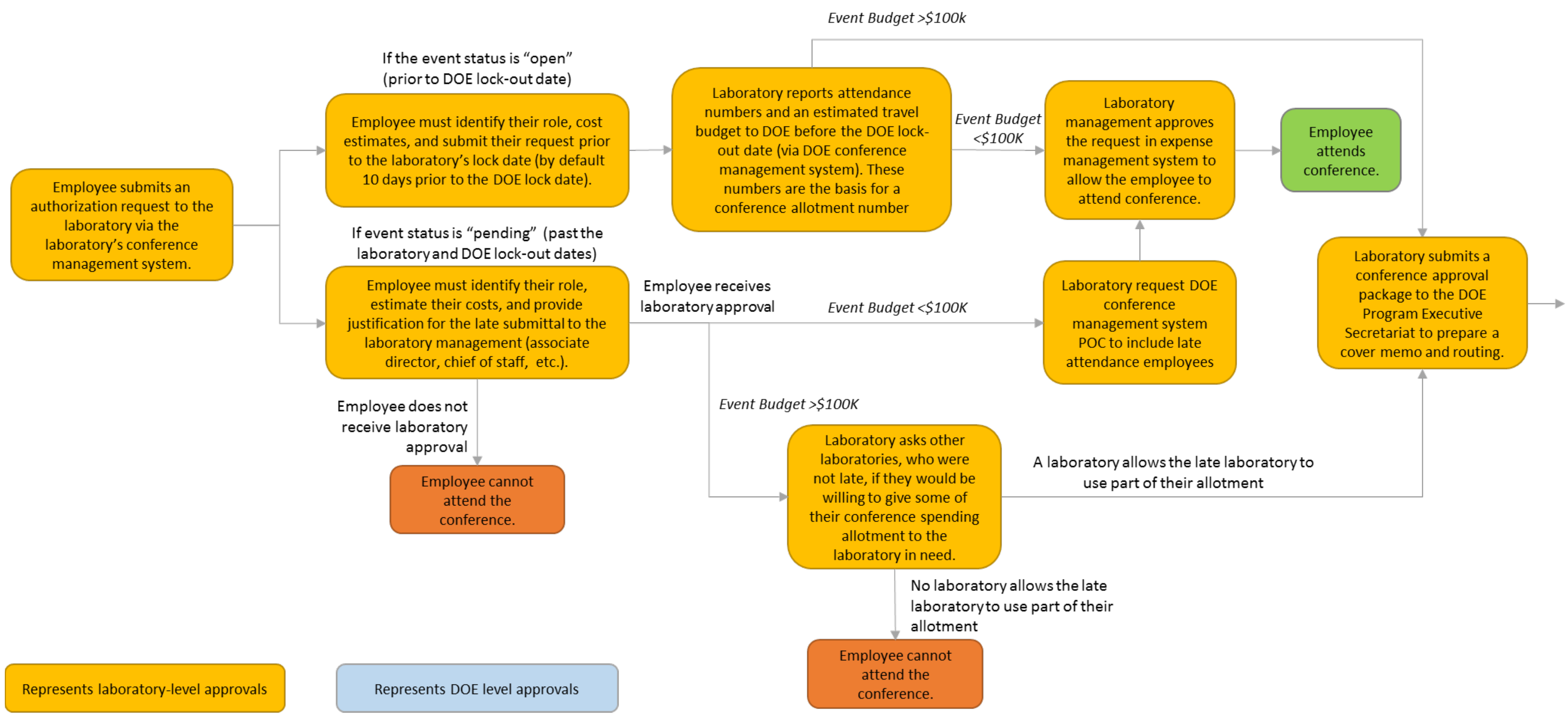
4. Bureaucratic and Unnecessary

Some laboratories experience approval overhead for activities such as Work for Others (WFOs), Cooperative Research and Development Agreements (CRADAs), conferences, and foreign travel and visitors. A laboratory that engages in these activities must seek a range of approvals across field elements and many headquarter offices. (Refer to Figure 12 and Figure 13 for depictions of the approval processes for WFOs and conferences, respectively.)



Source: Based on interviews.

Figure 12. Work for Others Approval Process



Source: Based on interviews.

Figure 13. Approval Process for Conferences (continued on next page)

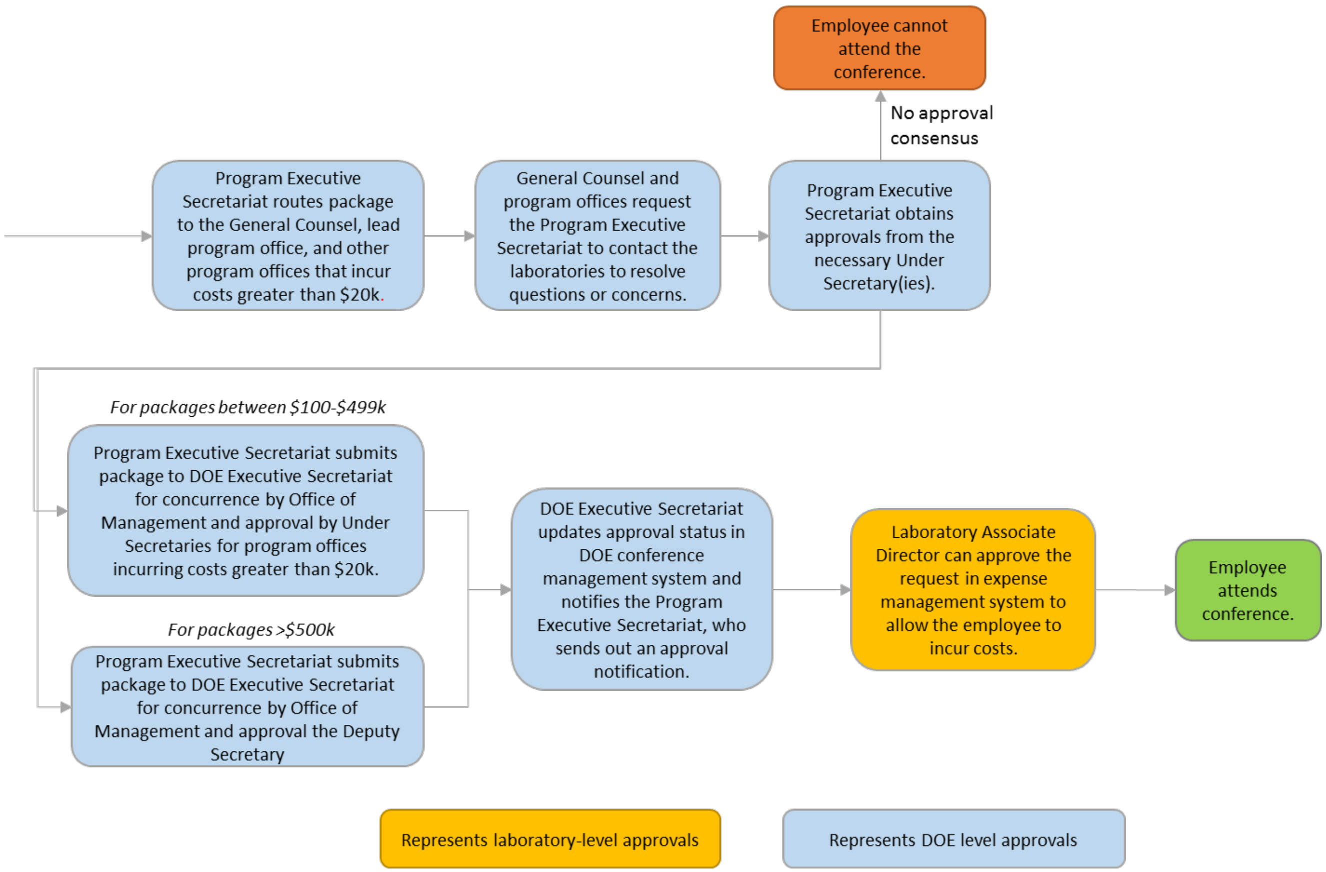


Figure 13—*Continued*

While approval processes for these activities is generally managed well by most laboratories and timelines can be reasonable (e.g., a 2–4 week turnaround for WFOs). However, some laboratories indicated instances in which lengthy approvals (taking several months to a year) have driven some WFO customers and scientific collaborators away from engaging with the laboratory. Lengthy approvals of WFO projects may be influenced by other factors as well, such as disagreements on intellectual property rights and requests to change standard contract clauses.

In 2012, OMB released a memorandum to all Federal agencies to promote efficient spending, which built upon Executive Order No. 13589 and a prior OMB memorandum on the topic,[58, 59] and outlined new policies and practices to reduce spending, largely for travel and conferences.[60] At the time, the DOE Deputy Secretary released a series of letters instructing the implementation of new OMB requirements.[61] Some of the new policies required that conferences for which total DOE travel costs were over $100 thousand required the Deputy Secretary's approval and conferences over $500 thousand required a waiver from the Secretary of Energy.

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. Laboratories may not even develop requests for conferences that meet thresholds and require additional senior DOE leadership approvals. Conference policies could hinder the laboratory's ability to retain the best researchers and to maintain a leading edge. Lengthier approvals for conferences have led laboratory employees to decline to submit papers or accept speaking invitations due to uncertainty about gaining approval to attend. When approval is not granted until close to the conference date, employees inevitably must spend more on conference registrations, lodging, and travel arrangements.

GAO reported that DOE officials provided examples of changes in conference participation at the NNSA laboratories during the period since the conference policy

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[58] Executive Order No. 13589, *Promoting Efficient Spending*, (November 9, 2011).

[59] Jacob J. Lew, *Eliminating Excess Conference Spending and Promoting Efficiency in Government [Memorandum]*, (Washington, DC: OMB, 2011).

[60] Jeffrey D. Zients, *Promoting Efficient Spending to Support Agency Operations [Memorandum]*, (Washington, DC: OMB, 2012).

[61] David B. Poneman, *Promoting Efficient Spending to Support Agency Operations [Memorandum]*, (Washington, DC: DOE, 2012).

change.[62] Data on conference attendance in 2009 and 2014 provided to the Commission by a handful of SC laboratories indicated a mixed result (Table 11).

Table 11. Total Employees Attending Conferences in 2009 and 2014 for Select Laboratories

	Number of Employees	
Laboratory	**2009**	**2014**
Argonne	1,969	3,541
Fermi	387	917
Thomas Jefferson	506	706
Princeton Plasma	290	264

Source: Data provided by select DOE National Laboratories

It is hard to draw definitive conclusions on the impact of the new conference management rules since many other factors are also at play, including increases and decreases in annual programmatic R&D funding. GAO noted that it was unable to determine whether the changes in conference participation by NNSA laboratory researchers could be directly attributable to the policy change because of incomplete data and other confounding factors, such as the budget cuts associated with sequestration. The increase at some of the SC laboratories may result from employees learning to more efficiently navigate DOE's conference policies. Laboratory staff have also noted that implementation of the new conference management policies requires more staff time and resources to approve the same amount of conference attendance requests. In addition, comparison of trends in conference attendance does not fully capture the demand to attend conferences since this does not account for conferences researchers chose not to pursue because of the added administrative burden.

DOE has made some changes to improve the process such as creating a list of reoccurring, non-DOE-sponsored conferences that will be subject to an expedited process and setting deadlines to attend conferences that allow time for the employees to receive discounted registration fees. However, these changes may not effectively alleviate the constraints employees face when making decisions about submitting papers, accepting speaking roles, and locking in cheaper travel arrangements.[63]

[62] GAO, *Defense Science and Technology: Further DOD and DOE Actions Needed to Provide Timely Conference Decisions and Analyze Risks from Changes in Participation*, (Washington, DC: GAO, 2015) Available at http://www.gao.gov/products/GAO-15-278.

[63] GAO, *Defense Science and Technology: Further DOD and DOE Actions Needed to Provide Timely Conference Decisions and Analyze Risks from Changes in Participation*, (Washington, DC: GAO, 2015) Available at http://www.gao.gov/products/GAO-15-278.

E. Past Reform Efforts

The long history of efforts to reform requirements at DOE include proposals to transition to external regulation, reform contracting practices, and conduct internal reviews (Table 12). Reforms have involved the National Laboratories and other sites in the DOE complex, including plant and production sites.[64] A look at these efforts over the past two decades reveals mixed perceptions of success on outcomes across the DOE enterprise.

The past reform efforts suggest that DOE's leadership agreed that requirements needed to be improved. Among the successes was the introduction of flexible oversight frameworks that reduce or tailor DOE requirements at specific sites. Critics claim that most reform efforts produced little or no substantial or long-lasting changes in the way of doing business at the laboratories. Reforms were often initiated with support from DOE's top leadership, who articulated goals of providing greater flexibility for laboratories and avoiding excessive oversight. Many of the reforms have been heavily collaborative. Generally, when initiating a requirements reform, DOE leadership has sought input and involved representatives from across the complex, including field offices and laboratories.

Table 12. Examples of Previous DOE Requirement Reforms

Reform Effort	Time Period
External Regulation (transition to Nuclear Regulatory Commission (NRC) and Occupational Safety and Health Administration (OSHA) regulations)	Mid-1990s to early 2000s
Kansas City Plant (KCP) Management Pilot	2006 to 2009
Hanford Site Mission Support Contract	2009 to present
NNSA Applications of the KPC Model to other sites	2009 to 2011; 2014 to 2015
DOE Safety and Security Reform	2010 to 2012
National Laboratory Director's Council (NLDC) Prioritization of Burdensome Policies and Practices	2011
Mission First Initiative and Contract Equivalencies Initiative	2012 to 2013
Y-12/Pantex contract consolidation	2014

[64] Although DOE plant and production sites were considered outside the scope of the Commission's charge, reform efforts at these sites provided lessons learned for the management of DOE requirements relevant to the national laboratories and were included in the Commission's analysis.

1. Successes

The specialized nature of improvements from successful reforms at NNSA plants and production sites provide some lessons that could be applied to the broader management of requirements at the national laboratories.

a. Kansas City Plant

In 2006, NNSA initiated a pilot at the Kansas City Plant (KCP)—a site that manufactures electronic and other non-nuclear components of nuclear weapons in Missouri. The pilot was successful in streamlining and eliminating many requirements by relying on industry standards and corporate best practices (Table 13). The number of requirements, including DOE orders, NNSA policies, and technical standards decreased from about 160 to about 70 after the reform.[65]

Table 13. Examples of DOE and KCP Requirements Before and After Reform

Operating Requirement	DOE	KCP
Quality Management	DOE Order 414.1D, Quality Assurance	International Standards Organization (ISO) 9001:2008*
Facility Safety	DOE Order 420.1C, Facility Safety	Rely on municipal firefighting services and eliminate on-site fire department
Environmental Safety and Health (ES&H)	10 CFR 851, Worker Safety and Health Program DOE Policy 450.4, Safety Management System Policy, orders, guides, and manuals	DEAR 970.5204-1 Integration of ES&H into work planning and control Occupational Safety Health Administration (OSHA) Requirements^ ISO 14001:2004
Emergency Management	DOE Order 151.1C, Comprehensive Emergency Management System, and guides	National Fire Protection Association (NFPA) 1600: Standard on Disaster/Emergency Management and Business Continuity Programs[#]
Security	DOE 470, Safeguards and Security Program series of requirements	Site-specific standard based on National Industrial Security Program manual**

Source: GAO 2014, 2007 KPC Report, NNSA. 2014. "Extension of Program Principles from the Kansas City Plant Oversight Pilot," Report to Congress. NNSA: Washington, D.C.

* ISO 9001:2008 is an international standard used in private industry to ensure that quality and continuous improvement are built into all work processes.

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[65] GAO, *National Nuclear Security Administration: Agency Expanded Use of Some Federal Oversight Reforms, but Is Still Determining Future Plans*, (Washington, DC: GAO, 2014). Available at http://gao.gov/assets/670/664835.pdf.

^ KCP initially maintained OSHA's VPP "Voluntary Protection Program," which was replaced by OHSAS 18001 for occupational health and safety management systems.

[#] NFPA 1600 has been adopted by the U.S. Department of Homeland Security as a voluntary consensus standard for emergency preparedness.

** NISP was established in 1993 by Executive Order No. 12829 and manages industrial security in private industry.

Many throughout NNSA, including KCP field managers and staff, view the pilot as successful, partly because of the high-level support from, NNSA leadership and field elements.[66] For instance, KCP established a joint-Federal field office and contractor board to identify non-value-added DOE requirements and prevent "creep" of new or revised requirements. In addition, the plant's work was low-risk and non-nuclear, resembling private sector manufacturing. Nuclear safety and security requirements did not apply to KCP's work, which facilitated the elimination of DOE requirements.[67] Some significant outcomes from the pilot included more than $465,000 yearly cost savings from recognizing that the municipality could meet onsite fire services. In addition, KCP refocused Federal oversight to rely on contractor and third-party assessments and data, primarily for lower risk activities. Oversight staff was reduced from 55 to 38 and resources re-prioritized towards high-risk activities.[68]

Due to the high-risk activities at other NNSA sites, the transition of the KCP model to those sites has been limited. (Refer to Section F.)

b. Contract Reforms

Although tangential to the direct reform of requirements, the following contract reforms at NNSA initiated new governance and oversight models that provide more effective means of implementing DOE requirements:

- The Y-12 National Security Complex in Tennessee and the Pantex Plant in Texas represent two core nuclear production sites in NNSA. In 2014, these contracts were consolidated into a single M&O contract. From contract planning to award, the process took 6 years.[69] Award fees are allocated to the contractor based on cost savings and continuous improvement at the sites, including personnel and operational efficiencies. The contract is envisioned to generate more than $3 billion in cost savings.

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[66] *Ibid.*

[67] *Ibid.*

[68] Number of staff based on interviews and current as of time of writing.

[69] GAO, *National Nuclear Security Administration: Reports on the Benefits and Costs of Competing Management and Operating Contracts Need to Be Clearer and More Complete*, (Washington, DC: GAO, 2014). Available at http://www.gao.gov/assets/670/669156.pdf.

- The Hanford Site in Washington established a separate performance-based contract for mission support services, such as facility maintenance and operations, and some items in the contract have a fixed price. The mission support contract has allowed oversight to identify what needs to be done by the contractor but not how.

2. Lack of Improvement

The processes to undertake past reforms incurred significant costs and required thousands of hours to respond to numerous requests to provide data, compile information, and provide input.[70] Critics from across the complex claim that results had little substantial or long-lasting benefits to laboratory operations. (Certain exceptions were previously mentioned.)

In some cases, reform efforts have failed to be implemented altogether not long after leadership has announced a commitment or intention to proceed with reform (Table 14). For instance, in the 1990s, the DOE Secretary at the time announced an initiative to shift the Office of Science laboratories to external regulation through the Nuclear Regulatory Commission and the Occupational Safety and Health Administration (OSHA). After multiple pilots of this initiative at several SC laboratories in the early 2000s, new DOE leadership announced that DOE would not proceed with the transition to external regulation due to its high cost.

In addition, DOE's safety and security reform, led by the new Office of Environment, Health, Safety and Security, reduced the total number of requirement documents by combining multiple relevant requirements into fewer documents.[71] It is unclear whether this and other reforms have led to the elimination of transactional and low-added-value requirements. Refer to Appendix H for further discussion of past reforms.

Table 14. Examples of Unsuccessful Requirement Reform Efforts

Reform Effort	Description	Reasons for Lack of Success
External	Focused on reform of Office of	Several DOE leaders transitioned in and out of their positions

[70] This information is based on interviews. DOE does not estimate the costs of reform processes and data was not collected to validate interviewees' opinions. The lack of assessments of costs to inform reforms and establishment of policies is the topic of a GAO report, see GAO, *DOE Needs to Determine the Costs and Benefits of Its Safety Reform Effort*, (Washington, DC: GAO, 2012). Available at http://www.gao.gov/assets/600/590256.pdf.

[71] The Office of Environment, Health, Safety and Security (EHSS) and the Office of Enterprise Assessment (EA) replaced the former Office of Health, Safety and Security (HSS) in May 2014.

Regulation	Science laboratories Nuclear Regulatory Commission and OSHA piloted reforms at several laboratories and assessed costs DOE conducted cost assessments	changing previous leadership's commitments DOE claimed that transition would be too costly up-front Lacked relevance to the DOE system as a whole since targeting science laboratories
NLDC Prioritization of Burdensome Policies and Practices	NLDC prioritized 18 policies and practices from 80 proposed policies and practices across the system	Some actions taken, but controversial policies and practices remain in effect
Mission First Reform Initiative	Stemmed from a response to an NRC study DOE created working teams in governance, finance, and contracting A 3-year implementation plan was developed but cancelled after 1 year	Security incident at the Y-12 complex stalled the reform Reform was cancelled in March 2013
Contract Equivalencies Initiative	Identified requirements above and beyond Federal, State, and local regulations NNSA laboratories analyzed requirements and proposed revisions	No actions taken on recommended revisions

Source: Based on interviews.

NLDC: National Laboratory Director Council, NNSA: National Nuclear Security Administration, NRC: National Research Council, OSHA: Occupational Safety and Health Administration.

3. Lessons Learned

The review of DOE's reform history indicates that reforms were often piece-meal, focused on single functional areas or sites, and not aimed to resolve systemic issues within the DOE system. For instance, the Commission identified the following issues with previous reform efforts:

- Excessive number of prescriptive contract requirements were expected to be implemented without regard to cost and balance of risks
- Requirements that instructed "how" work is to be conducted rather than describing performance and mission expectations
- Authorities for direction, oversight, and risk-acceptance were placed at various levels rather than a single location, creating complexity and confusion of roles and responsibilities
- Little or no risk tolerance and a lack of understanding of risks meant requirements could not be tailored to unique laboratory environments

Some lessons gleaned from past reform efforts suggest that reforms *can* work effectively in certain situations:

1. If reforms address simpler (i.e., single purpose), low-risk, non-nuclear operations. The addition of nuclear or radioactive research and operations adds complexity and greater scrutiny. Also nuclear requirements can spill over to low-risk non-nuclear operations.
2. If reforms are collaborative. Successful reforms are driven by strong leadership support at all levels and rely on expertise from appropriate stakeholders across the complex, particularly from those in the field.
3. If accountability and authority for oversight are aligned. Alignment leads to efficiencies by allowing greater tailoring of relevant requirements and reliance on third-party or laboratory assessments to maintain adequate safety and mission performance.

F. Ongoing Efforts to Reform Requirements

Several reform efforts are ongoing—two pilots initiated by the Office of Science, a review of outdated DOE requirements, and an evaluation led by NNSA on the use of national consensus standards. The SC pilots are at specific laboratories:

- One pilot is designed to eliminate relatively low-risk requirements from the M&O contracts, including human resources, foreign travel approvals, and data requests.[72]
- Another pilot is being proposed by a group at SLAC to consider changing SLAC's contract arrangement from an M&O to a cooperative agreement or a considerably streamlined M&O contract. The group is exploring which DOE requirements would apply to either type of agreement (if any).[73] SLAC and DOE intend to eliminate redundant and little value-add contract requirements that are not relevant to SLAC's work, similar to the process undertaken at KCP.

These pilots are being informed by parallel efforts to identify management concerns and actionable recommendations for reform:

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[72] At the time of writing, DOE had not selected the site for the pilot.

[73] 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 Grants.gov (www.grants.gov), of which most are for research rather than for facility construction and management.

- A Secretary of Energy Advisory Board (SEAB) task force established to study issues related to the health and management of the national laboratories[74]
- An Office of Science working group created to review input and study modifications to laboratory M&O contracts for single-program laboratories (DOE 2015)[75]

Requirements are also being reformed through authorities provided to the director of the Office of Management. According to DOE policy, the director of the Office of Management can cancel orders and guides that have not been recertified in the past 4 years.[76] The director of the Office of Management is responsible for presenting the requirement to the DRB for consultation. This process provides a means of attesting to the requirement's continuing relevance or assessing if revisions are necessary. The director of the Office of Management recently identified the 10 oldest DOE requirements—dating back to the 1980s—that were not recertified in the past 4 years and plans to review their relevance. Although this review will address only about 15 percent of the requirements in the recertification backlog, it provides a beneficial opportunity to eliminate unnecessary requirements.

Lastly, NNSA is leading an enterprise-wide effort to apply a process similar to that at KCP to compare DOE requirements with national consensus standards. The process will identify requirements that add little value to contractor performance and operations. The effort is ongoing and initial analysis indicates that there could be benefits in eliminating DOE requirements and relying on national standards for lower risk administrative functions, such as human resources and business and financial services. Given sweeping elimination of such contracts may not necessarily change the way contractors do business since requirements in these areas can also be regulated by Federal law or governed by corporate best practices. Nonetheless, cancellation of administrative requirements has the potential to streamline oversight.

G. Findings and Recommendations

The Commission has formulated the following findings related to the development and implementation of contractor requirements:

- There are too many requirements in areas that provide little or added value and are redundant of Federal, State, and national standards. DOE has been

[74] SEAB, *Report of the Secretary of Energy Task Force on DOE National Laboratories*.

[75] DOE Office of Science, *Working Groups to Study Modifications to Laboratory M&O Contracts for Single-Program Laboratories*, (Washington, DC: DOE, 2015).

[76] DOE Order 251.1C, Departmental Directives Program.

increasingly establishing requirements across various functional areas. There has been a significant increase in requirements related to safety, security, and environmental health; as well as lower-risk activities such as human resources, business services, and financial services. Generally, many of these requirements add little or no value to laboratory operations and performance, with exceptions in activities in nuclear, high-hazard, and/or classified areas where regulatory and industry standards may not apply or exist. Some of the DOE requirements are not even as up-to-date as Federal, State, and industry standards, which causes confusion and potential risks for subcontractors that comply with updated standards at their off-site locations and are brought on-site to a DOE laboratory.

- Requirements are too prescriptive and dictate *how* activities should be performed rather than *what* outcomes are to be achieved by the laboratories. Instead of guiding the laboratory's work, many DOE requirements dictate prescriptive compliance. This practice undermines the benefits from allowing M&O contractors to rely on regulatory standards and best practices from business principles for the operation and administration of the laboratories.
- Requirements dictate too many approvals, reflecting layers of bureaucracy and the lack of integrated responsibilities for oversight across headquarters and field elements. DOE's requirements can involve excessively bureaucratic approvals from many offices across the system rather than allowing decisions to be made at the lowest possible levels. The rationale for requiring these approvals is not explicit. It is also not clear whether laboratory or field element approvals could suffice, particularly in areas related to WFOs, CRADAs, conference management, and foreign travel. The current situation can cause delays and confusion regarding accountability and hinder collaborations that are critical to a high-performance research and development organization.
- DOE's process to develop and review requirements could improve rigor and feedback. DOE provides opportunities for involvement and input from the field elements and laboratories at various stages in the process. However, there is generally a lack of quality input, particularly on value and impacts, stemming from ineffective engagement and communication. Responsibility to provide feedback throughout the process to develop requirements lies with DOE program and functional offices, field elements, and the laboratories. Engagement could be improved by increasing participation from subject matter experts, particularly from the field, in the decision-making process and maximizing quality input.
- DOE does not properly consider risk and impacts to develop and implement requirements. Although some new efforts exist to review the risks associated with contractor requirements, these efforts are rudimentary and not consistently

applied across the system. In fact, DOE does not have a comprehensive framework to strategically assess the value of the accepting or ameliorating risks relevant to laboratories' operations. DOE lacks a core capability to independently assess risks and impacts to laboratory operations in order to effectively inform decisions for new requirements.

The Commission has the following recommendations for the Department to improve the development and implementation of requirements.

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.

Recommendation 8: DOE should modify its processes for developing directives, orders and other requirements to 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.

The Commission recommends the following specific and actionable strategies that involve Congress and stakeholders throughout the DOE enterprise, including headquarters, field elements, M&O contractors, and laboratories, to implement the recommendations above.

- DOE headquarters and Laboratories should work together to establish more robust DOE policies and processes to review and develop contractor requirements.
  - DOE headquarters should revise Draft 251.1d 'Departmental Directives Program' and the Technical Standards Program to:
    - Require authors, working with the DRB, to (1) present an analysis of the value and impacts of draft requirements to be reviewed by the DRB before final approval of a draft or recertification and (2) designate field element and laboratory representatives on writing teams for requirements to be applied in M&O contracts.
    - Where appropriate, automatically sunset requirements after a certain number of years, with certain exceptions for requirements in which national or industry standards to not apply or exist.

    - Expand participation of program offices, field elements, and laboratories in the DRB process and seek involvement of these groups through engagement with the Laboratory Operations Board (LOB) or the creation of a focused group under the Under Secretary for Management and Performance[77]

  - DOE headquarters should encourage the Director of the Office of Management to exercise his/her authority to cancel requirements that are overdue for recertification and initiate a DRB review for their continued relevancy.

  - Field elements and laboratories should provide rigorous feedback and evidence of impacts into RevCom and to the NLDC representative to inform DRB deliberations.

  - DOE headquarters should centralize the development of contractor requirements, including Technical Standards, Secretary Memos, Acquisition Letters, etc., rather than having separate programs and processes to establish contractor requirements (e.g., Departmental Directives Program, Technical Standards Program, etc.).

  - DOE headquarters should clarify mandatory contractor requirements versus non-mandatory guidance and best practices. The DRB should review non-mandatory guides, technical standards, and the like, invoked in orders and other mandatory documents and assess their continued relevancy. Invoked non-mandatory requirements should be included in mandatory contractor requirements and separate documentation eliminated.

- DOE headquarters, field elements, and laboratories should work together to address conservative interpretations of contractor requirements by establishing effective mechanisms to discuss intent, implementation, and assess relevancy of requirements to laboratory settings.

  - Laboratories should establish a joint-DOE field element-laboratory board to review the requirements in the DRB pipeline and engage early in discussions on interpretation and implementation.

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[77] The LOB was established by the Secretary of Energy in 2013 to improve the effectiveness and efficiency of the labs and of the relationships among labs, DOE, and contractors, *see* E. Moniz, *Letter to the Chairman Lummis and Ranking Member Swalwell, Subcommittee on Energy, Committee on Science, Space and Technology, House of Representatives*, (July 10, 2013). Available at http://science.house.gov/sites/republicans.science.house.gov/files/documents/Letter%20to%20Chairman%20Lummis%20and%20RM%20Swalwell.pdf.

- Encourage field elements to tailor requirements to the nature of work at the laboratories. This process should be transparent at all levels of the DOE enterprise and supported through maturity of CAS.
- Congress and DOE headquarters should revise relevant DOE requirements (Secretarial Memoranda, DEAR, directives, etc.) and M&O contract clauses, including FAR, as necessary to delegate approval authority locally to field elements for engagement activities, such as WFOs, CRADAs, conferences, and foreign visitors. Where appropriate, delegate approvals to laboratory leadership and conduct oversight and reporting periodically (on an annual or bi-annual basis).[78] .

- DOE headquarters, field elements, and laboratories should develop mechanisms to exchange lessons learned and cultivate effective communication across the DOE system.
  - DOE headquarters should encourage field elements and laboratories to exchange lessons learned and best practices in the implementation of CAS and oversight frameworks across the DOE system. DOE could coordinate this through existing cross-enterprise groups, such as the LOB, or establish a focused group under the Under Secretary for Management and Performance.
  - DOE headquarters should continue efforts to create an open and collaborative environment across the system, including engagement in boards, working groups, and other forums.
- DOE headquarters and field elements should institutionalize risk management practices and principles to address deficiencies in consideration of risk across the DOE system and help balance DOE’s roles as mission performer and self-regulator.
  - DOE headquarters should develop risk analysis capabilities to make DOE agile and responsive to the operational needs of the system. The Commission supports the Secretary of Energy’s recent establishment of a Chief Risk Officer role under the Associate Deputy Secretary’s

[78] A conceptual model proposed by NAS (2015) could be considered as a model to facilitate and streamline approvals processes for SPPs, CRADAs, conferences, and foreign visitors. NAS describes a ‘work scope agreement’ that identifies technical areas in which work can be executed. Similarly, technical areas and other criteria could be identified to characterize activities in which approvals are burdensome and not necessary. This process could serve as an umbrella approval for various projects, conferences, and foreign visitors. Refer to Appendix H of National Academies of Science (NAS). 2015. “Aligning the Governance Structure of the NNSA Laboratories to Meet 21st Century National Security Challenges.” National Academies Press: Washington, D.C.

responsibilities. This responsibility should be further supported by the establishment of a risk office and staff with the responsibility of engaging in independent risk analyses and risk management to inform requirements analysis and decisions.

  - Apply lessons learned and adopt and adapt risk management models from other regulatory agencies, such as the Nuclear Regulatory Commission, to DOE's management, oversight, and development of an enterprise-wide risk management model. See the box "Lessons Learned from Risk Management Frameworks at the Nuclear Regulatory Commission" in Section C of this chapter.

- DOE headquarters should eliminate any requirements that are duplicative of Federal regulatory and industry standards. See the following box "Opportunities for Laboratory Pilots to Streamline Requirements and Operations."
  - To address the confusion when implementing requirements, DOE headquarters should comprehensively review and eliminate any contractor requirements that are duplicative of Federal and State regulatory and industry standards or that provide little or no value add to the operations and performance of the laboratories' missions.
  - To facilitate these efforts, DOE headquarters should task existing cross-enterprise groups, such as the LOB, or create a focused group under the Under Secretary for Management and Performance to:
    - Identify and compile a record of outcomes and burdensome practices from recent reform efforts and assess their applicability.
    - Assess and develop an ongoing capability to evaluate contractor requirements for (1) impacts and value to enable performance, including execution of missions and ensuring adequate protection of environment, health, safety and security, (2) relevancy across specific sites in the DOE enterprise by cross-walking contractor requirements to Federal, State, or local regulations and industry standards and assess DOE's rationale for establishing requirements above and beyond these. DOE could revisit the Contract Equivalency Initiative process and expand this enterprise-wide.

Opportunities for Laboratory Pilots to Streamline Requirements and Operations

There are several opportunities for DOE to pilot requirement reforms that would expand reform efforts currently underway and leverage successful strategies from past reforms.

- DOE's Office of Science pilots that are currently underway to streamline requirements at specific single-program laboratories should be continued. DOE should explore the potential to expand pilots to multi-program laboratories and laboratories in other programs, including the NNSA laboratories. Lessons learned should be developed with input from across the DOE enterprise and systematically applied across the system.
- Pilot the elimination of DOE requirements from M&O contracts that present (1) little value-add and (2) are duplicative of Federal, State and local regulations and industry standards. The identification of requirements for reform could be based on the LOB or a new risk analysis office's efforts to assess the value and relevancy of requirements at specific sites across the system.
- Pilot innovative governance models and M&O contracting vehicles, such as fixed-price mission support contracts and cooperative agreements, which could leverage staff and resources, streamline operations, and generate cost savings.

Note: A description of cooperative agreements can be referenced in 31 U.S.C. §6305.

4. Local Oversight: Contractor Assurance, Site Offices, and Service Centers

A. Introduction

The laboratories execute their mission in the midst of a complicated oversight environment, including significant local or on-site oversight. Any recommendations about efficiencies at the laboratories must also take into account the local oversight environment of the laboratories. As we noted earlier, the SEAB Task Force on the DOE Laboratories identified no less than six groups involved with laboratory management and oversight.[79] DOE field elements primarily consist of two of these entities: DOE Site Offices (called Field Offices in NNSA) and DOE Service Centers. DOE operational oversight offices (e.g. the Office of Independent Enterprise Assessment and the DOE IG) also conduct onsite assessment and may be co-located with the laboratory, but this is discussed further in Chapter 5, Assessments and Data Requests. The multitude of oversight entities has led "to a highly burdensome operating environment that severely diminishes the effectiveness of this arrangement."[80]

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 audits 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 outside audits and inspections. As a result, site office leadership has been able to reduce

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[79] The SEAB Task Force on the DOE 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 (called Field Offices in NNSA), DOE Service Centers, DOE operational oversight offices (e.g. the Office of Independent Enterprise Assessment), [and] The M&O Contractor." SEAB, *Report of the Secretary of Energy Task Force on DOE National Laboratories*.

[80] *Ibid.*

the staff size of some site offices by a factor of two to reflect the reduced workload. The status and maturity of CAS varies across laboratories; so too does the extent to which site offices rely 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.[81]

Particularly important to local oversight is the relationship between the laboratory and its site office.[82] 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 a site office (or two) co-locates and oversees each of the 16 FFRDC laboratories.[83] In the recent Augustine/Mies panel report, the NNSA field offices were criticized as being too large and adding to "wasteful and ineffective transactional oversight."[84] 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. The Commission visited all 17 site offices and conducted interviews concerning the Commission's charge.

Another field element that has a role in managing the laboratories are support centers (also called service centers, business centers, or operational offices).[85] The support centers provide business, technical, and financial support to DOE headquarters and to the site offices. Within the past 10 years, in an effort to improve and streamline mission support, DOE and NNSA have reorganized the support centers, which has led to

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[81] NAPA, *Positioning DOE's Labs for the Future: A Review of DOE's Management and Oversight of the National Laboratories*.

[82] The importance of the site office/laboratory relationship is discussed in previous reports on the National Laboratories, such as NAPA, *Positioning DOE Labs for the Future*; SEAB, *Report of the Secretary of Energy Task Force on DOE National Laboratories*; the Galvin Report, SEAB, *Alternative Futures for the Department of Energy National Laboratories*, (Washington, DC: DOE, 1995); and Augustine/Mies, *A New Foundation for the Nuclear Enterprise*.

[83] 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, *see* http://nnsa.energy.gov/aboutus/ourlocations. For information on SC's 10 site offices, *see* http://science.energy.gov/about/field-offices/.

[84] Augustine/Mies, *A New Foundation for the Nuclear Enterprise*.

[85] More information on the support centers: NNSA http://www.nnsa.energy.gov/aboutus/ourlocations/nnsa-complex, SC http://science.energy.gov/isc/, EERE http://energy.gov/eere/about-us/business-operations/golden-field-office, NE http://www.id.doe.gov/, and EM https://www.emcbc.doe.gov/.

confusion surrounding their roles and responsibilities. Although few outside of the support center personnel can fully explain their role, they do serve important functions. The support centers aid the site offices in their oversight of the laboratories. Depending on the support center, they can also perform significant Department-wide functions such as managing grants or consolidated financial services (e.g., paying DOE's bills). The Commission also visited all support centers.

B. Contractor Assurance System (CAS)

The Contractor Assurance System (CAS) at the DOE laboratories is comparable to quality assurance or internal controls at a company, but in addition to providing assurance to M&O contractors (akin to a Board of Directors or company management), a DOE laboratory CAS also provides assurance to the laboratory's Federal owners and overseers, DOE.

DOE first introduced CAS to the laboratories in 2005 in order to address operational inefficiencies, which had been cited by previous reports, panels, and auditors of the laboratories.[86] DOE Order 226.1 established requirements for "all aspects of operations essential to mission success."[87] In 2007 and 2011, DOE issued revisions to clarify and enhance the order in response to "lessons learned" from incidents and suggestions by outside organizations.[88] In the justification memo for the second revision, DOE described CAS as "instrumental in putting into place a consistent comprehensive oversight model across the Department."[89] Also in 2011, NNSA created a policy letter on "Transformational Governance and Oversight" (NAP-21) to establish additional policy guidance for CAS specifically at its sites.

The requirement for a CAS has been inserted into each laboratory M&O contract by amending the H clause with similar language at each of the laboratories.[90]

1. Purpose of CAS

According to NAPA, the purpose of the Contractor Assurance System (CAS) is "to assure both DOE and contractors' management that laboratory operational and

[86] DOE, *DOE Order 226.1 Implementation of Department of Energy Oversight Policy*, (Washington, DC: DOE, 2005).

[87] DOE O 226.1 (2005).

[88] The new orders established in 2007 and in 2011 are DOE O 226.1A and DOE O 226.1B, respectively.

[89] DOE O 226.1A *Notice of Intent to Revise Department of Energy Order 226.1A* Implementation of Department of Energy Oversight Policy, *dated July 31, 2007* (2010).

[90] An "H clause" in a DOE laboratory M&O contract is a site-specific clause.

programmatic risks are effectively and efficiently identified, controlled, and managed."[91] Similarly, the Contractor Assurance Working Group of the Energy Facility Contractors Group (EFCOG) describes CAS as a cohesive system involving laboratory management ("contractor management"), the M&O contractor ("contractor governance"), and DOE oversight:

- A CAS enables contractor management to provide reasonable assurance that mission objectives will be met and contract requirements fulfilled; that site workers, the public, and the environment are protected; and that operations, facilities, and business systems are effectively run and continuously improved.
- A CAS enables an M&O contractor's governance system to define acceptable performance outcomes, to provide oversight of laboratory performance, and to hold contractor management accountable for these outcomes so that the contractor may provide assurance to DOE.
- Finally, a robust and effectively functioning CAS builds trust between DOE and its contractor, helps to ensure alignment between the DOE and contractors in accomplishing and addressing mission needs, and allows DOE to *optimize* its oversight function to leverage the processes and outcomes of its contractor(s).[92]

The CAS identifies, controls, and manages operational and programmatic risks (as described by both NAPA and EFCOG), but it also builds trust. Trust between DOE and its contractor is key to CAS performance. By trusting an effective CAS, DOE can change the level of its oversight in response to good performance.

To develop this trust, in addition to the systems and metrics that comprise the laboratory input to CAS (as described in DOE O 226.1B and the laboratories' associated H clauses), DOE oversight components must perform certain roles in ensuring the maturity and robustness of the CAS process (Table 15).[93]

Table 15. Contractor Assurance System (CAS) Roles and Responsibilities for DOE Oversight Organizations

Organization	Roles and Responsibilities
Headquarters and sponsoring program	• Provide strategy for CAS implementation both by the

[91] NAPA, *Positioning DOE's Labs for the Future*.

[92] Contractor Assurance Working Group of the Energy Facility Contractors Group, Elements of a Contractor Assurance System Prepared by the Contractor Assurance Working Group of the Energy Facility Contractors Group, (2010).

[93] The SEAB Task Force on the DOE Laboratories described six oversight components: laboratory management, DOE headquarters and sponsoring program offices, DOE site offices, DOE support centers, DOE operational oversight offices, and the M&O contractor.

offices	laboratories and by oversight organizations, including site offices • Support further maturation of CAS throughout the laboratory system • Promote capable leadership at site offices willing to further the principles of CAS and to change oversight based on laboratory performance
Site Offices	• Work in full partnership with the laboratory • Leverage laboratory management systems and oversight mechanisms • Enable mission execution at the laboratory as main priority and goal • Coordinate outside entities on behalf of the laboratory • Implement requirements through graded approach • Optimize workforce size based on improving laboratory management and processes
Support Centers	• Provide support to site offices and other DOE entities
Operational Oversight Offices	• Leverage site reviews of laboratory through site offices • Recognize the role of site offices as coordinators of the laboratories

Note: This list of DOE organizations is taken from the list of six organizations that have a role in oversight of the laboratories (as laid out by the SEAB Task Force on the DOE Laboratories). The non-DOE organizations are the M&O contractor and the laboratory management.

2. Implementation of CAS

In 2013, NAPA looked at DOE's 16 FFRDC laboratories, assessed their CAS, and recommended that CAS be further implemented and matured due to the potential benefits of the system. At the time that NAPA surveyed the laboratories, many still did not have a mature system. That said, the authors of the NAPA report nonetheless concluded that for those laboratories with robust CAS "the DOE oversight model [was] changing" for the better.[94] Today, we still see variation across the laboratories in terms of relationships with DOE and its site offices and effective implementation of CAS.

The Augustine/Mies panel report on the NNSA laboratories highlighted the erosion of trust in the NNSA system and although not referencing CAS by name, recommended that "leaders in both the government and M&Os should prescribe and enforce behaviors that rebuild credibility and trust."[95] GAO found that NNSA has not fully established

94 NAPA, *Positioning DOE's Labs for the Future: A Review of DOE's Management and Oversight of the National Laboratories*, (2013)

95 Augustine/Mies, *A New Foundation for the Nuclear Enterprise.*

policies or guidance for using information from CAS, which has led to inconsistency in NNSA field office procedures.[96] NNSA itself has been concerned that the laboratory CASs are not sufficiently mature to act as a reliable replacement for field office onsite inspections and transactional reviews.[97] Since CAS is already at least nominally in place at the NNSA laboratories and it has been shown to build trust and credibility at other laboratories, the NNSA laboratories could also benefit from a similar implementation of the system.

As the Commission conducted its interviews around the laboratory system, it became clear that though the term "CAS" is widely used, there is some variation in understanding of what it actually means. The potential benefits of CAS can only be realized if the site office is willing to rely on laboratory assessments. The levels of trust differ between the NNSA version of CAS and the SC or applied program office version of CAS. The building of trust between the site office and the laboratory and the optimization or 'changing/reduction' of DOE oversight as a result of CAS is integral in making the process work.

a. Office of Science Laboratories

> *"Internal controls in this laboratory—we don't need to prescribe a [new] process. Instead, [we] help bring in a process that depends on the contractor."*
>
> - Site office personnel at an SC laboratory

In response to its initial experience with CAS, SC modified the H clause in all its M&O contracts executed after January 2010.[98] The Office of Science describes the purpose of CAS as providing "transparency between the contractor and DOE to ensure alignment across the enterprise to accomplish mission needs, and for DOE to determine the necessary level of Federal oversight."[99] SC has also outlined the overarching principles of CAS:

- Line management is accountable for performance
- Assurance is an outcome
- Assurance is reasonable, not absolute
- Assurance covers the full scope of contractor operations

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

[97] NAPA, *Positioning DOE's Labs for the Future*.

[98] DOE Office of Science, "Oversight: Contractor Assurance Systems." Available at: http://science.energy.gov/sc-3/oversight/contractor-assurance-systems/.

[99] *Ibid.*

- Effective assurance is built on mutual trust between DOE and the contractor[100]

Effective implementation of CAS requires collaboration between DOE, especially the site offices, the laboratory, and the M&O contractor. The strength in this partnership then creates trust, even in cases of poor performance. As an example, since before 2005, the Radiation Protection Program at Argonne had repeated issues of noncompliance with 10 CFR 830 and 10 CFR 835.[101] Prior to 2005, the traditional oversight model had not improved Argonne's performance, and Argonne and its M&O contractor, the University of Chicago, could not provide adequate assurance that its Radiation Protection Program followed regulations or met DOE requirements.

The Argonne site office and a more involved M&O contractor (as required by CAS) helped work through these issues at the laboratory. In some cases the site office defended the laboratory to outside entities, including helping DOE enforcement fully understand that the laboratory was improving in terms of its compliance with regulations. This took place concurrently with, and was in part due to, the implementation of CAS across the SC laboratories. Instead of working against each other, the site office and the laboratory were able to leverage CAS to help the laboratory improve its operational performance. With improved communication, collaboration, and persistence, the laboratory is now compliant. This development of trust during a time of poor performance has also allowed for continued and improved collaboration between the two parties. The laboratory provides assurance and transparency while the site office responds to the improved performance of the contractor by reducing its oversight.

At the time of these issues, some at DOE headquarters saw the poor performance of the Radiation Protection Program as evidence that CAS was not working. On the contrary, CAS allowed for greater visibility and finer granularity of laboratory performance and increased transparency into the actions taken by management to improve the situation. Those who were on-site during this time say that the previous oversight model did not help the laboratory improve its performance, but that CAS was critical in the laboratory becoming compliant with DOE regulations. As one interviewee remarked, "not performing well does not mean contractor assurance is broken."[102]

Starting in 2010, SC conducted peer reviews of CAS across its 10 laboratories for assurance that all laboratories had rigorous systems in place and for dissemination of best practices. As an example, Brookhaven received the following peer review results:

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[100] *Ibid.*

[101] Site visit with Argonne/presentation slides have more information (February 27, 2013).

[102] Non-attributional interview, Fall 2014.

- The CAS fulfills the H clause and is effective
- Strong partnership evident and integral to the CAS' effectiveness
- The CAS enables mission execution—encompasses S&T and Operations
- Clear roles, responsibilities, accountabilities [between the site office, the M&O contractor, and the laboratory]
- Agreement on continuous improvement[103]

The reviewers suggested that Brookhaven Science Associates (BSA, Brookhaven's M&O contractor) improve its ability to describe how well CAS enables mission accomplishment, how CAS effectiveness is evaluated by the Board of Directors, and how independent reviews are determined and value disseminated. According to BSA and Brookhaven, the preparation for the peer review process added value to the laboratory, M&O contractor, and the site office because these entities prepared by jointly updating the CAS program documentation, which in turn facilitated a current knowledge of the CAS processes and their performance.

From the Argonne and Brookhaven examples on CAS implementation and peer review, respectively, the potential benefits of CAS become more apparent. When CAS works—when it mitigates risk and provides assurance to all stakeholders—the site office and the laboratory operate as a team. The Federal employees at the site office and the contractors at the laboratory perform separate and distinct roles, but each party works toward the overall goal of efficient and effective mission execution by leveraging the knowledge and expertise of each other. The laboratory is given increased flexibility in how it executes its programs and the site office holds the laboratory accountable for its results.

b. Applied Laboratories

Since the applied laboratories are stewarded by offices with only one National Laboratory each, the process by which peer review occurs is not as uniform as in the Office of Science. NREL and Savannah River both have a CAS clause in their contract, though their processes are still evolving along with their relationship with EERE and EM, respectively. The extent to which they leverage CAS is less clear.

> *"How should we self-regulate as an agency and what should that look like? An 'event' can happen, but the overreaction response to the event is [also what determines] the disaster."*
>
> *"Trust takes a long time to build and a moment to break."*
>
> - Personnel from an applied DOE laboratory

[103] Jessica Wilke, *BSA Contractor Assurance System: The Peer Review Experience*. (2011).

The Idaho National Laboratory, which was re-formed as a National Laboratory from Argonne West and Idaho National Engineering and Environmental Laboratory in 2005, together with DOE's Office of Nuclear Engineering (NE) and the Idaho Operations Office (IOO), has been leveraging the knowledge and experience of SC in tailoring CAS to its site.

Through these efforts, Idaho should be considered a top performer with CAS, demonstrating a good relationship between the site office and the laboratory.[104] The creation of CAS was from SC defining principles and experience, and Idaho's CAS was customized to fit the new national laboratory's focused mission.[105] NE, IOO, and Idaho have all been involved in the development of CAS with special emphasis on communication and trust between the laboratory and IOO. Now that the laboratory has more experience with CAS itself, IOO and Idaho plan to examine collaboratively the laboratory's current M&O contract in order to find opportunities to reduce burdensome or outdated requirements and assessments, thereby realizing the full benefits of CAS.

c. NNSA Laboratories

NNSA "has not established policies or guidance specific to using information from CAS to evaluate M&O contractor performance." – GAO 2015

As described by GAO's 2015 report on NNSA CAS, NNSA still needs to determine how the system is best used, especially by Federal overseers. Based on the Commission's efforts, NNSA seems to depict CAS as "CASs." In particular, NNSA's perception of the contractor assurance system is a system of metrics managed by the laboratory without the added necessity for change on the Federal side. Noteworthy is the fact that NNSA does not include in its CAS guidance the importance of the team formed by the M&O contractor, field office, and laboratory.

In its current implementation, NNSA does not stress the importance of the field's involvement as much as the other stewarding offices. This interpretation of CAS runs counter to NNSA's original purpose that CAS be "coupled with focused Federal oversight" and that "line oversight activities focus on areas of weakness in the contractor's program as evidenced by a tailored, risk-informed evaluation."[106] As

[104] Idaho Operations Office serves as both site office and support center for Idaho National Laboratory and the Office of Nuclear Energy.

[105] Interviews with Idaho National Laboratory, Idaho Operations Office, and Office of Nuclear Energy personnel, conducted 2014-2015.

[106] DOE, *Manual NA-1 SD 226.1A, NNSA Line Oversight and Contractor Assurance System Supplemental Directive.* (Washington, DC: DOE, 2008).

described by the Augustine/Mies panel report, “NNSA’s transactional oversight has proven to be expensive and counterproductive.”[107] While other laboratories have benefited from a reduction in oversight with further implementation and maturation of CAS, the NNSA laboratories have experienced CAS as just another layer of transactional oversight, and so CAS has been a burden for both NNSA and its laboratories.

From the GAO’s research, NNSA officials say that

> CAS is intended to allow the contractor to assess its performance; provide data for its management decision-making process; and more effectively manage processes, resources, and outcomes. When effectively implemented, each M&O contractor’s CAS should support the contractor in self-assessing performance, developing data for decision-making purposes, and more effectively managing processes, resources, and outcomes.[108]

This speaks to what the contractor should do in managing CAS, but does not lay out the responsibility of NNSA or its field elements. GAO recommended that NNSA describe what the field elements should do in using and approving CAS. This recommendation could go farther by establishing CAS as not just a system of metrics for the laboratories to use, but also a system to improve the working relationship between the laboratories and the site offices.

The issues with CAS in NNSA as described by GAO include the recent discontinuation of a process at NNSA HQ for validating site office oversight approaches, lack of guidance on how to use CAS to evaluate contractors, and potentially not enough qualified personnel within NNSA to implement CAS.[109] In response to the issues raised by GAO, NNSA is undoing NAP-21, its CAS guidance, and in its place, creating new policy for CAS. The projected date for this change is September 30, 2015, with an implementation guidance document due by March 31, 2016. During this process, NNSA has an opportunity to draw from the experience of the other stewarding offices. The new document and its associated requirements should take advantage of the best practices others in the Department have learned over the last 10 years.

As CAS is currently implemented, there is room for improvement. In general the Commission saw that the SC laboratories and their site offices seem to be performing the best, with the applied energy laboratories and their site offices next, and the NNSA laboratories and their field offices having the lowest performance. Not every SC

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[107] Augustine/Mies, *A New Foundation for the Nuclear Enterprise*.

[108] GAO, *NNSA: Actions Needed to Clarify Use of Contractor Assurance Systems for Oversight and Performance Evaluation*.

[109] *Ibid.*

laboratory has a mature CAS and not every NNSA laboratory has a broken relationship with their local DOE representatives.

What differs by stewarding office is how the Federal oversight responds to the laboratories' performance as determined by CAS measures. The principal Federal involvement in CAS, as described by SC, applied laboratories, the contractor assurance working group, and even the original wording of the NNSA guidance, is to change its oversight mechanisms and practices in response to laboratory performance by leveraging the information and data provided by the CAS systems and metrics. In general, NNSA seems to lag in implementation of CAS *systems* and has not stressed the importance of CAS *principles*, including building trust between field elements.

The actual Federal involvement by NNSA is to check every single one of the systems as set up by the laboratories and to determine if these systems are sufficiently rigorous for adequate assurance. The next step in dynamic oversight, viz., responding to the performance that these measures indicate, is conducted (and has been shown to be successful) at both the SC and applied laboratories, but not at NNSA. As a result the NNSA laboratories have not seen much change in their oversight and NNSA has not seen much benefit from CAS.

Since CAS is already present across the laboratory system and included in the M&O contracts, the Commission believes it can be further matured and implemented to resolve operational issues and to build trust at the NNSA laboratories. The Commission sees potential for CAS improvement, not in creating a new CAS system or new metrics, but rather reframing and reinforcing the current CAS and its principles, and leveraging peer review from the DOE laboratories with a robust CAS.

C. DOE Field Operations

CAS takes a system-based approach to oversight, coupling implementation of optimized programs, software, and metrics, to a process of contractor assurance that can be checked, measured, and affirmed. Rather than a static compliance framework, CAS encourages a dynamic, ever-evolving process that can and should be continually reworked based on how well contractors perform and how well their systems provide assurance.

CAS relies on mutual trust and collaboration between Federal and contractor staff, manifested in good relations between field office and laboratory leadership. For the most successful on-site relationships across the laboratory system, the site office and laboratory support the same mission, making for a more effective and efficient model of laboratory operations. When relations are more strained or roles less clearly defined, laboratory operations have suffered. Because of the potential impact a site office can have on the operations at a laboratory, it is important to understand its role, and how best to align the site offices with the core missions of DOE.

1. Site Offices

All 16 contractor-operated laboratories have a site office that reports directly to their stewarding office. Savannah River has an NNSA and an EM Office, and as a GOGO, NETL has no site office. As the Federal representative at the contractor-operated laboratories, site offices play an important role in ensuring that DOE's missions are delivered and the interests of the public protected.

a. Roles and Responsibilities of Site Offices

Site offices have many roles and responsibilities related to the Federal oversight and support of the laboratories. As the day-to-day representative of DOE headquarters in the field, much of DOE's policy and direction are implemented through site office staff. Site offices are also responsible for managing the laboratory prime contracts and making amendments as appropriate – such as authorizing new WFO agreements or CRADAs – as well as oversight of the operational and management performance of the contractor. For laboratories located on Federal land, site offices act as landlords to ensure effective management of Federal resources. In addition to these functions, site offices can and should be partners with the laboratory, providing mission support where appropriate. A good relationship between laboratory and site office is not only beneficial, but vital to effective and efficient laboratory operations.

Since site offices interpret Federal policy, a site office's culture can reverberate through a laboratory. When site office staff approach their responsibilities with a culture of general conservatism and risk-aversion, the relationship becomes transactional and arms-length, placing higher administrative burden on both staff at the site office and the laboratory as more time is dedicated to compliance, at the cost of reduced focus on core mission work. In contrast, site offices that work in partnership with their laboratory with a focus on mission achievement can protect public interests while empowering the laboratories to execute their missions.

A site office manager can develop a site office culture of supporting the laboratory mission and working collaboratively, but if any site office employees do not report to the manager, issues of conservatism, risk aversion, and getting in the way of mission execution can surface. While not a universal problem, this issue can cause serious issues with respect to Contracting Officers (COs) that do not report to the Site Office Manager. COs primarily sign-off on contract changes, and examples exist of COs unnecessarily delaying the transfer of funds for projects.

At Oak Ridge Site Office, until 2009, the contracting officer did not work for the manager. The Oak Ridge Site Office Manager, like other DOE site office managers, look at their office as a team that works together to support the mission of the laboratory. Prior to the change in 2009, the CO worked outside of this team, and impacted laboratory personnel's view of the site office. At the Oak Ridge Site Office and other site offices that have enacted this reporting structure, previous issues have been significantly reduced or eliminated through having COs report to the site office manager.

The level of oversight and involvement of the site office in day-to-day affairs varies across laboratories and stewarding offices. The Office of Science Management System (SCMS) provides guidance to its site offices, encouraging a risk-based approach to determining oversight priorities. By assessing issues based on their risk level, site offices can focus on the key, pressing issues. This is in contrast to using a less effective and potentially more burdensome "checklist" approach that requires site office involvement in every activity, no matter the risk involved. Other site offices take a more transactional approach, a problem sometimes exacerbated by having too many requirements. NNSA field offices in particular, have a larger volume of compliance requirements that must be checked, demanding more site office staff and pressuring the site office to adopt a more transactional model of oversight.

During its laboratory visits, the Commission noted that ongoing communication – both formal and informal – between site office and laboratory personnel, clear understanding of distinct roles and responsibilities, and an appreciation by the site office of their support of mission benefited both the site office and laboratory through less burdensome oversight and more streamlined resolution of any issues that arose. When the relationship was strong, site offices also acted as advocates for their laboratory, for example by removing irrelevant clauses from the contract, such as nuclear-related audits at non-nuclear laboratories.

Ultimately, the strength of the relationship between site office and laboratory must be nurtured by leadership and staff at both institutions. Laboratories must do their part, sharing their management systems and providing assurance through transparency. With this in mind, the influence of site offices on laboratories – both positive and negative – can be significant, and the Commission observed that where site offices saw their primary role as supporting the laboratories, rather than policing them, both site office and laboratories benefited.

b. Size of Site Offices

Laboratory site offices are criticized for being too large, especially at NNSA laboratories. As reported in the Augustine/Mies panel report, staff size at site offices can be a telling measure of transactional oversight. While plans to reduce the size of NNSA site offices are currently in place, a "considerable gap between NNSA averages and those of other DOE programs" still exist. Table 16 represents the staff pool at the laboratory site office in terms of FTEs.[110] A considerable gap also exists between the site office size at the DOE laboratories and that at comparable FFRDCs managed by other agencies, such as DOD and NASA.

Table 16. Site Office Size at DOE Laboratories and other Federal Laboratories

Site Office	Primary Sponsor	Stewarding Office	FTEs
Golden Field Office—site office component*	DOE	EERE	13
Princeton Site Office	DOE	SC	9
Thomas Jefferson Site Office	DOE	SC	12
Ames Site Office	DOE	SC	3
Brookhaven Site Office	DOE	SC	27
Fermi Site Office	DOE	SC	15
Pacific Northwest Site Office	DOE	SC	34
Argonne Site Office	DOE	SC	25
SLAC Site Office	DOE	SC	11.5
Oak Ridge National Laboratory Site Office	DOE	SC	40
Berkeley Site Office	DOE	SC	19.5
Livermore Field Office**	DOE	NNSA	83
Los Alamos Field Office**	DOE	NNSA	86
Sandia Field Office**	DOE	NNSA	81
		Total	*459*†
Aerospace	DOD	Air Force	0
APL (UARC)	DOD	Navy	10.5
Draper (nonprofit)	--	--	13
JPL	NASA	--	31
Lincoln Lab	DOD	Air Force	0-2

Source: SC Site Office Figures from Presentation by Joe McBrearty March 24, 2015; non-DOE FFRDCs supplied staff size data to Commission, June 2015.

* Golden Field Office value from interview, December 2014

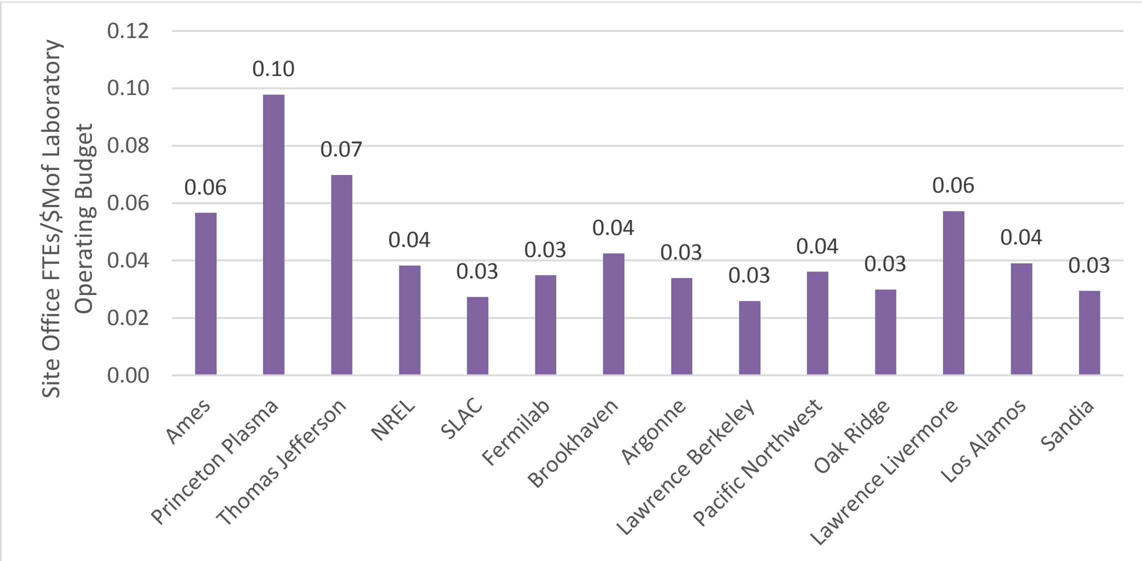
** NNSA Site Office Figures are from the Augustine/Mies panel report (Table 4).

† This total value does not include personnel who perform laboratory site office-like functions at the Idaho Operations Office nor the personnel at the two site offices for the Savannah River Site.

To account for differences in laboratory size, Figure 14 normalizes these figures by scaling full time employees to laboratory operating budget. The figure depicts almost a

[110] Augustine/Mies, *A New Foundation for the Nuclear Enterprise*.

factor of two difference between many of the site offices and the Princeton Site Office, but the Princeton Site Office has a small staff of only 9 employees. This suggests the normalization is less accurate for the laboratories with small operating budgets.



Source: Site Office FTE values from Table 16 of this report and from Table 4 from the Augustine/Mies panel report, December 2014, and operating budgets from Table 1 of this report.

Figure 14. Site Office FTE/ Laboratory Operating budget ($M)[111]

While the size of a site office approximates the level of transactional oversight, size alone should not be used to assess whether the staffing level at any given site office is correct and appropriate. Rather, whether or not a site office adds to the transactional burden at a laboratory or supports the laboratory's mission execution can be better extrapolated through how that site office interprets and implements DOE assessments and requirements, and whether the site office interacts with contractors in an adversarial manner. The right staff and appropriate size for a site office must be determined on a case-by-case basis, and within the context of a given laboratory's unique needs and challenges.

DOE also recognizes the size of site offices as a potential area of concern. Recently, NNSA field offices underwent a capabilities assessment to determine the appropriate number of employees needed to fulfill their Federal responsibilities. Although a thoughtful exercise, their assessment left out the possibility of reducing workload through effective implementation of CAS, meaning that the estimates for required staffing level were likely overestimated. This stands in contrast to the strategic reductions in force at

[111] Will need to be updated once have verified budget figures for laboratories.

the SLAC/Lawrence Berkeley site offices, which reduced the staff at both site offices by addressing attrition not by backfilling vacant positions but instead by distributing those responsibilities to the remaining staff. Through strong leadership and effectively implementing CAS, SLAC and Lawrence Berkeley site office leadership critically assessed their own responsibilities in the context of laboratory needs, allowing them to reduce their own size in an informed way. Despite their reduced size, both site offices continue to fulfill all of their Federal responsibilities.

c. Leadership from stewarding office to empower site office leadership

Throughout DOE and the National Laboratories, strong leadership emerged as a key element of effective site office operations. The strength of senior leadership in the Office of Science empowers site offices in SC to effectively implement CAS, which in turn helps headquarters prioritize its oversight efforts in an informed way. At any moment, there might be potentially thousands of areas to focus on across the system. CAS provides site offices the authority to assess and prioritize a given laboratory's key issues in a dynamic way. Rather than treat oversight as a static responsibility, under CAS site office personnel should expect each day's responsibilities to change as the environment and operations at the laboratory shift. Today, the Office of Nuclear Energy has adapted its processes to match those in the Office of Science. Specifically, leadership at NE has given blessing to its Idaho site office to cut requirements, coordinate external assessments, and track level of effort of assessments.

Changing needs at a laboratory can be addressed by strong leadership. For instance, when PPPL was given the go-ahead to restart operations at its National Spherical Torus Experiment - Upgrade (NSTX-U) after a two-year shutdown, the Office of Science recognized the heightened level of risk involved in the laboratory beginning its first major infrastructure project in decades. After determining that key project management skills were not present at the PPPL site office, SC prompted the Brookhaven site office management to step in, providing additional expertise and guidance to ensure that the project would proceed safely and on schedule.

When leadership fails to grant clear guidance and authority to site offices, roles become unclear and the site office does not have as much freedom to enact productive change at the local level. Unguided change may even be inconsistent with headquarters policy, as is sometimes the case for NNSA site offices.[112] Leadership should provide clear direction of the mission with CAS principles in mind, entrusting authority to the field office to make key decisions as best support the execution of mission.

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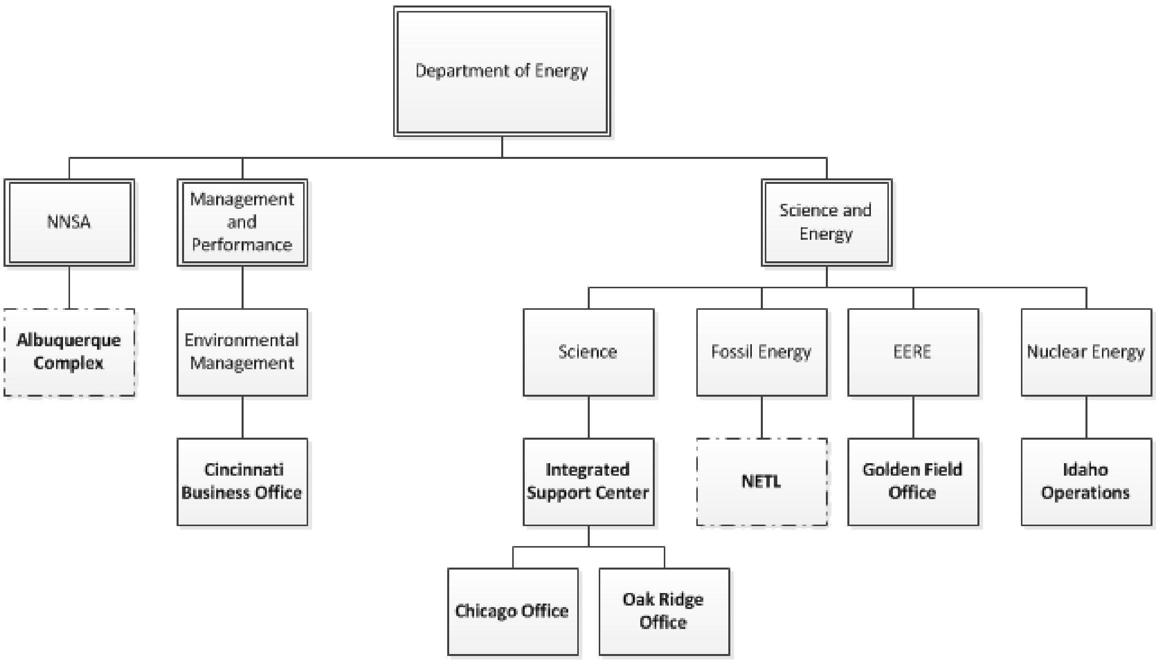
[112] GAO, *NNSA: Actions Needed to Clarify Use of Contractor Assurance Systems for Oversight and Performance Evaluation*.

2. Support Centers

In addition to site offices, DOE has support centers as another element of its field operations. Generally, support centers assist both site offices and HQ in providing both technical expertise and administrative manpower as needed. "Support Centers" is the all-encompassing term used in this chapter to refer to the operations offices, the consolidated business centers, and the service centers across the laboratory system. The Support Center Taxonomy within the Department is shown in Figure 15.



Note: NETL has no site office. Additionally, the Albuquerque Complex is "an arm of NNSA headquarters," but provides many of the same services as other support centers around the laboratory system and so is included amongst the "support centers."

Figure 15. Support Center Taxonomy

Currently, the roles, responsibilities, and authority of the support centers are not clearly understood by many in the laboratory system. Ideally, support centers should house and provide expertise to multiple site offices on the basis of mission-relevance, allowing individual site office size to be low, and to headquarters personnel in areas where efficiencies can be obtained. In their role of supporting headquarters, support centers conduct such responsibilities as payroll and contract processing. In many of the support centers, most of the staff is engaged in these responsibilities. For the staff in the support centers who support the site offices, site offices are their customers, drawing on the support centers' capabilities as needed. Table 17 describes the location, stewarding office, functions, and size of the support centers that serve the site offices of the National Laboratories.

Support centers are substantially larger than most site offices with the total workforce tripling the total workforce at laboratory site offices, a concern that DOE is currently investigating for both support center roles – supporting site offices and supporting headquarters. Over the last three years, SC has reduced the staff at support centers by 10-15 percent, purely by attrition. A similar approach to reduction should be explored at the other support centers. In general, while the Commission understands that the support centers play an important role, the bound of that role must be more explicitly delineated to both site offices and laboratories. Critically, support centers should not have approval authority, which belongs with site offices due to their ability to better assess laboratory needs.

Table 17. Support Centers across the DOE Laboratory System

Support Center	Location	Stewarding Office	Functions	Workforce
Albuquerque Office	Albuquerque, NM	NNSA	Support Center for 3 NNSA laboratory site offices- Headquarters Field Location	921
Environmental Management Consolidated Business Center*	Cincinnati, OH	EM	Support Center for EM cleanup sites	123
Golden Field Office	Golden, CO	EERE	Site Office and Operations Office for NREL and EERE	143
Idaho Operations Office	Idaho Falls, ID	NE	Site Office and Support Center for Idaho and NE	230
Integrated Support Center	Argonne (Chicago Office) and Oak Ridge (Oak Ridge Office)	SC	Support Center for all 10 SC laboratories	281
			Total	*1698***

* Due to the structure of the Office of Environmental Management, the Environmental Management Consolidated Business Center (EMCBC) provides support to the site offices associated with cleanup sites. Savannah River National Laboratory is part of the contract for the Savannah River Site and thus, the EMCBC provides support for the whole site's site office. Because of this, the staff associated with the EMCBC are generally concerned with site matters rather than other support centers that are focused more on laboratory matters.

** This total value includes personnel that perform site office-like functions at the Idaho Operations Office, and the Golden Field Office.

Although both a support center and a site office in function, the Golden Field Office can be used as an example of the myriad roles that a support center can provide. Most of the office works on issues that do not directly deal with NREL, its laboratory. Thirteen employees conduct the functions of the site office with a total of 30 employees that support the laboratory.[113] The rest of the support center conducts procurement services (including acquisitions and policy) and business services (including chief counsel and financial assistance) for EERE. The business services division obligates up to $800 million in financial assistance annually as opposed to the $400 million obligated for the NREL contract.[114]

In 2002, NNSA closed two operations offices and created a service center in Albuquerque. The service center was further reorganized in 2011 during a system-wide attempt to increase resources to mission execution by streamlining mission support functions. In this second reorganization, the service center manager was removed, the service center was re-named the Albuquerque Complex, and the staff began reporting directly to headquarters. While the reorganization was intended to reduce the staff size at the system, it failed to separate the support nature of the "support center" from approval authority, which remains an issue today. When support centers move beyond providing business, technical, and financial support to HQ and the site offices, and instead begin to exercise approval authority, support centers step beyond their appropriate role.

In contrast, the Office of Science Integrated Support Center (ISC) Service Plan discusses how roles can be delegated more reasonably among site offices and support centers (Figure 16). Prior to three years ago, the ISC offices had line authority over the site offices. Now, the Chicago Office and the Oak Ridge Office have the role of supporting the site offices and in this role, no longer have authority over approvals. Approval authority within the Office of Science had previously been an issue, and SC has worked to make the ISC roles and responsibilities more clear and appropriate.

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[113] Interview with Golden Field Office personnel, December 2014.

[114] *Ibid.*

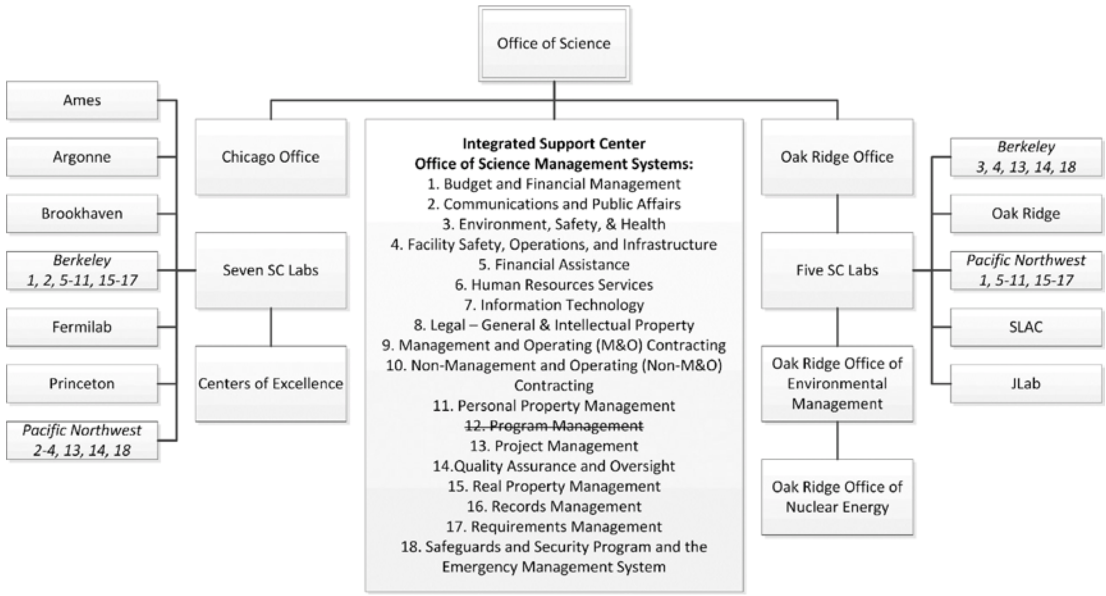

Figure 16. Depiction of the Service Plan of the SC Integrated Support Center

3. Evolving Oversight Functions under CAS

As CAS matures, site offices and support centers should expect to see their own oversight functions evolve. Since CAS is designed to make oversight adaptive to changing levels of risk and need, the importance of a strong relationship between site offices and laboratories is more important than ever. Only through strong site office leadership and clear understanding of laboratory operations can CAS succeed in streamlining laboratory oversight and moving away from a system that favors “checklist” compliance. Site offices and support centers may find their familiar roles, staffing, and even structure reworked under CAS. With those changes, however, is the promise of greater efficiency, stronger partnership, and ideally more effective performance of the laboratory mission.

D. Findings and Recommendations

Based on its work, the Commission found the following:

- CAS principles have been leveraged at sites to reduce the amount of oversight, including site office size.
    - A major role of the site office within CAS and the FFRDC relationship is to ensure that the mission of the laboratory is accomplished.
    - Benefits of CAS implementation include increased approval and authorizations at the laboratory/site level, reduced prescriptive and overlapping requirements, and decreased audits and inspections.

  - Some site offices have been reduced by half when the relationship between site office and laboratory is restored with capable site office leadership willing to make changes that result in reduced workload.
  - Peer review of CAS implementation across the 10 SC laboratories allowed for dissemination of best practices and assurance that all laboratories had rigorous systems in place.
  - Because NNSA is eliminating their current CAS policy (NAP-21) and creating a new one with guidance released by March 2016, NNSA has a current opportunity to improve oversight at the laboratories by including CAS principles and ideals in its new CAS policy.
- The roles, responsibilities, and authority of the support centers are unclear to many in the laboratory network. The optimal role of support centers is to provide business, operational, and technical support to site offices and headquarters, without line approval authority. Line approval authority is currently in place in some support centers.

Based on these findings, the Commission makes the following recommendations with respect to the laboratories' oversight environment:

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.

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.

Recommendation 11: DOE should clarify the role and authority of the support centers. If approval authority currently resides with a support center, DOE should remove it and reinstate it at either the site office or DOE headquarters, as appropriate. DOE should only permit support centers to perform audits and reviews of the laboratories in areas that are specifically within their realm of expertise.

The Commission also makes the following additional recommendations:

- DOE should help build trust between site offices (through the FFRDC relationship and the further implementation of CAS principles and ideals) and promote capable leaders with flexibility to reduce workforce due to changing oversight.
- DOE and LOB should encourage recurrent peer review of CAS (both for implementation and for effectiveness) across the laboratory system. The NLDC and FMC could both perform key roles in organizing this peer review process.
    - All laboratories and site offices should be involved, including those stewarded by NNSA. A graded approach will need to be used based on maturity of CAS across the laboratory system.
- NNSA should leverage best practices from SC and NE in creating their new CAS policy and requirements, including the critical importance of the relationship between the site office and the laboratory.

5. Assessments and Data Requests

A. Introduction

Previous reports on the National Laboratories have found that the laboratories are subject to too many assessments and data requests, which collectively represent a burden for the laboratories.[115] 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. Based on the data collected, the total number of annual external assessments at a laboratory ranges from 4 to over 300. The Commission found examples of burdensome and duplicative assessments at multiple laboratories, but this issue is most prevalent at only a few of the laboratories. In addition, the Commission found that onerous and lengthy data requests can often arrive at the laboratories without being sufficiently vetted or filtered.

1. Defining Assessments

Assessments are on- or off-site review, for which topic, scope, and frequency vary. For the purpose of this chapter, the term "assessments" is used for audits and inspections conducted by groups both internal and external to the laboratories. "Internal assessments," are audits and inspections conducted by M&O contractors, laboratory management and other organizations within the laboratory. The laboratories typically have various offices that conduct assessments, such as quality assurance, internal assessment, or internal audit offices. Laboratories also hire other organizations to conduct independent assessments of the laboratory directorates and its processes.

Management and operating (M&O) contractor audits and inspections are separate and independent from those conducted by directorates and offices within the laboratory. At many of the laboratories, the board of directors or other governing bodies may decide to conduct assessments for their own governance and oversight of the laboratory.

"External assessments," as defined in this report, are audits and inspections conducted by organizations that are external to the laboratory. The organizations

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[115] National Laboratory Director's Council. *NLDC Prioritization of Burdensome Policies and Practices*, 2011 (http://pogoarchives.org/m/nss/nldc-burdensome-policies-20110531.pdf); Augustine/Mies panel report, *A New Foundation for the Nuclear Enterprise* (2014); NAPA *Positioning the DOE Labs for the Future* (2013); Galvin *Alternative Futures for the Department of Energy National Laboratories* (1995).

"external to the laboratories" are further split into three groups based on proximity to the laboratory site and whether they are part of the Department of Energy (DOE) or not: local to the laboratory and internal to DOE ("DOE-local"), off-site and internal to DOE ("DOE-off-site"), and separate from DOE ("separate"). Table 18 displays the grouping of specific organizations into the 4 categories of assessments.

Table 18. List of Performers of Assessments at the National Laboratories

	External to the Laboratories		
Internal to the Laboratories (Internal)	**Local, Internal to DOE (DOE-Local)**	**Off-Site, Internal to DOE (DOE-Off-Site)**	**Separate from DOE (Separate)**
Independent Third Party	Site Offices‡	DOE—EA	DNFSB
Internal Audit Office	Support Centers**	DOE—IG	GAO
Laboratory Management		DOE Program Offices††	Local and State Authorities
Quality Assurance Office		Other DOE headquarters offices	Standards groups (e.g. ISO)‡‡
M&O Contractors†			Other Federal agencies

Note: Reviews conducted by shaded organizations are excluded from the assessments data. All underlined organizations' assessment processes are discussed in more detail in the text. This list of conductors of assessments is not exhaustive and instead is meant as a simple depiction of how the data are categorized.

† "M&O Contractors" refers to the parent organizations that manage the 16 FFRDC DOE laboratories under M&O contracts. These reviews are excluded from the data later in the chapter. These assessments are not strictly "internal" to the laboratory, but since they handle governance, the M&O contractors are included in the "internal" column for the purposes of this table.

‡ Although both "site office" and "field office" are used across the laboratory system for the site representation of DOE that conducts local oversight, this report uses "site office" for all of these offices.

** Service centers, business centers, operations offices, and support centers are collectively termed "support centers" in this report. Although no longer a "service center" within NNSA, the Albuquerque Complex conducts work similar to the support centers in other stewarding DOE offices and is grouped among the collection of laboratory system support centers in this report. Additionally, support centers are not always local to the laboratories, but their main customers are the site offices, which make their assessments most similar to those of site offices.

†† Technical reviews and assessments conducted by DOE Program Offices are not included in this chapter's definition of "assessments." Although these assessments are important to programmatic direction and program quality assurance, they are not included in this chapter and instead are referenced in the stewardship of the laboratory in Chapter 7, Alignment and Quality of the Laboratories.

‡‡ "ISO" stands for the International Organization for Standardization, which sets international standards and their accompanying certifications.

Within the "DOE-local" category of external assessments, site offices at each of the laboratories conduct the majority of assessments. NETL, as a GOGO, does not have a site office, and Savannah River has two site offices (one for NNSA and one for EM). All other laboratories have one co-located office that performs the operations of local oversight. Although both "site office" and "field office" are used across the laboratory system for the on-site DOE representatives who perform local oversight, this report uses "site office" to denote all of these offices. Support centers, which provide technical support to each of the site offices, mostly conduct assessments in concert with the laboratory's site office, but also have a few regular assessments at each laboratory. The support centers at NREL and at Idaho, the Golden Field Office and the Idaho Operations Office, respectively, perform the functions of both site offices and support centers in one entity.

Within the "DOE-off-site" category of external assessments are offices within the department that are not site offices or support centers. According to the data collected by this Commission, the primary conductors of assessments at the laboratories within DOE are the Office of Enterprise Assessments (DOE-EA) and the Office of Inspector General (DOE-IG). DOE-EA is the independent assessor within the department that conducts assessments in "nuclear and industrial safety, cyber and physical security, and other critical functions as directed by the Secretary and his Leadership team."[116] DOE-IG is the auditing organization charged with discovering "waste, fraud, and abuse" across the department.[117] DOE Program Offices conduct mostly technical reviews of programs and projects. Since these review processes are discussed at length within Chapter 7, Alignment and Quality of the Laboratories, they have been excluded from this chapter. Other DOE headquarter (HQ) offices conduct particular topical assessments at the laboratories such as the DOE Office of Project Assessment and the DOE Office of Management.

The "separate" category includes many organizations outside of DOE including the Defense Nuclear Facilities Safety Board (DNFSB); the Government Accountability Office (GAO); standards groups, including the International Organization for Standardization (ISO); local and state authorities; and other Federal agencies. The assessments from all "separate" organizations are included in the data that follows this discussion.

Using these categories, the Commission collected specific information about all assessments (title, assessor, and purpose) for each of the sites for one year (assessment

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116 "The Office of Health, Safety and Security (HSS) was divided into two separate organizations on May 4, 2014: The Office of Enterprise Assessment (EA) and the Office of Environment, Health, Safety and Security (EHSS)." For more information about the newly created DOE-EA, go to http://energy.gov/ea/office-enterprise-assessments.

117 More information about the DOE-IG can be found at http://energy.gov/ig/about-us.

open during any or all of FY 2014). Collectively, the Commission utilized these data in order to establish trends and to demonstrate how numbers of assessments can vary. Since definitions for "audits," "inspections," and "assessments" can be and are slightly different at each site, final conclusions cannot be drawn from these data alone. Thus, after receiving the list of assessments from all 17 National Laboratories, the Commission conducted interviews with representatives from the laboratories to elicit individual laboratory context and experience. These interviews provided detail on the impacts of the assessments at each laboratory.

Similarly, the processes of auditing organizations can illuminate the purpose of these assessments. The Commission interviewed the organizations that have been referenced the most in interviews. The exclusion of other groups and their processes does not mean these groups are exempt from the issues discussed.

2. Planning Processes for Assessors

a. Processes for Planning Internal Assessments

The laboratories conduct a fair amount of self-assessments. DOE requires some of these assessments, but most stem from the laboratory's management practices. These assessments are determined each year through internal assessment plans. Most of the laboratories use risk-based approaches to determine their internal assessment plans each year. As part of the Cooperative Audit Strategy to prevent duplicative assessments, the laboratories create an annual laboratory audit plan, these laboratory plans go to the audits division of DOE-IG, and then the audits division of IG creates their own annual audit plan for assessments at the laboratories.[118] The coupling of the two planning processes allow for the laboratories, the site offices, and the IG to be involved in assessment planning at the other organizations.

As an example of a laboratory's internal assessment planning, Fermilab has an Assurance Council that meets monthly and conducts review of its management systems. Fermilab has 16 management systems with topics ranging from Governance to Science to Legal. Each of these management systems has an owner in charge of keeping the system up to date with "changes in the laboratory's operating environment, applicable laws and regulations, self-assessments and the various review processes of the laboratory."[119]

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[118] DOE, *Acquisition Guide 70.4*, (Washington, DC: DOE, March 2004). Available at http://energy.gov/sites/prod/files/70.4_Cooperative_Audit_Strategy_0.pdf.

[119] More information about Contractor Assurance at Fermilab can be found at https://web.fnal.gov/organization/cas/Pages/default.aspx.

Annually, the Assurance Council creates the laboratory's assessment plan with Fermilab site office and local Chicago DOE-IG office personnel involvement.

Another example of internal planning is Brookhaven's internal assessment plan. Each of the 30 management system owners create a list of the highest potential risks in that area, and submits that list to their Assessment Support Center.[120] The Assessment Support Center takes the list of potential assessments by risk and by area, and in collaboration with the laboratory's site office, combines assessments where appropriate. Along with assessing institutional risk, this process determines the laboratory's assessments for the year based on available resources. With the risk determination, the process includes flexibility in case of incident or of necessary additions to take precedent over lower risk assessments.

In order to determine the effectiveness of this internal process in mitigating risk at the laboratory, Brookhaven, their site office, and the Chicago Office of the Integrated Support Center conducted a pilot risk gap analysis for one of Brookhaven's management systems: radiological control. The purpose of this risk gap analysis was to identify strengths and weaknesses in Brookhaven's risk assessment of radiological control. Brookhaven has now completed the first risk gap analysis pilot. The laboratory and the site office both expressed how this exercise has provided additional assurance in the laboratory's management systems.[121]

Both of these examples include involvement by site offices in laboratory processes in a way that adds value. An important aspect of internal assessments at the laboratories is the ongoing relationship between the laboratory and their site office. In cases where this relationship is healthy, the interaction between the site offices and laboratory often results in site offices leveraging the assessments conducted and data collected by the laboratory. Leveraging these systems requires the Federal employees to place increasing trust on laboratory systems while ensuring the rigor of these systems. In turn, the laboratory's systems and processes must be transparent and accessible to their site Federal authorities.

Effective implementation of a contractor assurance system (CAS) can impact the number and frequency of assessments. In this context, the purpose of CAS is for the laboratory to provide assurance to stakeholders through creation of systems and metrics to monitor performance and for the Federal stakeholders—DOE—to leverage the information from the contractor in areas of lower risk and better performance. This, in turn, should reduce the number of duplicative external independent reviews, and increase

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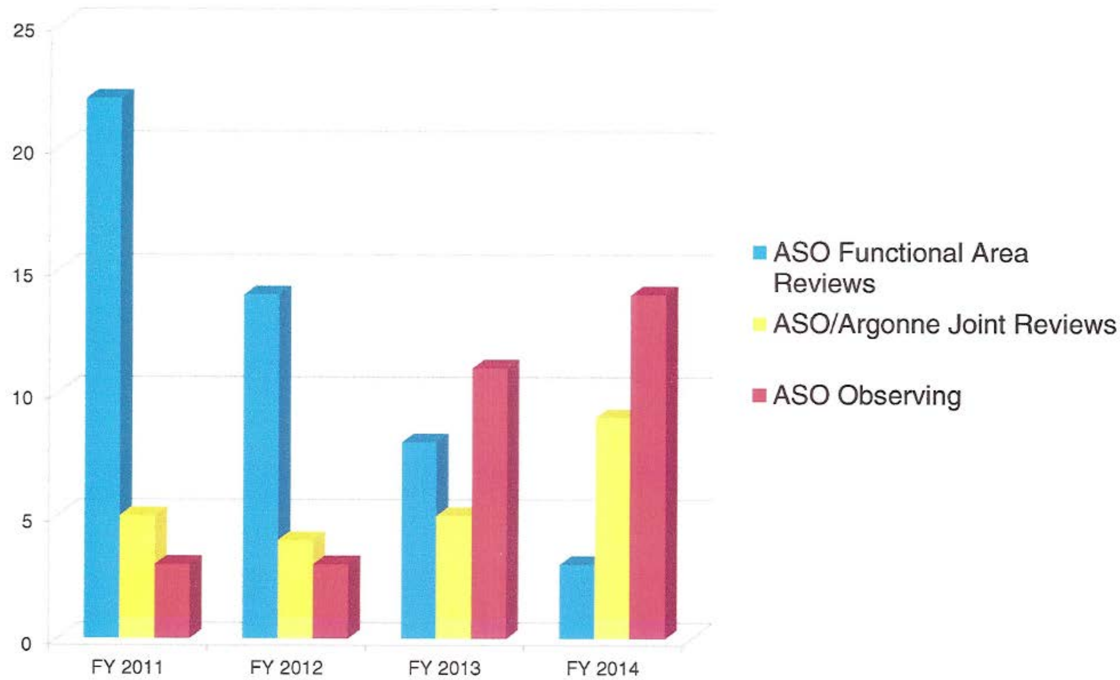
[120] From interview with the laboratory and site office personnel, April 2015.

[121] *Ibid.*

the number of shadowing and joint reviews conducted by the site office. This benefit of CAS has been realized in many of the SC laboratories with effective implementation of CAS principles. Argonne implemented CAS in 2010, and its site office, Argonne Site Office (ASO), provided the number of reviews for each year since then (Figure 17). This figure shows that ASO has increased observing and conducting joint reviews and has decreased independent reviews ("functional area reviews") since the implementation of CAS. This example shows that implementing CAS appropriately and effectively has the potential benefit of reducing assessments.



Source: Argonne Site Office presentation to Commission, November 5, 2014

Figure 17. Trend in Argonne Site Office Oversight under CAS

b. Processes for Planning DOE-Local Assessments[122]

As previously mentioned, the site offices are involved in the annual laboratory planning strategy in an advisory capacity. In addition to involvement with laboratory processes, some site offices track and trend the site office's assessments of the laboratory and use this information to determine future assessments.

For example, Oak Ridge Site Office organizes assessments in this way with a determination of level of risk and of frequency of assessments in each laboratory area.

[122] Role, responsibility, and size of site offices and support centers are discussed in Chapter 4.

This allows the site office to perform assessments on the subjects and areas that are the riskiest or those that have not been assessed in a while.

The Pacific Northwest Site Office (PNSO) also has risk-based processes to determine when to conduct independent reviews, and these processes are based on its laboratory's risk management approach, which produces risk profiles and heat maps.[123] For a specific program or area, the laboratory determines all risk statements, which describe potential risks, and then employs a Likelihood/Consequence Matrix to determine the overall risk assessments of those statements. In placing a potential risk on the Likelihood/Consequence Matrix, the laboratory decides the Likelihood of occurrence (ranging from Highly Unlikely to Almost Certain) and potential Consequence of the risk (ranging from Minimal to Catastrophic).[124]

Within the Timekeeping and Travel and Property M&O Program, the sub-program of Fleet Management has one property risk statement, which is a "fleet equipment accident with significant injury or loss of life due to improper maintenance management (maintenance owned by Property Management)."[125] The actual level of risk is determined from likelihood of causing mission impact, project interruption, reputation & image, and asset loss. At Pacific Northwest, Fleet Management has an overall actual risk of causing injury as "highly unlikely" with a potential impact of "serious/dangerous," and an overall risk of maintenance issue with vehicle as "unlikely" with a potential impact of "minimal." These risk assessments result in a total overall risk of "unlikely" with "minimal" impact (Table 19, Column A).

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[123] C. Caldwell and R. Haffner, *Prioritizing and Managing Risk across the Organization*. (Richland, WA: Pacific Northwest National Laboratory, 2012). Available at http://energy.gov/sites/prod/files/2013/12/f5/Caldwell.pdf

[124] *Ibid.*

[125] PNNL Finance Programs Risk assessment, July 2015; note that this is not a failing. This is a potential risk.

Table 19. Pacific Northwest Overall and Estimated "Uncontrolled" Risk Assessment for "Fleet Management"

A. Overall Risk Assessment*	B. Estimated "Uncontrolled" Risk Assessment**
Likelihood: Unlikely Impact: Minimal Color: Blue (Very Low) Driven by FM Risk 1	Likelihood: Possible Impact: Serious Color: Yellow (Medium) Driven by FM Risk 1

Source: Pacific Northwest *Finance Programs Risk Assessment* provided to the Commission, July 2015.

* The overall risk assessment for the program is assigned based on the highest risk assigned to the risk statement. This is the value that is displayed on the risk heat map in Figure 18.

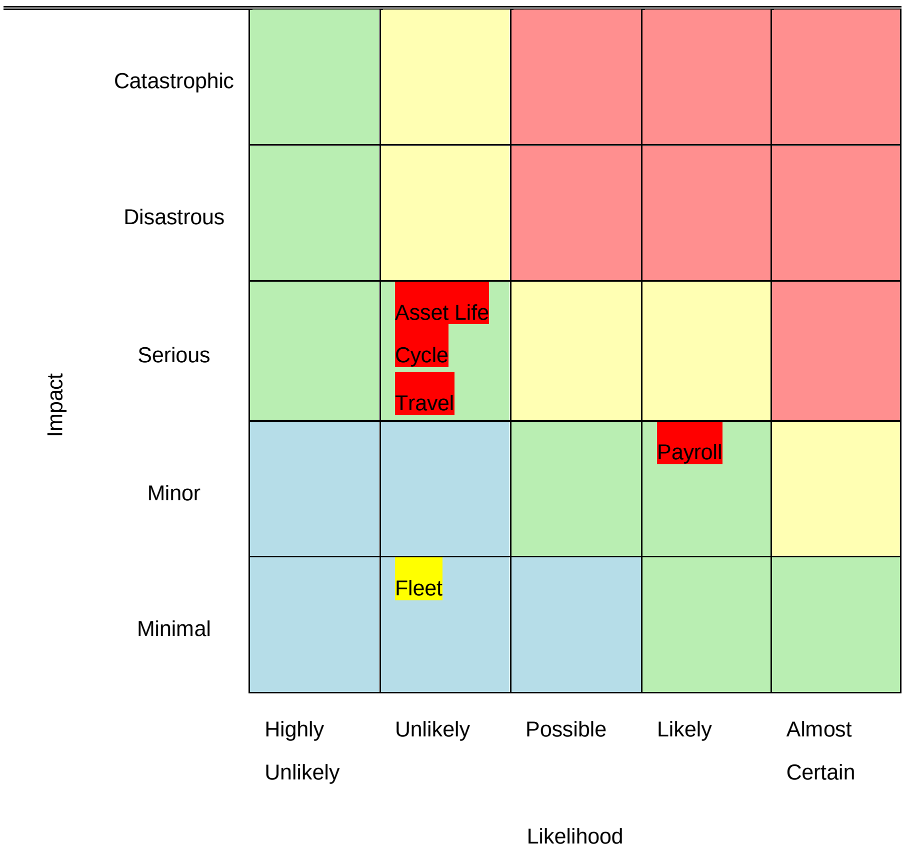
** This is a hypothetical assessment of risk if the program and all existing controls were removed.

The laboratory then determines the estimated "uncontrolled" risk assessment, which is the hypothetical assessment of risk if the program and all existing controls were removed (Table 19, Column B) In other words, A is the level of risk of this sub-program at the laboratory and B is the *hypothetical* risk if the laboratory's control systems were not in place (a level of risk *not* present at the laboratory). The intent is to try to assess the inherent risk associated with the program and better understand what the worst-case would be if all controls failed. It also provides a means for understanding the "risk reduction" value of the current controls.

After the overall and estimated uncontrolled risk assessments are conducted, the Fleet Management sub-program is placed on the Likelihood/Consequence Matrix according to its cumulative risk profile. This process is repeated for all sub-programs to create the entire heat map for the Timekeeping and Travel and Property M&O Program (Figure 18). Each sub-program is shaded by its estimated "uncontrolled" risk assessment. This level of risk is *not* present at the laboratories; this level of risk would occur only if all controls in place at the laboratory were removed. The Fleet Management sub-program resides in the Unlikely/Minimal box, corresponding with its overall risk assessment, and is shaded in yellow for its Possible/Serious uncontrolled risk assessment should the laboratory controls go away. Thus, for the Fleet Management sub-program, laboratory controls reduce risk from Possible/Serious to Unlikely/Minimal. The purpose of this heat map is to determine the risk profile at the laboratory, produce action plans to reduce risk, and to allocate resources according to risk. This heat map exercise is repeated for all programs and their sub-programs. Some have many more sub-programs that this example.

PNSO leverages the laboratory's risk-based process by utilizing Pacific Northwest's heat maps (since the maps are readily available to the site office). PNSO has defined five own "Focus Level Criteria" to prioritize each area's risk: Performance Trend, Confidence Based on Oversight Activities, Impact of Recent Changes, Importance of Controls, and

External Factors.[126] The "Focus Level Criteria" define for site office personnel how to determine risk of each area of the laboratory, and each criteria ranges from Minimal (1) to Very High (5). For the Performance Trend criterion, "no identified weaknesses" would correspond to Minimal risk, and the site office would assign Very High to "significant weaknesses exist and warrant direct PNSO attention." When the site office applies this risk determination to each sub-program with all five Focus Level Criteria, the resulting tool is a "Risk Thermometer," which is used to determine the need for independent reviews by the site office (Table 20).



Source: Information provided by Pacific Northwest, July 2015 (updated 3/16/15).

Note: The color that highlights each sub-program corresponds with the estimated "uncontrolled" risk assessment, which is the risk if no controls at the laboratory were in place (Table 19, B), and the box that the sub-program is in within the matrix corresponds with the overall risk assessment (Table 19, A).

Figure 18. Pacific Northwest Timekeeping and Travel, and Property M&O Program Risk Assessments Plotted on a Heat Map

[126] Site office interview, June 2015.

Table 20 depicts an example of the first step in the creation of the risk thermometer for one laboratory program (Worker Safety) in one sub-area (Working Alone). The heat map exercise that was explained for the Timekeeping and Travel, and Property M&O Program is repeated for all programs including Worker Safety. Based on the risk statement of "injury working alone" and according to the data displayed in Table 20, Pacific Northwest's determination of the controlled level of risk would be in the green region of the Likelihood/Impact Matrix, and the uncontrolled level of risk (the risk if no controls were in place) would be in the yellow region of this matrix. PNSO then assesses the risk level of injury working alone based on its five Focus Level Criteria, and results in a PNSO determination of "Minor" risk. The risk level value as established by Pacific Northwest is multiplied with the risk level established by the site office criteria to come up with a final product value of 12. This process is repeated for all sub-areas of Worker Safety (of which there are 44), and the sub-areas are ordered by the final Risk Product value. For Worker Safety, the risk product value ranges from 0 to 41. This value of 12, considered "Minimal" level of risk, within the Worker Safety Program is comparably low to the risk product values of other sub-areas such as Electrical Safety, Beryllium, or Fire Protection.

Table 20. Pacific Northwest Risk Thermometer Based on PNNL Heat Map

Program Title	Risk Statement	Likelihood (1-5); Impact (1-5) Uncontrolled	Likelihood x Impact = PNNL Risk Controlled	PNSO Focus Level Criteria (1=Minimal; 2=Minor; 3=Moderate; 4=High; 5=Very High)	PNSO Risk Product (PNSO Focus x PNNL Risk Product Controlled)

		Likelihood	Impact	PNNL Risk Product (Uncontrolled)	Likelihood	Impact	PNNL Risk Product (Controlled)	Performance Trend	Confidence Based on Oversight Activities	Impact of Recent Changes	Importance of Controls	External Factors	PNSO Focus Level Average	
Working Alone	Injury Working Alone	4	3	12	2	3	6	1	5	2	1	1	**2.0**	**12**

Source: Pacific Northwest Site Office, June 2015

PNSO has access to the management systems (through CAS) at the laboratory and leverages these systems in a way that more accurately determines which areas at the laboratory need independent reviews based on laboratory performance, time since last review, changes in the area, criticality of controls, and external factors. PNSO has only developed this process in the past couple of years, but sees the process as adding value and credence to their choice of assessments.

The risk thermometer, a risk determination that leverages the laboratory's heat maps, is a good example of how risk-based processes can be developed to reduce independent reviews. Instead of conducting an independent assessment for each area of the laboratory or attempting to determine risk of an area based on just one of the Focus Level Criteria (for example, "confidence based on oversight activities"), the risk thermometer method allows for a more detailed, and ideally more accurate, determination of the areas that need an independent assessment the most.

As part of their methods for leveraging laboratory processes, site offices shadow laboratory assessments, and conduct joint assessments with the laboratories. Shadowing and joint assessments allow the site offices to be involved in an assessment without duplicating the efforts of the laboratory. In shadowing, the site office participates in the assessment in an observational role while the laboratory takes the lead in determining the scope and focus of the assessment. For joint assessments, the site office and the laboratory explore a certain area, program, or operation together, jointly taking a lead role in determining scope prior to the assessment. All of the SC laboratories use joint assessments, shadowing, or both as an assessment oversight tool. The energy laboratories' site offices also utilize this strategy, and Sandia's site office has done this for at least 2 years.[127]

Lawrence Livermore and LFO have newly piloted a program to conduct joint assessments based on a model by the Nevada Test Site. In order to conduct this pilot, LFO and Lawrence Livermore agreed on definitions and threshold for risk. More transparency of systems, agreement on risk, and further acceptance of CAS principles may allow for more joint assessments and may even reduce the need for many independent reviews, as demonstrated by heat maps and risk thermometers at Pacific Northwest and PNSO and by the reduction in independent reviews at ASO mentioned earlier in this chapter.[128]

Risk-based processes will differ by site and each laboratory's management processes. Additional methods and processes could be disseminated between site offices through the Field Management Council, a committee made up of the Federal leaders at all DOE field facilities, or peer review of CAS.[129]

c. Processes for Planning DOE-Off-Site Assessments

Of the organizations within the DOE-off-site category of assessments, two organizations are presented here with their processes for conducting assessments at the laboratories, the DOE-IG and the DOE-EA.

1) DOE Inspector General (IG)

The Inspector General Act of 1978 established Offices of the Inspector General in agencies within the executive branch to "increase [the Government's] economy and efficiency." Each Inspector General Office is an independent organization for its associated Federal agency with the following objectives:

1. to conduct and supervise audits and investigations relating to programs and operations…;
2. to provide leadership and coordination and recommend policies for activities designed (A) to promote economy, efficiency, and effectiveness in the administration of, and (B) to prevent and detect fraud and abuse in, such programs and operations; and

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127 According to NAPA *Positioning DOE's Labs for the Future*, and assessments data received from the laboratories for FY14.

128 See Chapter 5, Section 2.a "Processes for Planning Internal Assessments".

129 See also Recommendation 9 in Chapter 4.

3. to provide a means for keeping the head of the establishment and the Congress fully and currently informed about problems and deficiencies relating to the administration of such programs and operations and the necessity for and progress of corrective action.[130]

As required under DOE Order 242.A, the DOE-IG conducts audits of the activities of "DOE, its contractors and financial assistance recipients" in the areas of "(1) financial and compliance; (2) economy and efficiency; and (3) program results."[131] This order also lays out the responsibility of DOE-IG to create a "DOE-wide audit plan," which should be coordinated with other organizations, such as GAO and contractor internal audit organizations, "to avoid unnecessary duplication."[132] This order also requires the management of all "field elements" to provide assurance of the "adequacy of coverage, technical competence, objectivity, and independence of audits conducted by internal auditors of DOE major facilities management contractors."[133]

Order 224.2A presents what is required and expected in IG's auditing of programs and operations. Order 221.2A describes the expectations of cooperation with the DOE-IG by personnel and organizations throughout the department.[134] "[DOE] and [NNSA] contractors must ensure that their employees cooperate fully and promptly with requests from the [IG] for information and data relating to DOE programs and operations."[135] The intent of both of these orders and the public law are to establish an IG office within the Department which has the duty to find waste, fraud, and abuse while having the authority to investigate claims at all of the sites.

In determining which assessments to perform in a given year, the DOE-IG, as mentioned previously, interacts with the internal audit organizations of the laboratories and the laboratories' site offices through the Cooperative Audit Strategy and the DOE Contractors Internal Audit Directors Steering Committee (CIAD).[136] The purpose of the Cooperative Audit Strategy is to provide a systematic, risk-based approach to prioritizing

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[130] 5 U.S.C. App. 3

[131] DOE, *DOE Order 224.2A, Auditing of Programs and Operations* (Washington, DC: DOE, 2007). Available at http://energy.gov/sites/prod/files/igprod/documents/DOE_O_2242a.pdf.

[132] *Ibid.*

[133] *Ibid.*

[134] DOE, *DOE Order 221.2A, Cooperation with the Office of Inspector General*. (Washington, DC: DOE, 2008). Available at http://energy.gov/sites/prod/files/igprod/documents/o2212a.pdf.

[135] *Ibid.*

[136] Department of Energy *Acquisition Guide 70.4 Cooperative Audit Strategy* (2004). http://energy.gov/sites/prod/files/70.4_Cooperative_Audit_Strategy_0.pdf

the IG's audits. It also helps prevent duplicative assessments throughout the laboratory system, and provides a formal way in which the IG interacts with contractor internal audit organizations and their site offices. As described by the Fermilab Internal Audit Directorate, the CIAD committee "provides an outlet to learn internal audit best practices, and network with [the internal audit directorate's] peers at other DOE contractor sites."[137] The CIAD regularly holds meetings and conferences, and interacts with the DOE-IG to bring up issues concerning audits and inspections across all DOE contractors.

Generally, the Commission found that the Cooperative Audit Strategy seems to work. Most of the laboratories say that the Cooperative Audit Strategy works in coordinating audits by IG, and the CIAD helps air grievances, solve problems, and disseminate best practices. The exception to this is a specific site (Oak Ridge) where the number of local IG personnel is large, which has led to the perception that the site is subject to more than its share of IG attention simply due to the close proximity.[138] Table 21 shows the locations and sizes of IG Field Offices.

DOE-IG has 10 field offices co-located at laboratories. These range in size from 3 to 39 full time equivalent (FTE) personnel that perform functions in audits, inspections, and investigations. The audits and inspections division of DOE-IG conducts the reviews of programs and operations as outlined by the organization's annual audit plan produced from the Cooperative Audit Strategy.[139] The investigations division of DOE-IG

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[137] Fermilab Internal Audit Directorate *About the Staff* http://www.fnal.gov/directorate/IA/IA_Staff.html, accessed July 15, 2015

[138] Oak Ridge provided 4 examples from 2014:

- DOE IG, *Audit Report: Follow-up on the Department's Management of Information Technology Hardware*, DOE/IG-0926, (Washington, DC: DOE, 2014): Out of $125M in IT hardware procurements, $2M were found to be more than necessary (1.6%). In the Department's response "it was clear that the Department was already addressing issues before the audit was conducted."
- DOE IG, *Audit Report: Follow-up on the DOE's Acquisition and Management of Software Licenses*, DOE/IG-0920, (Washington, DC: DOE, 2014): $1.4B is spent by DOE on IT, IG found DOE/contractors spent $600K more than necessary over a 3 year period. The time it took the IG to conduct the audit resulted in greater cost than savings. Further, the cost of implementing a tracking system and dictating how M&O contractors should perform software procurements is "not conducive to the operating basis behind M&O contracts."
- DOE IG, *Audit Report: Strategic Petroleum Reserve's Drawdown Readiness*, DOE/IG-0916, (Washington, DC: DOE, 2014): Found that SPR was not able to achieve max 90-day drawdown rate –this was because the program designed to ensure oil complied with state and Fed regulations prior to delivery had been suspended. Although IG acknowledged the lack of funding and that management was aware of the issue and had two working groups assigned to fix it, IG recommended DOE perform a long-range strategic review of the reserves.
- DOE IG, *Audit Report: Cost and Schedule of the Mixed Oxide Fuel Fabrication Facility at Savannah River Site*, DOE/IG-0911, (Washington, DC: DOE, 2014): GAO report was issued prior to this report which identified the same concerns noted by IG. Despite this, IG issued 3 recommendations, all of which were already being implemented by DOE.

[139] More information concerning DOE-IG audits & inspections can be found at http://energy.gov/ig/mission/audits-inspections.

“performs investigations into allegations of fraud, waste, and abuse in programs and operations.”[140]

Due to complaints from the laboratories about the DOE-IG, the Commission aimed to determine the level of performance of IG processes in preventing duplicative assessments and the extent to which IG personnel coordinate with other organizations. From this review, the DOE-IG headquarters location does a good job at coordinating with the internal audit organizations of the laboratories, and most of the field office locations also work to coordinate with laboratory site offices prior to conducting assessments. The Commission found that at a few sites the local IG offices invoke DOE O 221.2A which outlines how contractors must cooperate with DOE-IG personnel past the order’s intended use. This can result in scope creep and lengthy assessments. Further, some IG personnel seemed to have an adversarial relationship with some laboratories and their site offices. On the whole, these issues are not pervasive in the laboratory system. When the Commission discussed these issues with the IG, it appeared aware of these locality specific issues and it is working to resolve them.

Table 21. Locations of IG Field Offices by Type

Location	Co-Located DOE Offices	Office of Audit Services	Office of Inspections	Office of Investigations	Number of FTEs
Albuquerque	Albuquerque Complex	x	x	x	34
Chicago	Chicago Office	x	x		8
Denver	Golden Field Office	x	x		16
Germantown		x			13
Idaho Falls	Idaho Operations Office	x		x	10
Las Vegas	Nevada Operations Office	x			7
Livermore		x	x	x	21
Los Alamos		x			3
Oak Ridge	Oak Ridge Office	x	x	x	39
Pittsburgh		x		x	22

140 More information concerning DOE-IG Investigations can be found at http://energy.gov/ig/mission/investigations.

Richland		x		x	14
Savannah River	Savannah River Operations Office	x	x	x	13

Source: DOE-IG website and FY 2014 DOE Budget Request

Note: There is also a DC/Forrestal location, which is the DOE-IG headquarters and has 314 Full Time Equivalents (FTEs).

2) Office of Enterprise Assessments (EA)

The Office of Enterprise Assessments (EA) is the office of the Department's independent assessors. The office was previously part of the Office of Health, Safety and Security (HSS), and as of May 2014, HSS was divided into EA and the Office of Environment, Health, Safety and Security (EHSS).[141] EHSS is concerned with the policy, guidance, and reports concerning environment, health, safety, and security. EA assessments generally separate into the following offices: enforcement, cyber and security assessments, environment, safety, and health assessments, outreach and analysis, and the National Training Center. At the SC laboratories with no Category 1-3 nuclear facilities, EA safety has conducted only two Independent Safety Oversight Assessments within the past five years which shows how the safety office sees its purview as mostly nuclear facilities safety.[142]

According to EA, the office conducts major security inspections with large teams. It also, in its view, has most of the personnel that are trained for security assessments within the laboratory system; site offices generally do not have personnel that can conduct security assessments at the same level of rigor.[143] EA conducts assessments based on risk and utilizes large teams. Some laboratories said that this method is often preferred to other external assessments. Once the large team leaves, the assessment is completed, unlike other assessors who may send the laboratories follow-up data requests for up to a year. The Commission also heard instances when these large teams conducted risk-based processes prior to the assessment, but the actual assessment dragged on longer than potentially necessary. These more egregious examples seemed to result from external direction to conduct the assessment from either Congress or the Secretary. For example, at Idaho an EA safeguards and security assessment cost the laboratory $1.3 million. This assessment was in the wake of Y-12, and EA received external direction to conduct all-intensive security review at many DOE locations.

141 More information about DOE-EA can be found at http://www.energy.gov/ea/office-enterprise-assessments.

142 According to information provided by EA; the SC laboratories without Category 1-3 nuclear facilities are Ames, Brookhaven, Fermilab, Berkeley, PPPL, SLAC, and JLab.

143 According to EA interview.

Due to the criticality of both safety and security and the lack of sufficiently trained workforce at site offices in security, EA finds that it cannot leverage site office reviews as much as other assessors. As referenced previously and as indicated in the data presented later in this chapter, EA's assessments are mostly conducted at NNSA locations and so its perspective of the ability of the site office workforce is somewhat consistent with GAO's recent findings of NNSA workforce needs.[144] EA does not seem to leverage information from the laboratory due to the importance of being the independent assessor in the Department.

The Commission did hear of informal avenues of preventing duplicative assessments within the Department. DOE-IG conducted an in-briefing and through inviting the appropriate EA assessor, conversations revealed that an additional assessment by IG was not necessary due to EA's recent assessment of the same topic area. Informal processes like this example still can be further institutionalized, and an area ripe with opportunity would be further reliance on site office knowledge, as appropriate.

d. Processes for Planning Separate Assessments

Of the non-DOE assessors, two organizations are presented here with their processes for conducting assessments at the DOE laboratories, the DNFSB, and GAO.

1) DNFSB

DNFSB is "an independent federal agency within the executive branch of government, answerable to the President and subject to Congressional oversight and direction … [and] the only independent oversight entity involved in nuclear safety for DOE's defense nuclear complex."[145] The board of five presidentially-appointed members is independent from DOE and NNSA. The board conducts focused assessments of only the DOE laboratories with defense nuclear facilities (See Chapter 3 for a more detailed discussion of DNFSB).

The DNFSB has a very public process for how they conduct oversight including a prioritization determination that has a list of the main risk factors.[146] "Four types of safety oversight are underway at all times: evaluation of DOE's organizational policies and processes (i.e. DOE's safety framework); evaluation of actual hazardous

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[144] GAO. *NNSA: Actions Needed to Clarify Use of Contractor Assurance Systems for Oversight and Performance Evaluation.*

[145] DNFSB, *Background on Defense Nuclear Facilities Safety Board Oversight Processes*, and 42 U.S.C Section 2286(a).

[146] *Ibid.*

operations/activities and facilities in the field; expert-level reviews of safety implications of DOE's actions, decisions, and analyses; identification of new safety issues otherwise unknown in the DOE complex."[147] The board carries out oversight tasks based on DOE Manual 140.1-1 *Interface with the Defense Nuclear Facilities Safety Board*. The DNFSB does not develop any regulations of its own. As its primary role, the DNFSB reviews how DOE implements DOE-developed regulations.

"In a typical year, the Board's staff will average ten review team trips per month (total) split up among the numerous sites included in the defense nuclear complex." The Board's staff also makes sure that its field representatives rotate from facility to facility, and all of the staff in headquarters have some experience in the field. They see this rotational program as critical to training of all staff personnel. As described in the requirements chapter, the Board has decreased the number of recommendations to DOE over the past 20 years. This is an indication that as performance has improved at the facilities, the Board has suggested fewer changes.

There is confusion between DNFSB "recommendations" and suggestions or observations. DNFSB facility representatives produce weekly public-facing facility updates (1 page each), and these facility updates can be misconstrued as formal recommendations from the Board. The laboratories do not want to be out of compliance with DNFSB recommendations, and so these suggestions are followed, which contributes to over-conservatism at DOE and the laboratories.

Both DNFSB and EA conduct more assessments at the NNSA laboratories than the other laboratories due to higher risk profile and focus of their reviews. Because of this, both organizations see leveraging site office reviews as not possible due to the incomplete training of the workforce.

2) Government Accountability Office (GAO)

GAO examines whether taxpayer dollars are being put to the best use across the Federal Government. GAO conducts assessments on behalf of Congress in order "to help improve the performance and ensure accountability of the Federal Government for the benefit of the American people," and 95 percent of GAO's work is the result of a request or mandate from Congress.[148] According to GAO interviewees, the large number of requests from Congress enables and forces GAO to prioritize topics based on need and risk. GAO organizes its auditing teams by topic; for example, the group that audits the NNSA laboratories does all assessments in the natural resources and environment

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147 *Ibid.*

148 For more information about GAO, their website is http://www.gao.gov/about/index.html.

domain. At times, GAO teams will draw from expertise outside of the organization and assign stakeholders to teams.

In addition to duplicity of assessments with other assessors, interviewees cited the long length of time to complete an assessment as the primary issue with GAO assessments. On average, GAO assessments remain "open" for an average of 1 year, which means GAO can request additional data from the laboratory and the current state at the laboratories may not be reflected in the final recommendations and findings.[149] An independent international peer review of GAO from 2013 indicates that the organization has piloted new systems to monitor scope creep and excessive time for assessments.[150] GAO created these new tools in response to suggestions to "ensure oversight of significant changes to audit scope" and "enhance monitoring of time variances on audits."[151] Still unknown are the success of these measures, but the institution of these tools are an indication of GAO trying to fix these issues.

e. Leveraging External Assessments to Prevent Duplication

These external assessors (both within DOE and non-DOE) have risk-based processes as described, but there still exists some confusion as to how much they leverage each other's work. The Commission found examples, especially in response to large incidents, where many assessors each conducted their own independent review. These duplicative assessments seem to have decreased over time based on laboratory anecdotes, but they still occur and incur costs at the laboratories. Further coordination would be beneficial, especially within the Department.

Each one of these external assessors, GAO, IG, DNFSB, and EA, mentioned the difference in performance of oversight between NNSA and the rest of the program offices. Their impressions from conducting assessments at the laboratories are SC is the highest performer, then the applied programs, and then NNSA.

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149 Three laboratories provided data about the average length of GAO assessments, which was about 1 year (Idaho, Livermore, and Oak Ridge). Other interviews provided similar anecdotes.

150 Every 3 years, an independent organization conducts a peer review of GAO. For the calendar year of 2013, the Office of the Auditor General of Norway conducted the peer review and found that the system of quality control was providing adequate assurance. The peer review team also monitored suggestions from the 2011 peer review, including for GAO to "ensure oversight of significant changes to audit scope" and "enhance monitoring of time variances on audits." Auditor General of Norway, *International Peer Review of the Performance and Financial Audit Practices of the United States Government Accountability Office,* (2014).

151 Office of the Auditor General of Norway, *Report of the International Peer Review Team on GAO's Performance and Financial Audit Practices,* (2011).

3. Value of Assessments

Assessments are conducted for oversight, quality assurance, and to improve management. They are a necessary part of responsible oversight. The reasons to conduct assessments include (performer in parenthesis):

- Mitigate risk (all assessors)
- Effectively and efficiently manage (M&O contractor/laboratory management)
- Provide assurance to M&O contractor and to DOE (laboratory)
- As regulator or overseer, ensure quality and verify compliance of requirements (External entities [DOE, GAO, DOE-IG, etc.])

4. Issues with Assessments

For all the potential benefit of assessments, every auditing group should not assess all management systems and every aspect of the laboratory. In order to illustrate the issues that can occur from assessments, personnel from the laboratories and site offices cited issues related to assessments and provided examples of onerous assessments.

Duplicative audits can occur due to overlapping requirements and insufficient coordination of external assessors. Auditors' legal authority may overlap resulting in conflicting interpretations or the creation of multiple reporting mechanisms. Table 22 shows an example prepared by Idaho concerning the drivers for the contractor assurance system, quality assurance, integrated safety management system (ISMS), and entity assessment. All four programs require assessments for similar areas.

Table 22. Examples of Overlapping Requirements Resulting in Duplicative Assessments

Program	Driver	Areas of Programmatic Overlap	Assessment Requirement
Contractor Assurance System	DOE O 226.1B *Implementation of DOE Oversight Policy*	Performance Improvement Tools Assessments Issues Management Event Investigation Performance Monitoring Lessons Learned	Requires independent verification. Implemented through Peer Review every two years, plus DOE oversight
Quality Assurance	DOE O 414.1D *Quality Assurance*	Performance Improvement Tools Assessments Issues Management Performance Monitoring Roles and Responsibilities	Triannual

		(R2A2s)	
Integrated Safety Management System (ISMS)	Idaho Contract DE-AC07-05ID14517, Clause I.22 Department of Energy Acquisition Regulation (DEAR) 970.5223-1, *Integration of Environment, Safety, and Health into Work Planning and Execution* DOE P 450.4A	Performance Improvement Tools Assessments Lessons Learned Checking and Corrective Action Effective implementation of Management Systems (e.g. work control, ES&H, QA, CAS, LP, etc.)	Annual
Entity Assessment	Federal Managers' Financial Integrity Act (FMFIA) reporting requirements—A-123 Circular *Management's Responsibility for Internal Control*	Assessment of Effectiveness of Internal Controls • Safeguards and Security • Risk Monitoring • ES&H • Business Controls • Management Effectiveness • R2A2s • Strategic Planning & Capability Development • Issues Management	Annual

Source: Analysis completed by personnel from Idaho National Laboratory, June 2015.

Some assessors take up to a year or more to complete an assessment. The value of the information collected during an on-site inspection decreases with the increase in time before the report out to the laboratory. By the time the assessment report is published, the laboratory may have already addressed the problems raised.

Additionally, while assessments are "open" the laboratory must be available to these assessors for any follow-up data requests. The longer the assessment is "open," the more resources are devoted to these data requests. The average length of both GAO and DOE-IG assessments is 1 year.[152]

Some assessors come to the laboratory with undefined scope and unspecified level of effort prior to beginning the assessment. This makes it difficult for the laboratories to determine the appropriate number of resources or personnel to allocate to a specific

152 Information supplied by three national laboratories. The other national laboratories did not provide average length of GAO and IG assessments.

assessment. When the scope and level of burden on the laboratory are undefined or changing, the laboratory may devote resources to preparing for an assessment only for those efforts to be wasted when the scope changes. Similarly, without an estimate for level of effort, the laboratory cannot plan for allocation of resources. As mentioned previously in this chapter, one Safeguards and Security inspection at Idaho in 2014 by DOE-EA cost the laboratory $1.3M. Additionally, the Idaho Safeguards and Security program (developed through CAS) had previously identified all of the findings by the inspection team.[153]

Some laboratories complained about some assessors lacking the appropriate expertise, especially in technical domains. This requires laboratory staff to expend resources and time to teach the assessors how to assess the laboratory processes. Some contractors hired by Departmental auditors to assess the laboratories are not familiar with DOE requirements or processes.

External assessors, as described earlier in this chapter, describe their own "risk-based" processes for assessments, but these risk-based processes do not seem to extend to determining the value of independent assessments by that organization. Put in another way, the assessments conducted by other organizations are not formally introduced into these processes, which should impact the risk of a certain area. Similarly, the most burdensome assessments that duplicate the efforts of both the site office and the laboratory are often created or determined as needed by external assessors without a rigorous look at what has recently been assessed at the laboratory. One recent example is Sandia's Work for Others program (WFO). In the course of one year at the laboratory, GAO conducted an assessment of WFO; IG had an WFO audit, a cooperative research and development agreement audit (which includes WFO agreements), and the annual consolidated financial statement (which also includes WFO disclosure), and created a WFO task force; and NNSA's Office of Field and Financial Management (OFFM) conducted a biannual pricing review (which includes WFO).[154] None of the auditors reported any serious deficiencies with WFO at Sandia.

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[153] This inspection caused many issues. Idaho was told the assessment would only last 3 weeks and it ended up being conducted from January 16 – April 17, 2014. The data call prior to the assessment included 15,000 pages of data that were required to be sent hard copy to EA (HSS at the time). However, the EA team did not sufficiently digest the documents and asked for them to be reproduced when they arrived on site. After all of the inspection details (42 limited scope performance tests engaging 4-100 staff, 2 full scale force on force exercises, 350 staff performance tests, 273 physical system component tests, 150 briefings, meetings, and interviews, and 23 tours), the EA team gave the laboratory 2 hours to review the 200 pages of findings. The laboratory had self-identified all of the resultant findings. In all, these efforts cost the laboratory $1.3M, which excludes the expenses of the EA inspection team (estimated by the laboratory to be over 6000 hours).

[154] Information provided by Sandia through list of assessments for FY 2014.

The Commission found that although many of the laboratories had *specific* examples of onerous audits or inspections by outside institutions, only 4 of the laboratories would cite, when pressed, assessments as being *generally* burdensome on the laboratory. The three NNSA laboratories complained about a constant barrage of onerous assessments, and Oak Ridge has specific issues with IG assessments. The other laboratories had varying levels of burden from assessments, but most, including Oak Ridge, emphasized the importance of their relationship with their site office in helping to maintain a healthy level of oversight at the laboratory. The negative impacts of assessments incur cost at the laboratories, and the laboratories should quantify these costs so that a determination of level of burden could be made.

5. Number of Assessments across the Laboratory System

The Commission collected data from all 17 laboratories on assessments. Figure 20 shows the number of external (DOE-local, DOE-off-site, and separate) assessments conducted at each laboratory for FY 2014; this includes the assessments from every performer in Table 18 except for the laboratory, its M&O contractor, and DOE program offices. The laboratories in Figure 19 are organized from left to right by increasing size of operating budget. The exception to this is the Savannah River Site, which includes Savannah River National Laboratory, and has annual budget of about $2.5B.[155] Since Savannah River National Laboratory is part of the whole site's contract, many assessments are conducted on-site that include the national laboratory, but not exclusively so.[156] Thus the column that is labeled "Savannah River-only" refers to the assessments conducted only at the Savannah River National Laboratory, and the assessments conducted for the whole site that include the national laboratory are labeled "Savannah River Site."

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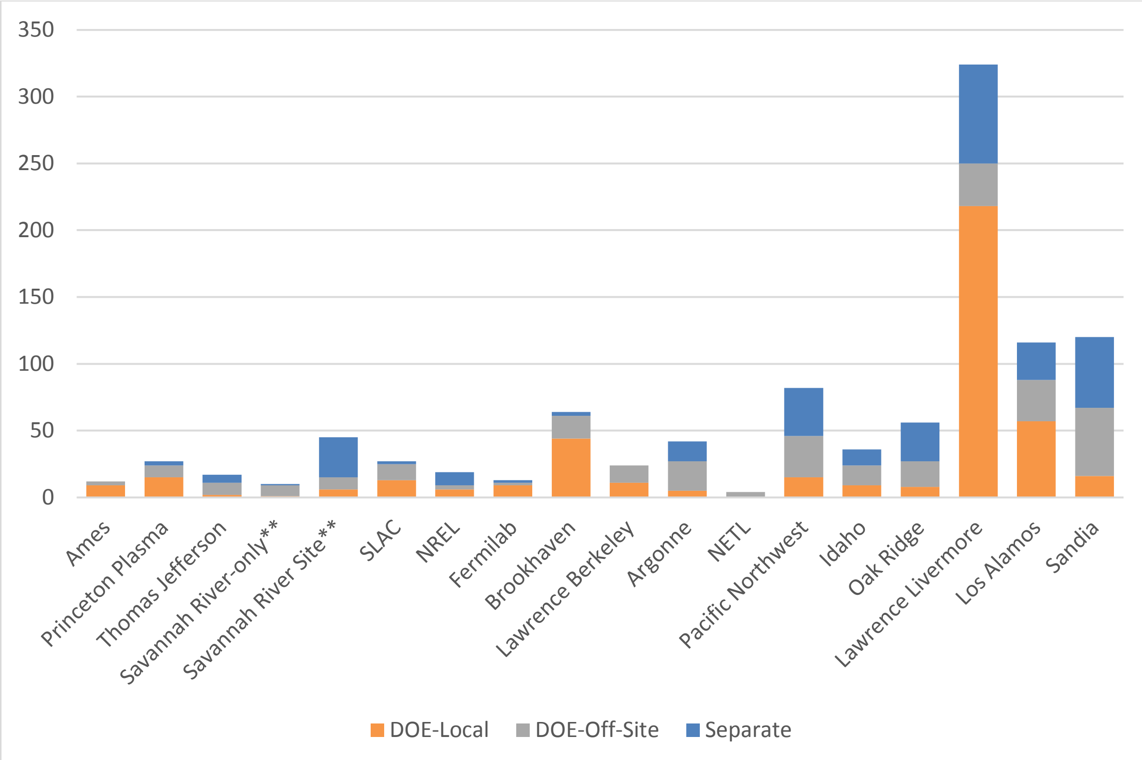
[155] Savannah River Nuclear Solutions. Savannah River Site Facts. (2012). Available at http://www.srs.gov/general/news/factsheets/srs_esrs.pdf.

[156] Other national laboratories are not a subset of a larger site. Instead, they have their own M&O contract. The exception to this is NETL, which is a GOGO.



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 19. Number of External Assessments at the DOE Laboratories (FY14)

Brookhaven and Lawrence Livermore are used as case studies to elucidate the differences in assessments across the laboratory system. In Figure 19 Brookhaven and Lawrence Livermore have a larger number of external assessments when compared to laboratories of a similar size. Although both values are relatively large, these assessments result in different impact on the laboratory. Brookhaven has a significantly higher number of *local* external assessments when compared to similarly sized SC laboratories. Brookhaven also has a strong working relationship with its site office, and the laboratory personnel, when asked, do not find these *local* external assessments especially burdensome.

Lawrence Livermore, on the other hand, has the largest number of external assessments by its site office, and presented many examples where assessments incurred costs not commensurate to value or risk. According to Lawrence Livermore personnel, the laboratory's large number of external assessments has resulted in a large burden on the laboratory. About 200 of these assessments are conducted by their site office, which oversees Livermore's systems through daily walkthroughs and independent reviews. Although both Brookhaven and Lawrence Livermore seem to have burdensome external assessments based on number, actual and perceived burden are vastly different at the two laboratories and are at least partially based on the quality of the relationship with each site office.

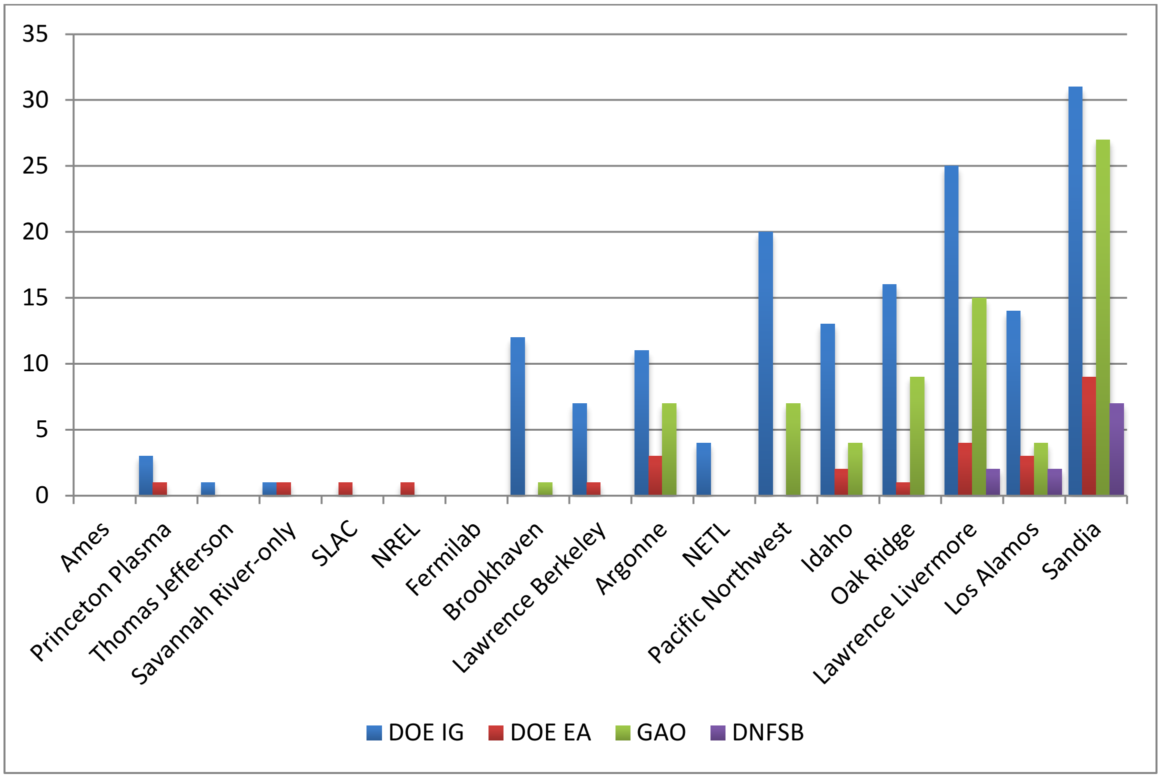
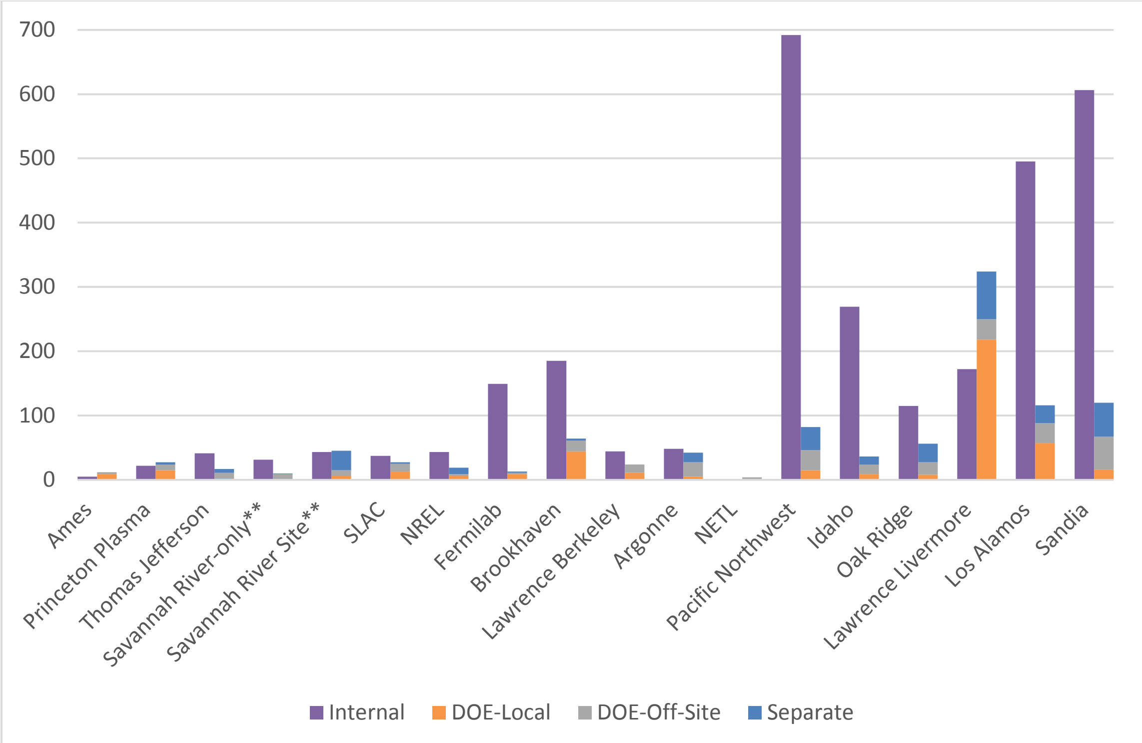


Figure 20. Number of Assessments by the DOE IG, DOE EA, GAO, and DNFSB (FY14)

Figure 20, the number of assessments by the IG, EA, GAO and DNFSB are displayed. While there are relatively few when compared to site offices, according to the laboratory staff, they can be the most burdensome. Site offices can help coordinate these; for example, Princeton Site Office conducts joint assessments with IG and EA. In addition, DNFSB has conducted a joint assessment with both the Sandia site office and EA.

A more complete picture can be seen when the internal data are paired with the external (Figure 21). The laboratories are once again organized from left to right by increasing operating budget.



Source: Data supplied by each laboratory, 2015.

Note: 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.

* The total number of assessments conducted by Pacific Northwest in FY14 is about 7400. This value includes independent assessments, internal management assessments, management activity observations, project reviews, and about 6000 space-based assessments (more rigorous than a cursory walkthrough). These all are considered the same level as "assessments" as the other laboratories. The 692 internal assessments included in this figure exclude the space-based assessments and the project reviews.

** 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 21. Number of External and Internal Assessments at the DOE Laboratories (FY14)

Adding internal assessments to the earlier comparison between Brookhaven and Livermore, Brookhaven had 185 internal and 71 external assessments in FY14 and Livermore had 172 internal and 324 external. Brookhaven has a relatively large number of external assessments, but the laboratory also has a large number of internal assessments. Brookhaven's culture of internal auditing differs from others in that they extensively track and trend their processes. This is one reason that their internal assessments value is larger than other laboratories. Conversely, the number of external assessments at Livermore is almost double the number of internal assessments. This comparison (as well as looking at the same values for other laboratories) suggests that healthier oversight environments may have greater internal assessments when compared to the number of external assessments. When taken together, the relative value of external to internal assessments provides some information about the added burden of external assessments. A greater ratio of internal to external can indicate a greater trust and reliance on laboratory data and systems.

The risk profiles of Livermore and Brookhaven are very different; one could expect the NNSA laboratory to naturally have a higher number of external assessments. The oversight environment in NNSA is more prescriptive and the auditors are less willing to rely on contractor assessments.[157] Sandia has 606 internal and 120 external assessments, and Los Alamos has 495 internal to 116 external assessments. These ratios of internal to external are much greater than Livermore and may suggest that the large number of external assessments at Livermore is not only due to the generally higher risk profile of NNSA laboratories. Sandia's and Los Alamos's self-assessments may be leveraged more than Livermore's self-assessments, and interviews would also suggest that this is the case. All 3 NNSA laboratories have high internal and external assessments. This may be partially attributed to them being bigger laboratories with higher risk profiles.

These high numbers are also likely due to the large number of requirements at NNSA laboratories. Livermore estimates that 40 percent of its internal assessments are required, about 44 percent of Los Alamos's internal assessments (204 of 460 noted as required or not required) are required, and about half of Sandia's internal assessments (287 of 564 noted internal assessments) are to "comply with requirements."[158] As mentioned in the chapter on contract requirements, NNSA has many more numerous and prescriptive requirements than other program offices. This increases the number of assessments as requirements can detail when assessments take place at the laboratory. If requirements are reformed, unnecessary or duplicative assessments may decrease at the NNSA laboratories.

The data presented in this section along with the interviews conducted across the laboratory system suggest that the issues of broken trust and burdensome oversight environment within the NNSA may manifest themselves in increased number of assessments at the laboratories. The burden at other laboratories has been reduced by the relationship between the laboratory and its site office and by involvement from the laboratory and Federal personnel in implementation of CAS. Whereas prior reports have found that most laboratories experience a great amount of burden due to assessments, this

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157 Based on interviews, site visits, and discussion in Chapter 4 on CAS, site offices, and support centers.

158 Livermore estimation from supplied data, Los Alamos value calculated from supplied data – 460 of the 495 assessments were marked as either required or not required, and Sandia calculated from supplied data. Those from Sandia noted as having a purpose of "comply with requirements" are counted in this number. Other purposes for internal assessments in the data set include Assess Risk Control, Improve Performance, Request by Customer, and Validate Contractor Assurance.

Commission, which is conducting its research a few years after the institution of CAS across the laboratory system, has found that the NNSA laboratories experience the largest burden from assessments.

6. Number of Assessments at other Federal Laboratories

To determine how the DOE National Laboratories compare to other laboratories, the Commission asked The Aerospace Corporation, Draper Laboratory, The Johns Hopkins University Applied Physics Laboratory, NASA's Jet Propulsion Laboratory, and MIT Lincoln Laboratory for the number of external assessments (non-technical/operations-related) that the laboratory receives each year. The response to this data request is found in Table 23. In general, the non-DOE laboratories seem to have fewer assessments than the DOE laboratories, particularly when compared by operating budget.

Table 23. How Assessments at Other Laboratories compare to DOE Laboratories

	Laboratory	Budget ($M)	External Assessments (FY14)
Non-DOE Laboratories	Draper Laboratory	491	12
	The Aerospace Corporation	890	3
	The Johns Hopkins University Applied Physics Laboratory (APL)	510	15
	NASA's Jet Propulsion Laboratory (JPL)	1670	23
	MIT Lincoln Laboratory	952*	72
DOE National Laboratories	Ames	36	12
	Princeton Plasma	81	27
	Brookhaven	770	69
	Idaho	1300	37
	Sandia	2500	120

Source: Values provided by each laboratory to the Commission, June 2015

* From NAPA *Positioning DOE's Labs for the Future* (2013), FY 2012

NAPA found that the main difference between DOE Laboratories and other non-DOE FFRDCs subject to "audits and operational reviews by external entities" are the "separate site office inspections, audits, or operational reviews [that] compound these operational reviews" at the DOE laboratories.[159] The reviews at non-DOE FFRDCs appeared to the Academy researchers as "less extensive and intrusive relative to the audit and oversight assessment environment facing many of the DOE laboratories, e.g., the Lawrence Livermore environment described [in the paper]."[160]

7. Level of Effort Associated with Assessments

While the data and interviews suggest that the most burdensome assessments occur at the NNSA laboratories, the quantity of that burden is hard to evaluate from past anecdotes without a figure for the level of effort involved for each assessment. The Commission attempted to quantify *how* different the burden is between these laboratories.

However, it became clear that very few laboratories track assessments by number of hours expended by personnel. Due to lack of data, the Commission was only able to review examples from three laboratories—NETL, Idaho, and Livermore. NETL developed an Audit Coordination & Tracking System (ACTS) in 2011, and ACTS has included the number of hours and associated level of effort of NETL assessments for the past 4 years. This system has allowed the laboratory to track the most burdensome assessments. For example, for its 4 IG audits in FY 2014 NETL expended about 1200 personnel hours. Livermore provided the Commission with an estimate amount of effort for their internal assessments, which was $32M and about 345,000 hours in one year. The laboratory has started to track level of effort for its external assessments. Idaho, as part of its development and implementation of CAS and as part of the ongoing healthy working relationship between the laboratory and the Idaho Operations Office, expressed during the site visit that the two organizations plan to start to track level of effort of assessments.

A determination of burden value would go far in solving the issue of whether examples of egregious assessments significantly outweigh other appropriately managed assessments. This metric would also help solve the issue of differences in definitions for assessments, audits, and inspections across the laboratory system.

The Working Group to Study Modifications to Laboratory M&O Contract for Single-Program Laboratories ("Evolutionary Working Group") was created to find solutions to issues at the laboratories that could be implemented through pilot contract modifications of a single-program laboratory's M&O contract. As part of its efforts, the Evolutionary Working Group collected external assessment data from the ten SC

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159 NAPA's *Positioning DOE's Labs for the Future* benchmarked the 16 DOE FFRDCs to MIT Lincoln Labs, JPL, Frederick National Lab for Cancer Research (FNLCR), Center for Advanced Aviation System Development, National Defense Research Institute, and the National Radio Astronomy Observatory.

160 *Ibid.*

laboratories and also attempted to determine the level of burden on the laboratories.[161] The Evolutionary Working Group was unable to obtain level of burden from the laboratories as "the data provided by the laboratories on DOE HQ Assessments are incomplete; they do not track these accurately."[162] The Evolutionary Working Group focused on reducing the burden of external assessments and has recommended that external organizations within the Department annually "provide an assessment cost/benefit analysis report," including site offices submitting an annual list of assessments.[163]

The recommendation from the working group applies to organizations within the Department (since this was in the group's purview), but this recommendation excludes the effort for internal assessments, and all non-DOE external assessments of which there are many. Of the external assessors discussed in this chapter, the working group's recommendation would apply to the DOE-IG and the DOE-EA. Conclusions about the amount of burden produced by assessments across the system will not be fully measured until all laboratories track level of effort of both internal and external assessments.

B. Data Requests

Data requests, or calls for information, arrive at the laboratories from many sources, and generally no central point of contact exists to field these calls. From interviews, data requests can be redundant, repeated, and unnecessary, have short turn-around times, and generally take much of laboratory personnel's time in order to respond appropriately.[164] Many of these requests do not include any indication of how the data will be used, which causes staff to follow-up with the original requestor many times.

Currently, extensive tracking of data requests does not occur at of the laboratories. Livermore, which only recently has started formally tracking large data requests, received over 155 data requests in one year. Informal calls and quick turnarounds during the year were not formally tracked. Additionally, requestors may call up or email anyone within the organization, and these calls for information are hard to track.

In order to set up a point of contact for the SC laboratories, the Office of Science began a few years ago filtering data calls to the 10 SC laboratories through the Deputy Director for Field Operations. Both SC and its laboratories see this process as being very

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161 DOE Office of Science, *Working Group to Study Modifications to Laboratory M&O Contracts for Single-Program Laboratories*.

162 *Ibid.*

163 *Ibid.*

164 One of the more egregious requestors asked laboratory staff to send the emails of all 17 DOE laboratory directors.

valuable it filters requests before arriving at the laboratories, even directing the requestor to the correct point of contact. Vague requests can turn into multiple conversations or creation of data until the call has been answered. The Deputy Director for Field Operations has been vigilant in making sure that data calls do not go to the laboratories before being vetted through that office, but unfiltered data calls, especially from within the Department, still arrive at the laboratories.

In improving the oversight environment for the laboratories, authors of the NAPA report *Positioning DOE's Laboratories for the Future* recommended that all site offices should act as coordinators or "gate-keepers" of the laboratories.[165] For the authors of the NAPA study, this role "should also apply to data calls generated by headquarters program and staff offices."[166] However, the problem with the site offices being the gate-keepers for data calls generated from the department is that many of the data calls are sent to all of the laboratories and could be answered by one call, rather than 5 or 17.

The Commission has received agreement from interviewees from headquarters, site offices, and laboratories that data requests have remained a serious problem. The current administration has been looking at opportunities to improve this problem, and this Commission believes that lessons can be learned from having a single point of contact for all laboratory data requests.

C. Findings and Recommendations

Based on its work, the Commission found the following:

- Assessments are not a crippling issue at the majority of the laboratories. But the NNSA laboratories express that they receive very burdensome assessments potentially due to over-reliance on transactional-based oversight and a large number of requirements.
- The contractor assurance system (CAS), when implemented well, adds high value to the laboratories and effective implementation has been shown to reduce oversight, including assessments.
- Most of the laboratories do not track the amount of effort associated with assessments. Conclusions about the amount of burden of assessments across the laboratory system cannot be fully measured until laboratories track level of effort.
- SC has successfully reduced the amount of unfiltered data requests at the laboratories through a single data request point of contact. This filtering process

[165] NAPA, *Positioning DOE's Labs for the Future.*

[166] *Ibid.*

does not occur at other laboratories, and burdensome data requests still arrive at all laboratories.

Based on these findings, the Commission makes the following recommendations with respect to assessments and data requests:

- DOE and its program offices should support continued implementation of CAS principles across the laboratory system. This will involve the following improvements for assessments:
    - Laboratories: Make internal assessment processes and management systems fully transparent to site office representatives
    - Site offices: Coordinate off-site and external groups and advocate for the laboratory in cases of duplicative audits
    - Site offices: As part of CAS, create risk-based processes for determining independent reviews. Where appropriate, leverage shadowing and joint assessments of contractor-led assessments based on risk.
    - External assessors: Leverage information from site offices and laboratories before conducting work on site to reduce duplicative assessments and amount of burden on the laboratories.
- DOE should move forward with the Evolutionary Working Group recommendation for DOE organizations that conduct assessments at the laboratories to provide an annual cost/benefit analysis of assessments for all laboratories.
- Laboratories should track the laboratory level of effort of all assessments.

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.

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

6. Flexible Budgeting

A. Prior Studies

An additional manifestation of an eroded FFRDC model is the decreasing size and tighter controls placed on laboratory budgets. Numerous studies spanning two decades, but particularly those in more recent years, have exposed the "budget atomization" problem confronting the laboratories. Budget atomization in this context refers to (1) ever smaller "buckets" of funding and tighter controls on movement of funds between buckets; or (2) greater rigidity within each bucket to address higher priorities or contingencies in laboratory operations.

While the Galvin report does not refer to budget atomization directly, its references to DOE's institutional fragmentation and treatment of laboratories as "a set of projects" appear prescient with respect to partial causes of the budget atomization problem. DOE's internal structure, when combined with the micromanagement that has become characteristic of an eroded FFRDC model, has resulted in further parsing of program funds and tighter controls at the project or task level. Additionally, the Galvin report rightly underscores the distinction between the short-term "job shop" approach relevant to most commercial sector research endeavors as opposed to long-term, multi-disciplinary scientific activities appropriate to a National Laboratory.[167]

More recent reports, the 2013 National Academies report, *Managing for High-Quality Science and Engineering at the NNSA National Security Laboratories*, and the 2014 Augustine/Mies panel report, for example, underscore the negative effect of budget atomization on NNSA laboratory operations. The National Academies report highlighted that historically the overall weapons program at each laboratory in principle had sufficient flexibility to use some of its budget to fund a robust research program, in support of the weapons mission. However, "the weapons program budget is subdivided into so many categories with so many restrictions that this important flexibility is effectively lost."[168] The loss of flexibility has reduced the amount of core program research and was deemed to have negative implications on recruiting key talent to the laboratories. A corollary in the Office of Science domain has one laboratory director

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[167] SEAB, *Alternative Futures for the Department of Energy National Laboratories*.

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

stating that he did not have sufficient flexibility in his budget to recruit a principal investigator that he deemed essential to achieving the scientific objectives of the laboratory.[169]

The 2013 NAPA report also offered an extensive overview of budget atomization. While recognizing that Congress and Federal contract administrators need visibility both to effectively manage programs and ensure accountability, the "budgetary controls that have led to the creation of thousands of 'funding buckets' significantly reduce the laboratories flexibility, creates excessive administrative costs and burdensome reporting requirements, and impedes mission accomplishment."[170]

While both the National Academies and the Augustine/Mies panel called on Congress to "reduce the number of restrictive budget reporting categories," the Augustine/Mies panel report also recommended that the Congress, Secretary, and Director[171] "adopt a simplified budget and accounting structure (by reducing budget control lines) that aligns resources to achieve efficient mission execution." Additionally, the Director 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."[172] The NAPA study did not focus on congressional controls, but rather recommended that DOE work on improving "its funds distribution system…not only the technical operation of the system, but how program offices' fund allocation processes can be modified to minimize the number of 'funding buckets'."[173]

Although the Senate Energy and Water Appropriations Committee staff recently spearheaded an attempt to reduce the number of control lines in the weapons program, this initial effort did not yield results. Congressional movement on this issue has been hindered by the question of the extent to which congressional control over taxpayer money hinders the agency's ability to actually meet the taxpayer's expectations regarding the return on investment. With respect to the NAPA report's recommendation, the Commission found no evidence of a DOE-wide effort to address how program offices might modify their fund allocation processes to address this problem. Furthermore, the

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169 Commission visit to Fermi, November 18, 2014.

170 NAPA, *Positioning DOE's Laboratories for the Future*, 26–27.

171 The "Director" reference in this recommendation is the Director of the newly formed Office of Nuclear Security; the Panel called for establishment of this Office and granting of new authorities for a Director who would serve at least six-year terms. See Congressional Advisory Panel on the Governance of the Nuclear Security Enterprise, *A New Foundation for the Nuclear Security Enterprise*, (Washington DC: IDA 2014): xiii.

172 *Ibid*.

173 NAPA, *Positioning DOE's Laboratories for the Future: A Review of DOE's Management and Oversight of the National Laboratories,* 28.

budget atomization problem is not uniform across program offices and any DOE-wide effort will have to take into account the huge variance among program offices' funding allocation approaches. Lastly, previous DOE efforts to address this issue failed due to its complexity and the sheer magnitude of operational and cultural changes required.

Whereas these previous studies identified the problem of micromanagement and emphasized its negative effect on operations at the laboratories, they did not reveal any systemic causes or offer specific solutions.

B. Budget Process and Causes of Atomization

The Commission pursued a rigorous examination of this issue to identify causes and determine potential solutions. The Commission investigated the various roles played by the Office of Management and Budget (OMB), Congress, and DOE headquarters in the budgeting process and gathered extensive data from several program offices and laboratories.

Each of the players in the budget process performs a role in allocation, apportionment, and fielding of money through various program offices to the laboratories, but the effects of atomization are not uniform across OMB examiners or across the congressional committees that oversee DOE funding. For example, while the stockpile stewardship budget remains tightly controlled and heavily segmented by Congress, the Office of Science budget is comparatively unconstrained. Conversely, OMB applies a quarterly apportionment process to the Office of Science funds, but not with respect to the weapons budget. Further, whereas what OMB submits to Congress in the President's Budget appears not to have significant implications for atomization, the combined impact of congressionally imposed "obligational control levels"—Congress's requirements regarding controls under a Continuing Resolution (CR) —and OMB's interpretation of congressional language regarding apportionment affect compliance-related activities at the laboratory level and DOE management and laboratory flexibility. A separate, but related, issue is that DOE's program offices internally manage and allocate funds in widely different ways, which creates additional complexity in determining causes and delineating potential fixes to the atomization problem.

An overarching problem for laboratory effectiveness is the breakdown of the budget process itself. The Budget Control Act combined with truncated timelines and uncertainty over actual annual funding—all while operating under a CR—severely inhibits flexibility at the laboratory level. The process is exacerbated by congressional language dictating allocations at the program, project, or activity (PPA) level during a CR. In addition, OMB's quarterly apportionment for some of DOE's major programs further constrains the laboratories' flexibility and creates additional transactional costs in mission execution.

The appropriations committee establishes so-called Congressional Obligation Control Levels (OCLs) as legal limits on appropriations funding for OMB and the respective agencies. 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 10 percent of the funding amount, whichever is lower, which allows for some movement of funding between OCLs without congressional approval. However, NNSA reported that when movement of funds that exceeds the statutorily defined thresholds between OCLs, the timeline for the necessary congressional approvals is between 3 and 6 months. DOE's general practice is to request such approvals "in bulk" so as to minimize the number of transactions required to move funds where needed to achieve mission objectives. The Commission found no evidence that movement of funds between OCLs creates an issue for non-weapons DOE program areas.

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 Obligational Control Level (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.[174] This, in combination with other Office of Management and Budget (OMB) apportionment requirements—including quarterly apportionment for the Office of Science and other program areas—creates constant turmoil and delay in getting money to the laboratories. The sites, in turn, have increasingly limited flexibility to achieve a sometimes wide-ranging and multi-year mandate in their research efforts on a small dollar increment within the limited timeframes of any single CR.[175]

Table 24 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.

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[174] 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)."

[175] OMB has three categories for its apportionment to agencies: Category A, split funding by time period (e.g., quarterly funding); Category B, split (or prohibit) funding by project (e.g., no funds for Small Modular Reactors), and; Category C, make funding unavailable this year, pushing it to future years (e.g., NNSA Pension funds). Each of these categories is further explained in Appendix I.

Table 24. Proliferation and Atomization of Laboratory Budgets into Funding Buckets by Legal Level

	Legal Control		Program Office		
	FY 2014 Approps Only				All Years
	Appropriation (year & period of availability)	PPA	9 digit BNR	Place	Place
Weapons	1	70	321	1,278	2,369
Def Prog	*1*	*44*	*161*	*566*	*979*
All other	*1*	*26*	*160*	*712*	*1,390*
Defense, EM	2	33	119	609	1,292
Science	3	26	253	1,054	2,120
EERE	3	18	84	553	1,253
OE	2	7	14	80	211

Source: DOE Office of the Chief Financial Officer.

1. Headquarters—Program Offices

Under each PPA listed in Table 24, the program offices further subdivide funding and then manage the work to be done, determine where it is to be done, and track the milestones that correspond to the funding being expended. The nine-digit Budget and Reporting (B&R) codes represent each program office's breakdown of funds for separate projects at different sites. Although headquarters approval for movement between B&R codes is not required, laboratory requests for such changes must be submitted to headquarters for their verification that such actions do not violate any Congressional controls. The actual implementation of any requested changes is performed at headquarters within DOE's accounting systems.

DOE's institutional fragmentation, with its attendant lack of uniformity across major program offices, is one facet of the atomization problem. The controls and processes for the increasingly smaller funding buckets vary widely among program offices. Similarly, each program office has different requirements regarding the platform for the financial accounting and reporting from the laboratories. Lastly, how the Work Breakdown Structure (WBS) associated with each B&R code is handled by different program offices creates either greater flexibility or even more onerous controls, depending on how each project is segmented into tasks and what reporting or other requirements are associated with the achievement of milestones within each task.[176] For example, several laboratories noted that the Office of Science does a fairly good job of embedding some flexibility within their WBS; conversely, DOE's Office of Energy Efficiency and Renewable Energy (EERE) was mentioned as having the tightest controls on its funding and a more restrictive WBS, thereby requiring more compliance-related transactions within each B&R code.

The controls imposed, or desired, by project managers in various programs is one significant cause of the budget atomization problem, and a serious obstacle to resolving it. Project managers too often wish to control their funding in small increments, with frequent, tactical milestones embedded within the WBS, in order to exercise "strong management". As was expressed by the Galvin Report and reiterated by recent reports, most prominently the NAPA 2013 study, the laboratories are not treated as a coherent whole, but rather as a conglomeration of projects. The budget atomization issue is symptomatic of stove-piped micromanagement at DOE headquarters. Not only is there a lack of uniformity across program areas within DOE, but there appears to be an increasing trend of "projectization" across the various program areas within each silo that is expressed in B&R codes and potentially further exacerbated by the WBSs. The extent of this problem also varies widely across the program offices. As a result, from a site level perspective, strategic "thrusts" at the laboratories frequently require patching together funding from different program offices, sometimes in combination with LDRD seed investments, to build a robust, coherent research thrust within the laboratory.

2. Site-Level Complexity

At the site level, congressional controls and institutional fragmentation combine to create a patchwork of legal controls, program office requirements, and non-uniform compliance-related transactions to track and report the use of funds within each B&R code. The difficulty presented by atomization differs widely by laboratory; indeed, staff at some laboratories claimed that they did not see this as an issue. That said, the more DOE program offices that provide the laboratory funding, the more complex the accounting and reporting environment. The size and potential complexity of the laboratories' Work for Others (WFO) portfolio further complicates this picture. For example, one of the multi-program Office of Science laboratories maintains six separate reporting platforms to fulfill the requirements of its DOE headquarters program offices. Different OCLs combine across program offices for any of the "multi-sponsor"

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[176] The work breakdown structure further segments each B&R code into manageable sections, potentially with compliance-related milestones associated with each task, for the work to be executed by the project team. It is at the discretion of each project manager within DOE to determine what level of detail or reporting requirement may pertain to any particular task and its associated funding bucket.

laboratories; the same holds true for B&R codes and corresponding WBSs created by each program office to manage and track funding. In addition, WFOs constitute an additional OCL and B&R code for each individual project.

The full complexity of the atomization problem goes beyond the OCL and B&R code level and is depicted by Figures 22 and 23 below. The top three parts of the pyramid in these figures (appropriations, congressional controls, and B&Rs) are all built into the DOE accounting system and are part of DOE's funds distribution process. The contractor cannot get paid unless the government obligates and pays money into the B&R funding buckets, thus the transactional requirement for the movement of funds between B&R codes. The next layer of the pyramid is at the project office level and reflects the segmentation set forth by the WBS for each project. This level of the pyramid is outside of the DOE accounting system and not directly part of the DOE's funds distribution process, but it illustrates how each B&R code (and funding bucket) is further segmented by the WBS at the project level. Whereas the two bottom layers of the pyramid reside outside of DOE's accounting system, the laboratory's corresponding IT system must align with and account for not only the B&R code fragmentation, but also the tasks and milestone "controls" embedded within the WBS corresponding to each B&R code. The final layer in the pyramid illustrates the contractor's detailed translation of these various control points for its own operational compliance and accounting purposes.

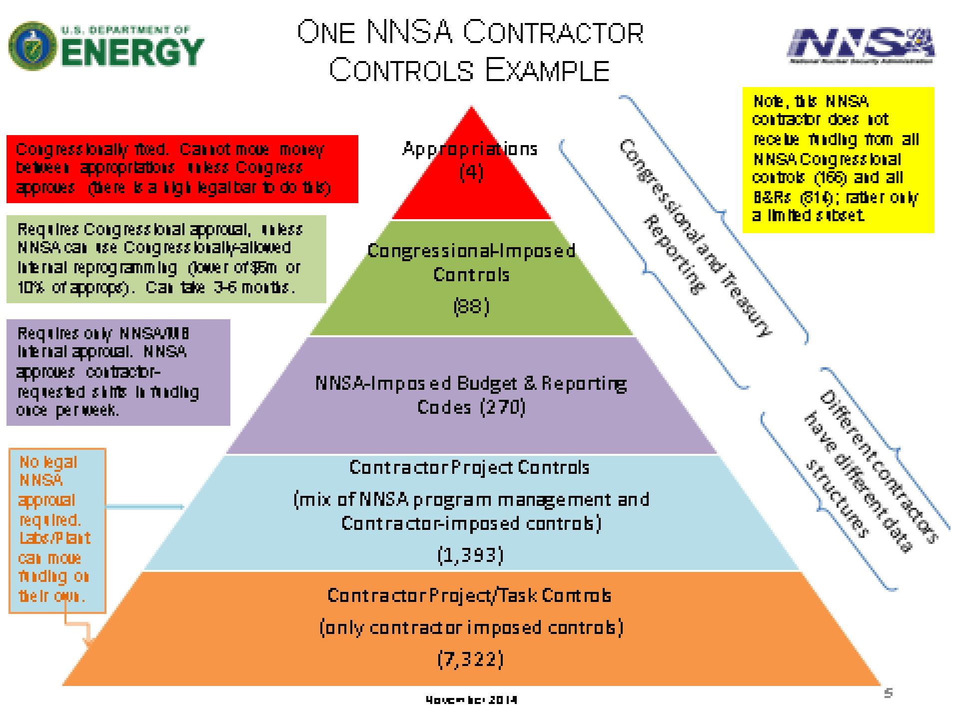


Figure 22. One NNSA Contractor Controls Example

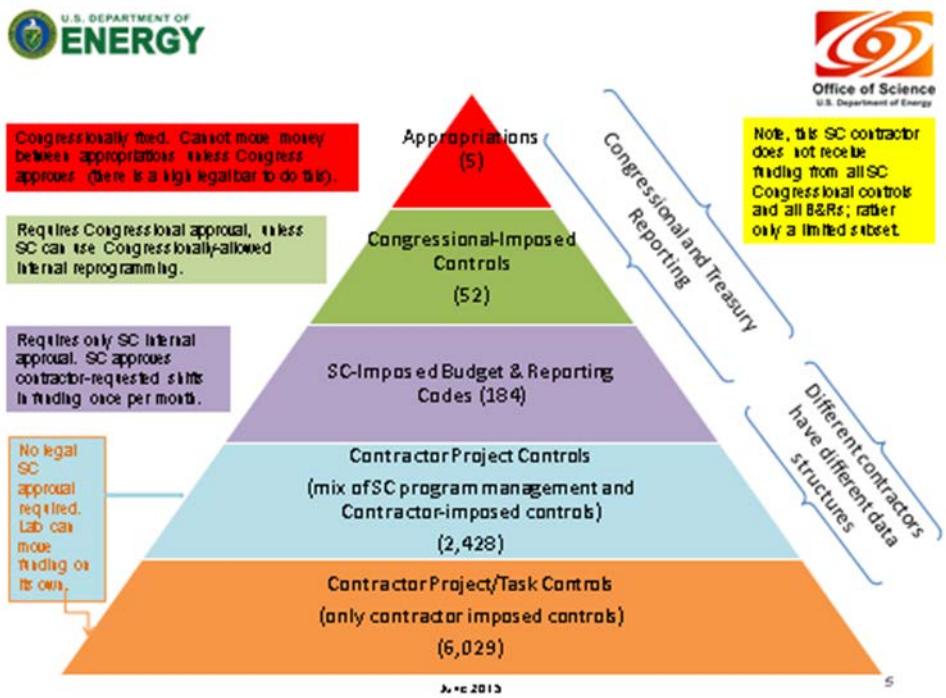
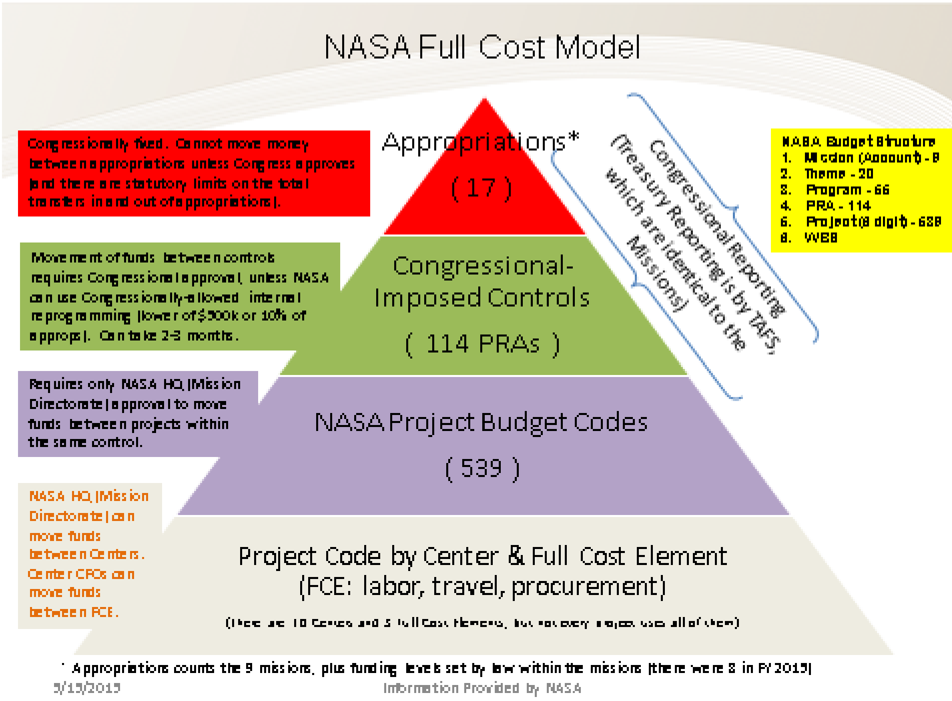


Figure 23. Office of Science Laboratory Controls Example

3. Comparisons with Other FFRDCs

The Commission's benchmarking efforts were revealing, particularly with respect to the National Aeronautic and Space Administration (NASA) as another science and technology agency with the Jet Propulsion Laboratory (JPL) as its core FFRDC. When the Commission requested a somewhat analogous outline for NASA's appropriations and the "budget atomization" for its laboratories and service centers, NASA headquarters provided Figure 24, a snapshot of obligations for all of NASA's appropriations.



Source: NASA, Office of the Chief Financial Officer.

Figure 24. NASA Full Cost Model

Similar to DOE, Congress does establish numerous legal controls, which is the first point of subdividing the appropriations into funding buckets.[177] Also any movement of funds between missions, themes, and project reporting attributes (PRAs) requires congressional notification and (in practice) approval. NASA's financial management is done in "full cost," where labor, travel, and procurement are all funded within the same 6-digit project code. NASA's Chief Financial Officer (CFO) has authority to move funds between missions and themes; the Mission Directorate and program offices allocate funds between programs, PRAs, projects, and centers; and center CFOs allocate funds between full cost elements within their center project allocation.

The apparent similarity between DOE and NASA with respect to congressional controls is striking. However, officials at JPL offered three fundamentally different aspects of how NASA makes budget allocation decisions and fields funding to JPL. First, JPL works closely with NASA headquarters to formulate their operational plans; adjustments to these plans are done in collaboration with headquarters.

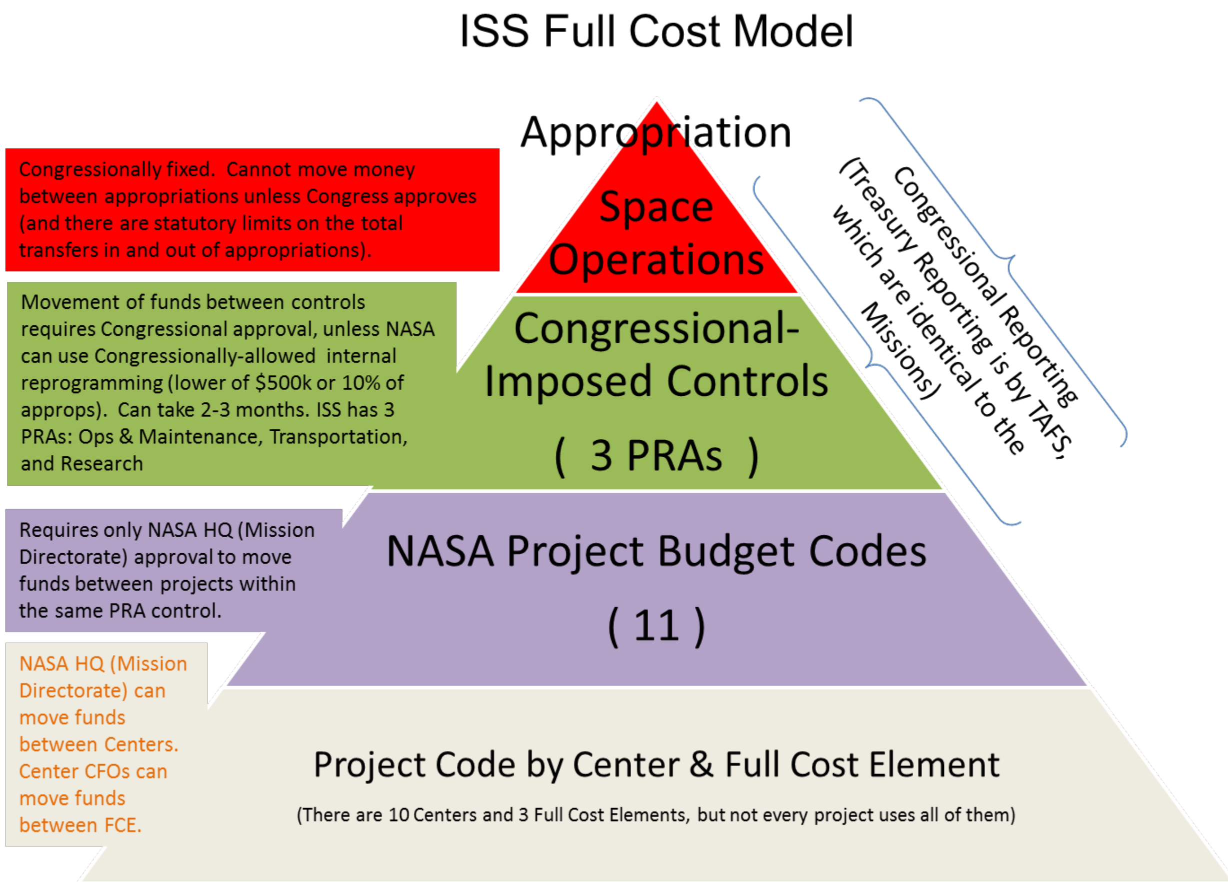
177 All of NASA's funds have 2 years of availability, except the Construction & Environmental Compliance and Restoration (CECR), which has 6 years.

Second, and most important, funding is provided to JPL at the program level and not broken into smaller projects. As a result, the funding for the International Space Station (ISS) program was provided to JPL as a single budget line item of about $250 million each year. JPL management was responsible for managing those funds to achieve the overall program goals, including hardware procurement, software development, mission planning and analysis, and so on. Within the DOE structure, one could think of the weapons life extension programs as being of similar scale, but those funds are allocated to the labs in very much smaller increments.

Finally, in addition to joint planning for implementation of NASA's major research, NASA headquarters retains a percentage of funding from each allocation to address contingencies that arise. JPL officials suggested that there is rarely a need to move funds between PRAs. Instead, program managers at headquarters can address any acute shortfalls through the contingency funding they retain at the outset. This evidences trust between HQ and the Lab.

a. NNSA and NASA Program-Level Comparison

The differences between NNSA and NASA funds distribution processes become more evident at the program level. While the agency-level view underscores many similarities, a comparison of two large, complex programs at these respective agencies reveals stark differences between NASA and NNSA. The graphics (Figure 25 and Figure 26) below depict the various levels of legal and managerial controls on NASA's funding for the International Space Station (ISS) Program and NNSA's funding for the B61 Life Extension Program (LEP).



Source: NASA, Office of the Chief Financial Officer.

Figure 25. NASA International Space Station (ISS) Program Full Cost Model

As previously mentioned, NASA headquarters has the authority to hold back funding for "unallocated future expenses" (i.e. reserves) in its development programs. In practice, however, headquarters generally distributes funding to the field centers as soon as there are contracts or grants to which funds can be obligated. In the case of the ISS Program depicted above, NASA headquarters generally fully distributes the funding in accordance with a plan developed by the ISS Program Office at Johnson Space Center. NASA headquarters ensures that the plan conforms to Congressional control levels, but otherwise accepts the Program Office's plan. If changes are requested by the Program Office in the execution year, headquarters will adjust the funds so long as the change does not violate any Congressional controls. Should the Program's plan necessitate movement of funds between Congressional Controls, NASA headquarters generally will propose an operating plan change to the Appropriations Committees.

On major projects and in accordance with the proposed operational plan, NASA gives full authority to the implementing project manager within an agreed upon overall budget, and conducts regular reviews to assess progress versus expenditure. In addition, the project at the Center gives full visibility and transparency in its expenditures and technical progress through regular communications between the project manager at the Center, and the corresponding executive at NASA headquarters. Rather than reliance on restrictive budgetary controls, these communications are anchored on trust between the parties with routine "verification" of progress.

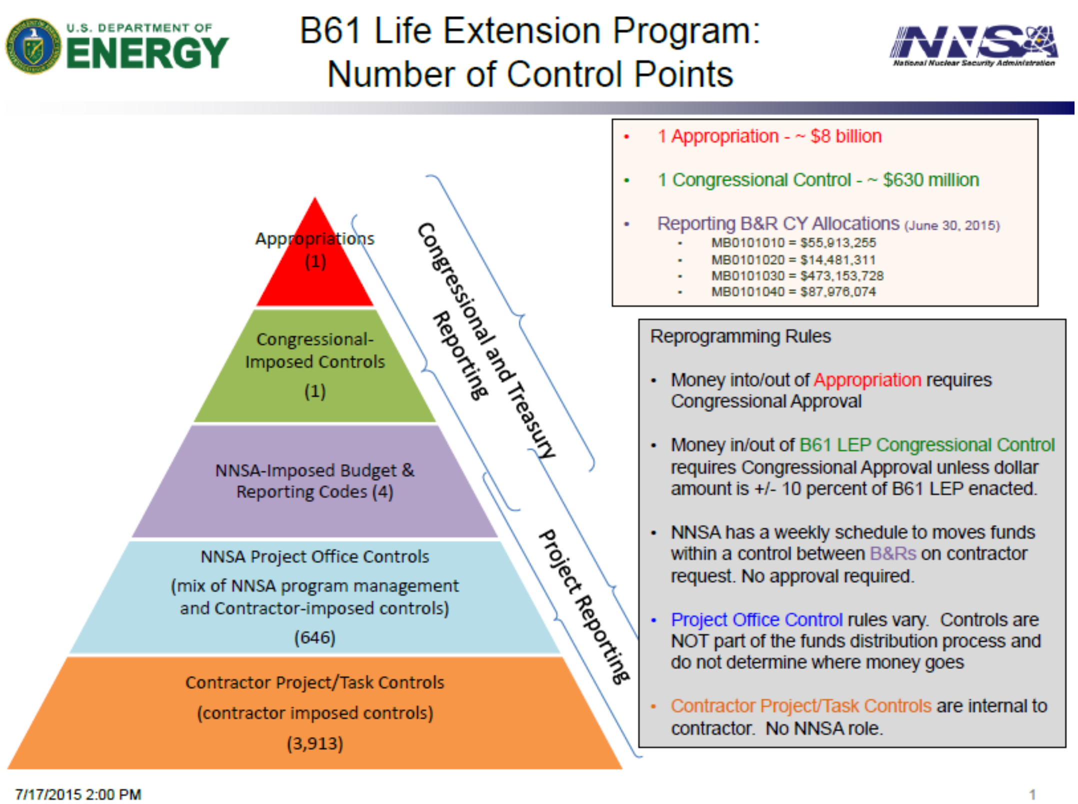


Figure 26. NNSA B61 Program Control Model

At the appropriations, Congressional controls, and B&R or PPA levels, these agencies would appear to have similar constraints and processes in the fielding of funds for program execution. The same legal controls exist contingent on appropriations committee actions, and each agency's headquarters further subdivides the congressional allocations prior to fielding. However, the similarities disappear below the program office level. As illustrated in Figure 26, for the B-61 LEP there is a single Congressionally-imposed control and only four NNSA-imposed B&R codes. However, at the next level of project office controls, these four B&R codes proliferate into just under 650 separate funding increments. Such fragmentation does not occur at NASA because of a trust-based allocation of funding and because full discretion for major projects is given to the relevant project manager. NASA's "reporting" process takes the form of routine measures of verification based on transparency between project managers, Centers and NASA headquarters. The equivalent does not hold true in the alignment and control of funds for the B61 LEP.

At the same time, the B61 pyramid presents a false picture with respect to how Congressional controls impact the actual execution of the B61 LEP. As both an R&D and production effort, any LEP relies on the capabilities and unique assets at various sites for successful execution. As the Augustine/Mies panel found, the LEP budget is heavily segmented by Congress and not aligned to a single program manager to ensure priorities can be addressed in a timely and efficient fashion.[178]

C. Summary Remarks

The causes of budget atomization are diffuse and its effects vary greatly across the enterprise. The atomization issue generally hinders laboratories' flexibility to pursue their research missions and engenders unnecessary transactional costs for headquarters as well as the laboratories. But the constraints created by smaller funding buckets and tighter controls are by no means identical or even similar across the enterprise. Staff at some laboratories even suggested that budget atomization is not an issue for them at all.

Additionally, as pinpointed in the Galvin report, some aspects of the atomization problem result from how the laboratories operate in a radically changed environment. This was particularly evident for the larger, multi-purpose laboratories.

The congressional language that creates legal controls at the PPA level under a CR has a hugely negative impact on headquarters' fielding of funding to the laboratories, while also undermining the laboratories' effectiveness in making decisions about priorities. Still, no simple fix will address all the effects of budget atomization, particularly those that result from a broken budget process or institutional fragmentation.

A key issue for the weapons program is alignment of resources across eight sites and the flexibility to address contingencies in the production schedule as they arise. This translates into frustrations over the congressional OCLs when there is a serious budgetary shortfall. With over 80 OCLs applicable to the weapons program, the means to address any major contingency will hinge on a 3- to 6-month process to garner congressional approval for the movement of funds. No other program within DOE's broad mission area

[178] Congressional Advisory Panel on the Governance of the Nuclear Security Enterprise, *A New Foundation for the Nuclear Security Enterprise*, (Washington DC: IDA 2014): 44, 57.

is comparable to the complexity of the weapons program, particularly the Life Extension Programs, as it pertains to resource alignment and mission execution.[179]

Whereas OCLs are a major constraint on efficient execution of the weapons program, they do not appear to create an onerous impediment to other programs at DOE. At the same time, the raw data suggest that more B&R codes per OCL are created for the Office of Science on average than are created for other program offices. The Office of Science funds more basic research activities and sponsors more laboratories than do the applied or weapons program offices, smaller buckets of funding being fielded to many laboratories is likely an appropriate approach to getting the maximum return on the taxpayer's investment.

EERE was repeatedly mentioned during interviews and laboratory visits as having the most tightly controlled funding increments. At the laboratories surveyed specifically on this problem, the suggestion was that these controls were the result of inflexible WBSs. In 2014, EERE leadership established a policy for its program managers to assign fewer, larger projects to the laboratories. 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 to one per quarter. These milestones are to be well-defined, quantitative and rigorous. Accountability is still key in that every 12 to 18 months, the office makes a go/no-go decision on a project based on the work accomplished to date. The Commission fully supports these efforts.

The budget atomization problem at the laboratory level depends on which DOE program office sponsors the laboratory, whether it is a single-program or multi-program laboratory, the nature of the work conducted at the laboratory (basic or applied), and the size of the laboratory's WFO portfolio.

D. Findings and Recommendations

Because budget atomization is a systemic problem with varying impacts across the program areas within the DOE, the Commission concluded that budget atomization can largely be addressed by Department-wide focus on and adherence to a few principles in its funds allocation process.

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:

[179] *Ibid*.

- 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 Commission recognizes that this effort will extend beyond the current Secretary's tenure. Therefore, we encourage the current DOE leadership to institutionalize these principles and processes to ensure continuity and comprehensive implementation.

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.

The Commission also endorses the Augustine/Mies panel's recommendation that calls for the Congress, Secretary, and NNSA Administrator to "adopt a simplified budget and accounting structure" through reduction of OCLs and to "better align resources" for efficient mission execution. In addition, the NNSA Administrator 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."[180]

[180] *Ibid.*

7. Alignment and Quality of the Laboratories

As the steward of the 17 National Laboratories, DOE is responsible for aligning work with mission priorities, ensuring the quality of the research and research programs, monitoring for duplication, and providing sufficient resources to allow the laboratories to execute the Department's missions.

A. DOE and Laboratory Strategic Planning

One of the Department's most critical roles as a steward is to provide 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, but few processes exist that provide this type of strategic direction to the laboratory system as a whole. There are new initiatives, such as the Crosscuts and Science and Energy Plan that serve this function in part. While these activities are creating strategic links across Departmental programs and between programs and laboratories, they have either been focused on a single, albeit broad, topic (in the case of the Crosscuts) or have focused on pieces of the mission (in the case of the Science and Energy Plan which excludes the nuclear and environmental management missions).

The Commission strongly believes that strategic planning for both the Department and the laboratories is best accomplished jointly, with DOE, the DOE program offices and the laboratories working together. The level of laboratory involvement in DOE strategic planning varies by office. For example, the DOE Office of Science (SC) laboratories are involved in SC's Laboratory Strategic Planning process, described in more detail below, but they may be absent from broader discussions involving SC's overall direction, priorities, and funding levels. In contrast, the Office of Nuclear Energy (NE) recently updated its R&D roadmap through a process that involved the deputies and representatives from all the National Laboratories. Idaho National Laboratory was responsible for collecting this input, which NE used to make its final decisions on the R&D strategic plan.

The consensus among current laboratory management is that Secretary of Energy Moniz is committed to and taking steps to increase laboratory involvement in DOE's strategic planning. The Commission concurs with this assessment and notes, for example, the Big Ideas Summits, which involve the laboratories in discussions of ways in which their capabilities could help solve grand challenges. Secretary Moniz has also been a strong supporter of the National Laboratory Directors' Council during his tenure, which has improved communication between the laboratories and DOE's senior management. In addition, the Department has initiated system-wide strategic planning through programmatic Crosscuts. One key to the success of the crosscut initiative is the treatment of laboratories as partners in the strategic planning exercise. As experts in their fields, laboratory scientists and engineers have much to contribute to determining the most likely course of scientific and technological developments. The Commission believes that the Department urgently needs to institutionalize laboratory involvement in DOE strategic thinking in order to ensure a consistent and productive relationship between the laboratories and DOE management that is not subject to fluctuation as a result of changes in DOE's leadership.

B. Processes to Ensure Alignment of Research and Research Programs

SC has established effective formal processes to ensure proper alignment between the research being done at its laboratories, its research programs and the Department's missions and strategic priorities. These processes are used to both encourage and discourage the development of new technical capabilities. Alignment is assessed during the annual review process, which involves both the Laboratory Strategic Planning process and the Performance Evaluation and Measurement Plan (PEMP).[181] During the Laboratory Strategic Planning process, SC asks the laboratory leadership to define a long-range vision 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 leadership settle on new research directions and the expected development or sustainment of capabilities. In addition, program 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.

An excellent example of this is the recent report spearheaded by SC's Office of High Energy Physics. In 2014 the Particle Physics Project Prioritization Panel (P-5), a subpanel of the High Energy Physics Advisory Panel (HEPAP), which jointly advises NSF, published a 10-year strategic plan for high energy physics in the United States.[182] The panel included leading experts in the field not only from the DOE laboratories, but also from universities and other laboratories in both the U.S. and abroad. This P-5 report

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[181] The PEMP is described in more detail in section C.1 of this chapter.

[182] Particle Physics Project Prioritization Panel (P-5), *Building for Discovery: Strategic Plan for U.S. Particle Physics in the Global Context* (Washington, DC: DOE, 2014).

showcases a unified, community-led effort to communicate realistic priorities to the SC. It was the product of a year-long community-wide study and recommends a prioritized and time-ordered list of facility upgrades and research projects that address five scientific drivers. The SC program directors are in the process of implementing the report's recommendations by phasing out certain projects and initiating funding for others.

NNSA's planning processes are unavoidably more complex because there are few technically competent reviewers outside the weapons complex capable of contributing effectively to the strategic planning process. Each program office in NNSA reviews its strategic plans with the laboratories. For example, Defense Programs (NA-10) coordinates the Stockpile Stewardship and Management Plan, a congressionally mandated 25-year program and capabilities-focused document that is a collaborative effort involving all the sites and stakeholders.[183] 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. However, since these reviews are program based, the effectiveness at providing overall strategic direction to the three weapons laboratories remains unclear. NNSA has also recently instituted a process similar to the PEMP, but the NNSA process has focused more on operations than on strategic direction over the past several years.

According to interviewees, other offices rely on informal processes that can be effective for ensuring proper alignment between the laboratories and DOE. By co-locating about half of its staff in Idaho, NE has established daily communication with its laboratory. While this approach may not be practical for DOE's larger program offices (e.g., SC and NNSA), it appears to be effective for NE. Numerous interviewees stated that some kind of continuous dialogue between the laboratory and DOE headquarters can be an effective alignment and planning mechanism, beyond what formal processes can accomplish. This underscores the importance of staff rotations between the laboratories and the program offices in DOE headquarters, an idea discussed elsewhere in this report. The effectiveness of informal processes may depend on the involvement of a relatively small number of participants. The NNSA Office of Counterterrorism and Counterproliferation (NA-80), for example, includes a small community of researchers and DOE staff, and its small size allows for frequent dialogue to control alignment and strategic direction.

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[183] The Stockpile Stewardship and Management Plan's (SSMP) validity as an executable plan remains an issue of debate between the DOD customer and NNSA. See Augustine/Mies, *A New* Foundation *for the Nuclear Security Enterprise*.

C. Processes to Ensure High-Quality Research and Research Programs

The SC has relatively 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 programs. The processes in place at the other DOE program offices are not as mature.

1. Office of Science Annual Review Process: Performance Evaluation and Measurement Plan (PEMP)

The SC conducts an annual evaluation of the scientific, technical, managerial, and operational performance of its 10 laboratories. This process is coordinated by SC's Office of Laboratory Policy[184] on behalf of SC's Director. These evaluations provide the basis for determining annual performance fees and the possibility of winning additional years on the contract through an "Award Term" extension. They also serve to inform DOE decisions regarding whether to extend or to recompete the management and operating (M&O) contracts when they expire.

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

The SC laboratory appraisal process uses a common structure and scoring system across all laboratories. It is structured around eight performance goals, each of which is comprised of several objectives. The eight performance goals and objectives are given in Table 25.

Table 25. Eight Performance Goals and Objectives Used in the PEMP

Performance Goals	Objectives
1. Mission Accomplishment (Delivery of S&T)	• Impact (significance) • Leadership (recognition of S&T accomplishments)
2. Design, Construction and Operation of Research Facilities	• Design of Facility • Construction of Facility/Fabrication of Components • Operation of Facility (e.g., availability, reliability, and efficiency of facility) • Utilization of Facility to Grow and Support Laboratory's Research Base and External

[184] Note that SEAB has recently suggested this name be changed to the Office of Lab Policy Implementation, as it does not formulate policy.

	User Community
3. Science and Technology Project/Program Management	• Strategic Planning, Stewardship of Scientific Capabilities and Programmatic Vision • S&T Project/Program/Facilities Management • Communications and Responsiveness to DOE Headquarters
4. Leadership and Stewardship of the Laboratory	• Leadership and Stewardship of the Laboratory • Management and Operation of the Laboratory • Contractor Value-Added
5. Integrated Environment, Safety and Health Protection	• Worker Safety and Health Program • Environmental Management System
6. Business Systems	• Financial Management System(s) • Acquisition and Property Management System • Human Resource Management System and Diversity Program • Internal Audit, Information Management, Assurance, and Other Administrative Systems
7. Facilities Maintenance and Infrastructure	• Manage Facilities and Infrastructure (F&I) in a Manner that Optimizes Usage and Minimizes Life Cycle Costs • Plan for and acquire the F&I required to support future laboratory programs
8. Security and Emergency Management	• Emergency Management System • Cyber-Security and Protection of Classified and Unclassified Information • System for the Physical Security and Protection of Special Nuclear Materials, Classified Matter, and Property

Within each objective, the SC program offices and Site Offices can further identify a small number of 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 that laboratory evaluate its S&T performance (Goals 1–3 in Table 3). In addition to the SC 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 (Goals 5–8). Site Offices and the SC program offices provide input regarding the contractor's performance with respect to Goal 4 to SC's leadership to determine the laboratory's score in this area. In determining these grades, the SC 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, DOE OIG, and other parts of DOE; and the results of SC's own oversight activities. The evaluation process concludes with meetings for all the performance goals, during which the various organizations involved report their proposed scores and work to ensure a consistent and fair approach across all ten SC laboratories.

The PEMP process uses a five-point grading system. The grade for each of the performance goals is based on a weighted computation of the scores of the individual performance objectives identified for each Goal. SC uses the resulting performance goal grades to create annual "report cards" for each laboratory that are publicly available on the SC website.

Other significant assessment activities also occur within the SC program offices. These reviews include division-led laboratory management reviews that provide strategic vision for the research programs, including discussion of topics for current and proposed white papers and related LDRD activities. They not only cover the status of each project, but also include 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 review takes 2 to 3 days to complete, involves numerous subject matter experts, and considers the following key performance metrics:

- The number of unique users served;
- Facility operational hours and reliability;
- Number of peer reviewed publications;
- User satisfaction and staff morale;
- Environmental and health/safety factors;
- Effectiveness of Advisory Committees; and
- Strategic planning for the future.

2. Office of Science External Review Processes

Each of the programs within SC have established Advisory Committees to provide independent advice to SC's Director regarding the scientific and technical issues that arise in the planning, management, and implementation of the programs. These recommendations include advice on establishing research and facilities priorities;

determining proper program balance among disciplines; and identifying 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. Membership of these committees is also increasingly including international participants. Particular attention is paid to obtaining a diverse membership with a balance of disciplines, interests, experiences, points of view, and geography.

The SC Director also 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."[185] 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 panel is made-up of scientists and research managers recognized to have significant expertise in the appropriate field. Although panel members are familiar with DOE research programs, a significant fraction of the COV members do not receive DOE funding. 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. The Associate SC Director in charge of the program element under review must provide a response within 30 days of the acceptance of the report.

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 to ensuring the quality and impact of the science supported by SC. For example, in SC's Office of Nuclear Physics (NP) a Comparative Review is held of all the research grants across the entire NP portfolio to assess the relative and absolute competitiveness of the grants within each NP subfield (Low Energy Nuclear Physics, Medium Energy Nuclear Physics, Heavy Ions, and Nuclear Theory). These reviews provide a critical assessment of all grants, resulting in the identification of those efforts to be phased out so that funding can be re-competed. The Comparative Review carried out by NP in FY 2013 resulted in approximately 25 percent of the least competitive grants being closed out. Not only did the review provide important input to NP regarding the quality and balance of its research portfolio, but it also helped establish a strategic vision for U.S. nuclear science developed in partnership with the broader research community.

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[185] DOE Office of Science, *Committees of Visitors*, last modified March 18, 2013. Available at http://science.energy.gov/sc-2/committees-of-visitors/.

3. Competitive Funding of Office of Science Programs

Peer review and competitive funding are essential for ensuring high-quality science and technology research. The SC makes extensive use of peer review to maintain the high quality of the research it funds. Its review methods, which closely resemble the well-developed methods of NSF and NIH, take one of three forms: mail reviews, panel reviews, and site visits. Mail reviews are generally used for open solicitations in which proposals arrive throughout the year. Reviewers are usually given 6 weeks to review the proposal and return the review. Panel reviews are created for targeted solicitations when many proposals arrive simultaneously. Multiple panels of 10–15 people each convene in Washington, DC, to evaluate the proposals and submit reviews. For a large solicitation, the total number of panelists at any given time can total in the hundreds. Site visits are coordinated for large group programs, such as National Laboratory efforts or large facility competitions. Researchers make presentations to the site visit team who then may interact with and ask questions of the investigators. The site visit team members then submit independent reviews to DOE.

The Office of Science budget supports research (~39 percent in FY 2014); facility operations (~37 percent in FY 2014); construction (~14 percent in FY 2014) and other (~9 percent in FY 2014), which supports Federal staff, Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs, and a few small other activities. These percentages have remained constant to within about 1 percent over the past decade.[186]

The percentage of SC's overall budget given to the laboratories, universities and industry for FY 2009 to FY 2014 is presented in Table 26.

Table 26. Office of Science, FY 2009–FY 2014 Laboratory versus Universities versus Industry Funding

	FY 2009*	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
SC Labs	72.5%	71.7%	73.9%	73.9%	74.1%	72.9%
Universities	16%	16.4%	14.8%	14.7%	14.8%	15.8%
Industry	1.8%	1.9%	2.1%	5.5%	5.4%	5.6%
Other	9.7%	9.9%	9.2%	5.9%	5.7%	5.7%

* FY 2009 does not include Recovery Act funding.

[186] Private Communication from P. Dehmer, July 7, 2015.

The research portion of SC's budget supports single investigators, small and large groups, and center activities (e.g., Energy Frontier Research Centers, Bioenergy Research Centers, and Energy Innovation Hubs) at both universities and laboratories. These activities normally are competed at their inception and reviewed at three- to five-year intervals thereafter. Depending on the nature of the activity, the competition may be open to various combinations of universities, laboratories, and industry. Examples from two of the program offices within SC provide important insight into the level of competitive funding within DOE's Office of Science.

In FY 2014, SC's Basic Energy Science (BES) program funded research at more than 170 academic institutions located in 50 states and at 15 DOE laboratories. Research funds were generally competed openly to the community and awarded on the basis of peer-reviewed quality, without regard to affiliation. Of the FY 2014 BES research budget, 47 percent was awarded to universities and 53 percent to laboratories. During that year, university proposal success rates were in the range of 15–20 percent for new grants and 65-70 percent for renewals. These rates declined from those of prior years because of the full funding requirement, which was initiated starting in FY 2014, for grants totaling under $1M.[187]

Likewise, in FY 2014, SC's High Energy Physics (HEP) program funded research in about 100 academic institutions located in 38 states and in 9 DOE laboratories. These research funds were also generally competed openly to the community and awarded on the basis of scientific merit and impact, as judged by peer-review. Of the FY 2014 HEP research budget, 32 percent was awarded to universities, and 68 percent to the laboratories. University proposal success rates were approximately 20 percent for new grants and 80 percent for renewals. Again, these rates were lower than those of prior years because of the requirement to fully fund new grants totaling less than $1M. Renewals and new grants are competed together according to the same review and selection criteria. For DOE laboratory projects, proposals for new efforts are peer-reviewed and existing research efforts undergo triennial comparative peer-reviews among the participating HEP laboratories. Low-performing efforts at the DOE laboratories are restructured or redirected.[188]

4. Assessment Processes at Other DOE Program Offices

Those interviewed by the Commission generally agree that SC's processes for assessing the quality of both the research conducted by their ten laboratories and of the research portfolio in each SC program are far more mature than those in the other DOE

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[187] *Ibid.*

[188] *Ibid.*

program offices. For this reason, it is often suggested that the other DOE program offices adopt these processes. Some factors, however, necessarily limit the applicability of SC's processes to other programs. For example, because the research at the NNSA laboratories is often classified, there are far fewer investigators with the requisite technical capabilities and so there is inherently less competition. The classified nature of the work also affects NNSA's use of Advisory Panels and Committees of Visitors. Nonetheless, the SC processes have influenced other DOE program offices. For example, NE has adopted a PEMP-like process modeled after SC, but with greater emphasis on safety. Also, NNSA is working with SC to establish project assessment processes similar to those in SC's Office of Project Assessment. The Commission also notes that an ongoing National Academies study is reviewing peer review and design competition at NNSA's three national security laboratories (Los Alamos, Lawrence Livermore and Sandia).[189]

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.[190] Subsequently, the DOE Deputy Secretary released guidance on the implementation of the new OMB requirements.[191] At every laboratory visited, the Commission was told 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 has led many laboratory scientists to choose not to submit and/or present papers at scientific conferences for fear they will not be able to attend. Although DOE has made some changes to improve the process, such as creating a list of reoccurring non-DOE sponsored conferences that will be subject to an expedited process, OMB's regulations and their implementation by DOE may have resulted in a decline in conference attendance at some laboratories.[192] 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

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[189] Further information can be found at http://www8.nationalacademies.org/cp/projectview.aspx?key=49632.

[190] J. Zients, *Promoting Efficient Spending to Support Agency Operations* [Memorandum]. (Washington, DC: OMB, 2012)

[191] D. Poneman, *Promoting Efficient Spending to Support Agency Operations* [Memorandum]. Washington, DC: DOE, 2012)

[192] GAO, *Defense Science and Technology: Further DOD and DOE Actions Needed to Provide Timely Conference Decisions and Analyze Risks from Changes in Participation*, (Washington, DC: GAO, 2015). Available at http://www.gao.gov/products/GAO-15-278.

in scientific journals in a timely fashion.[193] 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.

D. Alignment with DOE's Objectives and Level of Duplication of Research

1. Alignment with DOE's Strategic Priorities

Research funded by the stewarding program office of the laboratory is likely aligned with the strategic priorities of the office and so will also be aligned with DOE's strategic priorities so long as the office itself is aligned with those priorities.[194] The question of alignment or misalignment usually arises when one considers research funding from other program offices within the Department, other Federal agencies, or other entities altogether. As with everything involving the laboratories, the magnitude of this issue varies when one looks at different laboratories across the laboratory system. For example, over 97 percent of Fermilab's budget is provided by SC's Office of High Energy Physics, which enables a significant amount of control over its research activities by its stewarding office. On the other hand, only 58 percent of Sandia's funding originates from NNSA and only 20 percent of Pacific Northwest's funding comes from SC. The National Laboratories also currently have the authority to spend up to 6 percent of their funds on LDRD. Depending on the size of the laboratory budget, this amount can represent a sizable investment in new research areas.

The Commission notes that there are examples of the National Laboratories changing their research focus in response to changes in DOE strategic priorities, national needs or a changing research landscape. An excellent, and current, example is Fermilab's response to the P-5 Report mentioned earlier. As a result of the P-5 Report, Fermilab is moving away from accelerator-based high energy physics (most of which is now being done at CERN, the European Organization for Nuclear Research) and is focusing much of its research on neutrino physics using its accelerator complex. Another example is the 2013 Office of Nuclear Physics review of research it supports in the fields of heavy ions, medium energy, nuclear structure and nuclear astrophysics, nuclear theory, and fundamental symmetries. The review provided important input regarding the quality and

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193 National Academy of Sciences, National Research Council, *Strategic Engagement in Global S&T: Opportunities for Defense Research* (Washington, D.C.: National Academy of Sciences, 2014).

194 Issues related to program office alignment with DOE strategic priorities are outside the scope of the Commission's charge.

balance of its research portfolio and helped establish the strategic vision for U.S. nuclear science developed in partnership with the broader research community.

Based on its observations, the Commission believes that the National Laboratories' research programs and capabilities are 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 and there is progress in implementing such processes in other offices.

2. Alignment with the Broader Science and Technology Enterprise

DOE is a steward of the important national assets and capabilities that exist at the National Laboratories. A crucial point is that these assets and capabilities benefit the entire science and technology community. Often when activities at the laboratories are perceived as "misaligned" with DOE strategic priorities, the activities do, in fact, align with the needs of this broader community, the strength of which is certainly of strategic importance to DOE, as well as the Nation.

A historical example involves DOE's work on the human genome. Los Alamos and other DOE laboratories were integral to the successful completion of the Human Genome Project. DOE originally announced its Human Genome Initiative in 1986 and was ultimately joined by the National Institutes of Health (NIH) in a combined project. Stemming from the laboratory's expertise in the biological effects of irradiation, Los Alamos had developed the capacity to isolate, clone, and package chromosomes into libraries and operated a public gene data bank. The Battelle Technology Partnership Practice estimated the economic impact of genomic research to be $796 billion, a return on investment of 141:1.[195] Despite the tremendous social, technological, and economic impact, DOE's involvement in the Human Genome Project is often criticized as "mission drift."[196] The Commission notes, however, that Los Alamos's initial work was clearly mission-related, and that while one might argue that the Human Genome Project should have been initiated by NIH, the fact is that the Nation is currently accruing the benefits of this effort in large part because DOE had the foresight and necessary capabilities to address this challenge.

Currently, many tens of thousands of scientists utilize the user facilities at the National Laboratories each year, including thousands funded by the NIH and the National Science Foundation (NSF). Essentially all DOE user facilities are oversubscribed, a sign

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195 S. Tripp and M. Grueber, *Economic Impact of the Human Genome Project* (Battelle Memorial Institute, 2011).

196 Senate Appropriations, Energy and Water Development Subcommittee, testimony at the July 2014 CRENEL Commission meeting.

of their critical importance to the broader research community and an argument for expanding, rather than contracting, their work in this domain. For example, according to Argonne, the Center for Nanoscale Materials accommodates roughly 70 percent of meritorious user proposals and the Advanced Photon Source accommodates only about 30 percent.

Another example of the National Laboratories supporting a broader range of missions, beyond their core activities for DOE, involves their work for the Department of Homeland Security (DHS). DHS has authority equal to DOE's to request technical and scientific assistance from the National Laboratories in order to address specific DHS science and technology needs. In creating DHS, Congress intended that the new office should take advantage of existing facilities and capabilities, including the DOE National Laboratories, and saw no need to establish a new system of DHS laboratories.[197] The laboratories also serve a vital role enabling the Department of Defense, Department of State, the Intelligence Community, and others to meet their missions.[198]

The Commission believes the laboratories need some measure of flexibility to be able to pursue valuable research in service of the broader science and technology community, but the flexibility must be within reason. The Department, through its strategic oversight of the laboratories, should provide feedback when activities seem to veer from DOE's core mission. DOE must take care in its supervision, however, because relevance to mission often takes time to become apparent. This can be accomplished through on an agreed-upon strategic plan that describes the vision for the laboratory and an annual operating plan for how the strategy will be executed. .

3. Appropriate Levels of Duplication

Competition and therefore a certain amount of duplication are 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

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[197] In addition to the equal access provision in the Homeland Security Act of 2002 regarding DOE laboratories, the Act also authorized the Secretary of Homeland Security, acting through the Under Secretary for Science and Technology, to establish one or more Federally Funded Research and Development Centers. DHS currently sponsors two of its own FFRDCs: the Homeland Security Systems Engineering and Development Institute and Homeland Security Studies and Analysis Institute. More information on the roles performed by these centers is available at: .http://www.dhs.gov/science-and-technology/ffrdcs.

[198] Support of other Federal agencies will be discussed further in Chapter 9.

therefore be struck between allowing creativity and innovation to blossom and appropriately managing resources to maximize productivity. Resources should allow the maximum number of participants and different ideas to thrive during the genesis of a new field or technology. But once a specific scheme has proved superior to others, resources should be directed there. As such, DOE should give the laboratories the flexibility to pursue new lines of inquiry using, for example, LDRD, so long as the funds align with mission priorities. Once research has matured beyond a certain threshold, the Department should then provide expert strategic oversight and guidance for the laboratories to coordinate and potentially consolidate their programs to achieve the most 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 competitions and an inter-laboratory peer review competitive process to develop and maintain its nuclear deterrent for over 50 years. Los Alamos and Livermore have participated in vigorous 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.

Through managed peer competition, the NNSA laboratories invented weapon concepts that are the basis for all current U.S. warheads; they designed, engineered and tested warheads to meet Cold War requirements; tailored weapons for different military applications; and developed modern safety features. Now the principle 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, 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 the judgments from 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.[199]

[199] The Commission notes that an ongoing National Academies study is currently reviewing peer review and design competition at NNSA's three national security laboratories (Los Alamos, Lawrence

The hands-on experience and expertise needed to assess the components of U.S. nuclear weapons exists only at the NNSA laboratories. These laboratories are responsible for maintaining their systems in the active stockpile, providing independent peer reviews of critical stockpile issues and each other's work, conducting annual assessments required to maintain the stockpile, and developing the necessary science base to carry out these activities. Each laboratory has its own process, culture, and organization to address stockpile challenges. By providing critical "checks and balances," such peer review ensures a credible second opinion that can lead to alternative policy options and validate technical recommendations to decision makers. The government must have the best possible advice on what stockpile actions are required, when they must occur, and how they must be accomplished. For example, decisions must be made about whether the future stockpile systems will be a continuation of the current incremental Life Extension Programs (LEPs), whether they should feature reused components, or if it will be necessary to newly manufacture components or systems. And it is also imperative that the safety and security of these systems be continually improved.

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 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. In fact, in the weapons modernization program the design is getting more complicated. Consider, for example the W-80-4. Although the scope of this LEP is not yet fully defined, this is the first LEP that will put an adaptation of an existing warhead in a new delivery system. There will also be significant new safety and security features added. In addition, since the start of the Stockpile Stewardship Program, Los Alamos and Lawrence Livermore have continued to discover problems never revealed by the earlier nuclear explosive testing and have solved problems that nuclear testing could not. For example, starting with different hypotheses about the aging behavior of plutonium, Los Alamos and Lawrence Livermore research showed that the plutonium pits in nuclear weapons were more stable than originally thought, providing greater confidence in the reliability of the pits and the stockpile. As a result, taxpayers were saved the cost of designing and constructing a multibillion-dollar Modem Pit Facility. Another example involves the interpretation of past nuclear test data. Historically, Los Alamos and Lawrence Livermore developed different way of inferring the yield of a weapon from the underground test data. The two laboratories are now engaged in a process to generate a

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Livermore and Sandia). Further information can be found at http://www8.nationalacademies.org/cp/projectview.aspx?key=49632.

common understanding of this issue. This, in turn, has led to an enhanced understanding of the processes that take place within a nuclear weapon. Resolution of the longstanding energy balance problem, an enduring discrepancy in the nuclear test database, is yet another example of the nuclear weapons science ongoing at these laboratories.

Simply maintaining the stockpile in the absence of nuclear testing will also present scientific and technical challenges. The rate of age-related changes in the stockpile is likely to increase over the next decade. Furthermore, we have little experience with weapons significantly older than 30 years. Finally, successive refurbishments of existing warheads will result in a steady departure from the weapon configurations validated by nuclear explosive testing. These issues will pose increasing risks over the long term. Expert judgment, validated through a comprehensive assessment process that includes in-depth, competitive peer review underpinned by multidisciplinary science, will be vital to success.[200]

The current Annual Assessment Process, central to stockpile stewardship, employs an independent team of technical experts from one physics laboratory to critique the work of another in assessing each weapon type in the stockpile. Such "Red Teams" are uniquely qualified because they draw from the only organizations that have the experimental and computational tools required to do the detailed technical evaluations. Red Teams are an essential strength of the process, providing independent technical reviews with the demanding rigor required for the scientific assessment of warhead certification. The Nation's nuclear stockpile remains viable because the competencies of each laboratory are strengthened through this competitive process. In fact, in 2007 the JASON recommended expanding inter-laboratory peer review to improve the rigor of the current weapons certification process. According to the JASON, a more comprehensive peer review approach, using stockpile stewardship tools and nuclear weapons experts at the two physics design laboratories, will enhance confidence in weapons certification, significant findings analyses, LEPs and replacement warhead design, if needed.

Because of the core expertise in nuclear materials and properties and unique scientific facilities, Lawrence Livermore and Los Alamos are also able to support activities aimed at reducing the threats posed by the proliferation of nuclear weapons and other weapons of mass destruction (WMD). These activities include nuclear forensics and development of a broad range of radiation, chemical, and biological detectors. Because of the complimentary nature of the technical capabilities at Los Alamos and Lawrence Livermore, elimination of one physics design laboratory would seriously threaten work to prevent proliferation at its source, detect and reverse proliferation activities, respond to

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[200] *Ibid.*

the threatened or actual use of such weapons, and avoid surprise regarding the WMD capabilities and intentions of others.[201]

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 that 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 strongly 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. In-depth, independent expert review can best exist through the inter-laboratory peer review process. Since nuclear weapons research involves classified information and explores ranges of temperatures, pressures and other physical regimes not usually accessed by the general scientific community, the cumulative knowledge, expertise, and experimental capabilities that allow a researcher to become an expert only exist at the nuclear weapon physics design laboratories. These capabilities must be maintained for national security reasons.[202]

a. Large User Facilities

Because of the significant resources involved, the Department has developed processes for prioritizing user facilities[203] and avoiding duplicative facilities. These processes are often led by external topic-based advisory panels and involve multiple Federal agencies—for example, the Basic Energy Sciences Advisory Committee (BESAC)[204] and the previously noted HEPAP,[205] which reports to DOE and 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. 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 (LCLS-II) to integrate new functionality; Argonne to incorporate diffraction limited storage ring technology into its Advanced Photon Source Upgrade (APS-U); and terminated Lawrence Berkeley's proposed Next Generation Light Source (NGLS). This strategic restructuring of facility upgrades and

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201 *Ibid.*

202 *Ibid.*

203 See Appendix J for more information on DOE user facilities.

204 For more information see http://science.energy.gov/bes/besac/. DOE has not requested NSF's participation in BESAC, a fact which several interviewees criticized.

205 For more information see http://science.energy.gov/hep/hepap.

termination of a proposed facility has been claimed to have saved between approximately $250 million and $850 million, while simultaneously ensuring the United States remains at the forefront of light source and storage ring science.[206] It also ensures that the broader S&T community will have the facilities it needs.

DOE also collects user community input in less formal ways. Throughout the planning stages for the upgrade to the National Synchrotron Light Source (NSLS) at Brookhaven National Laboratory, DOE, NIH, and the laboratory hosted scientific workshops, working groups and advisory panels. Life sciences research constitutes about 40 percent of the users of the NSLS and one-third of these users are funded by NIH.[207]

A question sometimes asked is why NSF, NIH, or the National Institute of Standards and Technology (NIST) is not the steward of the large national scientific user facilities. The Commission notes that DOE is by far the largest funder and the most experienced manager of basic research in physical science in the government.[208] As the above examples illustrate, DOE has developed vehicles whereby the Nation's scientific community has significant input to the strategic planning that is important when dealing with facilities as large as these. In essence, the decision to create user facilities is based on the mission needs of DOE and guided by advice from the scientific community; DOE then constructs and operates them and NSF and NIH funds much of the research that uses the facilities. The DOE SC user facilities support important areas of science and their operations are funded and they are governed in a manner that insures the most competitive proposals are able to use the facilities so that science is advanced in an optimal way. It is therefore the Commission's view that DOE understands the need, priorities and market for these facilities and is the appropriate department to construct and manage them.

b. Research and Development Activities

The processes for R&D activities and those for large user facilities are not entirely distinct. For example, the P-5 report involved both planning and prioritization exercises for user facilities and strategic direction for R&D activities. Since large user facilities affect the direction of R&D activities across many programs, the processes must often be intertwined.

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[206] DOE Office of Science, *FY 2015 Budget Request to Congress for DOE's Office of Science* (Washington, DC: DOE, 2014).

[207] V. Peña, S. Howieson, and S. Shipp, *Federal Partnerships for Facilities, Infrastructure, and Large Instrumentation* (Alexandria, VA: Institute for Defense Analyses, 2013).

[208] NSF, National Center for Science and Engineering Statistics. *Science and Engineering Indicators 2014* (Arlington, VA: NSF, 2014), See Figure 4-20 and Appendix Table 4-37.

As an example of a new process for coordinating R&D across program areas of the Department and the laboratory system, Secretary Moniz has organized two Big Ideas Summits (in 2014 and 2015) with the National Laboratories. The laboratories bring topics for consideration to become large DOE initiatives. For three of the ideas discussed during the 2014 event (grid modification, subsurface science, and the nexus of energy and water) DOE created Federal program manager Tech Teams to explore the creation of initiatives across the laboratory system.[209]

Grid modification and modernization is now a top-down initiative from DOE and is becoming well-coordinated across the program offices and the laboratories. This area is recognized as one of the grand challenges that need a broad R&D approach. Originally, many of the laboratories performed research related to the electric grid. After some success with this research, DOE saw grid modernization as an important program to fund, and now the laboratories are working with DOE management to create a multi-laboratory grid consortium co-led by NREL and Pacific Northwest.[210] The grid modernization laboratory consortium engages 10 of the laboratories to work on solutions to grid modernization, and to leverage the capabilities at each of the laboratories. The laboratories also work in cooperation with the private sector electric utility industry, universities and other research organizations, such as the Electric Power Research Institute (EPRI) and NIST. This consortium approach is intended to demonstrate that organized laboratory collaboration can be implemented by DOE in addressing grand challenges. One important question in this connection concerns the timing of the move from numerous independent research projects to a well-coordinated, multi-laboratory effort in partnership with other Federal agencies and the private sector. The Commission believes that, while important, the grid modernization program was initiated across the Department later than it should have, perhaps by as much as a decade. As a result of the Department waiting this long to act, the laboratories doing work in this area have been competing against one another for funds, undertaking smaller, less coordinated projects.

This is an example of the laboratories freelancing in early stages of new R&D areas. The underlying issue is one of trust: the National Laboratories do not fully trust DOE and therefore maintain secrecy about some of their actions, operating below the radar to create new programs and compete for turf in new and emerging areas.

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[209] DOE created Tech Teams in advanced computing, clean energy, manufacturing, supercritical carbon dioxide, subsurface technology and engineering, water energy, and grid modernization. See Basic Energy Sciences Advisory Committee to the U.S. Department of Energy, *Public Meeting Minutes July 29-30, 2014*, North Bethesda, MD, 11.

[210] The laboratories involved in the consortium are Ames, Brookhaven, Idaho, Los Alamos, Lawrence Berkeley, Lawrence Livermore, NREL, Oak Ridge, Princeton Plasma, and Sandia. More about the funding and coordination can be found at: http://energy.gov/sites/prod/files/2014/10/f18/07Keynote-PHoffman-WParks.pdf.

c. Appearance of Duplication

The laboratories have scientific and technical facilities and capabilities that may appear duplicative at a high level but in fact are complementary and coordinated. Three illustrative examples are highlighted below.

1) Synchrotron Light Sources

DOE is the steward of five synchrotron light sources: the Advanced Light Source (ALS) at Lawrence Berkeley; the Advanced Photon Source (APS) at Argonne; the Linac Coherent Light Source (LCLS), which is currently undergoing an upgrade to LCLS-II, at SLAC; the NSLS-II, which is an update from its original NSLS, at Brookhaven; and the Stanford Synchrotron Radiation Light Source also at SLAC (Figure 27).[211] As a whole, the light sources serve over 10,000 users across the fields of biology (including medicine and environmental science), chemistry (including pharmacology), geology, materials science, and physics.

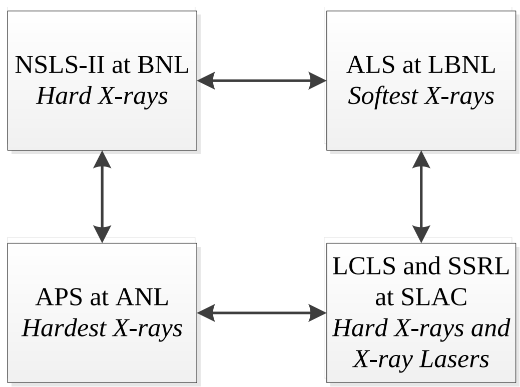

Figure 27. Properties of the Light Beams at Each of the Synchrotrons

Although all the light sources produce intense beams of light, each facility is unique in terms of its spectral output (see Figure 29). The wavelength of the light determines the nature of the research for which the light source is best suited. For example, hard X-rays (short wavelengths) can study the structure of materials on the length scale of an atom, whereas soft X-rays and vacuum ultraviolet light (longer wavelengths) are best suited to study chemical reactions and biological materials. Synchrotrons are used in many fields and produce relatively similar science, but the user communities working at the different light sources are notably different.

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[211] More information about the DOE light sources can be found at: http://science.energy.gov/bes/suf/user-facilities/x-ray-light-sources/.

Another important issue in this connection involves access to these light sources. Within the scientific community, it is generally agreed that regional access to user facilities is critical. Illustrating this point are the concerns voiced by the biology community prior to the upgrades of the NSLS:

> Much of the growth in beamline number, quality and capability in recent years has occurred…in the mid-west and the Bay area. While these developments are welcomed by all because of their positive impact on the nation's scientific capabilities, they pose a significant logistical problem for investigators based on the east coast, who increasingly find themselves having to travel long distances to collect data hands-on at state-of-the-art beamlines.[212]

2) Nanoscale Science Research Centers

Through the National Nanotechnology Initiative (NNI), DOE/SC is the steward of five Nanoscale Science Research Centers (NSRCs): the Center for Functional Nanomaterials (CFN) at Brookhaven, the Center for Integrated Nanotechnologies (CINT) at Sandia and Los Alamos, the Center for Nanophase Materials Science (CNMS) at Oak Ridge National Laboratory, the Center for Nanoscale Materials (CNM) at Argonne, and the Molecular Foundry at Lawrence Berkeley.[213] Smaller and more focused nanotechnology research centers exist through other Federal agencies as well, including the National Cancer Institute, NIST, and NSF, which has fourteen facilities located at universities across the country.

The locations of the NSRCs were strategically chosen through peer-review competition by the Office of Basic Energy Science in SC based on the capabilities of the National Laboratories that house them, and their differentiating characteristics parallel the differences in research at the laboratories (see Table 27). The DOE NSRCs also leverage the capabilities of their co-located user facilities. For example, the CNM at Argonne has a dedicated beamline on the APS that uses hard X-ray nanoprobes. Similarly, the Molecular Foundry at Lawrence Berkeley works with both the ALS and the National Energy Research Scientific Computing Center (NERSC).

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[212] BioSync, *Biological Applications of Synchrotron Radiation: An Evaluation of the State of the Field in 2002* (Stanford, CA: Structural Biology Synchrotron users Organization, 2002), 10.

[213] More information about the DOE NSRCs can be found at: http://science.energy.gov/bes/suf/user-facilities/nanoscale-science-research-centers/ or https://nsrcportal.sandia.gov/Home/About.

Table 27. Detailed Description of Capabilities of the DOE Nanoscale Research Centers

	CFN	CINT	CNMS	CNM	Molecular Foundry
Create	Block Co-polymer Self-Assembly	Giant Nanocrystal Quantum Dots	Stable-isotope labeled soft matter	Hybrid Nanomaterials	Bio and biomimetic nanostructures
	DNA-Mediated Self-Assembly of Nanomaterials	Semiconductor Nanowires	Carbon nanostructures	Oxide Molecular Beam Epitaxy	Robotic synthesis of colloidal nanocrystals
	Electrophoretic Deposition of Nanomaterials	Biomimetic Membranes	Chemistry in confinement	Nanocarbon Materials	Hybrid organic/inorganic mesoscale materials
		Metamaterials	Direct-write EBID nanostructures	Bio inspired hybrid materials	Nanostructured porous frameworks
		High-Mobility MBE	Anionic polymer synthesis	Nanomechanical devices and novel nanofabrication techniques	Sub 10 nm nanofabrication
			Complex oxide heterostructures (PLD)	Engineered nanoparticles	Photonic and mechanical nano-probe
Characterize	In-Operando Nanocatalyst Characterization by Electron Microscopy and Synchrotron Light-Based Spectroscopy	Discovery Platforms	Band Excitation scanning probe microscopy	Hard X-ray nanoprobe: nano-diffaction, fluorescence, and 3D nanotomography	High resolution electron scattering
	Aberration-Corrected Environmental Transmission Electron Microscopy	Nanomechanics	STEM Imaging and Spectroscopy	Ultra high vacuum STM	In-situ probing and imaging
	Ambient-Pressure X-ray Photoemission Spectroscopy	Super-resolution Optical Imaging	Atom probe and electron tomographies	In Situ and Scanning Probe Microscopies	Imaging of magnetic surfaces
	Aberration-Corrected Photoemission Electron Microscopy	Ultrafast Spectroscopy/Carrier Dynamics	He-ion microscopy	Non-linear phenomena	Hyperspectral Nano-optical dynamic Imaging
	Ultrafast Optical Spectroscopy in Electrochemical Environments	Optical Nanoprobes	Operando Electron Microscopy	Time-resolved UV-VIS-NIR-IR emission and absorption spectroscopy	Tomography of single proteins and nanoparticles
	Reactor Scanning Tunneling Microscopy	In Situ Microscopies			Ultrasensitive Liquid AFM
Understand	Bridging from Atomic-scale Theory to Nanoscale Phenomena	Classical DFT at Interfaces	Computational electronic structure theory	Electrodynamics, quantum dynamics of light-matter interactions	Interfacial Electronic Structure/Dynamics
	Theory of Directed Assembly in Soft and BioNanomaterials	Non-adiabatic DFT	Large-scale ab-initio molecular dynamics	DFT, molecular dynamics of molecular conversion and ionic transport	Ab initio Excited-States/Spectroscopy/Transport
		Soft Material Molecular Dynamics	Computational quantum many-body theory	Atomistic simulations of friction and other physical properties of nanoscale materials	Statistical Mechanics of Self-Assembly
			Stochastic interactions in confinement		

Source: Adapted from DOE Nanoscale Research Centers, https://nsrcportal.sandia.gov/Home/Capabilities.

3) High Performance Computing

The National Laboratories have had a significant impact on high performance computing (HPC) in two ways—by conducting the up-front research necessary to field first-of-a-kind systems (e.g., developing code optimized for new computing architectures) and through their procurement, via R&D partnerships with vendors, of several generations of high performance computers. By enabling industry, the DOE laboratories have helped make these machines available to a broad community. Recently, this has resulted in the development of the Cray and IBM BlueGene lines of supercomputers, both of which underwent a long period of co-development at the laboratories before being introduced to a broader, commercial audience. The laboratory's role as key sponsors and customers of supercomputers also drives the technology and the industry in important ways. For example, the laboratories played an important role in establishing floating-point arithmetic (rather than logical operations) as the key performance metric defining high performance computing. This role for the National Laboratories continues as HPC moves into exascale computing.

The DOE laboratories currently boast 32 of the world's 500 fastest supercomputers.[214] Leading in computing, however, is not just dependent on hardware. Most of the laboratories have a substantial HPC capability with scientists and engineers who utilize the computing power for applications in energy, science, and national security. Differences in these HPC facilities and programs lie in the technical specifications of the machines, and the applications of the research projects. Like the NSRCs, computing centers support their co-located facilities. The SC Advanced Scientific Computing Research (ASCR) Program funds and manages three supercomputing facilities and advanced scientific networks located at Oak Ridge, Argonne, and Lawrence Berkeley.

In addition to purview, the machines and computing centers across the laboratories differ in architecture and computing codes. Highlighting these differences is the newly developed Collaboration of Oak Ridge, Argonne, and Lawrence Livermore National Laboratories (CORAL), which is a procurement and collaboration project among the three laboratories, NNSA and SC. Oak Ridge, Argonne, and Lawrence Livermore plan an extensive collaboration in HPC, leveraging each laboratory's distinctive capabilities and mission. The plan includes new procurements at each laboratory and will be supported by the ASCR Oak Ridge Leadership Computing Facility (OLCF), the ASCR Argonne Leadership Computing Facility, and the NNSA Advanced Simulation Computing (ASC) program. According to the public release, Oak Ridge's new system, Summit, and Argonne's new system will "have architecturally diverse computers to manage risk during a period of rapid technological evolution." [215]

Generally, differentiated HPC programs benefit mission-driven science at the laboratories.[216] In the case of national security, the NNSA Stockpile Stewardship

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[214] B. Dotson, "Supercomputers: Extreme Computing at the National Labs." Last modified September 4, 2013.

[215] "Collaboration of Oak Ridge, Argonne, and Livermore (CORAL)." DOE Office of Science and National Nuclear Security Administration. Last modified December 17, 2014.

[216] See SEAB, *Report of the Task Force on Next Generation High Performance Computing* (Washington, DC: DOE, 2014).

Program depends on the computing capability of the NNSA laboratories to "assess the safety, security, and effectiveness of the stockpile" in the absence of testing.[217]

E. Findings and Recommendations

Based on its work, the Commission observes the following:

- The National Laboratories' research programs and capabilities are 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.
- Strategic planning for both the Department and its laboratories is best accomplished jointly between DOE and laboratory leadership. Currently, the level of laboratory involvement in DOE strategic planning varies by office.
- The current Secretary and his management team are making advances towards more fully involving laboratory leadership in Departmental strategic planning. It is important to institutionalize these improvements so the Department and laboratories may continue to benefit from these practices in the future.
- The Office of Science has relatively mature processes in place for assessing the quality of both the research conducted by their ten laboratories and of the research portfolio in each SC program. The processes used by SC have begun to influence other DOE program offices.
- 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.
- The National Laboratories have scientific and technical facilities and capabilities that may appear duplicative at a high level but in fact are complementary. The duplication that exists in R&D programs and user facilities is intentional, managed and beneficial to the Nation.
- In the absence of nuclear explosive testing, the nation's confidence in the stockpile ultimately rests on the technical and scientific judgments of the NNSA laboratories. Each of these laboratories has its own processes, culture, and organization to address stockpile challenges. By providing critical "checks and

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217 "NNSA Stockpile Stewardship Program Quarterly Experiments," *National Nuclear Security Administration*, Accessed January 15, 2015, http://nnsa.energy.gov/ourmission/managingthestockpile/sspquarterly.

balances" senior decision makers are provided a credible second opinion that can lead to alternative policy options and validate technical recommendations.

- Considering the maturity of the research program area:
  - At very early stages, it is beneficial to have many laboratories, universities, and other institutions exploring potential avenues for research.
  - In the intermediate stages, DOE may wait too long to provide strategic guidance to the National Laboratories. As a result, there is some period in time in which the laboratories are competing with one another to lay claim to new research areas in a manner that is not strategic.
  - At late stages, in "mature" R&D programs, it is appropriate to have expert peer review teams from universities, industry and other relevant communities guiding DOE on where there should be centers of excellence, how much duplication to support, etc.

Based on these observations, The Commission makes the following recommendations:

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.

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.

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. DOE should not impose additional limitations, but should provide maximum flexibility and authority to the laboratories to administer conference policies, with transparency and accountability.

Recommendation 20:[218] 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.

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.

[218] We have preserved the numbering of recommendations from Volume 1, which results in some anomalies in numbering in Volume 2.

8. Laboratory-Directed Research and Development (LDRD)

As science advances and the Nation's priorities change, the National Laboratories must keep an eye to the future, adapting and updating their skills and capabilities to meet evolving mission needs. The ability to invest in staff, capabilities, and enter new research areas as needed is crucial to laboratory performance. Laboratories rely on LDRD programs to achieve these goals.

Congress has charged the Commission to analyze the effectiveness of the use of LDRD to meet DOE's science, energy, and national security goals; to evaluate departmental oversight of the LDRD program for statutory compliance; and to quantify the extent to which LDRD supports recruitment and retention of qualified staff.

A. Background

LDRD is a program designed to support researcher-initiated work of a creative and strategic nature. It allows laboratories to provide a means to seed fund promising research ideas, attract top talent, and address challenging strategic questions in innovative ways. Authority to fund and manage discretionary research programs within the laboratories was authorized in the Atomic Energy Act of 1954, and institutionalized as an official DOE program in NDAA FY 1991.

LDRD's five primary objectives as articulated by DOE Order 413.2B[219] are to:

- Maintain the scientific and technical vitality of the laboratories;
- Enhance the laboratories' ability to address current and future DOE/NNSA missions;
- Foster creativity and stimulate exploration of forefront science and technology;
- Serve as a proving ground for new concepts in research and development;
- Support high-risk, potentially high-value research and development.

The LDRD program meets these goals through the competitive solicitation and funding of projects, awarding projects by merit using a peer-review process that employ

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[219] DOE, *DOE Order 413.2B*, (Washington, DC: DOE, 2011).

both external and internal peer reviewers. LDRD 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. Many laboratories also depend on LDRD to support the recruitment and retention of qualified staff.

Laboratories acquire funding for LDRD as an overhead fee on work performed at the laboratory. Authorizing legislation caps total LDRD expenditures to a set percentage of the laboratory's annual operating budget. The current cap for LDRD is 6 percent annually, reduced from 8 percent in FY 2014 under the Consolidated Appropriations Act for FY 2014.[220] Before FY 2006, research projects funded by LDRD were not charged overhead fees. Since the Consolidated Appropriations Act of 2006, LDRD projects are charged fully burdened overhead rates for researcher time and the use of laboratory facilities.

1. LDRD Is Implemented by Laboratories and Overseen by DOE

When crafting LDRD programs, laboratory directors balance individual laboratory needs with the strategic interests of DOE and other major customers. Proposed plans for the size of each laboratory's LDRD program are reviewed by their stewarding program offices at DOE. Once funding levels are approved, laboratories distribute LDRD funds to researchers based on a competitive, merit-based review of project proposals. To ensure the objectivity and quality of review, laboratories use both internal research staff and external reviewers from industry and universities to assess the scientific merit of proposals.

Laboratory directors design LDRD proposal solicitations to meet specific laboratory needs, and often emphasize projects that directly relate to major laboratory and Department strategic initiatives. Laboratories tend to organize their LDRD portfolios into strategically solicited topics and seed funding for exploratory research. Because LDRD is proposal-based, laboratories can capture innovative ideas of high scientific merit that fall outside of explicit strategic initiatives but still relate more broadly to DOE's missions. DOE site office and headquarters staff are required to review and approve all projects within the LDRD portfolio for mission alignment and compliance with the Department's statutory requirements. These requirements prohibit the use of LDRD funds for projects that would require non-LDRD funds to accomplish their technical goals, for general purpose capital expenditures, and as substitution for programmatic projects where funding has been limited by Congress or DOE/NNSA.

[220] Consolidated Appropriations Act, 2014, 113th Congress, January 17, 2014.

Congress has previously raised concerns over the discretionary nature of the LDRD program, and identified as potential issues the improper use of LDRD funds, mismanagement of the program, and lack of mission alignment within the project portfolio.[221] Responding to these concerns, recent reviews and audits of LDRD have judged the program favorably. In its most recent report on LDRD, GAO answered eleven congressional questions related to LDRD and found that the program met statutory requirements and that laboratories clearly communicated the costs of LDRD to customers.[222] More recently, DOE's Inspector General reported in an audit to determine whether Lawrence Livermore was effectively managing its LDRD program that "nothing came to [the IG's] attention to indicate that controls were not in place over initial LDRD project approval and subsequent project management," and made no recommendations regarding the program's management.[223]

Interviewees at DOE headquarters and laboratories report that the current LDRD program is well-managed to support DOE and other Federal agency missions and that existing oversight mechanisms ensure compliance of LDRD with Department regulation. Oversight is important to ensure that laboratories use LDRD funds appropriately, but the Commission believes that the statutory requirement that every LDRD project be individually reviewed—which in FY 2014 totaled 1,662 projects—may be excessively costly and burdensome to both Departmental and laboratory staff. Though both laboratories and DOE HQ report that the process of review and approval are not overly burdensome, the Commission finds the degree of oversight to be – at least on a philosophical level – counter to tenets of trusted partnership. The Commission suggests, as a potential alternative, a set of periodic audits or a sampling of each year's project pool, which may be sufficient for compliance and a more efficient alternative to the current oversight.

2. LDRD Funding Levels Vary across the Complex, Based on Size and Mission Needs

Funding levels for LDRD are set by each laboratory in agreement with the laboratory stewarding office and vary widely across laboratories, reflecting the diversity of the laboratories in terms of size and mission needs. Figure 28 presents reported LDRD

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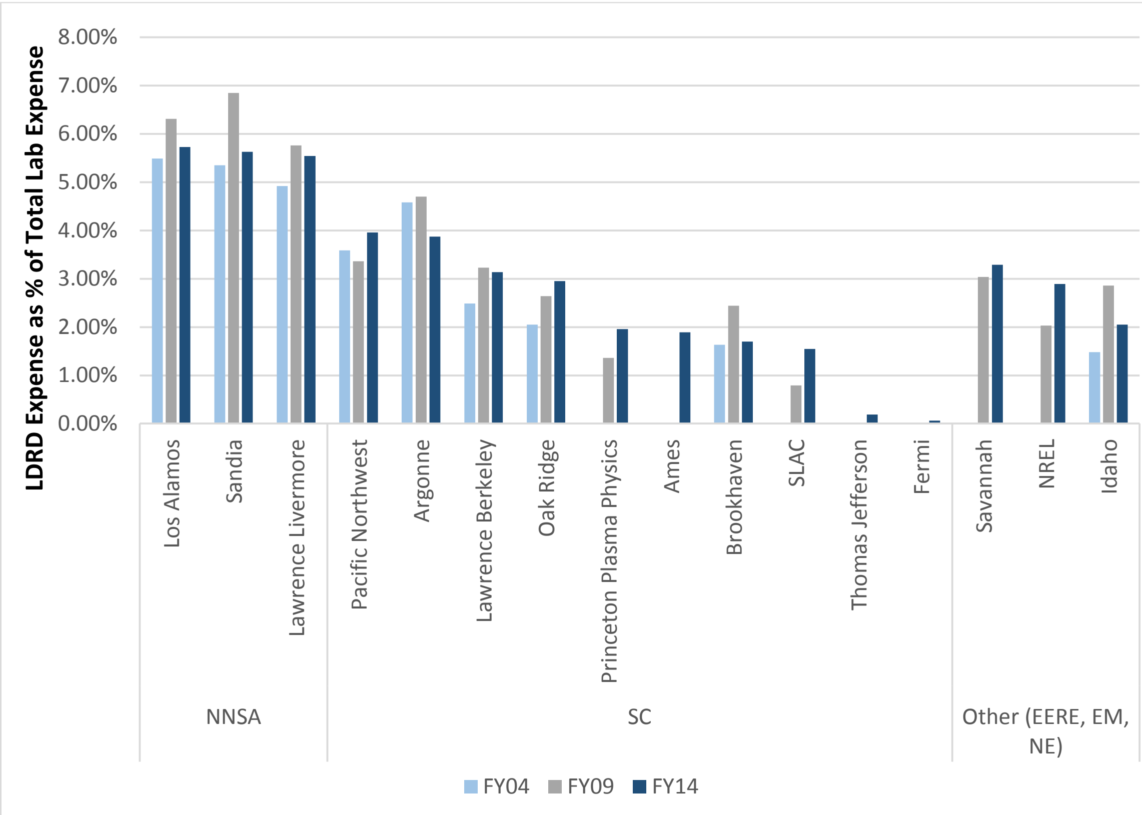
221 FY 2005 House Report 198-554 and FY 2006 House Report 109-86 raise specific concerns about the accounting policies and management of LDRD. Similarly, GAO released reports in 2001 and 2004 in response to congressional concerns over whether LDRD programs met DOE selection guidelines and statutory requirement, and whether LDRD costs were being clearly communicated to customers.

222 GAO, *Information on DOE's Laboratory-Directed R&D Program*. (Washington, DC: GAO, 2004).

223 DOE IG, *Audit Report*, *Lawrence Livermore National Laboratory's Laboratory Directed Research and Development Program*, (Washington, DC: November 2014).

spending as a percentage of total laboratory expenditures in FY 2004, FY 2009, and FY 2014, arranged by stewarding office (NNSA, SC, and other). During FY 2004 and FY 2014, the percentage cap on LDRD spending was 6 percent, versus 8 percent from FY 2006 to FY 2013.



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% during the same year, to be reduced to 6% while maintaining the burden in FY 2014. In terms of FTE hours of work, an 8% burdened cap enables less research to be conducted than with a 6% 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 28. Reported LDRD Spending as a Percentage of Total Laboratory Expenditures, FY 2004, FY 2009, and FY 2014

Total spending on LDRD in FY 2014 totaled $526.9 million, represented in descending order by laboratory in Table 28.

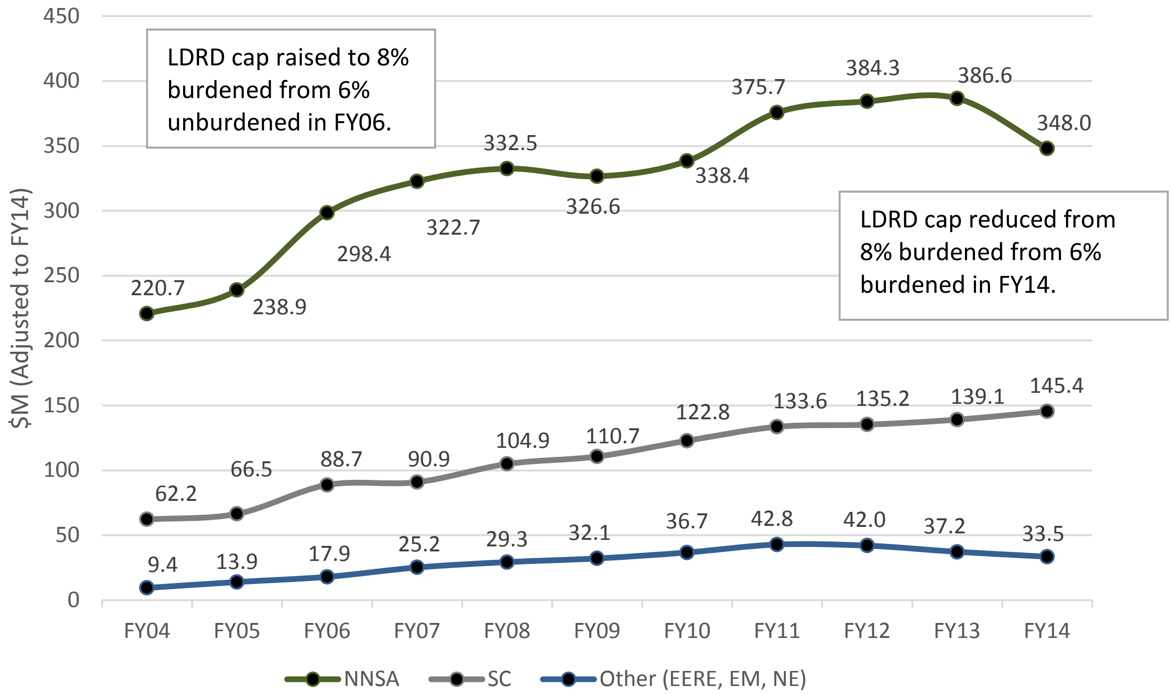
Table 28. FY 2014 LDRD Costs by Laboratory

	LDRD Costs ($M)	LDRD Costs (%)
NNSA		
Sandia	151.3	5.63%

Los Alamos	118.5	5.73%
Lawrence Livermore	78.2	5.54%
Office of Science		
Pacific Northwest	38.9	3.96%
Oak Ridge	36.3	2.95%
Argonne	29.2	3.87%
Lawrence Berkeley	23.6	3.00%
Brookhaven	9.6	1.70%
SLAC	4.4	1.55%
Princeton Plasma Physics	2	1.96%
Ames	1	1.89%
Fermilab	0.2	0.06%
Thomas Jefferson	0.2	0.19%
Other (EM, NE, EERE)		
Idaho	17	2.05%
NREL	10.3	2.89%
Savannah	6.2	3.29%
Total LDRD Costs	526.9	n/a

Source: Data derived from DOE Fiscal Year 2014 LDRD Report to Congress.

NNSA laboratories were responsible for 66 percent of total LDRD expenditures for FY 2014, compared to 27.6 percent at Office of Science laboratories and 6.6 percent at the remaining laboratories. These proportions have remained roughly consistent over time, as represented in Figure 29. The drop in funding seen in FY 2014 reflects the reduction of the percentage cap on LDRD from 8 percent to 6 percent, which primarily impacted the NNSA laboratories.



Note: Data derived from DOE Fiscal Year 2004-2014 LDRD Reports to Congress.

Figure 29. Total LDRD Spending, FY 2004–FY 2014

NNSA laboratories spend more on LDRD in both percentage and absolute terms. This is a result of both greater total laboratory expenditures and different mission needs. Staff recruitment and retention was cited as one of the major outcomes of LDRD programs at NNSA laboratories. Interviewees reported that defense and nonproliferation programs at the three NNSA laboratories lack extensive opportunities for researchers to pursue investigator-driven, program-independent research. Independent research is important to staff scientists, so NNSA laboratories use LDRD to provide research staff these opportunities. In doing so, laboratories are able to recruit the highest quality researchers in a field where laboratories must compete with academia and industry for talent. In addition, LDRD allows the laboratories to recruit researchers who do not yet have security clearance and to give them leading edge scientific work while they await their clearances. LDRD's broader scope also lets laboratory researchers engage with peers in the scientific community, exposing them to new ideas and preventing them from becoming isolated from progress in their fields. While this may give the impression that LDRD programs are not sufficiently mission-focused, broadened scope ensures laboratories can effectively develop their workforce and anticipate needs for future national security challenges. NNSA oversight still ensures that projects remain pertinent to the broader DOE mission.

Non-NNSA laboratories elect lower LDRD rates for a variety of reasons. Interviewees reported that science and energy laboratories rely less heavily on LDRD to recruit and retain staff due to the research opportunities already available through science programmatic work and the appeal of energy missions to many academic researchers. Furthermore, while all laboratories collaborate with academic and industry partners, non-NNSA laboratory directors must be especially considerate of costs to customers when determining LDRD overhead rates. High overhead fees discourage these partnerships, limiting a laboratory's ability to disseminate the products of its research to the Nation. These cost considerations prompt laboratories to elect lower LDRD and other overhead rates, rather than spend as close to the statutory limit as possible.

B. LDRD Programs Support Vitality of National Laboratories in Multiple Ways

Interviewees reported many positive outcomes of LDRD, including (1) the fostering of capabilities and development of major scientific and technical programs; (2) recruitment, development, and retention of talented staff, especially as pertinent to weapons science; and (3) promoting a culture of innovation and providing a source of cutting-edge research ideas.

1. LDRD Builds Capabilities to Develop New Programmatic Areas and Meet Shifting Mission Needs

Interviewees attribute the success and development of many noteworthy laboratory programs to the development and fostering of capabilities by earlier LDRD investments. For competitively awarded programs such as the Joint Center for Energy Storage Research at Argonne, the Joint Bioenergy (JBEI) Institute program at Lawrence Berkeley, and the Energy Frontier Research Center led by NREL, LDRD funds built the foundational expertise needed to implement these programs. Seeded by relatively small early investments, these programs produced large returns, both scientific and financial. The $250 million JBEI program at Berkeley—established in 2007—arose from $484,000 in LDRD funding that began in the years prior, and has helped translate many inventions to the private energy industry. Under the direction of former Lawrence Berkeley Director and former Secretary of Energy Steven Chu, Lawrence Berkeley's LDRD program actively encouraged and awarded projects that focused on renewable energy technologies. These projects brought together a core team of researchers and developed the technical foundations that allowed laboratory leadership to argue strongly for JBEI's placement at the laboratory. In FY 2008, Lawrence Berkeley secured not only the JBEI program but the $500 million contract for the Energy Bioscience Institute (EBI), an internationally competed Institute funded by British Petroleum. The laboratory's ability to successfully compete for both JBEI and EBI stemmed directly from earlier LDRD projects, and Director Chu's decision to invest LDRD funding in renewable energy. Other major programs cited by interviewees as supported by early-stage LDRD include the Molecular Foundry at Lawrence Berkeley, both the original Advanced Photon Source and its upgrade at Argonne, and work on the Human Genome Project.

As leaders of large scientific and technical enterprises, laboratory directors are well-positioned to discern potential future mission challenges in the areas of energy, science, and national security. In the 1990s, laboratory leadership at Sandia identified the growing importance of biosciences to the Nation's long-term, strategic interests, and used LDRD to begin establishing a core technical capability in biosciences.[224] These early investments prepared Sandia to participate in DOE initiatives in bioenergy and chemical-biological nonproliferation and enabled Sandia to respond to advances in biosciences and growing national security concerns over the threat of biological and chemical weapons. Today, programmatic work at Sandia related to biosciences, energy, safety, security, and defense totals $50–60 million, and Sandia continues to invest LDRD funds in the biosciences.[225]

2. LDRD Is Vital to Recruitment, Development, and Retention of Laboratory Workforce, Especially at NNSA and Non-SC Laboratories

NNSA laboratories heavily rely on LDRD programs to support laboratory efforts to recruit the workforce and develop necessary technical skills to carry out the NNSA's mission of stewarding the Nation's nuclear security and weapons programs. Technical expertise in nuclear weapons science exists exclusively within the NNSA laboratories, and that expertise can only be preserved by recruiting, training, and retaining new staff.

A substantial proportion of post-doctoral researchers at NNSA laboratories are supported by LDRD and many are transitioned to full-time staff. Table 29 presents the percentage of post-docs at NNSA laboratories recruited and retained through LDRD programs; post-doctoral researchers are a crucial source of the NNSA laboratories' scientific workforce. NNSA laboratories must often hire people who have not yet gotten 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. Interviewees from both DOE headquarters and laboratories concur in emphasizing the criticality of LDRD to support recruitment and retention for the nuclear security mission.

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[224] As reported through correspondence with representatives at Sandia.

[225] *Ibid.*

Table 29. 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%

*Data for Lawrence Livermore collected for FY 2010-FY 2013. Provided by NNSA.

Overall, LDRD supported 26.3 percent of the total post-doc population at the DOE laboratories in FY 2014.[226] Non-NNSA laboratories also recruit through LDRD. Many early career staff at the laboratories cited the ability to pursue research through LDRD as an important factor in their decision to work at the laboratories. Table 30 presents LDRD support of post-docs in FY 2013 broken down by laboratory. At non-SC laboratories in FY 2013, LDRD programs support 50 percent of the total post-doc population (594 of 1186 post-doctoral students, as tabulated below). Since LDRD programs provide laboratory staff the opportunity to pursue new research concepts, laboratories where those opportunities are scarcer must make greater use of flexible LDRD funds to recruit talented new researchers.

Table 30. Post-Doctorates Supported by LDRD at National Laboratories, FY 2013

Laboratory	% of Total Post-Doctorate Population	# of Post-Doctorates
Savannah (EM)	64%	7
Los Alamos (NNSA)	57%	343
Idaho (NE)	46%	6
Lawrence Livermore (NNSA)	46%	111
Sandia (NNSA)	45%	97
NREL (EERE)	29%	30
Pacific Northwest (SC)	26%	69
Argonne (SC)	25%	101
Brookhaven (SC)	16%	27
Lawrence Berkeley (SC)	13%	88
Oak Ridge (SC)	12%	68
Princeton Plasma Physics (SC)	10%	2
SLAC (SC)	9%	12
Ames (SC)	2%	1

Source: Data provided by Department of Energy, Office of Science. Fermilab and NETL did not support LDRD programs during FY 2013.

226 DOE, *Fiscal Year 2014 Report to Congress on LDRD at the DOE National Laboratories.* (Washington, DC: DOE, January 2014).

Among SC laboratories, LDRD is also used for workforce development through post-doc fellowships, university partnerships, and strategic hires in critical areas; though LDRD is not relied on to the extent it is at non-SC laboratories.

3. LDRD Fosters an Innovative Environment and Generates Cutting-Edge Research Ideas

One of the LDRD's stated objectives is to support high-risk, potentially high reward R&D, enabled by the program's investigator-driven proposal system. Solicitation processes vary to some degree across the system, but typically researchers are invited to submit proposals either within strategically pre-determined categories or ideas that fit broadly. Selection for projects at both pre-proposal and proposal phases of review were highly competitive across the laboratories.

DOE collects three metrics to measure LDRD's scientific productivity: number of peer review publications, patents, and invention disclosures.[227] These metrics are published by the DOE CFO's Office in its annual report to Congress on LDRD. LDRD projects at some laboratories produce a disproportionately large volume of scientific output when compared to the percentage of funds dedicated. For example, close to 50 percent of Lawrence Livermore's 1,126 patents filed between FY 1999 and FY 2013 arose out of LDRD-associated projects.[228] Even though LDRD was less than 6 to 8 percent[229] of the laboratory's funding each year, close to half of the laboratory's patents stemmed from LDRD work.

The impact of the LDRD program cannot be captured completely through metrics such as follow-on funding, recruitment statistics, or measures of scientific productivity. Certain advances and scientific outputs of LDRD can only be captured through a broader understanding of how LDRD supports future programmatic activities. At Lawrence Livermore, for example, LDRD investments advanced high pressure physics techniques, measurement capabilities, and analytical tools to compare the performance of new and aged plutonium samples. Lawrence Livermore used these techniques to find that the plutonium pits in the Nation's stewarded weapons could last longer than previously expected, effectively extending the lifetime of the nuclear stockpile. These findings contributed to the decision to scrap plans to build the Modern Pit Facility, estimated to cost $4–10 billion. Interviewees reported the impacts of this LDRD project as one of the

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[227] As a metric of LDRD outcomes, some individual laboratories track the amount of subsequent programmatic funding that follows from research conducted through LDRD, but DOE does not collect this data at the central level.

[228] Lawrence Livermore National Laboratory, *LDRD FY 2007Annual Report*, (LLNL, 2007). Additionally, all other Annual Reports through FY 2013.

[229] Based on the percentage cap on LDRD funding during that fiscal year.

largest successes of the stewardship program, due to dramatic savings on costly life extension programs. LDRD outcomes like these are not always evident through official reported metrics, but are nonetheless an important product of LDRD programs.

C. Congressional Changes to LDRD Accounting Policies

In FY 2006, Congress required the laboratories to burden LDRD, changing the cap from an unburdened 6 percent to a burdened 8 percent.[230] Then in FY 2014, Congress reduced the LDRD cap from 8 percent to 6 percent, still burdened.[231] The Commission investigated how this change impacted the availability of LDRD funds and the ability of the laboratories to fulfill its vital missions.

Responses to the Congressional reduction in cap were mixed. 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 only modest to minimal impact. The Commission was met with concern from some interviewees that the burdening of LDRD was a double-counting that effectively halved the purchasing power of LDRD funds. This was not true in the case of all laboratories, with some reporting that the burdening of LDRD was more an administrative change than a real reduction. Overhead costs associated with LDRD projects had always been accounted for, and the burdening change merely institutionalized current practice. That said, the quantitative difference between burdening and unburdening LDRD is significant. Prior to Congressional policy changes in FY 2006, LDRD was historically unburdened with a 6 percent cap. To reach 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).[232] Given the mission importance of LDRD, the Commission strongly endorses a reconsideration of LDRD policy.

It is noteworthy that even when laboratories had discretion to spend more on LDRD, most laboratories did not spend "to the cap," due to a combination of sensitivity to passing on additional overhead costs to customers and the fact that a lower LDRD spending was sometimes sufficient to meet a laboratory's needs. These factors counter the view that LDRD is a program of unbridled 'excess.' Rather, LDRD is a carefully

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

231 Consolidated Appropriations Act, 2014 (Public Law No. 113-76).

232 For 6% unburdened, each $1M of laboratory budget would provide $60K in LDRD funds. Assuming an 80% overhead rate, the same $1M would provide ~$45K under an 8% burden and only ~$33K under a 6% burden. To reach levels comparable to the 6% 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 real work while the remainder ~$44K would be collected as overhead.

considered research portfolio, sized to appropriately meet mission needs at the discretion of laboratory leadership. For those laboratories with programs closer to the cap—primarily the NNSA laboratories—the decrease from 8 percent to 6 percent resulted in 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. The Commission acknowledges that there are sound rationales for either burdening or not burdening LDRD funds. Congress should set the cap at a level that supports an amount of direct R&D work that fulfills the purposes of the LDRD program. In the judgment of the Commission, that should be comparable to historical levels prior to the changes in 2006.

D. Findings and Recommendations

LDRD is an investment by the laboratories in the future. The purposes of LDRD are clear and crucial: to recruit, develop, and retain a creative workforce and to produce the innovative ideas vital to a laboratory's ability to produce the best scientific and future mission work. For these reasons, the Commission strongly endorses the need for LDRD programs, both now and into the future.

The Commission has formulated the following findings with regard to LDRD:

- LDRD has a long history of support and accomplishments, dating back to 1954 when it was first authorized by the Congress. Formal requirements for LDRD projects, external review, and DOE oversight ensure that projects are selected competitively and that they explore innovative, new areas of research not already covered by existing programs.
- LDRD is a resource for supporting cutting edge exploratory research prior to the time that a research program is identified and developed by DOE. Multiple LDRD projects at various laboratories may be funded in the same topic area as a means of exploring different potential paths for an ultimate program in the field. These small, early stage projects provide valuable insights for the peer-review, strategic assessments by DOE as part of the program planning process.
- LDRD is an important recruitment and retention tool for the National Laboratories. This is especially critical at the NNSA laboratories, which must attract new staff into the laboratories in order to maintain a highly-trained workforce to support the NNSA's nuclear weapons and national security missions.

The Commission has the following recommendations for the Department and Congress with regard to LDRD:

Recommendation 19:[233] 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 likely only impact the LDRD programs of the NNSA laboratories.

[233] We have preserved the numbering of recommendations from Volume 1, which results in some anomalies in numbering in Volume 2.

9. Diverse Support of Other Agencies

DOE defines WFO[234] as "the performance of work for non-DOE entities by DOE contractor personnel and/or utilization of DOE facilities that is not directly funded by DOE appropriations."[235] Such work can emanate from the requirements of other Federal agencies, state or local governments, academia, and industry. As outlined in DOE Order 481.1C, and consistent with 48 CFR 970-1707, the purposes of WFO are to:

- Provide non-DOE entities access to highly specialized DOE facilities, services, or technical expertise (to include working in classified environments);
- Assist other Federal and non-Federal agencies in accomplishing otherwise unattainable goals and avoiding possible duplication of efforts;
- Maintain core competencies at the laboratories;
- Enhance science and technology capabilities;
- Increase R&D interactions between the laboratories and industry, in the interests of technology transfer, development, and commercialization; and
- Retain and attract high-quality personnel. (WFO can appear to be more "relevant" to real-world issues, especially for those at NNSA laboratories.)

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

This chapter describes the scope of WFO by various Federal agencies and within the laboratories. It then assesses how well Federal agency WFO aligns not only with DOE missions, but also what unique capabilities the National laboratories offer to these other Federal users. It next focuses on the range of customer views about the laboratories' performance—essentially, their level of satisfaction. In looking at the ability of WFO

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[234] The Commission recognizes DOE has renamed WFO as Strategic Partnership Projects (SPP) but has elected to continue using the original term since it is more recognizable to the public at large.

[235] DOE. *Order 481.1 Work for Others (Non-Department of Energy Funded Work).* (Washington, DC: DOE, 1997).

customers to shape the laboratories' capabilities to meet their future requirements, this section concludes with a review of the mandate and performance of the Mission Executive Council (MEC) to date.

A. Varied Scope of WFO

Of the total $17.2 billion funding for the laboratories in FY 2013, WFO accounted for 14 percent ($2.43 billion). Of that amount, by far the largest customer is the Department of Defense (DOD), accounting for $1.49 billion (61 percent).[236] The other major Federal agencies supplying funding are: the Intelligence Community (IC); Department of Homeland Security (DHS); Department of Health and Human Services (DHHS), specifically in the form of grants from the National Institutes of Health; NASA; and Nuclear Regulatory Commission.[237] Other Federal agencies, representing a lower level of funding, include: Department of State, Federal Bureau of Investigation (FBI), and National Oceanic and Atmospheric Administration (NOAA). Figure 30 depicts these funding levels for FY 2013, as executed (to include non-Federal funding sources as well). A review of total WFO funding since FY 2009 shows little variation year to year, and fairly steady levels of funding from DOD, DHHS, and NASA throughout this time. In contrast, funding from DHS and the Nuclear Regulatory Commission has fallen by 37 percent (from $472 million to $278 million) and 34 percent (from $80 million to $53 million), respectively; according to discussions with the Commission and staff, these declines have generally not been as a result of dissatisfaction with the laboratories' performance, but rather due to overall budget reductions. The concern is that continued budget cuts coupled with continued increased costs for work at the laboratories may well result in the inability of these agencies to have the necessary work done for their missions.[238] In turn, other Federal funding has increased by 36 percent and non-Federal funding by 20 percent in that timeframe. Of note, the level of funding from the IC has increased appreciably since 2001.

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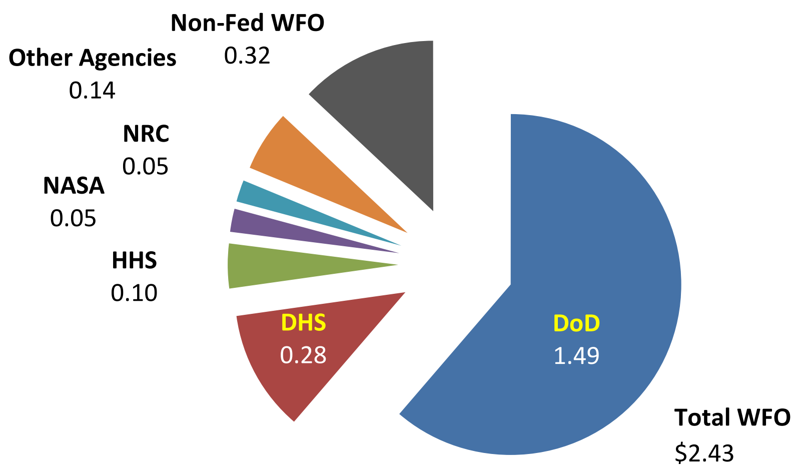
236 This figure does not include funding for the existing nuclear weapons and naval reactors programs.

237 For purposes of this unclassified report, the extent of the IC's use of the national laboratories is necessarily discussed in generic terms. The Office of the Director of National Intelligence (ODNI) was established to manage intelligence efforts across a number of Federal organizations (see http:www.intelligence.gov/mission/member-agencies, accessed 8 January 2015). As such, IC inputs to the Commission were coordinated through the ODNI, although individual not-for-attribution interviews were also conducted with IC representatives from several organizations.

238 As noted in DHS, "Utilization of the DOE National Laboratory Complex: The DHS Perspective." Presentation for the Commission to Review the Effectiveness of the National Energy Laboratories, Alexandria, VA, October 6, 2014, and in not-for-attribution interviews conducted by staff supporting the Commission, November 21, 2014 and January 14, 2015.

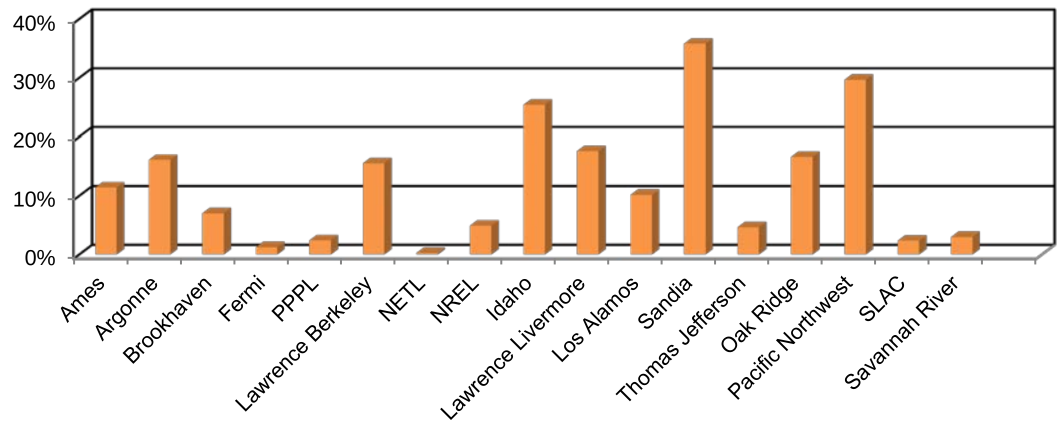


Source: DOE Office of Science, "Work for Others Program: Interagency Work," Presentation to the Commission, October 2014.

Figure 30. Actual FY 2013 WFO Funding, by Customer ($ in Billions) for all Laboratories

Just as there are appreciable differences across Federal sponsors of WFO at the laboratories, so too are there considerable differences both in the dollar value of WFO and the percentage WFO represents of each laboratory's overall budget. Figure 31 provides data on the latter point in aggregate for FY 2009–FY 2013, as executed.[239] In both categories, Sandia stands out in terms of WFO's significant role: some $900 million in WFO in FY 2013 accounted for about 35 percent of Sandia's overall budget.

239 There have not been large variations in the amount of WFO funding each laboratory has received over these five years, with two exceptions. One was a dramatic increase in Fermi's funding in FY 2013 due to the state of Illinois funding a building; the second was a marked increase, especially in FY 2012 and FY 2013 at NREL, which was primarily driven by greater DOD investments in energy efficiency work.



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

Figure 31. WFO as a Percentage of Average Total Budgets, FY 2009–FY 2013, by Laboratory

B. WFO Support to DOE Missions and Other Agencies' Needs

DOE has processes in place to ensure that WFO aligns with the Department's missions. The laboratories falling under the Office of Science, for example, are required to prepare a section in their annual report (to the Office of Science) describing the current WFO portfolio, near-term issues, and overall WFO strategy. NNSA laboratories must identify any capability or facility for which external funding is more than 25 percent.[240] DOE reports that WFO has historically been synergistic with DOE core mission work, and that it has "frequently resulted in cost avoidance at DOE, improved capability for core mission work, and/or workforce development."[241] Multiple Federal agencies 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 WFO; 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.

Another important dimension of WFO is the extent to which the National Laboratories are able to provide unique capabilities and facilities to these customers. Some of these capabilities—such as genome sequencing at Los Alamos and bio-risk management at Sandia—are widely recognized as being world-class capabilities.

240 Written document prepared by DOE, "Work for Others Program: Interagency Work," 3.

241 *Ibid*, 2.

Customers also identified the incalculable benefits of being able to use the laboratories' highly qualified personnel for technical advice and as unbiased third-party evaluators. In addition, the Nuclear Regulatory Commission relies on the unique expertise at laboratories in dose assessments and reactor risk and reliability assessments and analysis. For its part, NASA relies on four of the laboratories for its radioisotope power systems, which currently represents most of NASA support to the DOE laboratories; these laboratories are the only ones that have this capability. Emerging areas of study include nuclear surface power and nuclear thermal propulsion, which NASA anticipates will grow in importance in the coming years. Other unique assets used by other Federal agencies include: the National Ignition Facility (NIF) and Z-division (which provides technical assessments of foreign nuclear programs and weapons capabilities), both at Lawrence Livermore, as well as the synchrotron light sources at Argonne, Brookhaven, Lawrence Berkeley, and SLAC.

C. Federal Agency Satisfaction with the Laboratories' Performance

With few exceptions, those interviewed for this study and those who testified before the Commission noted an overall good-to-high level of satisfaction with the work the laboratories do for them, based on their responsiveness and the overall quality of their work. Many interviewees have noted that the cost of doing business with the laboratories is seen to be high relative to other entities due to their overhead rates (as well as the 3 percent tax that is levied on all WFO to cover administrative costs associated with managing the work).[242] These high costs can be a deterrent in using them, and may well become a greater factor if Federal agency budgets are further trimmed. While most WFO customers feel they are getting their money's worth, and they recognize that there are expensive facilities and assets at the laboratories that must be maintained, some argue that they are not relying on the laboratories for these facilities, but rather the subject matter expertise, and therefore the rates are excessively high for the type of work being performed. An additional qualifier evident across the interviews is that some laboratories are seen to perform better than others; as one interviewee put it, there are "islands of excellence" but also "pockets of mediocrity."[243] As a result, individual responses in any given organization can run the gamut, and can depend on individual personalities, but the overall consensus is that the laboratories produce high-quality work. Indeed, a number of people from various agencies underscored the important point that WFO customers have the ability to "vote with their purse." The fact that WFO funding has remained steady thereby demonstrates the general level of satisfaction. Finally, there is across-the-board

[242] At the same time, it is important to note that WFO does not pay for major equipment or facilities. As such, DOE is not recovering all its costs, even though the overhead rates are high.

[243] Interview with DOD official, October 21, 2014.

recognition that effective communications and interactions, both with the laboratories and with DOE headquarters, are vital to ensure an understanding of WFO needs now and in the future. Initiatives such as personnel exchanges and having a designated laboratory employee frequently visit major customers (serving as a "customer relationship manger") can help provide these necessary communication channels.

Where satisfaction is much lower is in the role that DOE headquarters plays in WFO. Customers across the Federal agencies make a point of distinguishing between the laboratories who "know what they're doing, and they do it well," and DOE, which is seen more often as an impediment and a source of frustration.[244] Another source of frustration with DOE headquarters is the lengthy process required to obtain WFO approvals, especially within the NNSA laboratories, and the fact that this process is usually the same for a small level of effort as it is for a multi-million dollar initiative. There has been some progress in using standardized umbrella agreements, which identify acceptable areas of work, but this has yet to be applied consistently across the system.[245] 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 WFO approval process.

Aside from the Life Extension Programs, DOD customers are generally satisfied with the overall relationship, and note the important roles the laboratories play in a number of DOD areas of responsibility, such as threat reduction and energy efficiency, an area of growing interest to DOD. In fact, the laboratories' efforts to transition to being national security laboratories have made them more useful to other agencies, such as DOD. There are, in fact, some initiatives under way to ensure that the ease of sending work to the DOE laboratories has not led DOD customers to rely too heavily on them. In at least one case, such an initiative resulted in the decision to have a specific project performed outside the laboratory system, but the process took 9 months longer, the cost was ultimately the same, and the DOD office's confidence in the quality of the product to be delivered is substantially lower.[246] In the cases of DHS and the IC, strategic

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[244] Few have been as vocal about these frustrations as the nuclear weapons sponsors in DOD, who point to frequent schedule delays and cost overruns (often created by burdensome headquarters-imposed requirements), the lack of transparency in how DOE is spending the funds, and a belief that too much work is focused on "science," to the detriment of the Life Extension Programs. Technically, however, the Life Extension Programs and other work related to the nuclear weapons program is not "Work for Others", but part of the core mission of the DOE.

[245] This issue and recommendations to improve the process have been identified most recently in two other studies: Augustine/Mies, *A New Foundation for the Nuclear Enterprise*, and NRC, *Aligning the Governance Structure of the NNSA Laboratories*.

[246] Interview with DOD official, October 17, 2014.

investments have been made in some cases to ensure that a capability critical to their missions is maintained.[247]

Both DHS and the Nuclear Regulatory Commission have instituted performance reviews of the National Laboratories, soliciting inputs from the program managers on the extent to which the laboratories are meeting their agency mission needs and whether they are providing value-added work.[248] Scoring by both agencies across the laboratories averages 3.6–3.9 out of a total possible 4.3 points, meaning they "exceed" or "notably exceed expectations." While noting a generally high level of satisfaction, DHS identified two areas as challenges, (1) that the laboratories are often not as focused on the turn-around time DHS requires (typically 18–24 months) and (2) that they are not as transition-oriented.[249] As a way of addressing its satisfaction with the laboratories' performance, Nuclear Regulatory Commission, DOD, IC, and FBI customers all noted that if performance is not up to expectations, they will not do future work with that laboratory or specific principal investigator; it is a "vote with the purse" system.

As noted earlier, the IC has expanded its use of the National Laboratories considerably since the events of 9/11.[250] The IC stresses the importance of knowing that capabilities are there to make a difference for a given IC mission, and knowing whether those capabilities are healthy or are at risk. The IC has also developed a way of funding work at the laboratories which aligns well with meeting its needs and is therefore satisfied with the support the National Laboratories provide.[251]

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[247] Among DHS' long-term investments are the National Infrastructure Simulation and Analysis Center at Sandia and Los Alamos; the Industrial Control Systems Cyber Emergency Response Team (ICS-CERT) at Idaho; the Biodefense Knowledge Center at Lawrence Livermore; the National Visualization and Analytics Center at Pacific Northwest; and the Interagency Modeling and Atmospheric Assessment Center at Lawrence Livermore. As noted in DHS, "Utilization of the DOE National Laboratory Complex: The DHS Perspective."

[248] The Office of National Laboratories in the Science and Technology Directorate of DHS has done these assessments, *National Laboratory Performance Assessment*, for FY 2011, FY 2012 and FY 2013. The Nuclear Regulatory Commission has done so only for FY 2014, *DOE Survey Results*, because it has only just recently consolidated working with the laboratories into one office, the Acquisition Management Division.

[249] DHS, "Utilization of the DOE National Laboratory Complex: The DHS Perspective." (Washington, DC: DHS, 2014).

[250] Description of the IC's use and satisfaction with the laboratories is based on a coordinated input received from ODNI as well as not-for-attribution interviews with representatives from the Central Intelligence Agency and the Intelligence Advanced Research Projects Activity.

[251] No further detail about this process can be provided in an unclassified report.

D. Mission Executive Council

The Mission Executive Council (MEC) was established in July 2010 through the signing of the document "Governance Charter for an Interagency Council on the Strategic Capability of DOE National Laboratories as National Security Assets," by the leaders of DOE, DOD, DHS, and ODNI.[252] The MEC's 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, identifying common areas of interest across these agencies, and (ideally) ensuring the capabilities to address these areas are maintained. The MEC is therefore meant to serve as the mechanism for these agencies to interact with the National Laboratories on a strategic level. The MEC does not, however, involve any financial obligation on the part of any of the signatory agencies.

The MEC consists of two members from each of the four signatory agencies at the undersecretary level; in addition, the Chairman of the DOE National Laboratory Director's Council and the DOD Director for the Defense Laboratories Office regularly attend the MEC's quarterly meetings. About 2 years ago, the MEC's processes were improved by the creation of a planning group, comprised of senior staff from the four departments, which meets much more regularly, thereby providing greater continuity and stability. The MEC is required to report annually, focusing on the following issues: assessing the adequacy of national security science, technology, and engineering capabilities at the laboratories in identified cross-cutting areas; identifying science, technology, and engineering capabilities that need interagency attention; and recommending what capabilities should be developed or sustained in order to close identified gaps. The MEC was further tasked in the National Defense Authorization Act (NDAA) FY 2013 to submit a report on how effective it has been, whether the WFO program has been strengthened, and whether it has worked on ways to increase cost sharing.

A recent National Research Council (NRC) report that looked in detail at the MEC and its performance noted the failure to date of the MEC to fulfill its mandate in many respects and emphasized the need for the MEC to play a greater strategic role.[253] This Commission similarly notes that assessments among those it has interviewed about the MEC's utility to date are tepid at best. While the purpose of the MEC—ensuring the preservation of a technology base to meet government-wide, national needs—is laudable,

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[252] Its membership and responsibilities are described in 10 U.S. Code § 188, Interagency Council on the Strategic Capability of the National Laboratories.

[253] NRC, *Aligning the Governance Structure of the NNSA Laboratories to Meet 21st Century National Security Challenges*.

the question has been raised whether the MEC can have the desired effect without more resources. However, this Commission supports the findings of the NRC report, which argues that the MEC should be reinvigorated to fulfill a strategic role by ensuring that the agencies are aware of the skills of the laboratories and that the laboratories are aware of the major challenges confronting the agencies now and in the future. The NRC report also found that the MEC does not need additional authorities to serve as the interagency integrator in identifying future S&T needs and that the MEC should work with OMB, Office of Science and Technology Policy (OSTP), and Congress to advocate for necessary investments in laboratory facilities and equipment, as appropriate.

E. Findings and Recommendations

The Commission has the following findings:

- The National Laboratories are national assets that perform important work that goes beyond DOE's own programs and supports other Federal agencies, public institutions, universities, and the private sector. The laboratories provide unique capabilities in terms of expert personnel capable of providing both large-scale, long-term support and meeting rapid response needs. They also build and operate large-scale, state of the art research facilities that are used extensively by the broader science and technology community in support of many diverse public and private needs.
- DOE has policies in place to ensure that WFO meets necessary criteria and, in appropriate areas, aligns with the Department's missions.
- On the whole, WFO customers are very satisfied with the quality and value of the work performed by the laboratories. However, many customers feel that laboratory costs are high relative to other institutions. They are also less satisfied with interactions with DOE headquarters.
- Absent established relationships with DOE or the laboratories, it is sometimes unclear to WFO customers where to find the needed capability within the National Laboratory system. Various forms of communication, to include personnel exchanges and "customer relationship managers" have been tried in some areas and have proven helpful.
- There is insufficient strategic planning involving other Federal agencies regarding their future needs for expert personnel and facilities to support WFO.
- The Mission Executive Council, consisting of the DOE, DOD, DHS, and the IC, is not as effective a coordination resource as it was intended to be.
- Some Federal agencies have established an annual process to evaluate their level of satisfaction with the DOE laboratories performance, but this is not done

systematically across all WFO sponsors nor do the existing evaluations differentiate notably among the laboratories.

Based on these findings, the Commission makes the following recommendations with respect to WFO:

Recommendation 22: DOE should establish policies and procedures to make the Work for Others (WFO) 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 WFO 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 WFO customers about where specific capabilities lie within the laboratory system.

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

This strategic focus should include efforts already identified in other recent reports:[254]

- Provide the mechanism for interagency strategic S&T planning, including the development of a mission statement for the laboratories for their "national security mandate."
- Develop a systemic approach, to include working with OMB, OSTP, and Congress, to advocate for necessary investments in laboratory facilities and equipment.
  - Serve as the vehicle for WFO customers to offer more predictable mission sets for the next several years to help guide the laboratories' investments in staff and facilities.
- The coordinating office for contacts with the laboratories within all major Federal WFO agencies should establish annual evaluation processes, drawing on the processes already established at DHS and the Nuclear Regulatory Commission. For all these agencies, these evaluations should be made more

[254] Recommendations 2, 3, and 5 in NRC, *Aligning the Governance Structure of the NNSA Laboratories to Meet 21st Century National Security Challenges*, and Recommendation 19 in Augustine/Mies panel, *A New Foundation for the Nuclear Security Enterprise*.

rigorous so that the evaluations better highlight areas of excellence and areas needing improvement.

10. Collaboration with the Academic Community

It is mutually beneficial for academia and the DOE laboratory community 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 enhanced external guidance to the laboratories through the academic peer review process. Academics, for their part, benefit from involvement in the large, long-term, multidisciplinary projects that are common at the DOE laboratories and from access to DOE's user facilities.

A. Laboratory/University Researcher Collaborations

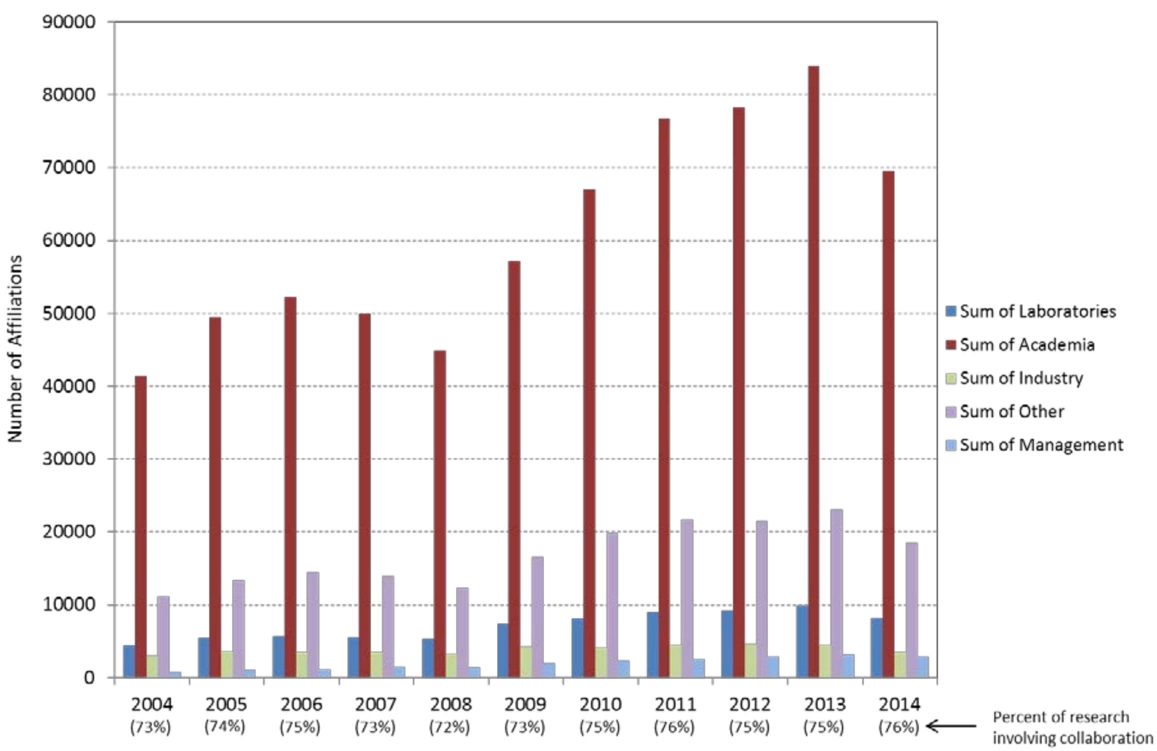
To understand both the level of collaboration that exists between the DOE laboratories and other entities and to understand who the laboratories are collaborating with, the Commission performed a bibliographic analysis of the laboratories' publications between 2004 and 2014. The intent of this effort was to determine if, as is often suggested, the laboratories are separate, insular, entities or if they collaborate with others, including other DOE laboratories. Elsevier's Scopus was chosen as the initial data source as it is one of the most comprehensive peer-reviewed literature abstract and citation databases available. In this analysis the number of affiliations serves as a proxy for the level of collaborative research on-going at the laboratories and type of affiliations show who the laboratories are collaborating with. The analysis looked at collaborations between each DOE laboratory and the other laboratories in the system, academia, industry and miscellaneous organizations, including consortia, non-academic research centers, and other government laboratories. In total, roughly 310,000 publications were included.

Note: "Other" includes consortia, non-academic research centers, and other government laboratories. "Management" refers to the M&O Contractor

Figure 32 shows the number of different affiliations[255] for the years between 2004 and 2014, broken out by the type of collaborator. It represents a roll-up of the data from all 17 of the National Laboratories. It is interesting to note that almost 75 percent of the research performed at the laboratories involves some form of collaboration and that this

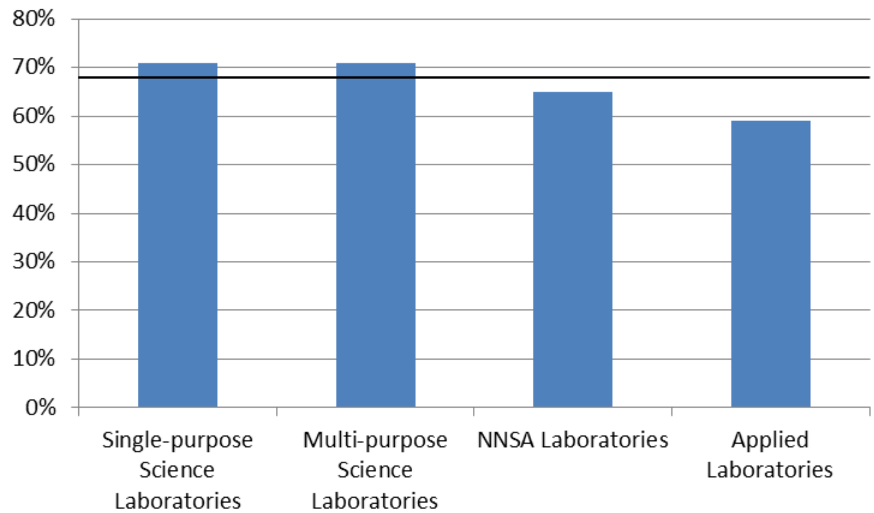
[255] An "affiliation" is defined to mean another DOE laboratory, an academic institution, an industry laboratory or any other research organization that is collaborating with a given DOE laboratory.

number has stayed relatively constant over the last decade. The graph also shows that collaborations with the academic community dominate. In fact, over the last decade 68 percent of the laboratories' collaborators have involved academia. There is some variation in the level this collaboration that is mainly related to the type of research being done at a given laboratory. For example, at the SC laboratories, 71 percent of the collaborations involved academia, whereas for applied laboratories (Idaho, NETL, NREL and Savanah River) this number was closer to 59 percent. Because of the nature of their work, one might expect that the three NNSA laboratories would collaborate less with academia than other laboratories in the system. Interestingly, the data does not bear this out. In fact, over the last decade the percentage of collaborations involving academia for the weapons laboratories is very close to the average for the entire laboratory system (Lawrence Livermore: 62 percent, Los Alamos: 67 percent, and Sandia: 61 percent). This is illustrated in Figure 33.



Note: "Other" includes consortia, non-academic research centers, and other government laboratories. "Management" refers to the M&O Contractor

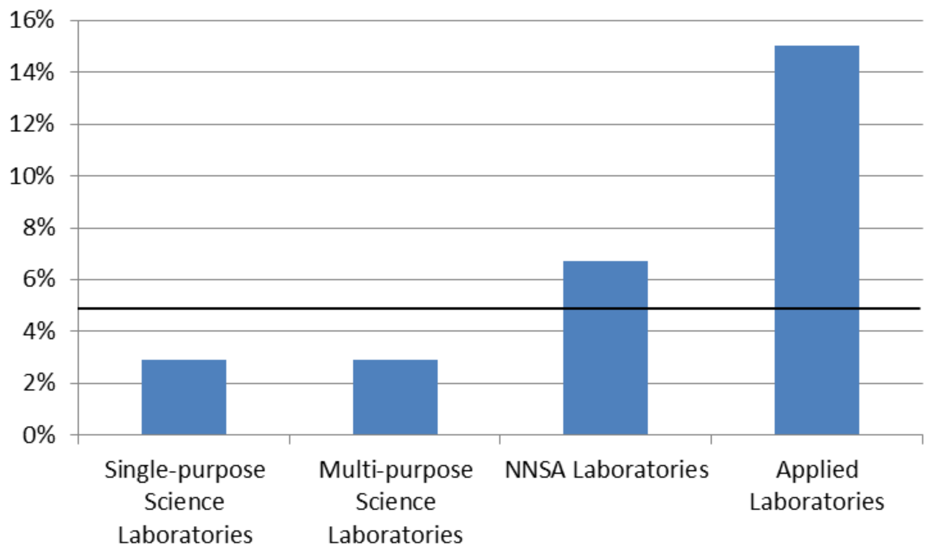
Figure 32. Co-authorship analysis examining the collaborations between the DOE laboratories and other laboratories in the DOE laboratory system, academia, industry and "other" organizations



Note: The horizontal line represents the average for all of the laboratories (68 percent).

Figure 33. Percentage of collaborations involving academia for different segments of the DOE laboratory system

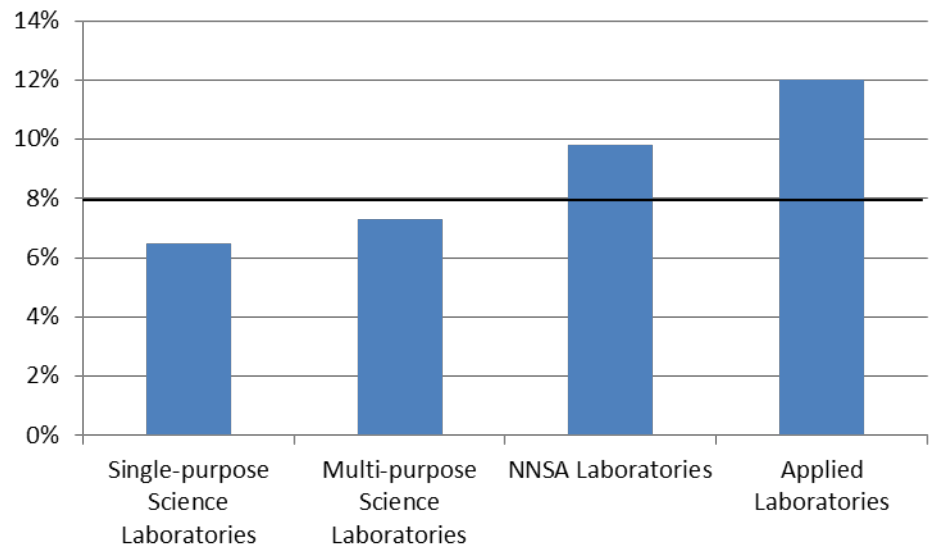
The interaction between the DOE laboratories and industry, as measured by the number of affiliations, is relatively small. Over the last ten years only 4.7 percent of the laboratories' collaborators in the open scientific literature have involved industry. This is perhaps not surprising as scientific publications are generally not the objective of these interactions. There is also considerable variation in the level of collaboration, again related to the type of research being done at a given laboratory. For example, at the science laboratories (both single purpose and multi-program) only 2.9 percent of the laboratories' collaborators were from industry, whereas at the applied laboratories this number was close to 15 percent. It is interesting to note that 6.7 percent of the NNSA laboratories' collaborations involved industry. This number is largely driven by Sandia, where 15 percent of their collaborations involved an industrial partner (Figure 34).



Note: The horizontal line represents the average for all of the laboratories (4.7 percent).

Figure 34. **Percentage of collaborations in published papers in the scientific literature involving industry for different segments of the DOE laboratory system**

The interaction between the laboratories themselves, as measured by the number of affiliations, is also smaller than one might expect. Over the last decade only 7.8 percent of the laboratories' collaborators have involved another DOE laboratory. Here again this may be a result of the fact that metrics related to scientific publications do not catch many of the interactions that occur between the laboratories and so may not be a complete proxy for the laboratory's interactions with each other. For example, such metrics may not capture collaborations such as the support being provided by Lawrence Berkeley, Brookhaven, Jefferson and Fermilab in SLAC's upgrade to the Linac Coherent Light Source (LCLS). They may also not capture collaborative efforts between the laboratories that characterize DOE's emergency response efforts around the globe. There is again wide variability in the level of collaboration related to the type of research being done at a given laboratory. For example, at the science laboratories, only 7.1 percent of the laboratories' collaborators were other DOE laboratories, whereas at the applied laboratories this number was close to 12 percent. 9.8 percent of the NNSA laboratories' collaborations involved another DOE laboratory (Figure 35).



Note: The horizontal line represents the average for all of the laboratories (7.8 percent).

Figure 35. Percentage of collaborations involving other DOE laboratories for different segments of the DOE laboratory system

B. Multi-institution Funding Contracts

In addition to researcher collaborations, DOE has initiated multi-institution partnerships through initiatives such as the Energy Innovation Hubs, Energy Frontier Research Centers (EFRCs), and the Bioenergy Research Centers (BRCs). Each of the four multi-million dollar Energy Innovation Hubs focuses on a particular energy challenge that had been resistant to solution by conventional R&D management. Three of the four are led by a National Laboratory. The EFRCs are multi-investigator, multidisciplinary centers led by universities, National Laboratories, and private research institutions. The 46 EFRCs launched in August of 2009 involve 850 senior investigators; 2,000 students, post-doctoral fellows, and technical staff; 115 institutions; and over 260 scientific advisory board members from 13 countries and over 40 companies. The three BRCs are vertically integrated research institutes, and two of them are led by National Laboratories.

The ultimate goal of these multi-institutional mechanisms is to combine innovation, risk tolerance, and disciplined project management to identify and support a portfolio of projects that are risky and exploratory and focused on delivering innovative products into real applications.[256] SEAB recently completed a review of these constructs and found that each has been successful in encouraging collaboration of the National Laboratories with

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[256] SEAB, *Task Force Report to Support the Evaluation of New Funding Constructs for Energy R&D in the DOE* (Washington, DC: DOE, 2014).

academia (in the case of the EFRCs) and with both academia and industry (in the case of the BRCs and Hubs), but it recommended more disciplined management on the part of DOE.[257] One criticism of the Hubs is that the system results in the proposal "losers" being excluded from the project, when they likely could still make valuable contributions to the endeavor.

C. Findings and Recommendations

Based on its work, the Commission observes the following:

- The DOE laboratories are often portrayed as separate, insular entities that have little or no interaction with the broader S&T community. This portrayal is patently false. The evidence suggests that almost 75 percent of the research performed at these laboratories involves some form of collaboration and that this number has stayed relatively constant over the last decade.
- Collaborations with the academic community dominate the interactions of the National Laboratories with the broader S&T community. Over the last decade 68 percent of the laboratories' collaborators have involved academia.
- Because of the nature of their work, one might expect that the three NNSA laboratories would collaborate less with academia than other laboratories in the system. The data does not bear this out. In fact, over the last decade the percentage of collaborations involving academia for the weapons laboratories is very close to the average for the entire laboratory system.
- New funding approaches for collaborative and multi-institution R&D for the National Laboratories, academia and the private sector appear promising. These include the Energy Frontier Research Centers and the Energy Innovation Hubs.

Based on these observations, the Commission makes the recommendation with respect to the laboratories' support to the broader S&T community:

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.

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[257] *Ibid.*

11. Partnering with Industry and Transitioning Technology

The National Laboratories partner with industry and transition technology through many channels. Table 31 describes various ways laboratories transmit their work to society. Laboratory impacts on the market and society can be captured in part through metrics such as patents, invention disclosures, and cooperative research and development agreements (CRADAs). These measures attest to direct transfers of laboratory knowledge, but laboratories also disperse innovative ideas and technologies through the other mechanisms described. The impacts of some of these mechanisms are harder to quantify in terms of return on investment but they still support the diffusion of important technological concepts. The diversity of mechanisms speaks to the different sorts of collaborations that occur at the National Laboratories.

Table 31. Mechanisms for Technology Transfer

Indirect Pathway Mechanisms	Direct Pathway Mechanisms	Network Pathway Mechanisms
Conference papers	*Invention protection*	Commercialization Assistance Program
Education Partnership Agreements	Invention disclosures	Entrepreneurship-in-residence programs
Field days	Patent applications	Entrepreneurship training
Hiring students	Issued patents	Mentor-protégé program
Publications	*Direct transfer of property*	Personnel Exchange Agreements
Seminars	Material Transfer Agreements	Partnership Intermediary Agreements
Teaching	Patent licenses	Venture capital forums
Workshops	*Collaborative Research Agreements*	
	Cooperative Research and Development Agreements	
	Resource Use Agreements	
	Commercial Test Agreements	
	User Facility Agreements	
	Work for Others	
	Participation in startups by laboratory researchers	

Source: M. E. Hughes, S. V. Howieson, G. Walejko, et al. *Technology Transfer and Commercialization Landscape of the Federal Laboratories*, IDA Paper NS P-4728. (Alexandria, VA: Institute for Defense Analyses, 2011). Adapted from R. Ruegg, "Delivering Public Benefits with Private-Sector Efficiency" in *Advanced Technology Program: Assessing Outcomes*, edited by C.W. Wessner (Washington, DC: National Academies Press, 2000); and Federal Laboratory Consortium (FLC), *The Green Book: Federal Technology Transfer Legislation and Policy* (Washington, DC: FLC, 2009).

Data for FY 1999 to FY 2012 for many of the direct mechanisms can be found in Table 32.

Table 32. DOE Laboratory Technology Transfer Data

FY	Total Active CRADAs	New CRADAs	Invention Disclosures	Patent Applications	Issued Patents	New Invention Licenses
2001	558	204	1527	792	605	226
2002	872	192	1498	711	551	206
2003	661	140	1469	866	627	172
2004	610	157	1617	661	520	168
2005	644	164	1776	812	467	198
2006	631	168	1694	726	438	203
2007	697	182	1575	693	441	164
2008	711	178	1460	904	370	177
2009	744	176	1439	775	520	139
2010	697	176	1616	965	480	166
2011	720	208	1820	868	460	169
2012	742	184	1661	780	483	192

Source: NIST, Federal Laboratory Technology Transfer Fiscal Year 2011: Summary Report to the President and Congress, September 2013; NIST, Federal Technology Transfer Data 1987–2009, October 2011.

A. DOE and Technology Transfer

Since the 1980s, technology transfer has been a formal responsibility of all laboratory scientists and engineers consistent with their mission responsibilities.[258] However, for decades, DOE has endured political pressure oscillating between criticisms for favoring industry too much and condemnation for not doing enough to boost the economy. For a period in the mid-1990s, Congress provided DOE with funds to support researchers in CRADA participation, which led to a rise in the number of CRADAs at the National Laboratories. An article in *The Philadelphia Inquirer* derided the practice as

[258] Federal Technology Transfer Act of 1986 (P.L. 99-502), codified at 15 U.S. Code § 3710(a)(2).

"corporate welfare."[259] The GAO determined that the elimination of this type of CRADA and other funding programs resulted in a 40 percent decrease in the number of DOE CRADAs between 1996 and 2001. According to GAO, many industry partners cancelled CRADAs when they learned that they would have to cover all the research costs.[260]

The pendulum swung the other way when, about a decade ago, Congress directed DOE to increase its focus on technology transfer through the Energy Policy Act of 2005.[261] The act required DOE to establish a technology transfer coordinator, a technology transfer working group and an energy technology commercialization fund to promote energy technologies for commercial purposes. The fund was intended to be an annual set-aside of 0.9 percent from applied research and development funds.[262] Up until now, the Department has met the obligation by counting CRADAs and similar technology transfer agreements.[263]

More recently DOE and its laboratories have been the subject of a number of reports criticizing their lack of engagement with industry to bolster national and regional economic development. *Turning the Page: Reimagining the National Laboratories in the 21st Century Innovation Economy* by a coalition of think tanks argued that in order to turn the laboratories into "21st century engines of innovation," three areas must be reformed: (1) the troubled relationship between DOE and the laboratories, (2) the stove piping of research funding and strategy, and (3) the weak link between laboratories and the market.[264] Brookings Institution's *Going Local: Connecting the National Laboratories to their Regions for Innovation and Growth* criticized DOE and the laboratories for inconsistent economic missions, the difficulty small firms have accessing

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[259] G. Gaul and S. Stranahan, "How Billions in Taxes Failed to Create Jobs" *Philadelphia Inquirer*. June 4, 1995.

[260] GAO, *Technology Transfer: Several Factors Have Led to a Decline in Partnerships at DOE's Laboratories* (Washington, DC: GAO, 2002).

[261] Energy Policy Act of 2005 (P.L. 109-58).

[262] *Ibid*, Sec. 1001(e) Technology Commercialization Fund.—The Secretary shall establish an Energy Technology Commercialization Fund, using 0.9 percent of the amount made available to the Department for applied energy research, development, demonstration, and commercial application for each fiscal year, to be used to provide matching funds with private partners to promote promising energy technologies for commercial purposes.

[263] T. Michael, "The Mysterious Tech Commercialization Fund." *Innovation* 11 (3, 2013).

[264] N. Loris, S. Pool, J. Spencer, M. Stepp, *Turning the Page: Reimagining the National Labs in the 21st Century Innovation Economy* (Washington, DC: The Information Technology and Innovation Foundation, 2013).

the laboratories, the laboratories' lack of regional engagement, and the restrictions caused by DOE's micromanagement.[265]

Not surprisingly given this history, DOE has not taken a consistent department-wide stance on technology transfer and partnering with industry. This has led to differences in emphasis on and mechanisms used for technology transfer at the National Laboratories, which is largely dependent on the laboratory's stewarding office. As the lead laboratory for DOE's EERE, NREL stresses transferring applicable energy technologies more heavily than basic research-focused SC laboratories. Individuals within SC have specifically argued that products of DOE basic research laboratories are too far removed from the market to justify funding their advancement through mechanisms such as technology maturation funds. These laboratories have traditionally relied more heavily on dissemination through publications and conferences, rather than industry partnerships.

The Commission recognizes the importance of a positive culture for engaging in technology transfer and partnering with industry. Researchers will be more likely to participate in these activities if they feel leadership at both the laboratory and DOE is supportive of their efforts. The Commission also recognizes that each laboratory is likely to have its own approach to technology transfer and economic development, reflecting the laboratory's unique mission, culture and geographic setting.

B. Barriers to Industry Partnerships

Multiple barriers to productive laboratory-industry interactions have been identified by the Commission's research, past studies and a 2009 request for information (RFI) issued by DOE to industry.

1. Required Terms

Certain legally required terms, namely indemnification clauses and advanced payment for CRADAs and non-Federal WFO, can be significant challenges, especially for small and medium-sized businesses. These requirements shield the government from risk, but limit potential opportunities for collaboration and inhibit technology transfer. DOE has made strides to reduce the burden of advanced payment by decreasing the requirement from 90 to 60 days of expected cost. In addition, advance payment requirements may be waived for state and local governments that have a constitutional prohibition. Industry has also pointed to royalty-free license to practice (or "government-purpose rights"), rights to compel a license (or "march-in rights"), and the heightened

[265] S. Andes, M. Muro, M. Stepp, *Going Local: Connecting the National Labs to their Regions for Innovation and Growth* (Washington, DC: The Brookings Institution, 2014).

DOE U.S. manufacturing requirements as impediments to industry engagement.[266] There is no option to relax these terms and industry partners must take them or leave them.

2. Negotiation Complexity and Length

There is flexibility for certain terms, such as intellectual property, but any use of non-standard language leads to a lengthier DOE review and approval process. According to one laboratory, any change will add 3 to 4 months to the negotiation time. This may cause some partners to walk away from the deal. Not to say that this is wholly DOE's fault as the delay can be at least equally attributable to industry partner attorneys. In extreme cases, one sentence in a contract can hold up an agreement for more than a year. Some partners complain that non-uniform intellectual property and contractual terms, applications and scheduling processes across the laboratory network makes partnerships cumbersome for institutions and industry that seek expertise from multiple laboratories. Yet, this is likely not an issue for large, sophisticated companies that are accustomed to negotiating different contracts with different partners as a matter of routine.

3. Too Early Stage

Finally, many technologies under development at DOE laboratories are at too early a stage to ignite industry interests. There is often gap between where the laboratories stop working on a technology and where industry is willing to pick it up, but no funding is provided to work in that gap. Absent technology maturation funds or private sector funding, these technologies stagnate in the development pipeline and never reach the market. This technological "valley of death" is widely recognized, and many past efforts have sought to tackle the issue. Even if all other administrative and legal barriers are addressed, technology maturation remains a time- and resource-intensive process that requires dedicated investment to succeed. When Foundation Capital reviewed IP at Oak Ridge as part of an Entrepreneur in Residence (EIR) program, they found that while the laboratory had strong IP in specialized technologies, most of it was too far from commercialization to serve as the foundation of a new start-up.[267]

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[266] 15 U.S.C. §3710a(c)(4)(B) requires a preference U.S. manufacturing for any intellectual property stemming from a CRADA, but DOE has specific guidance that makes this requirement more stringent than other agencies.

[267] One of the filters for review was the technology must be fit for private funding within 12 months of the EIR program start. M. Bauer, "Foundation Capital EiR1 at ORNL," Presentation to Commission, May 22, 2015. http://energy.gov/sites/prod/files/2015/06/f22/Bay%20Area%20Industrial%20Partners_Michael%20Bauer.pdf.

In addition to the above barriers, the Commission was presented with a number of other issues. Many reported that working with laboratories was expensive, citing high laboratory overhead rates as the greatest barrier to partnership. Also the timescale for doing experiments at DOE laboratories often does not match industry requirements.

For their part, laboratories argued that technology transfer is to some degree an “unfunded mandate” with unrealistic expectations: laboratories are obliged to produce positive benefits to society, but without dedicated funding from DOE to support technology transition and industry partnerships. Others felt the main barrier was identifying prospective partners and recognizing what really has commercial potential.

C. Innovative Practices

Partnerships between laboratories and industry benefit the Nation by transitioning laboratory technologies to broad applications. To facilitate these partnerships, DOE and laboratories have developed innovative tools and mechanisms to make the laboratories more accessible.

1. Centers and Institutions

At some laboratories, centers and institutions support technology transition and industry partnerships explicitly. For example, at Fermilab, the Illinois Accelerator Research Center interfaces with industry and seeks possible commercial applications for accelerator technologies. Similarly, Lawrence Livermore and Sandia have jointly established the Livermore Valley Open Campus initiative. Launched in 2010, the campus supports industrial collaboration research and development in unclassified areas, allowing Livermore and Sandia researchers to apply their non-weapons skills and work more easily with industry. LVOC is a campus-like environment with collaborative space, providing ready access for all partners, including foreign nationals. In 2011, Livermore also opened its High Performance Computing Innovation Center, which will facilitate cross cutting partnerships and academic alliances in computing and manufacturing through co-location of facilities and people.[268] The Critical Materials Institute at Ames enables researchers to engage industry and determine which materials actually have commercial potential. The Combustion Research Facility at Sandia was born out of gasoline crises of the 1970s and has had several high profile success stories including

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[268] Richard A. Rankin, “LLNL Technology Transfer,” presentation to Commission to Review the Effectiveness of the National Energy Laboratories (May 2015). Available at http://energy.gov/sites/prod/files/2015/06/f22/Technology%20Transfer%20Coordinators_Richard%20Rankin.pdf.

Cummins' first computationally designed diesel engine. This engine can now be found in over 200,000 Dodge Ram Heavy Duty Pickup Trucks.[269]

2. External Outreach

Laboratories have recognized the importance of engaging external advisors to assist in identifying and transitioning promising technology. Lawrence Berkeley is in the process of creating and consulting an industry advisory group.[270] Lawrence Livermore utilizes what they call an expanded entrepreneur network, which involves an industrial advisory board, entrepreneurs-in-readiness, and developing a deep bench of industry experts.[271] The NREL Venture Capital Advisory Board meets quarterly and provides advice to the technology transfer office and reviews the laboratory's technology maturation fund proposals.

3. Maturation Funding

DOE and the laboratories have also attempted to overcome the barrier that their technologies are too early stage through technology maturation funds. There have been technology maturation fund programs over the past 20 years at both the laboratory and headquarter level. Among them are the DOE Office of Science Laboratory Technology Research Program (1992–2004) and the more recent EERE Technology Commercialization Fund (2007–2008). Both centralized programs have since been discontinued, but laboratories continue to invest in their own technology maturation programs using funds gathered from royalties, DOE funding, and state government support. These include Argonne's technology maturation program and Pacific Northwest's Technology Maturation Program. One of Pacific Northwest's most visible transitions of technology is the millimeter-wave body scanner that is widely used by the Transportation Safety Administration at airports throughout the U.S. Technology maturation funds from Battelle were used to optimize the algorithms required to address privacy concerns, thus facilitating a license to fully deploy and commercialize the

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[269] Bob Hwang, "Combustion Research Facility – Industry Interactions and Impact", presentation to Commission to Review the Effectiveness of the National Energy Laboratories (May 2015). Available at http://energy.gov/sites/prod/files/2015/06/f22/Technology%20Transfer%20Coordinators_Bob%20Hwang.pdf.

[270] Elsie Quaite-Randall, "Technology Transfer at Berkeley Lab," presentation to Commission to Review the Effectiveness of the National Energy Laboratories (May 2015). Available at http://energy.gov/sites/prod/files/2015/06/f22/Technology%20Transfer%20Coordinators_Elsie%20Quaite-Randall.pdf.

[271] Rankin, "LLNL Technology Transfer."

technology. Dedicated funding to laboratories for technology maturation is not uniformly supported by offices within DOE.[272]

4. Legal Mechanisms

Legal hurdles can often discourage collaborations with industry, leading some laboratories to explore new creative legal mechanisms to increase partnerships. For example, Lawrence Berkeley has created CalCharge, a modified “umbrella” CRADA that allows companies to join in as little as 6 weeks and is especially favorable to small businesses that may not have the capital to invest fully in a traditional CRADA. Sixty small California companies are currently involved in CalCharge, and SLAC has also adopted the CalCharge model. Los Alamos’ preferred mode of operation is to use umbrella CRADAs.

In 2011, DOE also began a 3-year pilot program for its Agreements for Commercializing Technology, as a simpler and more nimble alternative to the more contractually complicated CRADAs and WFO.[273] Eight laboratories initially opted to participate in the pilot and the program has been extended. As of May 2014, 4 of the 8 laboratories had a total of 73 ACTs with a total value of over $60 million.[274] One limitation of ACT is that no Federal funding may be used to pay for the laboratory’s services. This includes Small Business Innovation Research (SBIR) or Small Business Technology Transfer (STTR) grants, and there is concern that this may limit the effectiveness of the mechanism itself. DOE should consider lifting the prohibition on using Federal funding for an ACT project to increase the pool of eligible business partners for the laboratories.[275]

Recently DOE established the Fast Track CRADA Program. The Fast Track CRADA Program streamlines the execution of CRADAs by forgoing individual agency approval for each agreement so long as the agency has approved an annual strategic plan.[276] However, Fast Track CRADAs can only contain “standard, pre-approved terms

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272 S. Howieson, E. Sedenberg, B. Sergi, and S. Shipp. *Department of Energy Technology Maturation Programs*. IDA Paper P-5013 (Alexandria, VA: Institute for Defense Analyses, 2013).

273 S. Howieson, B. Sergi, and S. Shipp, *Department of Energy Agreements for Commercializing Technology*.

274 DOE IG, *Audit Report: The Department of Energy's Implementation of the Pilot Program for Agreements for Commercializing Technology*, OAS-M-15-04, (Washington, DC: DOE, June 2015).

275 S. Howieson, B. Sergi, and S. Shipp, *Department of Energy Agreements for Commercializing Technology*.

276 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

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 WFOs that deviate from standard terms and conditions. DOE published several options for particular articles found in CRADAs, such as Personal Property and Product Liability.[277] It would be helpful if DOE could delineate the range of acceptable terms and conditions for all articles in CRADAs and WFO agreements to decrease negotiation and review time.

5. Lowering Barriers for Small Business

Laboratories and DOE have also taken some steps to lower the costs of partnerships and facilitate access to laboratories' facilities. America's Next Top Energy Innovator Program works to lower costs of an option agreement for up to three patents and deferring patent costs for startup companies.[278] The five laboratories with Nanoscale Science Research Centers have established a single entry point, simplifying the process and avoiding duplicative applications. DOE also launched the $20M Small Business Vouchers Pilot in 2015. Five laboratories—Oak Ridge, NREL, Berkeley, Sandia, and Pacific Northwest—were selected as the leads for the pilot, which will provide vouchers to more than 100 small businesses so they can access laboratory expertise and tools.[279]

6. Facilitating Researcher Engagement

Recognizing that people are key to the actual transfer of technology, laboratories have made strides to facilitate researcher engagement. Multiple laboratories—including Oak Ridge, Princeton Plasma, Sandia, and Thomas Jefferson—have attempted to encourage their researchers to engage in entrepreneurial activities through entrepreneurial leave programs. For example, Sandia has established the Entrepreneurial Separation to Transfer Technology program. The program allows employees to leave to start a company and guarantees reinstatement if the researcher returns within two years. Researchers can request an extension for a third year. Between 1994 and 2008, nearly 140 Sandia employees participated. Entrepreneurial Separation to Transfer Technology

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in an agency-approved joint work statement (JWS), or if permitted by the agency, in an agency-approved annual strategic plan (ASP).

[277] DOE, *DOE Order 483.1A, Alternate Clauses, Additional Articles and General Guidance*, (Washington, DC: DOE, November 2013).

[278] K. Edmonds, "America's Next Top Innovator: Lab Tech for Startups," *DOE*, last modified March 27, 2013, http://energy.gov/articles/americas-next-top-innovator-lab-tech-startups.

[279] D. Danielson. "New National Labs Pilot Opens Doors to Small Businesses," *Breaking Energy*. July 9, 2015.

program alumni have started 44 and expanded 46 companies.[280] Thomas Jefferson researchers used its Entrepreneurial Leave Program to found BNNT, LLC (Boron Nitride Nanotubes), which began construction on a factory May 1, 2013 in Newport News, VA.

Other strategies include establishing a commercialization manager for each directorate (Pacific Northwest) and providing entrepreneurial training (Lawrence Livermore). In 2014 DOE launched Lab-Corps to better train and empower national laboratory researchers to successfully transition their discoveries into high-impact, real world technologies in the private sector.[281]

D. State/University Partnerships for Economic Development

The Commission would like to highlight (once again) the value of DOE laboratories establishing partnerships with states and universities. In addition to the benefits already mentioned, these relationships can greatly facilitate technology transition and laboratories' ability to contribute to economic regional development.

DOE laboratories with university managers have the option to use the university technology transfer office for many of their patenting and licensing needs. This allows the laboratory to tap into university expertise and free up scarce laboratory technology transition resources and staff. At Princeton Plasma, for example, all invention disclosures are screened and administered through the university office. University partners may also assist in securing partnerships by minimizing the negative impact of required terms. Ames' relationship with Iowa State University helps the laboratory obtain outside partners for its Materials Preparation Center. Under DOE rules, the laboratory must collect a cash advance for any materials ordered. Iowa State University extends Ames a $200,000 line of credit to cover any partners that are unwilling or unable to submit advanced payment. Ames also works closely with the university research foundation on patents, plans, and licensing.

In addition, laboratories have partnered with states and universities to create centers of economic activity. Battelle and DOE have partnered with the Port of Benton, Washington State University—Tri-Cities and a private developer to create the TriCities Research District. The designated area of the District includes Pacific Northwest and Washington State University—Tri-Cities campuses, and a 90,000 square foot high technology business incubator. The District is designed to connect "private sector

[280] Sandia National Laboratories. "Sandia Entrepreneurial Program Is Back." November 24, 2008, https://share.sandia.gov/news/resources/releases/2008/entrepreneur.html.

[281] DOE. "Energy Department Announces New Lab Program to Accelerate Commercialization of Clean Energy Technologies," October 29, 2014, http://energy.gov/articles/energy-department-announces-new-lab-program-accelerate-commercialization-clean-energy.

companies, entrepreneurs and investors to a highly educated workforce of engineers and scientists to further develop, innovate and commercialize new products,"[282] and promises to greatly enhance the laboratory's access to the external world.

E. Findings and Recommendations

The Commission has found the following with respect to technology transition and partnering with industry:

- Technology transition and partnering with industry is an important part of the mission of the National Laboratories. 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. This is at least partially due to oscillating political pressure that swings from criticisms for favoring industry too much and condemnation for not doing enough to boost the economy.
- The barriers to partnership seem to be significant for many entities, particularly small businesses. These include the early stage of development of available technology the financial cost of collaboration with the National Laboratories, including the advance funding requirement, the complexity of many required contract terms, the length of negotiation and approval times, and the inability or difficulty of National Laboratory researchers to consult.
- 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 physical institutions, such as the Illinois Accelerator Research Center at Fermilab 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.
- Relationships with states and universities can greatly facilitate technology transition and laboratories' ability to contribute to economic regional development.

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[282] Tri-Cities Research District. "What We Are and What We Provide," last modified 2015..

Based on these findings, the Commission makes the following recommendations with respect to technology transition and industry partnerships:

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 should encourage the laboratories to adopt the innovative mechanisms their fellow laboratories have piloted. Specific recommendations include:

- DOE and the laboratories should utilize industry advisory groups for research planning and quality reviews just as they use academic peer groups.
- DOE should facilitate technology maturation through the creation of a centrally funded technology maturation fund.
- Congress should permit Federal funding to be used for ACT agreements
- Laboratories should review and improve their policies related to consulting and entrepreneurial leave.
- DOE should conduct evaluations to more accurately capture the return on investment of the laboratory network's contributions.

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.

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

12. Operating User Facilities

DOE user facilities are federally sponsored research facilities available for external use to advance scientific or technical knowledge (See Appendix J for a complete list of user facilities). The facilities operate under the following conditions:

- "The facility is open to all interested potential users without regard to nationality or institutional affiliation."
- Allocation of facility resources is determined by merit review of the proposed work.
- User fees are not charged for non-proprietary work if the user intends to publish the research results in the open literature. Full cost recovery is required for proprietary work.
- The facility provides resources sufficient for users to conduct work safely and efficiently.
- The facilities support a formal user organization to represent the users and facilitate sharing of information, forming collaborations, and organizing research efforts among users.
- The facility capability does not compete with those from an available private sector entity."[283]

A. Value to the S&T Community and the National Economy

The Commission considers DOE user facilities to be an indispensable resource to DOE, the broader S&T community, and the Nation as a whole. The user facilities benefit the broader S&T community and the Nation through user communities whose research is often funded through other sources, such as NSF, NIH, NASA, DOD, and private industry.[284] The SC light sources alone are utilized by over 30 Fortune 500 companies and hundreds of universities.[285]

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[283] DOE Office of Science. "User Facilities," last modified November 24, 2014.

[284] In a hearing to the House Subcommittee on Energy and the Environment, Dr. Antonio Lanzirotti, the chair of the National User Facility Organization, described the collective user community at the time to include 45 Fortune 500 companies, over 600 universities, and 45,000 scientists. 7,000 of these users were estimated to be students and postdoctoral researchers. The list of these companies and

In addition to the service provided to the entire S&T community, the laboratories use and operate these facilities to conduct research to support the missions of DOE and other Federal agencies and to attract and to retain top talent.[286] The types of user facilities include X-ray synchrotrons, nanotechnology centers, computing facilities, and fusion reactors. Access to user facilities allows a large number of outside researchers, tens of thousands each year, to perform R&D that often could not be done otherwise. In addition to the capabilities of the machines and facilities themselves, the technical expertise of the laboratory scientists and engineers who use and operate the user facilities are at the foundation of the value added to the government, university, and industry scientists who use these assets in their research. During testimony to the Commission, industry representatives attested to the value of the user facilities and the technical expertise that comes along with them.[287]

In the charter for a House subcommittee hearing on user facilities, the light sources were specifically mentioned as having made "numerous breakthroughs and innovations ultimately applied to advances in industrial sectors such as aerospace, medicine, semiconductors, chemicals, and energy."[288] The far-reaching breakthroughs and innovations due to use of the light sources, just one type of user facility, and further testimony in that subcommittee hearing indicate that single examples of research conducted at these user facilities are not sufficient to explore the full impact of the user communities.[289] However, almost all parties at that hearing (representatives from Congress and from user facilities) specifically mentioned that the collection of user

universities can be found in the hearing proceedings. 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).

[285] From SC Deputy Director Patricia Dehmer's testimony to the Commission on September 15, 2014. The SC light sources are the Advanced Light Source at Lawrence Berkeley, the Advanced Photon Source at Argonne, the Linac Coherent Light Source at SLAC, the National Synchrotron Light Source II at Brookhaven, and the Stanford Synchrotron Radiation Lightsource at SLAC.

[286] During site visits, many early career scientists and engineers mentioned that large user facilities were a key factor in applying for and eventually accepting positions at the DOE laboratories.

[287] From testimony to the Commission on November 4, 2014.

[288] *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).

[289] At its November 2014 meeting at Argonne, the Commission heard from industry representatives whose companies are involved with the user facilities. On the whole, these industry representatives are satisfied with the value they receive from the laboratories and the user facilities. Any issues dealt with operational and efficiency concerns.

facilities housed by the DOE and its laboratories could not be supported by the resources of any other institution or company.

The number of user facilities across the DOE laboratory system is between 30 and 80 user facilities. The variability in this value is based on the differing designations for a "user facility."[290,291,292,293] SC, DOE, the National User Facility Organization (NUFO), and the laboratories each have slightly different criteria to qualify facilities as "user". Although some commonality exists, the lists are not entirely the same. As described by SC, user facilities generally provide technical expertise, foster user communities for collaboration and information dissemination, and choose users through "merit review of proposed work."[294] These facilities are in high demand, and the Commission was repeatedly told that some user facilities are up to 300 percent oversubscribed.[295] The primary complaint from current and potential users regarding the user facilities involves the difficulty in securing access due to the overwhelming demand.

B. Operation of User Facilities

User facility planning and operating budgets are determined by the laboratory's stewarding office. SC determines the future of its user facilities with the user communities and the laboratories collaboratively through its strategic review process (described in Chapter 7), and this review process has the capacity to create new and to terminate older user facilities.[296] SC also allocates about 40 percent of its funding to the operation of scientific user facilities.[297]

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[290] The majority of the laboratory complex's user facilities are located at SC laboratories, and work proposals are selected through a merit review process to allocate facility resources. A list of the user facilities designated "user" by each laboratory is provided in Appendix J.

[291] DOE Office of Science. "U.S. Department of Energy Office of Science User Facilities, FY 2015," last modified October 1, 2014.

[292] Note that on September 30, 2014, the Electron Beam Microcharacterization Centers at Ames, Lawrence Berkeley, and Oak Ridge were merged with their co-located Nanoscale Science Research Centers. Note also that the National Synchrotron Light Source NSLS has ceased operations for the new facility, NSLS-II. DOE, "DOE Designated User Facilities," last modified October 21, 2013.

[293] National User Facility Organization. "Facilities," accessed January 15, 2015.

[294] DOE Office of Science. "User Facilities," last modified November 24, 2014.

[295] Oversubscription of user facilities is also discussed in *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) (statement of Dr. Persis Drell).

[296] Most recently, the Tevatron Collider at Fermilab and the Holifield Radioactive Ion Beam Factory at Oak Ridge were discontinued, and the upgrade of NSLS (NSLS-II) at Brookhaven was confirmed. SC also funds user facilities that are not located within the DOE Laboratory complex including the

Laboratories have found that DOE offices have a variety of policies and practices for covering operating costs of facilities, but this is likely by design. DOE funds user facilities differently depending on the development level of the research being performed there. If the research is very early stage, DOE expects to support all the baseload costs and research costs. At the other end of the spectrum, for late stage research, DOE expects full cost recovery from industry users. For user facilities supporting research that falls somewhere in between, DOE supports a portion of the operating costs but not all.

Based on this model, it is understandable that Office of Science includes operating costs in the laboratory budget when it builds a new facility because of the early stage of its research areas. Of course, if industry uses SC facilities for proprietary research, they may do so by providing full cost recovery. However, other offices, such as EERE, have built facilities at laboratories without committing any money to operation because they are relying on industry contributions. Laboratories complain that this leads to a requirement for higher cost recovery, which severely limits their ability to attract users, especially from smaller companies. In these situations, there appears to be a difference in opinion between DOE and laboratories of the agreed upon funding model for particular user facilities.

At Savannah River, operating costs are part of a site-wide prioritization for facilities revitalization, meaning the laboratory competes with other cleanup facilities activities and funding for maintenance is decided by the NNSA field office and the EM site office. This dynamic presents additional barriers in optimizing the laboratory's operations unique to Savannah River.

Although most DOE user facilities are located at SC laboratories, the applied energy and NNSA laboratories also operate user facilities. At NREL, EERE funded the building and operation of the Energy Systems Integration Facility (ESIF). ESIF, like SC user facilities, provides the expertise of experienced scientists and engineers as part of the facility, and in its first year, confirmed 40 partnerships with industry and academia. To ensure success, EERE provides ESIF's operating costs, which the Commission commends. In contrast, the FLEXLAB at Lawrence Berkeley has not been afforded this flexibility, which has resulted in increased dependence on external partnerships to run the facility.

The NNSA laboratories also have SC-like user facilities, including the National Ignition Facility (NIF) at Lawrence Livermore. These facilities support the laboratories'

General Atomics DIII-D Tokamak and the Michigan State University construction and operation of the Facility for Rare Isotope Beams (FRIB).

[297] From testimony to Commission, from interviews, and in House user facility hearing proceedings (112th Cong. 21-61 (2012)).

programmatic success and allow external researchers to access the facility. The laboratories also have facilities that benefit other Federal agencies, and although this type of facility is not open to the entire scientific community, the laboratories argue that the value to the users is similar to the SC user facilities.

C. Findings and Recommendations

The Commission has found the following with respect to 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. For example, researchers funded by NSF and NIH account for as many as half of the users at some key DOE user facilities. Many of the scientific user facilities run competitive, peer-reviewed processes to allocate time among potential researchers, and all of the Office of Science 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 regarding user facilities is very strong. The best-run processes, such as those of SC, involve extensive work by peer review panels that utilize 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. This strong strategic planning extends to go/no-go decisions concerning user facilities and heavily relies on the expertise of peer review panels.

The Commission has the following recommendations with respect to user facilities:

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.

13. Overhead

Without exception, the Commission found all of the National Laboratories to be concerned and proactive about assessing overhead cost, all the more so in times of constrained budgets. As one laboratory director aptly put it, every dollar spent towards overhead is one less dollar to the experiment, the research outcome, the scientific result. Laboratories are often criticized for being too expensive, and specifically for having excessive overhead or indirect costs. These costs are a normal part of doing business, however, and institutional functions such as accounting, payroll, information technology, and maintenance are essential if the laboratories are to fulfill their missions.

At the same time, while overhead is unavoidable, it is controllable. Pursuing opportunities to reduce overhead without reducing work quality is an important responsibility for both DOE and laboratory contractors. With these considerations in mind, the Commission addresses the following question: are overhead costs at the National Laboratories too high?

A. Background

Overhead or indirect costs are those expenses not directly attributable to specific projects. These include major equipment purchases used by multiple researchers, facilities-related expenses such as utilities, maintenance, and security, as well as administrative costs such as legal and financial services, executive management, payroll, and human resources. In contrast, direct costs are those associated with a single project. These include labor, project-related travel, and raw material costs.

Different institutions sometimes pool, allocate, and define direct and indirect costs differently. For example, a university might distribute the costs of its electricity across all of its functions, whereas a laboratory with energy-intensive user facilities could choose to charge a portion of utility costs directly to individual researchers based on hours of facility use. Neither method of allocation is wrong. Rather, institutions develop accounting systems that best match their specific situation.

1. Overhead Rates Are a Representation of Institutional Efficiency

Overhead rates approximate an organization’s efficiency and cost of doing business by comparing indirect and direct costs. Rates can be calculated and conceptualized in different ways, however, and these differences must be reconciled to ensure that rates from two different institutions—two laboratories, or a laboratory and a university—capture truly comparable qualities.

The term “overhead rate” is used to describe two related but fundamentally different ideas. First, overhead rates can describe a material reality in the form of a ratio comparing direct costs and indirect costs incurred. This rate accounts for all the costs an institution incurs and is meant to be primarily descriptive. The other use of the term refers to a multiplier applied to direct expenses as a means of determining price. For instance, if a nonprofit law firm has a 40 percent overhead rate, then if an hour of a lawyer’s time costs $100, the *price* to purchase that time would in fact be $140, where the 40 percent is applied on the $100 base to cover costs such as office supplies, building rent, and secretarial salaries. While this price-determining multiplier may be based on the material reality, it is not synonymous with the ratio of indirect and direct costs. Certain costs may be excluded from pricing calculations, or additional margin added for profit. This study uses overhead rates to describe the first definition in an attempt to capture more closely the material reality of laboratory costs, rather than pricing.

As a baseline, overhead rate can be calculated using the following formula:

$$Overhead\ rate = \frac{Total\ indirect\ costs}{Total\ direct\ costs}\ \% \qquad (1)$$

This formula makes clear how sensitive overhead rates can be to the assignment of costs to direct or indirect pools. If, for instance, facility costs are not included in the indirect cost pool, the overhead rate would be correspondingly lower. Furthermore, if a cost is treated as direct by one institution and indirect by another, the resulting rates will be less accurate as a representation of relative institutional efficiency.

Like laboratories, universities are R&D institutions that play an important role in the Nation’s scientific enterprise. For research funded by Federal agencies, universities negotiate the appropriate overhead rate to cover the indirect costs of Federally-funded research with the DOD Office of Naval Research or the Department of Health and Human Services. This facilities and administrative (F&A) rate is calculated using the following formula:

$$Overhead\ rate\ (universities) = \frac{Total\ indirect\ costs}{Modified\ total\ direct\ costs\ (MTDC)}\ \% \qquad (2)$$

Modified total direct costs (MTDC) exclude subcontracts and large capital purchases from direct costs, the argument being that subcontracted work and capital purchases do not incur indirect costs in the same way or at the same rate as on-site work does. Note, however, that depreciation of capital purchases in proportion to their support of research will be in the indirect costs (numerator). In addition, universities also have different negotiated F&A rates for on-site and off-site work. Comparisons between university and laboratory overhead rates are discussed in greater detail in following sections.

2. Overhead rate as a comparison metric—useful, but not comprehensive

When different institutions provide a similar product, overhead rates can be a useful comparison metric. If a product's material and labor expenses are uniform—the denim in a pair of jeans, for instance—a lower overhead rate more closely reflects a leaner, more efficient organization with lower indirect costs.

Overhead rates alone cannot determine a product's value, however. Indirect costs do not describe fully a product's quality, since expertise of labor, quality of raw materials, and the like are all variations in direct cost. Comparisons are further complicated by the fact that laboratories sometimes treat similar costs differently. NNSA directly funds the portion of their laboratories' safeguards and securities costs which is not Work for Others, whereas other laboratories include those costs in their overhead fee. Similarly, laboratories with major facilities that consume large amounts of electricity may fund those utilities as a direct cost associated with research time, rather than as a general overhead expense. National Laboratories operated by universities also benefit from unique leveraging opportunities, since university M&O contractors can sometimes cover certain costs for its laboratory. Benefits can range, for example, from coverage of snow removal, leases, and subsidized occupational medicine, to joint faculty appointments and technology transfer support from the host institution.

Additionally, less immediately comparable products or business models are difficult to assess through overhead comparisons. While both universities and National Laboratories conduct Federally-sponsored research, these institutions fulfill different major functions. Universities both educate students and conduct research, and not all university funding is Federal. On the other hand, the National Laboratories are government-owned FFRDCs. Their missions include stewarding open user facilities beyond the scale of those offered at most universities and conducting R&D in areas of classified national security-related research.

Even among themselves, laboratories are diverse. Differences in mission scope, nature of facilities, and location can have major impacts on costs and the comparability of laboratory rates. Laboratories that work with special nuclear materials require increased safeguards and security, while those in the Bay Area face a highly competitive labor market for highly-skilled, technical positions. Factors as mundane as the market price for electricity or the need for winter heating can impact laboratories' costs in material ways.

In addition, the Commission had to deal with considerable uncertainty in its analysis. Complete data on what is included in overhead calculations is not publicly available, requiring us to make reasonable assumptions to fill in the gaps. There is likely considerable error in our estimates, as discussed further below.

Despite these complications, overhead rates bear scrutiny, if for no other reason than the belief held by many that rates are too high. Comparisons are made and discussed in the following section, taking into account the factors described above.

B. Overhead rates at laboratories are comparable to the official rates at research universities

In order to address the question of whether the National Laboratories are too expensive, the Commission compared the indirect costs at Laboratories to those at selected major research universities. Universities were chosen for comparison because they also perform a significant amount of research for the Federal government. The Commission also investigated comparisons with five other R&D performing institutions—the Aerospace Corporation, APL, Draper Laboratories, JPL, and Lincoln Laboratories—but was unable to get enough of a sample to support reliable comparisons.

As a preliminary step, we divided 15 of the 17 laboratories into two categories. There are similarities among each category that bear on their overhead costs. Two laboratories—Savannah River and NETL—are excluded from the pool, due to reasons described in the Table note below. Table 33 shows the overhead rates for the two categories of National Laboratory. Overhead rates were calculated by dividing reported total indirect costs by total direct costs.

Table 33. Unadjusted Indirect Costs as a Percentage of Total Direct Costs at National Laboratories

Category	Overhead Rate (Mean)	Standard Deviation
NNSA	79%	8%
Non-NNSA	50%	10%

Notes: Percentages represent the mean overhead rate for each category, calculated by dividing total direct costs by total indirect costs. Laboratory data are derived from the DOE Institutional Cost Report for FY 2014. NNSA laboratories include Los Alamos, Lawrence Livermore, and Sandia. Non-NNSA laboratories include Ames, Argonne, Brookhaven, Fermilab, Lawrence Berkeley, NREL, Oak Ridge, Pacific Northwest, Princeton Plasma, SLAC, and Thomas Jefferson. NETL and Savannah River are excluded from this data since these laboratories do not report into the ICR data base (NETL is a GOGO laboratory and Savannah River data are reported only as aggregated with the Savannah River Site).

NNSA laboratories have higher overhead rates than multi-program and single purpose laboratories due to factors associated with their national security and nuclear missions. These costs include legacy facilities; increased security and safety costs needed for on-site nuclear materials and to securely conduct weapons R&D and operate nuclear facilities; and specialized technical requirements and equipment needed for the national security mission.

To make the numbers in Table 33 comparable with university overhead rates, adjustments were made to address differences in how universities and laboratories define and pool their direct and indirect costs, as described below.

1. Laboratories and universities account for capital expenditures and major facility construction differently

A major difference between university and laboratory rates relates to how facilities and capital construction costs are accounted. Laboratories do not account for depreciation as an indirect cost, meaning that the overhead rates in Table 33 underrepresent actual facilities costs.

Following Federal standards, laboratories report expenditures for major capital construction as direct costs only in the fiscal year that those costs are incurred. Depreciation and debt-related interest on buildings and equipment are not accounted for as a direct or indirect cost. In contrast, when universities construct research buildings or purchase major research equipment, the depreciation costs and annual interest on debt related to the financing of these investments are added to the indirect cost pool and collected over the estimated useful lives. Initial construction costs are also excluded from official F&A pricing rate negotiations. This difference has a large impact on rate calculations, especially at laboratories undergoing large construction projects such as facilities upgrades. When accounting for facilities costs this way, the direct cost base at laboratories increases while the indirect cost base decreases, deflating the overhead rate.

To better compare rates at universities and laboratories, funding of line item construction projects from Office of Science Program Offices and the Science Laboratory Infrastructure (SLI) program were excluded from the direct cost base. Similarly, the portion of NNSA maintenance and repair costs that are directly funded was excluded. A list of these projects and their costs are included in Table 34.

Table 34. Direct Funding to Construction Projects and Maintenance at National Laboratories, FY 2014 ($M)

Laboratory	Project	Sponsor	Total Project Cost (TPC)
SLAC	LCLS-II facility construction	SC-BES	$85.7
Brookhaven	NSLS-II facility construction	SC-BES	$53.7
Thomas Jefferson	CEBAF upgrade	SC-NP	$30.0
Fermilab	Long Baseline Neutrino Facility	SC-HEP	$26.0
Fermilab	Muon to Electron Conversion Experiment	SC-HEP	$35.0
Fermilab	Utilities Upgrade	SC-SLI	$34.9
Thomas	Utility Infrastructure Modernization	SC-SLI	$29.2

Jefferson			
SLAC	Science and User Support Building	SC-SLI	$25.5
Los Alamos	Direct-Funded Maintenance and Repair	NNSA	$66.4
Lawrence Livermore	Direct-Funded Maintenance and Repair	NNSA	$17.4
Sandia	Direct-Funded Maintenance and Repair	NNSA	$4.5

Note: TPC includes Total Estimated Costs (TEC) and—if appropriate—Other Project Costs (OPC). TEC includes design, contingency, and construction phase costs such as construction and equipment management. OPC include conceptual design, R&D, start-up, and contingency funds. OPC for SLI projects are funded through overhead, and are not included in TPC. OPC for non-SLI construction are funded through operational funds. TPC figures are drawn from the FY 2014 enacted costs as reported in the Basic Energy Sciences, High Energy Physics, Nuclear Physics, Science Laboratories Infrastructure, and NNSA FY 2016 Budget Requests to Congress.

Some safeguards and security costs are also funded at the three NNSA laboratories through direct programmatic funding, since these costs are related to the unique nature of work conducted at weapons laboratories. Even though it is reasonable for NNSA to fund these costs directly, they are by nature support functions. Therefore, for the purpose of greater comparability in our analysis, these costs were treated as indirect costs.

The effect of the exclusions in Table 34 is to increase the overhead rates listed in Table 33. This is reflected in the adjusted rates shown in Figure 38 and discussed further below.

Having removed construction costs from the Labs' direct costs, comparability with university rates would be further improved if depreciation and interest expense were added to the Labs' indirect costs. In the absence of data to support such an analysis, we considered this different treatment of facilities costs as a source of error in our comparisons. This is discussed further below along with other sources of error.

2. Overhead rates are comparable after adjustments are made for different accounting practices and business models

Adjusted laboratory rates and university official F&A rates are compared in Figure 38. NNSA laboratories have higher rates than both their non-NNSA and university counterparts. The non-NNSA laboratories' rates are comparable to the universities' rate. The figure shows them to be almost equal, but, as discussed previously and further below, the rates may not in fact be so close due to uncertainties and certain incomparable elements.

Two primary factors influence our comparison between laboratory and university rates. First, and largest, are facilities costs. As noted above, universities include depreciation and interest expenses associated with facilities while the Laboratories do not, although some facilities costs – e.g. operation and maintenance expenses – are treated as indirect costs at both types of institution. Based on public information available at six major research universities we estimated that the depreciation and interest expenses represent 14.5 points (or 25.4 percent of the mean 57 percent university F&A rate).

Offsetting to some extent the error introduced by facility cost is the second primary factor: the cap on university administrative rates. In 1991, OMB imposed a cap of 26 percent on the amount of administrative expenses that universities could charge to federal grants. Actual administrative costs at universities, however, are higher than 26 percent. In 2010, GAO published a report assessing Federal policies for reimbursement of university F&A costs.[298] In their survey of schools receiving more than $10 million in federal grants in FY 2007, schools reported as the uncapped administrative component of F&A rate a mean of 30.9 percent, leading to an undocumented 4.9 point difference.

Combining these two sources of error, the Laboratory rates may be higher in actuality by about 10 points. Nevertheless, we find the Laboratory and university rates to be comparable, especially when one considers that there are many university indirect costs of research which will be lowered by the institution's ability to spread those costs over non-research functions. In contrast, laboratories are required by law to collect full cost recovery for all work, eliminating the possibility of unaccounted expenses. Taking this into account would further reduce the potential error.

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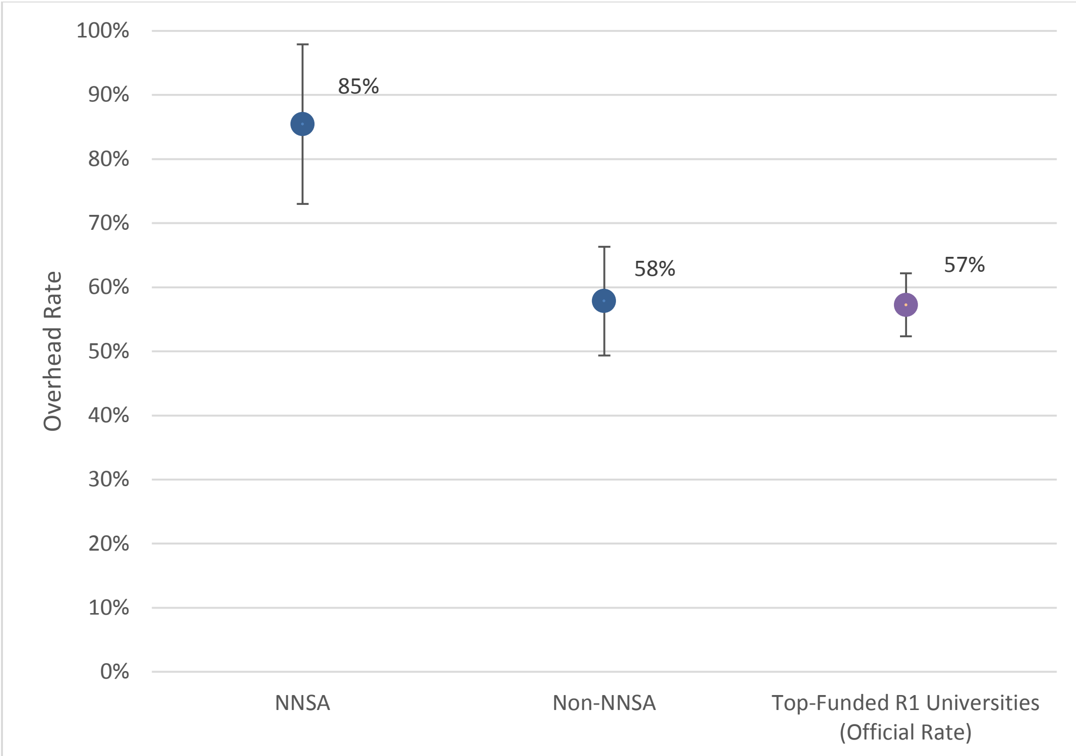
[298] GAO, *University Research – Policies for the Reimbursement of Indirect Costs Need to be Updated.* GAO-10-937. (Washington, DC: GAO, 2010).



Note: Percentages represent the mean overhead rate for each class of laboratory, as calculated by dividing total direct costs by total indirect 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. University data is derived from published F&A rate agreements for FY 2013 at top-funded research universities. Top-funded R1 universities include only "Research I" universities, as designated by the Carnegie Foundation within the NSF Higher Education Research & Development (HERD) 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 as discussed in the text and shown in Table 33.

Figure 36. Adjusted Indirect Costs as a Percentage of Direct Costs at National Laboratories (grouped by class) and Top-Funded R1 Universities, adjusted for direct laboratory construction

Are National Laboratories in fact more expensive than universities? Yes, but probably not significantly. This should be expected as laboratories face some costs that universities don't, such as nuclear safety and security, and universities can spread overhead costs over non-research missions.

C. Laboratory Cost Accounting and DOE Management—balancing flexibility and transparency

As the steward of Federal funds, it is DOE's responsibility to ensure that taxpayer dollars are not being spent wastefully. To fulfill this responsibility, DOE needs to have a robust understanding of laboratory cost accounting.

In the spirit of the government-owned, contractor-operated model of FFRDCs, laboratories are given the flexibility to determine—within the bounds of Federal cost accounting standards (CAS)—how costs are pooled and allocated. This flexibility allows National Laboratories to leverage the strengths of their M&O contractors, and apply accounting practices that match the diverse nature and scope of work across laboratories.

Laboratory accounting practices are federally regulated, and reviewed by different parts of DOE, including the CFO's Office, the IG, and Program Offices. Laboratories outline their cost models and accounting practices in detail to the DOE's CFO office in annual disclosure statements. These statements require approval and are vetted for CAS compliance. Additionally, laboratories report all their costs into STARS, the DOE-wide cost reporting system, on a biweekly basis. Prior review of laboratory financials from 2013 identified some laboratories as at-risk for cost manipulation, which DOE and the laboratories have sought to address.[299] More recent audits have typically not encountered evidence of non-compliance with CAS.[300]

Financial systems used at laboratories are designed primarily for accounting and internal management, however, and not cross-system analyses. Transforming financial data into a form that allows for management decision-making and identification of cost drivers is a resource and time-consuming process. Most recently, DOE has developed, in partnership with the National Laboratories CFO's Working Group, the Institutional Cost Report (ICR) as one way to supply high-level systematic data to the Department and other stakeholders regarding costs at the laboratories. While the system continues to mature, ICR holds promise as one mechanism by which DOE can better understand costs across all of the National Laboratories.

1. The Institutional Cost Report (ICR) provides a mechanism to assess costs, and should continue to be improved

In 2010, DOE initiated the Institutional Cost Report (ICR) as a mechanism to collect high-level cost data from a number of DOE's contractors, including the sixteen FFRDC laboratories. Developed jointly by DOE and the National Laboratories, laboratories report their costs into a set of high-level categories. These total costs are then compared against the internally audited DOE financial system. By collecting data in this form, ICR seeks to present financial data in a format that allows the Department to glean insights and survey

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[299] GAO. *National Nuclear Security Administration – Laboratories' Indirect Cost Management Has Improved, but Additional Opportunities Exist.* GAO-13-534. (Washington, DC: GAO, 2013).

[300] DOE IG, *Allocation of Direct and Indirect Costs – Cost Accounting Standard 418 - at LLNL*. (Washington, DC: DOE, 2013).

costs across the system, as well as provide laboratories the opportunity to benchmark their costs among themselves.

ICR data from FY 2011 to FY 2014 has been collected in two exhibits. The first exhibit breaks down costs by their original category: salaries, benefits, travel, procurement (including breakouts for utilities versus capital expenditures), subcontracts, and so forth. These costs are not broken down into direct versus indirect: wages and salaries of laboratory directors, administrative staff, technicians, and researchers all fall into the salaries category. The second exhibit allocates costs to direct costs and twenty-eight categories of indirect cost.

Laboratories differ in how data are collected for ICR, due to variations in how each laboratory translates information from its own accounting systems into the ICR template. Differences are addressed through ongoing laboratory peer reviews that seek to improve data quality by ensuring that data is collected as consistently as possible. That said, the ICR is not audited, and is designed primarily to provide high-level survey data. ICR data are also limited in their ability to benchmark to outside R&D institutions except at a high level, due to the specificity of categories to laboratory work.

ICR can identify when certain cost types are rising, either as a percent of total laboratory costs or in total dollars. The DOE CFO's Office has used these data in the past to identify and address cost concerns with regard to pensions and travel costs. ICR is also useful for determining when laboratories are outliers with respect to specific types of cost, and can prompt DOE and other auditing bodies to inquire after costs that appear anomalous, overrun, or unreasonable.

The Commission has observed from ICR data that National Laboratories spend a roughly proportional percent of their individual budgets in most of the categories of overhead cost reported in the ICR. For costs where larger ranges are observed (safeguards & security, environmental safety and health, and facilities-related maintenance), greater variance is expected due to factors including the differing nature of work and the condition of aging facilities. Overall, measured against each other through internal benchmarking, laboratory indirect costs appear reasonably consistent.

ICR data will become more useful as consistency of data collection improves with subsequent years. With more fiscal years of data, ICR can be used not only for cross-laboratory comparisons, but for analyzing trends within a single laboratory, where differences in how laboratories translate their own financial systems into the common format of the ICR are less influential.

2. For the purpose of public disclosure and greater accountability, DOE should publish laboratory overhead rates in an annual public report

The National Laboratories were founded in service of the Nation, and, as publicly-funded institutions, they have achieved unprecedented advances for science and America's national security. Key to this success was the innovation of a government-owned, contractor-operated business model, which allowed the Federal government to tap the expertise of the Nation's universities and industrial sector. Under the FFRDC/M&O model, government and contractor strove together as partners in a relationship of clearly understood roles. Government set the "*what*" of strategic direction and provided funding, while contracted university and industry partners enjoyed the flexibility to determine precisely "*how*" to meet the technical and scientific challenges confronting the Nation.

Perhaps the greatest strength of the FFRDC/M&O model was the freedom it granted contractors to innovate and apply their best practices to meet national need. This freedom, however, comes not granted but earned, through proven ability to deliver and time-fostered trust with the Federal government. As the vast majority of the work at the seventeen laboratories is publicly funded, 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. For these reasons, DOE should publish an annual report of the overhead rates at the National Laboratories, and require a consistent method for reporting indirect costs across all laboratories.

D. Summary Remarks

To ask whether overhead costs at the National Laboratories are too high should prompt an immediate follow-up question: How best can overhead costs at laboratories be reduced? During its visits to the laboratories, the Commission learned that the laboratories have taken strides in recent years to reduce indirect costs. One laboratory succeeded in streamlining its business while also initiating a burgeoning LDRD program. By taking care to balance the growth of its LDRD program with savings elsewhere, the laboratory increased its own research output with no increase in costs to the customer. Similar stories were told across the system.

As with all other R&D institutions, the internal pressure at laboratories to keep overhead rates low is significant. While perhaps not quite so competitive as for-profit businesses or research universities, laboratories do compete with one another for research projects and funding, and laboratories with lower overhead rates may have a competitive advantage in making the case that research or major projects should go to them over their competitors. Along with regular financial audits and review of laboratory systems, meaningful positive incentives and well-managed competition can be powerful tools available to DOE for the purpose of reducing laboratory overhead costs.

In this chapter, the Commission used financial data to assess overhead costs at laboratories and universities. Though useful, this approach has difficulty quantifying "stealth overhead," or the losses in productivity that result from staff spending an excessive amount of time on bureaucratic or administrative tasks, rather than mission-related work. Financial data can signal, but not always pinpoint these sorts of costs. The Commission is greatly concerned with the impacts of stealth overhead on the effectiveness and efficiency of the National Laboratories, and addresses these questions in other sections of its report. The Commission expects these types of cost to decline if the Commission's recommendations are implemented, because the amount of resources devoted to transactional oversight will be reduced.

E. Findings and Recommendations

The Commission has formulated the following findings with regard to overhead and cost accounting:

- National Laboratories are diverse institutions with cost drivers that reflect notable differences in mission scope, condition of facilities, location, and other factors. These differences demand that benchmarking efforts take into consideration how contextual differences impact costs.
- NNSA laboratories have higher overhead rates than other National Laboratories and research universities. This difference appears due to the unique facilities and mission of those laboratories.
- Overhead rates at non-NNSA laboratories are also higher but remain comparable to the negotiated rates at research universities once institutional differences are accounted for.
- As government-owned, contractor-operated FFRDCs, the National Laboratories have the flexibility to develop cost accounting systems that best meet the needs of their laboratory while remaining compliant with CAS.
- Laboratory financial systems are vetted for compliance by DOE, and regularly audited by other organizations, including the IG and GAO. Recent audits have not identified non-compliance with CAS; reports from 2013 and earlier, however, have identified some laboratories as at-risk for cost manipulation.
- As a survey instrument, ICR allows DOE to (1) identify trends in cost drivers within one or multiple laboratories and (2) identify outlier laboratories and assess whether costs at a laboratory are reasonable by comparing across the National Laboratories.
    - o Laboratories spend a similar percent of their total operating budgets to most categories of overhead cost reported into ICR. Costs that are not

rationalized by the diverse contexts in which the Laboratories operate are areas ripe for further inquiry.

The Commission has the following recommendations for the Department and laboratories with regard to overhead and cost accounting:

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.

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

14. Facilities and Infrastructure

A. Background

DOE laboratory facilities and infrastructure include research and development (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 telescopes, supercomputers, workstations for beamlines, industrial 3-D printing machines, and detectors, and infrastructure associated with the laboratory, such as utility plants and roadways. User facilities fall within this definition, but were discussed in more detail in Chapter 12.

1. Current State of DOE Laboratory F&I

The laboratory network as a whole consists of 845,380 acres, which house 5190 buildings and trailers. Table 35 provides an overview of the magnitude and condition of facilities and infrastructure at the 17 DOE Laboratories.

Table 35. Overview of DOE Laboratory Facilities and Infrastructure

	Acres	Buildings and Trailers				
National Laboratory	# of Acres	Total by Count	Total by Square Feet (SF)	Total SF Leased	Replacement Plant Value (RPV) ($M)	Deferred Maintenance (DM) ($M)
Ames	8	12	327,664	0	$75,937,104	$1,501,376
Argonne	1,521	105	5,088,372	340,710	$2,177,197,935	$91,505,157
Brookhaven	5,628	344	4,865,753	0	$2,294,501,997	$112,430,818
Fermilab	6,811	424	2,488,064	0	$709,712,766	$5,813,388
Idaho	560,180	508	5,771,058	1,202,678	$3,970,756,549	$137,344,582
Lawrence Berkeley	85	141	2,039,300	362,115	$1,114,486,306	$62,201,268
Lawrence Livermore	7,741	536	6,988,749	24,250	$4,973,884,771	$277,864,318
Los Alamos	25,375	982	8,680,295	485,606	$11,324,151,950	$607,665,259
NETL	243	115	1,195,715	36,759	$444,808,692	$11,367,931
NREL	329	28	999,796	0	$409,350,671	$13,476
Oak Ridge	33,473	409	5,997,966	1,196,812	$2,197,318,883	$133,301,482
Pacific Northwest	751	67	2,205,600	955,420	$687,679,668	$4,103,043
Princeton Plasma	89	32	759,903	0	$271,422,490	$62,326,230
Sandia	193,520	1028	7,619,270	397,876	$4,627,289,482	$477,462,579
Savannah River		184	1,719,956	117,700	$2,339,622,348	$173,029,790
SLAC	452	187	1,646,814	654	$821,239,851	$10,322,107
Thomas Jefferson	174	87	966,166	76,151	$347,103,807	$4,682,867
Total	845,380	5190	59,419,431	5,196,731	$38,786,465,268	$2,172,935,671

Source: Data provided by DOE from the Facilities Information Management System (FIMS) database, FY 2014. Figures do not include “Other Structures and Facilities (OSF)”, which account for non-buildings, such as roads, fencing, storage reservoirs, and stacks (when not a part of a building)

Notes: Replace Plant Value is the cost, in current year dollars, to design and construct a notional facility to replace an existing facility at the same location. Deferred Maintenance is the total cost of all repairs that have been postponed.

2. Impact of F&I on Laboratory

Facilities and infrastructure can have a significant impact on laboratory research and operations in a variety of ways. Laboratory facilities and infrastructure may have inadequate functionality for mission performance. For example, cooling requirements for supercomputers, filtration systems for clean rooms, and ultra-low seismicity for scanning tunneling microscopy/spectroscopy are all critical to enabling successful completion of particular research goals. In FY 2014, three HVAC failures at Lawrence Livermore resulted in program delays in optics, machining and sample inspections.[301] In addition, substandard or outdated facilities and infrastructure can have negative impacts on the environmental, safety and health condition of the laboratory. According to personnel at Oak Ridge, 25 percent of the injuries are due to legacy issues.[302]

Failure to modernize facilities and infrastructure will lead to higher maintenance costs. Since overhead is a primary source of funding for maintenance costs, this situation can lead to an increase in overhead. Higher overhead costs make it more difficult for the laboratory to stay competitive within the DOE system and the broader S&T enterprise, impeding its ability to attract and secure research funding. 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 (discussed further in Excess Facilities section).

Lastly, leadership across DOE and the laboratories has reported that poor infrastructure has led to problems recruiting and retaining high-quality scientists and engineers. Competing for top talent with universities and industry becomes that much more difficult when the condition or functionality of the workspace is deficient. One laboratory found that new to mid-career employees were leaving because of the sorry state of the facilities and infrastructure. On the other hand, NREL reported that new facilities have improved their record of recruiting and retention.

3. Funding Structure

DOE laboratory facilities and infrastructure construction and renovation are primarily funded through centrally-controlled line items or locally-controlled General Plant Projects (GPP) and Institutional General Plant Projects (IGPP). General Plant

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[301] R. Haldeman, “Maintaining the Infrastructure to Support the Nuclear Security Enterprise,” presentation to the Commission to Review the Effectiveness of the National Energy Laboratories. February 24, 2015.

[302] J. Smith, “The Importance of Core Infrastructure.” Presented to the Commission to Review the Effectiveness of the National Energy Laboratories. February 24, 2015.

Projects are funded through research program funding and must be projects necessary to adapt facilities to new or improved research, development, or production techniques; to affect economies of operation; and to reduce or eliminate health, fire, and safety problems. Institutional Plant Projects are funded through overhead because they serve the entire site and cannot be attributed to a single research program. Both General Plant Projects and Institutional General Plant Projects are limited to $10M per project and, as such, generally constitute maintenance or light renovation of existing facilities. Though congressional approval is not required, DOE notifies Congress of any project above $5M as a courtesy. In the FY 2016 budget request, DOE included $107M for General Plant Projects carved out of program budgets.[303]

Line items are approved by Congress and are for projects greater than $10 million. Given the cost, new construction or substantial renovation generally require a line item. The Office of Science runs the Science Laboratories Infrastructure (SLI) Program that amounted to $79 million in the FY 2015 budget request. NNSA line item projects are funded by the Readiness in Technical Base and Facilities (RTBF) Program that was $2.055 billion in the FY 2015 budget request. The RTBF program is split roughly evenly between the three weapons laboratories. Previously NNSA used the Facilities Infrastructure Recapitalization Program (FIRP) to reduce deferred maintenance and the Roof Asset Management Program (RAMP) to rehabilitate or replace roofs, but both have expired.

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. A capital budget distinguishes certain types of investments from other expenditures in the budget. For example, cash spending on capital projects is segregated in a capital budget and depreciation on Federal capital assets is reported in the regular budget. This allows current costs to be allocated to future time periods. The private sector takes advantage of this approach to spread capital costs over the period when benefits are accruing from the investment. Various government bodies have considered the idea of the Federal government moving to a capital budget, but have dismissed it because of the increased complexity, diminished transparency and the increase in sensitivity of the Federal budget to external factors such as depreciation factors.[304]

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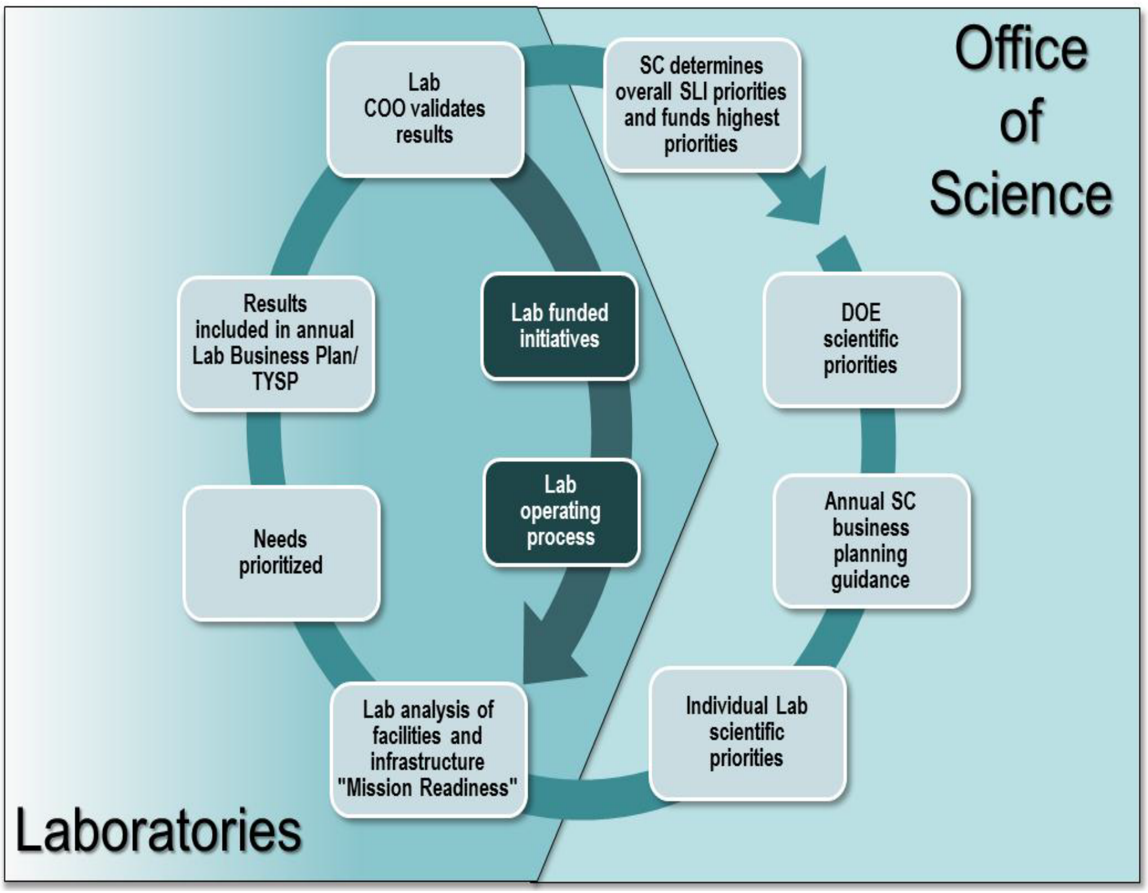
[303] SC - $22.4M, NNSA - $47.8M; EM - $12.5M, NE - $23.2M, and FE - $1.25M.

[304] See, for example, Congressional Budget Office, Capital Budgeting. May 2008, which references past studies that rejected a capital budget for the Federal government, including the 1967 Presidents Commission on Budget Concepts and the 1999 Presidents Commission to Study Capital Budgeting.

4. Planning Processes

Facilities and infrastructure planning occurs at multiple levels—at each individual laboratory, within each stewarding office, and across the Department as a whole.

As required by DOE Order 430.1B, each laboratory must document real property asset site planning and performance in a Ten Year Site Plan that is kept current and covers a 10-year planning horizon.[305] SC laboratories' site plans are now integrated into the Annual Laboratory Review and Plan, which ties mission readiness to laboratory facilities and infrastructure by identifying gaps and plans to fill those gaps. Mission readiness is determined using a framework illustrated by Figure 37.



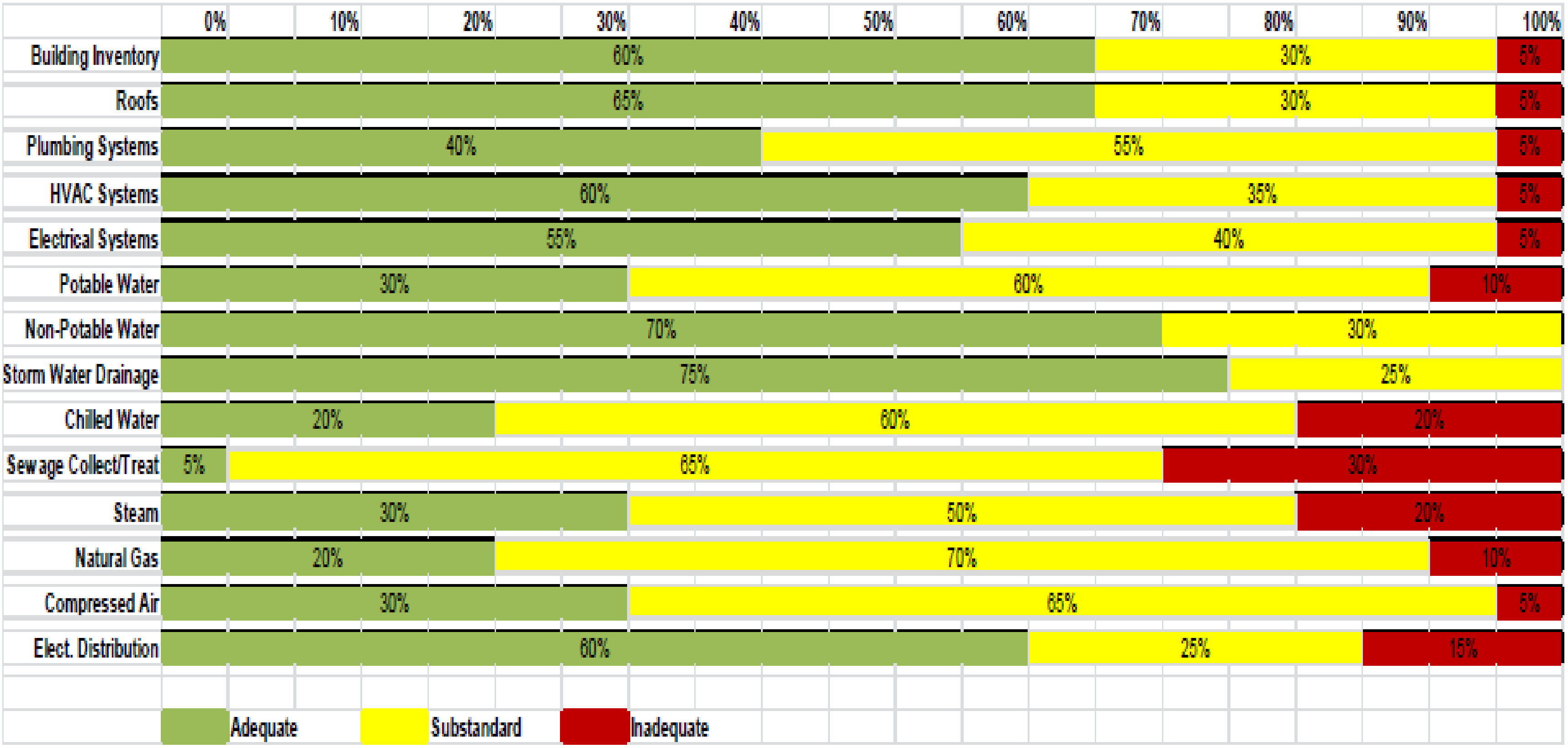
Source: L. Eberhardt. Office of Science National Laboratories Facilities & Infrastructure: Mission Readiness Model. December 9, 2009.

Figure 37. Mission Readiness Assessment Process

305 DOE. *DOE Order 430.1B Change 2, Real Property and Asset Management*. (Washington, DC: DOE, 2003).

Each SC laboratory site plan includes an overview of site facilities and infrastructure, the results of the Laboratory Operations Board (LOB) condition assessments, a campus strategy, gaps and proposed investments. The LOB condition assessments determined the relative percentage of adequate, substandard, and inadequate assets for each category of facilities and infrastructure (see Figure 38 for an example).[306]

[306] LOB is discussed further in Current Efforts section.



Source: Office of Science, The U.S. Department of Energy's Ten-Year-Plans for the Office of Science National Laboratories, FY 2014. August 2014.

Figure 38. Oak Ridge Condition Assessment, FY 2014

SC also organizes a Mission Readiness Peer Review among its laboratories where it sends facilities and infrastructure personnel from SC laboratories to assess the facilities and infrastructure processes of other SC laboratories.[307] The peer review focuses on the overall quality and credibility of facilities and infrastructure plans as an avenue for improving the Mission Readiness assessment process. Laboratories involved in the peer review team are asked to evaluate whether the process is comparable to one that would be produced by their own laboratory. Peer reviews of all the SC laboratories are completed on a three-year cycle.

In FY 2013, NNSA expanded DOE Order 430.1B to a Twenty-Five Year Site Plan for its laboratories to encompass the entire approximate facility life cycle. According to the NNSA, the most important component to the site plan is "how attainment of the [program's] infrastructure goals sustains core capabilities and meets mission commitments."[308] The NNSA laboratory site plans include a site overview and snapshot; changes from the prior year site plan; future vision and core capabilities for the tactical planning horizon (5 year plan of President's Budget plus 5 years) and strategic planning horizon (plus 20 years), and real property asset management—a brief discussion of the site's footprint management and gross square feet reduction, future space plans, facility condition, maintenance, security infrastructure and how are addressing the program goals.

Because the demand for facilities and infrastructure project funding is greater than available resources every year, DOE must develop a prioritized list for the system. For the Science Laboratories Infrastructure Program, SC holds an annual meeting to solicit input from site offices and laboratory Chief Operating Officers on projects identified in each Annual Laboratory Plan and to provide feedback on the projects. NNSA personnel may be invited to presentations for laboratories with extensive NNSA work. During a closed-door Federal session, the Associate Directors for each research program give their input on how the projects will impact their missions. The SC Director then decides which projects will be put forth in the budget request, subject to the Secretary's final approval.

NNSA uses the Construction Working Group to prioritize projects. The voting membership of the Construction Working Group includes members from NNSA headquarters, NNSA laboratories, production plants and the Nevada Test Site. After each laboratory—working with its field office—provides a list of projects with their rationale

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[307] See as an example, Peer Review Report of Jefferson Laboratory's Implementation of the Mission Readiness Process. September 8-10, 2010. https://www.jlab.org/div_dept/dir_off/oa/secure/TJNAF%20Mission%20Readiness%20Peer%20Review%20Final%20Report%20(11-2-10).pdf. Individuals from Ames, Fermilab, Princeton Plasma and Pacific Northwest comprised the peer review team.

[308] NNSA, *Twenty Five Year Site Plan (TYSP) Narrative Guidance*, (Washington, DC: DOE, May 2012).

described in mission gap statements, the Construction Working Group scores all the projects. All members score the operational and business goals criterion; only NNSA headquarter personnel score the mission deliverables criterion; and field office managers score the improvement of safety criterion. The group deliberates and makes final decisions over a two day meeting in Washington, D.C.

B. Issues

The most pressing issues facing DOE laboratory facilities and infrastructure relate to the condition of facilities and infrastructure, planning and construction, and lack of resources.

1. Condition of Facilities and Infrastructure

The condition of laboratory facilities and infrastructure across the network is being hampered by deferred maintenance and excess facilities.

a. Deferred Maintenance

Deferred maintenance refers to facility and infrastructure repairs that were postponed in order to lower costs, meet budget levels, or liberate funding for research. These projects can include roofing repair or replacement, correction of structural defects, or repair or replacement of installed utility and distribution systems.[309] At the DOE laboratories, deferred maintenance is a significant issue, since researchers and program managers typically want to invest their limited dollars in science rather than in items such as roofs. In addition, at certain sites, maintenance can only take place during the summer when temperatures are above freezing. This also coincides with the end of the fiscal year when pots of money are smallest. While a program might set aside maintenance funding at the beginning of the fiscal year, unpredictable incidents will eat into that allocation over the year. But the longer maintenance is deferred, the larger and more expensive the problem becomes. With neglect, minor repair work can evolve into more serious conditions. Failures are increasing in frequency and severity as facilities and infrastructure age and deferred maintenance grows.

[309] According to DOE Order 430.1B, Deferred Maintenance does not include:

- Regularly scheduled janitorial work such as cleaning and preserving facilities and equipment.
- Work performed in relocating or installing partitions, office furniture, and other associated activities.
- Work usually associated with the removal, moving, and placement of equipment.
- Work aimed at expanding the capacity of an asset or otherwise upgrading it to serve needs different from or significantly greater than those originally intended.
- Improvement work performed directly by in-house workers or in support of construction contractors accomplishing an improvement.
- Work performed on special projects not directly in support of maintenance or construction.
- Non-maintenance roads and grounds work, such as grass cutting and street sweeping.

The current estimated cost of clearing the entire deferred maintenance backlog for the laboratory and plant complex is over $5B; the laboratory portion is over $2B. NNSA laboratories and plants account for about $3.5B; NNSA laboratories account for approximately $1.3B. However, it is important to note that not all deferred maintenance is created equal; some is by design, such as from excess facilities that will eventually be demolished. Generally, deferred maintenance costs are consistent with the size of each laboratory across the system.

NNSA attempted to get a handle on their sites' deferred maintenance problem through targeted funding. The Facilities and Infrastructure Recapitalization Program (FIRP) was a decade-long program created to reduce the substantial backlog of facility maintenance, repair and demolition projects across NNSA's eight sites, but it ended in 2013.[310] It averaged $170M a year and was still insufficient to address NNSA's deferred maintenance needs. From 2002 to 2012, deferred maintenance in NNSA went from $2.5 to $3B. FIRP was supposed to be replaced by Capabilities Based Facilities and Infrastructure (CBFI) Program in FY 2013, but in the midst of sequester, CBFI was not funded. In the two years since FIRP ended, deferred maintenance has grown from $3 to $3.5B. NNSA staff stated that while fenced money is essential, FIRP was not as focused on the most critical maintenance needs as it could have been. According to personnel at Sandia, decreases in the RTBF program have also led to an increase in deferred maintenance.

Laboratory staff expressed concern because the costs of maintaining their facilities and infrastructure are greater than the funds provided by the Department. Lawrence Livermore personnel argued that they need ~$50M in equipment investments and ~$50M in facility life extension programs, and they cannot fix infrastructure problems of this magnitude with indirect funds. They believe it requires line item support. Brookhaven already spends 10 percent of its overhead on deferred maintenance ($80–$100 million per year) but 33 percent of its facilities are inadequate or substandard according to the results of the LOB assessment.[311]

b. Excess Facilities

Facilities are deemed "excess" if they have no future mission. The natural conclusion to the facilities life cycle is deactivation and decommissioning (D&D).[312]

[310] NNSA, "NNSA Completes Successful Facilities and Infrastructure Recapitalization Program," last modified February 20, 2013.

[311] Discussed further in Current Efforts section.

[312] "Deactivation is the process of placing a contaminated, excess facility in a stable condition to minimize existing risks to workers, the public and the environment. Decommissioning takes a facility to its ultimate end-state through decontamination and dismantlement." DOE IG. *Audit Report: The*

Excess facilities that have not yet been deactivated and decommissioned must be stabilized and then surveilled and maintained until their D&D. Under the current system, programs are responsible for construction and operation of facilities, but there is no assigned responsibility for D&D. Laboratories have contaminated and non-contaminated excess facilities that they cannot afford to D&D. The rough order of magnitude cost for D&D of excess facilities at SC laboratories is $2B.[313]

The cost of the D&D process is especially significant if facilities are contaminated. DOE established the Office of Environmental Management (EM) in 1989 to oversee cleanup of its weapons research and production legacy. The total cost of cleanup was estimated to be $280 billion in 2013. As of 2015, EM has determined that 234 additional facilities meet its transfer criteria, but it does not have the funding to accept them for remediation.[314] Therefore, the stewarding offices remain responsible for keeping the facilities stable, including the necessary surveillance and maintenance costs.[315] These costs can be significant. Lawrence Livermore, for example, spent $2.5 million on operating and maintenance for the B251 Heavy Element Facility since 2008 and Argonne spent over $19 million on the Alpha Gamma Hot Cell Facility. The stewarding offices have also identified an additional 140 excess contaminated facilities that EM has yet to assess. According to DOE's Inspector General (IG), the transfer of these contaminated facilities may not occur until 2025 or even 2035.[316] In addition to the issue of cost of surveillance and maintenance for the program offices, these contaminated excess facilities continue to pose a risk to mission, workers, the public and the environment. One serious problem with transferring additional excess contaminated facilities to EM is that the program already has insufficient budget to meet its state compliance agreements.[317]

Department of Energy's Management of High-Risk Excess Facilities. (Washington, DC: DOE, January 2015).

313 Smith, "Importance of Core Infrastructure."

314 This figure includes both laboratories and production plants. Ibid; M. T. Janaskie, T. J. Kliczewski, A. P. Szilagyi, C. Urland, M. Gresalfi, and C. Negin. "The Transfer of Excess Facilities, Materials, and Wastes into DOE's Environmental Management (EM) Program: Successes Resulting from EM's Transfer Review Process-11246." WM2011 Conference, February 27-March 3, 2011, Phoenix, AZ.

315 The IG found offices had spent more than $380M on operating and maintenance for the 234 facilities between 2008 and 2015.

316 DOE IG, *Audit Report: The Department of Energy's Management of High-Risk Excess Facilities*.

317 The Comprehensive Environmental Response Compensation and Liability Act and the Resource Conservation and Recovery Act authorize the states to enter into legally enforceable compliance agreements that provide for establishing enforceable schedule milestones that govern the work to be done. In addition to the above type of state compliance agreements, there are agreements with other federal agencies, court-ordered agreements with states, and other agreements, such as orders to enforce state hazardous waste management laws. In total, DOE has approximately 70 compliance agreements in place at 23 waste cleanup sites.

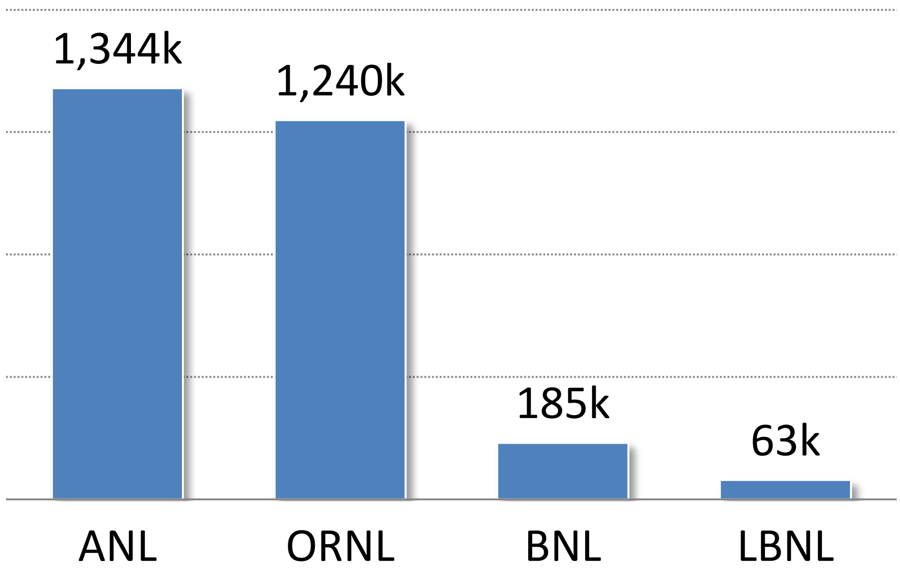
Critics argue the Department must conduct a comprehensive look across the excess facilities portfolio to determine which are either the riskiest facilities or the lowest hanging fruit. According to the DOE IG, "Environmental Management and the various program offices focused their respective budgetary resources based on individual program priorities instead of on the highest risk facilities across the Department." Laboratory personnel asserted that EM's prioritization process is largely site specific; meaning specific projects with high need but in lower priority sites (e.g., Savannah River) may not be highlighted. Argonne is trying to get out of the "nuclear business" but it has a few excess radioactive facilities that have not been transferred to EM and are in the D&D queue. Even though these facilities could represent "easy wins," they are not rising to the top in the EM prioritization process. The LOB has recently initiated a review of excess facilities, which will be discussed further in Section C.

Non-contaminated excess facilities could be leased to interested third parties if DOE was granted Enhanced Use Lease (EUL) authority. EULs are long-term leases on agency-owned property in exchange for cash or in-kind consideration. Federal agency EUL programs have allowed private or non-profit entities to develop vacant land or occupy excess Federal facilities such as power plants, housing and healthcare facilities, office space, and parking facilities. Five agencies currently use EULs—the Department of Agriculture, the Department of Defense, the Department of State, the Department of Veteran Affairs, and the National Aeronautics and Space Administration—but the authorities vary in the maximum length of lease, permitted properties, and possible leasing terms. While GAO has criticized agencies for failing to accurately account for the costs associated with their EUL programs, agencies claim the program helps them better utilize unused facilities, enhance mission activities, they benefit from the associated cash revenue and in-kind consideration.[318] DOE does not currently hold EUL authority.

The issue of excess facilities is not felt uniformly across the laboratories. Some laboratories do not have a problem at all. For example, Ames has no excess square feet and Sandia personnel asserted that, if anything, it needs more space. But excess facilities are negatively impacting the bottom line of other laboratories. Excess facilities at Los Alamos cost $3 per square foot, which is covered by overhead. See Figure 39 for excess square footage for select SC laboratories.

[318] GAO, *Improved Cost Reporting Would Help Decision Makers Weigh the Benefits of Enhanced Use Leasing*. GAO-13-14, (Washington, DC: GAO, December 2012).

Figure

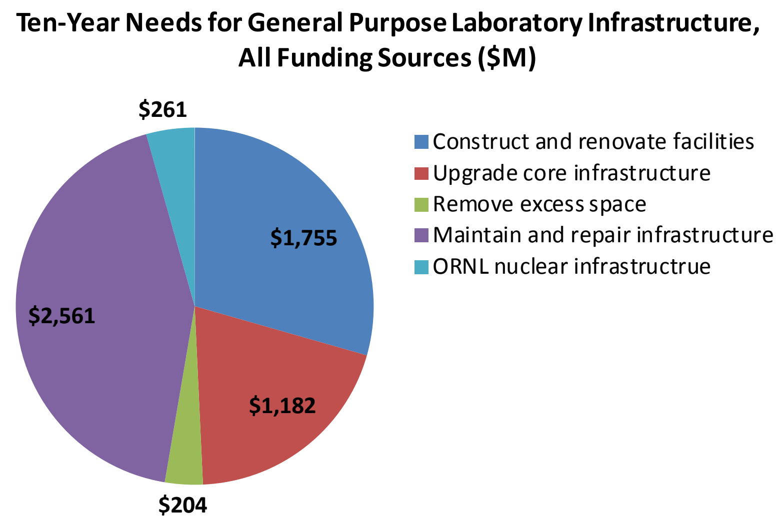


Source: J. Smith, The Importance of Core Infrastructure. Presented to the Commission to Review the Effectiveness of the National Energy Laboratories, February 24, 2015.

Figure 39. Gross Excess Square Feet in Select SC Laboratories

2. Resources for Facilities and Infrastructure

The primary concern related to resources for DOE laboratory facilities and infrastructure is the sheer magnitude of need to maintain and revitalize the system. For example, SC laboratories have identified $6B of needed investments over the next ten years (Figure 40). Nearly $700M of these investments are needed for basic systems that form the backbone of the laboratories, including electrical systems, water systems, and waste systems.



Source: J. McBrearty, Office of Science Briefing to the Commission to Review the Effectiveness of the National Energy Laboratories (CRENEL). February 24, 2015.

Figure 40. SC Laboratory Facilities and Infrastructure Investment Needs

Facilities and infrastructure at the laboratories also suffer because of the uncertainly of funding. DOE began construction at NETL on a test bed facility for fossil energy similar to the user facility at NREL, but the programs ended funding before construction was complete. Since the Department did not provide resources for repurposing the partially built facility, it never got off the ground and industry was unable to use it.

a. Alternative Financing

Alternative financing or third party financing describe leasing agreements for construction, renovation, and modernization of real property assets. The Federal Government contributes the real property or land and a private entity borrows 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. The Office of Management and Budget (OMB) decides whether the lease is an operating or capital lease through a process known as "scoring". A capital lease is considered a capital acquisition, meaning an agency must request and allocate full budget authority up-front in the amount equal to the asset's total cost.[319] On the other hand, an operating lease is considered an annual operating expense, which means that agencies request and allocate budget authority in the amount equal to an annual lease payment every year until the end of the lease term.

[319] Office of Management and Budget (OMB). *Circular No. A-11, Appendix B - Budgetary Treatment of Lease-Purchases and Leases of Capital Assets*. (Washington, DC: OMB, 2014).

DOE formally submitted 13 laboratory and plant facility projects to OMB from 2001 to 2010. Eight of these projects qualified as operating leases, but none have done so since 2007. The Department has found several of the scoring criteria found in Appendix B of OMB Circular A-11 particularly challenging to overcome and has (thus far unsuccessfully) proposed modifications. The second criterion prohibits a bargain-price purchase option. After a capital asset has been fully depreciated, private entities are typically willing to sell the fully depreciated asset at a bargain price — even for as little as $1 — but this type of agreement is disallowed by OMB regulations. Also since 2000, there has been a new interpretation of the fourth criterion, which states, "[t]he present value of the minimum lease payments over the life of the lease does not exceed 90 percent of the fair market value of the asset at the beginning of the lease term."[320] OMB now requires this calculation performed using the private construction cost rather than government construction cost, making the standard very difficult to meet. In addition, the fifth criterion requires the asset be "a general purpose asset rather than being for a special purpose of the Government," but OMB has not defined "general purpose" in the Circular and has generally taken a narrow view of the definition.

After a multi-year hiatus, the Department and laboratories are renewing efforts to develop alternative financing proposals to submit to OMB for scoring.[321]

Proponents of alternative financing argue that it allows laboratories to pursue construction projects in times of budget austerity. Instead of securing the entire cost of the facility up front during the agency appropriation process, the laboratory borrows the money from a private financier and pays off the loan through overhead over a period of decades. Supporters also assert that when comparing the full life-cycle costs of an alternatively financed facility to a line item, they found the alternatively financed projects had lower costs for construction, lower costs for operation and quicker building times.[322] Once the debt is retired, rent payments end, which is key to the finding that alternative financing leads to a cost savings in the long run.

Critics of alternative financing do not approve of DOE mortgaging the government when there is no guarantee the Nation will continue to see a mission need for maintaining

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[320] OMB, *Circular No. A-11, Appendix B – Scoring Lease-Purchases and Leases of Capital Assets.* (Washington, DC: OMB, 2000).

[321] At least two laboratory alternative financing proposals are in development, one at Brookhaven and one at Savannah River.

[322] Contractor Financial Management Alliance, *Economics of an Alternatively Financed Facility: Four Case Studies*. Authors reviewed the cost data and operational experience from four recent alternatively financed projects: Pacific Northwest's Biological Sciences Facility and Computational Sciences Facility, Oak Ridge's Multiprogram Research Facility, and Argonne's Theory & Computing Sciences (TCS) Building.

a laboratory.[323] It is also an issue of control; Congress is the "keeper of the purse" and ought to be the final arbiter for these significant financial decisions, not the executive branch. There has also been some doubt expressed regarding the conclusions of the laboratories' economic analysis—critics do not understand how alternative financing can prove to be less costly when it is always more expensive for the private sector to borrow money than it is for the government.

The Commission has been disappointed by the lack of independent analysis of alternative financing, particularly cost benefit analyses. There is one GAO study from 2004, which analyzed two types of third-party financing projects—public-private partnerships for facilities and infrastructure and energy savings performance contracts (ESPCs).[324] GAO planned to perform a cost analysis of 6 energy savings performance contracts (ESPCs) and 5 public-private partnerships for facilities and infrastructure—including cash flow schedules, expected savings and costs, such as principal payments, interest payments, measurement and verification fees, operations and management, and energy service company markups. However, the GAO conducted *only* a cost analysis of the ESPCs because data were insufficient to analyze public-private partnerships for facilities and infrastructure. By comparing data from six ESPCs and similar Federally-contracted projects, the GAO concluded that the acquisition of capital through ESPCs is from 8 to 56 percent more expensive than through full, up-front appropriations. CBO 2005 cites this ESPC-specific estimate for all third-party financed projects, including public-private partnerships for facilities and infrastructure.

The GAO emphasized that for the 5 public-private partnerships for facilities and infrastructure studied, it was difficult to assess how much the projects would have cost under up-front appropriations. However, the GAO 2004 report did include a cost comparison related to the interest rates of bonds obtained by the private developer. In several cases, the present value of the long-term lease payments exceeded the value of the bonds due the project's interest rates. Yet, the analysis does not consider other possibly important costs, such as opportunity costs, associated with Federal contracts if approved through full, up-front appropriations.

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[323] Supporters argue this point is nullified by the 365 termination clause in case of end of mission need that is part of every lease.

[324] GAO, *Capital Financing: Partnerships and Energy Savings Performance Contracts Raise Budgeting and Monitoring Concerns*, (Washington, DC: GAO, 2004). CBO also released a study in 2005 but it bases its cost estimates on the GAO analysis. Congressional Budget Office (CBO). *Third-Party Financing of Federal Projects*. (Washington, DC: CBO, 2004).

C. Current Efforts to Improve

Recent efforts to improve the facilities and infrastructure state of affairs have been undertaken at the Department-level, stewarding office level and laboratory level.

1. Department Efforts

Secretary Moniz reestablished the National Laboratory Operations Board (LOB) in July 2013 to "tackle the administrative issues affecting the laboratory system using an enterprise-wide approach."[325] The LOB reports to the Office of the Under Secretary for Management and Performance. Members of the LOB include headquarters and laboratory personnel.

In 2013 and 2014 the Infrastructure Assessment Subgroup of the LOB carried out a significantly revised approach to infrastructure assessments. The Infrastructure Subgroup was co-chaired by the Office of Science COO and Thomas Jefferson COO.[326] The change was intended to combat a credibility gap, inconsistent definitions and criteria, inconsistent data, the fact that a financial proxy had been used for infrastructure condition instead of mission orientation, and the lack of an enterprise view of infrastructure. The Infrastructure Subgroup set out to establish consistent definitions and an inventory of mission unique facilities, assess the condition of assets to support program capabilities, link functionality of space and its utilization to capabilities, establish linkages between strategic plan, core capabilities and the assets that underpin them, and align reporting to core capability and DOE strategic objectives. The outcomes of the exercise are consistent definitions, criteria and data for the Department and a uniform assessment of all assets, allowing for credible, data-driven infrastructure decisions aligned with program capabilities at the laboratory level, program level and enterprise level.[327]

The infrastructure managers involved in this LOB effort have proposed a plan that would institutionalize an "Infrastructure Strategic Plan" as an enterprise-wide process. This would be spearheaded by a new "Infrastructure Executive Committee", which would also ensure continued visibility of general-purpose infrastructure issues. The committee would be responsible for analyzing the status of the Department's general purpose infrastructure, routinely briefing senior leadership on the enterprise view, and formulating recommendations

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325 B. Geman, "Moniz reshuffles Energy Department management structure," *The Hill*,, July 19, 2013.

326 U.S. DOE National Laboratory Operations Board Infrastructure Assessment Subgroup Charter. http://fimsinfo.doe.gov/Downloads/Infrastructure_Assessment_Group.pdf.

327 J. McBreatry, "Briefing to the Commission to Review the Effectiveness of the National Energy Laboratories (CRENEL)," presentation to the Commission to Review the Effectiveness of the National Energy Laboratories, February 24, 2015.

Another working group was stood up under the LOB to focus on excess facilities. The leadership is a blend of headquarters and laboratory personnel; there is one co-chair from a laboratory, one from NNSA and one from the Office of Environmental Management (EM). The group is currently compiling data to get an accurate assessment of the magnitude of the problem—the deadline for laboratories to provide excess facilities information was June 1, 2015. When the group initially set out to perform an enterprise-wide assessment of excess facilities, it found the DOE real property database Facilities Information Management System (FIMS) had insufficient information, such as missing cost information, disposal readiness, complexity of disposal, and mission impact.

Current DOE leadership is also attempting to address the deferred maintenance backlog. The Secretary has announced the policy of no net increase in deferred maintenance. The policy requires that Program Offices should provide sufficient funding for infrastructure maintenance to avoid any further increase in the level of deferred maintenance for the FY 2016 budget request and beyond.[328] The budget also provides for $100 million for the most critical general purpose plant projects identified by the LOB.

2. Office of Science Efforts

The Office of Science emphasized facilities and infrastructure in the FY 2014 Annual Laboratory Plans and Reviews for its 10 laboratories. Not only was each laboratory required to present on infrastructure during its performance review for the first time, but also to include a campus strategy in its Annual Plan. The campus strategy includes a rigorous condition assessment of current assets; definition of future capabilities needed; a gap analysis that identifies the infrastructure to provide those capabilities, as well as excess assets that can be eliminated; a comprehensive evaluation of alternatives to fill gaps; and a reasonable path forward for needed investments.

The Office of Science has also been making a concerted effort to decrease deferred maintenance through laboratory and line item investments (Figure 41).

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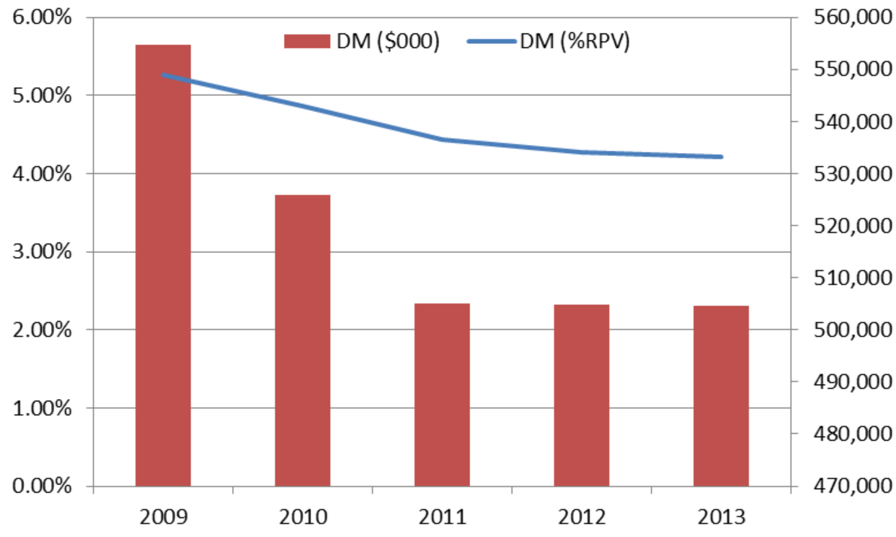
[328] See DOE website, "FY 2016 Budget Justification," http://energy.gov/cfo/downloads/fy-2016-budget-justification.



Source: J. McBrearty, Office of Science Briefing to the Commission to Review the Effectiveness of the National Energy Laboratories (CRENEL). February 24, 2015.

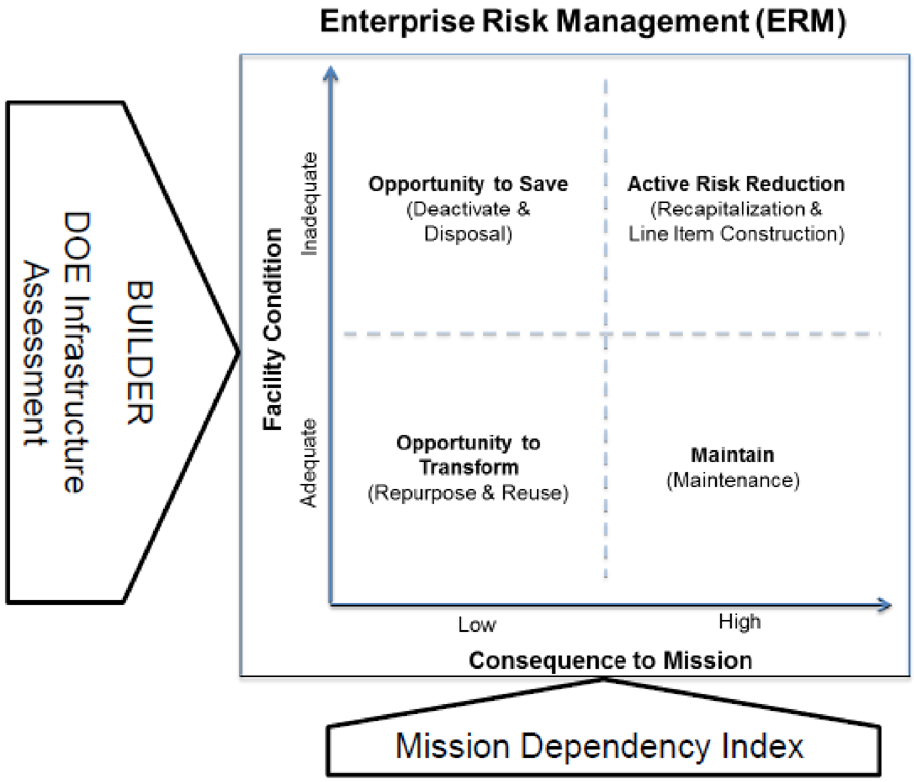
Note: Large drop in funding between 2009 and 2010 is due to the higher than typical funding from ARRA in 2009.

Figure 41. Deferred Maintenance at SC Laboratories (2009–2013)

3. NNSA Efforts

NNSA is evolving to Enterprise Risk Management, a risk-based management structure involving quantifiable decision-making. According to NNSA personnel, prioritization decisions were made using the gross categories of *mission critical*, *mission dependent*, and *not mission dependent*. These bins do not accurately capture the complexity of facilities condition and can lead to counterintuitive results. For example, at Los Alamos multiple facilities generate low-level liquid waste. All of these facilities are *mission critical*. However, all these facilities send their waste to a single facility for treatment and disposal. If the facilities are unable to dispose of their waste they cannot operate, yet the waste treatment facility is only considered *mission dependent*. Under this system, five mission critical facilities are reliant on a *mission dependent*, supposedly low-level waste facility. If one of the *mission critical* facilities goes down, it goes down alone, but if the *mission dependent* facility goes down, it takes five other facilities with it.

To address the above paradox, NNSA is moving to a matrix system of high to low failure risk and high to low consequence of failure (Figure 42). The location of the facility on the matrix determines how its repair needs are handled. High consequence, high failure risk facilities are subject to active risk reduction. High consequence, low failure risk facilities are maintained or maintenance is deferred during tight budget periods. Low consequence, high failure risk facilities are slated for D&D because of their high liability and low return on investment of repair. Lastly, low consequence, low failure risk facilities are repurposed.



Source: R. Haldeman, Maintaining the Infrastructure to Support the Nuclear Security Enterprise. Presented to the Commission to Review the Effectiveness of the National Energy Laboratories. February 24, 2015.

Figure 42. NNSA's Improvement Strategy

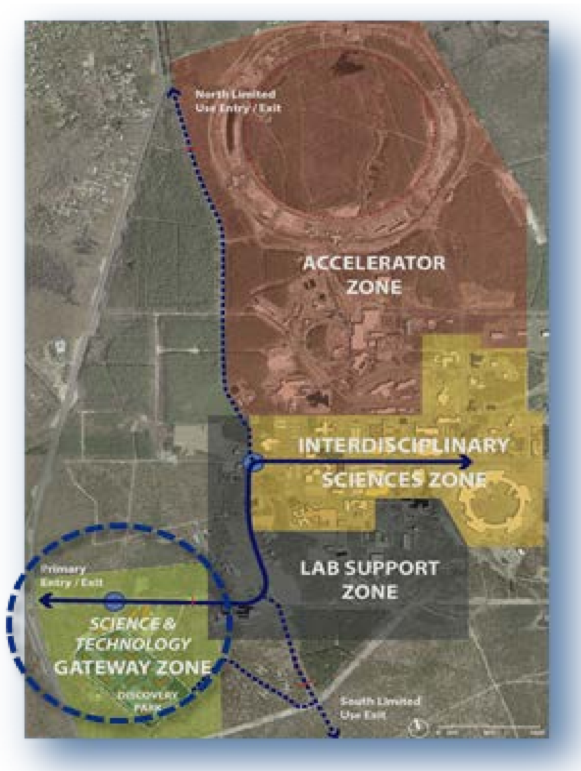
NNSA is also currently focusing its efforts on improving the timeliness and quality of facilities and infrastructure data. It has adopted BUILDER, a facilities and infrastructure data management system used by the Army Corps of Engineers, which provides information at a system rather than asset level.[329]

[329] BUILDER is a data management system developed by the Army's ERDC's Construction Engineering Research Laboratory and endorsed by the DOD for use across all military departments. BUILDER serves as an inventory tool and provides information on condition, functionality, mission dependency, and general F&I information to generate work schedules for future maintenance. Conveniently, F&I staff conducting condition assessments can use a pen-based electronic clipboard to enter data directly into BUILDER's Remote Entry Database during inspections. Moreover, the IMPACT modeling tool within BUILDER forecasts maintenance, repair, and replacement work requirements over the next 10 years. BUILDER has been used by the Navy for 2 years and is being tested throughout the Air Force and Army. Engineer Research and Development Center (ERDC). *BUILDER Condition Assessment Manual for Building Component-Sections*. (Champaign, IL: ERDC, 2006).

4. Laboratory Efforts

DOE Laboratories have been pursuing a variety of infrastructure planning strategies and funding sources to attempt to revitalize their campuses in the time of budget austerity.

Many laboratories have sophisticated and comprehensive infrastructure plans. For example, Brookhaven's Ten-Year Brookhaven Campus Vision. As laid out its Campus Vision, the laboratory will focus key Federal investment in critical core buildings to enable the scientific agenda, make research safe and cost effective by downsizing the campus and demolishing old buildings, ensure scientific reliability through targeted utility infrastructure investments, and support the growing population of critical scientific users through "Discovery Park". "Discovery Park" aims to improve regional development and partially eliminate aging infrastructure through a public-private partnership (Figure 43).



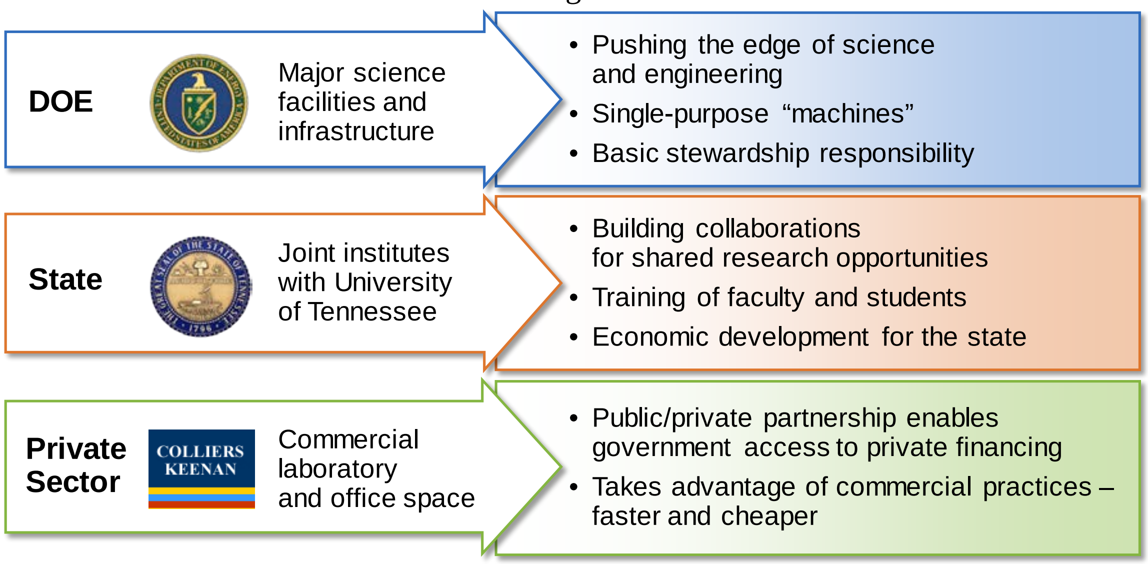
Source: L. Bates, *A 10-Year Strategic Infrastructure Plan to Deliver the Full Potential of Brookhaven National Laboratory*. Presented to the Commission to Review the Effectiveness of the National Energy Laboratories. February 24, 2015.

Figure 43. Brookhaven's Campus Proposal Including Discovery Park

Another key component is the "Space Reduction Plan," which is an ongoing multi-year plan to consolidate out of and demolish old inadequate buildings.

Oak Ridge is taking a portfolio approach to revitalizing its facilities and infrastructure by tapping into the whole suite of funding sources, including line item funding, Energy Savings Performance Contracts (ESPCs), private sector funding, institutional general plant projects, and state funding (See Figure 44).

Figure



Source: J. Smith, The Importance of Core Infrastructure. Presented to the Commission to Review the Effectiveness of the National Energy Laboratories. February 24, 2015.

Figure 44. Oak Ridge’s Portfolio Approach to Facilities and Infrastructure Revitalization

D. Findings and Recommendations

The Commission has formulated the following findings for DOE laboratory facilities and infrastructure:

- Facilities and infrastructure are critical to the ability of laboratories to meet their missions as well as attract and retain high-quality scientists and engineers
- Deferred maintenance and demolition of excess facilities must be addressed or else the problem will continue to worsen
- The natural tendency of researchers and program managers is to spend their money on either new facilities or R&D, not maintenance or disposal of aged facilities
- The Environmental Management portfolio only includes a small portion of facilities ready for D&D

- Alternative financing is not being fully utilized as a potential mechanism to construct and renovate facilities and infrastructure and no projects have been approved by OMB since 2007. In addition, no independent economic analyses of laboratory operating leases have been completed.
- Recently the department and laboratories have been making strides to address the facilities and infrastructure issues, first by accurately assessing the scope of the problem. These efforts have appropriately been a collaborative effort between the Department and the laboratories.

The Commission has the following recommendations for Congress, the Department, and the laboratories for facilities and infrastructure:

- DOE should continue department and laboratory efforts, which have been particularly successful due to participation by both DOE and laboratories
- DOE should establish the Infrastructure Executive Committee that includes both Department officials (programmatic and functional) and laboratory personnel
  - DOE should conduct enterprise-wide facilities and infrastructure planning using rigorous risk assessment models and tools to better inform funding priorities

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

- Revitalize existing laboratory infrastructure by:
  - Addressing the issue of excess facilities through the following mechanisms:
    - Congress should set aside funding for D&D of excess facilities
    - DOE should develop a strategic, integrated plan that schedules D&D of excess contaminated facilities and allocates Environmental Management and mission program funding to risk reduction until the D&D is completed
      - DOE should conduct an accurate cost benefit analysis of excess facilities that compares the costs of maintaining excess facilities with the cost of D&D
      - DOE should perform a new review of contaminated facilities that is based on priority rather than the current site-based approach. The review should consider a portfolio of investments based on hazards, costs and value, as well as “easy wins”
    - Congress should grant DOE pilot legislative authority for enhanced use leases

- DOE should maintain or decrease the level of deferred maintenance across laboratory system

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 develop a long-term plan to deal with the shortfall in facilities and infrastructure resources.

- Embrace a diversity of funding options by:
  - DOE should pursue a portfolio approach to revitalizing infrastructure, including alternative financing and leveraging funding across sectors, including other Federal agencies and State governments
  - DOE should identify effective practices to engage with local institutions (academic, industry) and internationally to finance building maintenance and repair
  - Congress or DOE should conduct or mandate an independent economic analysis of laboratory operating leases
  - OMB should revise OMB Circular A-11 rules to allow bargain-price-purchase option (or establish a new mechanism for financing transactions and scoring that allows agencies pursuing operating leases to obtain equity in asset over time), reinstate original interpretation of 90 percent of fair market value as the true government cost rather than what it would cost the private sector to construct the facility, and define “general purpose” asset
  - DOE should evaluate possibility of establishing a separate enterprise-wide budget accounts to fund construction, recapitalization, maintenance and operations, and disposition of laboratory facilities and infrastructure that aligns with the establishment of an enterprise-wide strategic planning process
  - Congress should adopt a Federal capital fund for construction, recapitalization, maintenance and operations, and disposition of laboratory R&D facilities and infrastructure to better plan for needs across the Federal laboratory enterprise and strategically address the life-cycle management
  - Congress should raise the threshold for IGPP and GPP to allow laboratories more flexibility in making funds available for smart infrastructure improvements.

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.

- DOE should develop and implement and well-defined user facility funding model matrix to increase transparency and certainty for laboratories operating user facilities.

15. Project and Program Management

A. Introduction

This chapter focuses on project and program management performance at the DOE. A project normally involves construction of a building or facility. For DOE, projects can mean first-of-kind, complex construction where, for example, nuclear materials are handled. A program is a broader concept that may or may not involve several construction projects, an example being the ongoing program within the NNSA to extend the life of its aging nuclear weapons.

DOE's management of projects and programs has become an increasingly high priority over the last 10 years given the constrained budget environment coupled with growing concerns expressed by various congressional committees, GAO, OMB and other stakeholders.

The Commission examined both the historical and current record of performance across the Department. It also reviewed reforms undertaken by DOE more recently. This assessment involved:

- Reviewing the historical record of project and program performance reviews. These included reviews by government organizations, such as the GAO, but also by non-government entities, such as the National Academy of Public Administration and the Augustine-Mies Congressional Advisory Panel on the Governance of the Nuclear Security Enterprise.
- Analyzing available DOE-provided data on project performance. In 2009, DOE's Office of Acquisition and Project Management (APM) developed a project data set called the Project Assessment Rating System (PARS) II that allows for standardized project performance comparisons over time and across program offices on all capital asset projects over $10 million. PARS II is a relatively new information tool for the Department's use in decision-making that is also helpful for oversight entities, including Congress, GAO, and OMB.
- Focusing on a few large projects. The Commission gained a greater understanding of some of the large-project issues—those completed, terminated, and underway.
- Reviewing numerous DOE documents and conducting in-depth interviews with present and former senior DOE officials. Officials with responsibilities for project and program performance across the Department provided insight into the kinds of reforms DOE is instituting to achieve better performance.

B. History of DOE's Project and Program Performance

1. Outside Reviews and DOE's Response

In 1990, GAO placed DOE on its High-Risk List of agencies and programs that are considered high risk because of their susceptibility to fraud, waste, abuse, and mismanagement. The list is updated every 2 years or at the start of a new Congress. Independent studies in the 1990s indicated that DOE projects took longer and cost about 50 percent more to complete than comparable projects at other Federal agencies or in the private sector.[330] Average expenditure on DOE projects then was about $4 billion, which underscored the potential magnitude of inefficiency.

In 1996, GAO reported the results of its review of 80 DOE projects completed between 1980 and 1996, which were designated as major system acquisitions. GAO found that DOE completed 15 of them, most of them finished behind schedule and with cost overruns. Three of these were not used for their intended purpose. Another 31 projects were terminated prior to completion after expenditures of over $10 billion. The remaining 34 were described as ongoing; with many having cost overruns and schedule slippages. GAO identified four principal causes for these problems: (l) flawed incentives for employees and contractors; (2) insufficiently skilled DOE contract managers; (3) poorly defined or changing project missions; and (4) incremental project funding.[331]

Since then, numerous studies and reviews, including DOE's own, have identified a host of interrelated causes of project management challenges and failures:[332]

- Diffuse project ownership; unclear lines of authority and accountability throughout DOE **(**GAO 1998; GAO 2003; DOE 2014)
- Shrinking pool of qualified project management or technical expertise (DOE 2008; GAO 2008)

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[330] Figure is from an internal DOE document written in the early 2000s, *Legislative History of DOE's Project Management.*

[331] GAO, *DOE: Opportunity to Improve Management of Major System Acquisitions.* RCED-97-17. (Washington, DC: GAO, 1996).

[332] The studies or reviews cited in this list include: NAPA, *Positioning DOE's Labs for the Future*; DOE, *Improving Project Management;* GAO, *DOE Lacks an Effective Strategy*; GAO, *Status of Contract and Project Management Reform*; GAO, *Actions Needed to Develop High-Quality Cost Estimates*; NRC, *Progress in Improving Project Management at the Department of Energy*; DOE Inspector General, *Management Challenges at the Department of Energy*; GAO, *Office of Science Has Kept Majority of Projects within Budget,*; GAO, *Contract and Project Management Concerns*; DOE, *Department of Energy Corrective Action Plan*; and DOE Inspector General, *Management of High-Risk Excess Facilities.*

- Lack of independent assessment function with access to senior DOE officials (NRC 1999; DOE 2014)
- Cost estimation and other budget issues—poor cost estimates; understated contingency reserves; incremental funding (GAO 2003; GAO 2010; DOE 2014)
- Insufficient attention to contractor's prior performance record; need for major construction projects and highly important programs to be assessed under stand-alone laboratory or contractor evaluation factors (NAPA 2013; DOE IG 2011; DOE 2014)
- Inadequate planning upfront (NRC, 2001; DOE 2008; DOE 2014)
- Requirements growth with cost consequences (DOE 2014)
- Lack of alignment between contractor incentives and good project management (GAO 2009)
- Organizational culture and insufficient attention from DOE or laboratory leadership (DOE 2014)
- Lack of Department-wide risk assessment in allocating environmental management resources (DOE IG 2015)

In 2000, the DOE Deputy Secretary approved a new Office of Engineering and Construction Management (OECM), issued DOE Order 413.3 on project management,[333] and created a Project Management Initiative directing changes in the Department's project management effort. A principal guide behind these efforts was a report by the National Research Council (NRC), *Improving Project Management in the Department of Energy*. Throughout the late 1990s, congressional appropriators and authorizers had, on several occasions, expressed concerns about project management. They supported the new OECM office by providing increased funds for it.

In 2008, Congress directed DOE to develop an action plan to remove it from the High-Risk list. In that same year, DOE issued a report, which highlighted departmental efforts to address causes of its significant project management issues.

In November 2010 and in response to congressional direction and criticism from GAO and OMB, the Deputy Secretary of Energy significantly updated the then-current version of DOE Order 413.3A (July 6, 2006) with 413.3B, which has the goal to "deliver every project at the original performance baseline, on schedule, within budget, and fully

[333] DOE. *DOE Order 413.3 Program and Project Management for the Acquisition of Capital Assets*. (Washington, DC: DOE, 2000).

capable of meeting mission performance, safeguards and security, quality assurance, sustainability, and environmental, safety, and health requirements."[334] The revised DOE Order develops a framework for different project phases to achieve this goal, but, the DOE noted in its 2014 internal report that the order is not well-understood, followed, or enforced.[335]

In May 2012, APM was established, combining the project and contract management oversight offices of OECM and the Office of Procurement and Assistance Management. APM has the responsibility for improving and monitoring project management across the Department; it provides an independent assessment of a project's progress in monthly reports that are posted on the Department's website. It plays an important role in some of the most recent reform initiatives of the Secretary of Energy, particularly in integrating Department-wide policies, regulations, standards, and procedures related to acquisition, program, and project management.

GAO has acknowledged DOE's efforts by removing pieces of its portfolio from the High-Risk List. Office of Science was removed in 2009 and the high-risk designation for NNSA and EM was narrowed to projects valued at over $750 million in 2013. Nevertheless, GAO still has concerns about the Department's capacity overall to address fully its contract and project management challenges.[336]

2. DOE's Historical Data on Project Performance

APM monitors construction projects across the Department in the PARS II database using standardized metrics. The Commission compared data for all projects over $10 million between 2009 and 2014.

Important DOE definitions, including those for project or portfolio success are as follows:

- **Directed Change**: DOE policy directives or statutory or regulatory actions initiated by entities external to the Department, including congressional funding reductions. Directed change decisions are reviewed and verified by APM and OMB and follow a baseline management process.
- **Project Success**: Projects completed (referred to by DOE as CD-4) within the original scope baseline and not to exceed 110 percent of the original approved

[334] DOE. *DOE Order 413.3B Program and Project Management for the Acquisition of Capital Assets*, (Washington, DC: DOE, 2010).

[335] DOE, *Improving Project Management: Report of the Contract and Project management Working Group*, (Washington, DC: DOE, November 2014).

[336] GAO, *High-Risk Series: An Update.*GAO-15-290, (Washington, DC: GAO, February 2015).

cost baseline (referred to by DOE as CD-2), unless otherwise impacted by a directed change.[337]

- **Program Office Portfolio Success**: On a program portfolio basis, 90 percent of projects must meet the criteria for project success criteria over a 3-year rolling timeframe.

Table 36 displays project success for each DOE program office between 2009 and 2014. As noted above, the DOE target for each program office is a 90 percent success rate. Based on the data, SC has consistently hit this target. In addition, the "Other" category, which combines the Offices of Fossil Energy (FE), Nuclear Energy (NE), and Energy Efficiency and Renewable (EERE), has improved over time and maintained a 100 percent success rate for the last few years. On the other hand, EM and NNSA show a negative trend. However, APM notes that an alternative measure gives a more positive outlook for NNSA and EM completed projects. The percent of project dollars going to successful NNSA projects in the last three years was 92 percent ($673 million out of a total of $728 million). For EM, the corollary measure was 75 percent ($2.58 billion out of a total of $3.44 billion).

[337] The stages of the capital acquisition process within DOE start at CD-0 and end at CD-4 (project completion); they are described later in this chapter. See also DOE Order 413.3 B.

Table 36. DOE's Historical Record of Project Success

	Percentage of Success (Actual)					
Capital Asset	**FY 2007–09**	**FY 2008–10**	**FY 2009–11**	**FY 2010–12**	**FY 2011–13**	**FY 2012–14**
SC	91	92	100	100	100	100
NNSA	75	68	75	81	64	55
EM Const.*	—[†]	—	0	0	0	0
EM Clean-up	—	100	94	86	84	67
EERE/NE/FE***	67	0	83	100	100	100
All	79	78	89	87	84	76

Source: These data come from APM and cover all capital asset projects, both those managed by national laboratories and commercial contractors. The percentages are based on a three-year rolling timeline.

*EM = Environmental Management

**EERE = Energy Efficiency and Renewable Energy; NE = Nuclear Energy; FE= Fossil Energy

†Dashes in a table cell mean there were no projects. A "0" means there were some (usually a very small number) but none was successful.

Prior to 2009, standardized metrics on project success across DOE are not available. However, SC has tracked final project cost and schedule outcomes since the late 1980s. An SC capital asset project is defined as having a total project cost (TPC) of $10 million or greater. SC defines "success" as a project completed within the original cost and schedule baseline. There is no allowance for a 10 percent cost variance as there is in the measure currently used by APM for DOE-wide reporting.

SC provided data show that 68 projects were completed between 2002 and 2014 (Table 37).[338] One was canceled and four were unsuccessful; 94 percent (64 projects) were successful in terms of cost and 93 percent (63 projects) were successful in terms of schedule performance. SC exceeded the current DOE target of 90 percent over this 12-year period. In two cases, directed changes, which are due to a policy decision outside the purview of the project director, such as receiving fewer appropriations than requested, resulted in upward baseline adjustments without a negative impact on the project success metric.

338 Stephen W. Meador, "Office of Science Projects Perspective," presented to the Department of Energy Acquisition and Project Management Workshop, (Washington, DC: DOE, 2015).

Table 37. Office of Science Projects Completed Between 2002 and 2014

		Cost Success		Schedule Success		Total Project Cost (TPC)		
Site	Number of Completed Projects	Number	Percentage	Number	Percentage	Initial Baseline ($M)	Final ($M)	Percentage Cost Increase
Argonne	5	5	100%	3	60%	$60	$60	0%
Brookhaven	12	12	100%	12	100%	$261	$260	–1%
Fermilab	10	10	100%	10	100%	$1,069	$1,096	2%
Thomas Jefferson	2	2	100%	2	100%	$84	$84	0%
Lawrence Berkeley	13	12	92%	12	92%	$440	$435	–1%
Oak Ridge	13	13	100%	13	100%	$1,702	$1,773	4%
Pacific Northwest	1	1	100%	1	100%	$224	$224	0%
Princeton	3	2	67%	2	67%	$141	$143	1%
Sandia	1	1	100%	1	100%	$76	$76	0%
Stanford	8	6	75%	7	88%	$595	$638	7%
Total Projects	68	64	94%	63	93%	$4,653	$4,789	3%

Source: Office of Science, Office of Project Assessments.

Note: SC defines "success" as a project completed within the original cost and schedule baseline.

SC practice is to establish credible cost and schedule objectives supported by rigorous pre-project planning, firm funding commitments by project owners, and regular independent project reviews. SC then executes projects using a "build to cost" approach. This method incentivizes project teams to maintain good project performance in order to deliver scope that maximizes scientific capability.

When asked about how often de-scoping occurs in the context of the build-to-cost approach, a senior SC representative confirmed that all of the office's successful projects in Table 37 actually met the baseline scope. The SC representative explained that this achievement was possible given careful estimation and disciplined execution of contingencies, which cover costs resulting from incomplete design, unforeseen and unpredictable conditions, or uncertainties within the defined project scope. The representative underscored that a contingency is not a substitute for making an accurate estimate of expected cost.

According to SC officials, large and complex projects require about 40–50 percent contingency for the conceptual design phase; 30–40 percent at the time of the performance baseline; and over 25 percent through the execution of the project. Once those contingency amounts are established for any project, they are held by and controlled by the Federal Project Director, and only released to the project through a carefully managed formal change control process.

3. Three Large DOE Projects

Despite the generally favorable record for at least a portion of the portfolio, DOE project management, as a whole, has been viewed as lacking. This may be due to a few high profile projects that struggled or failed, two of which are described in more detail below. We also include an example of a successful project to provide a more balanced picture.

a. National Ignition Facility (NIF)

NNSA completed construction of NIF at Lawrence Livermore in 2009. It is the world's largest and highest energy laser. NNSA considers NIF critical to creating—in the laboratory—the high-energy density conditions that exist within a nuclear weapon. Given the moratorium on nuclear testing, the goal is to validate computational codes used for assessing the safety and reliability of the Nation's nuclear weapons stockpile. NIF is an important means of replicating nuclear test conditions and also is a critical element of the Inertial Confinement Fusion (ICF) program. NIF is therefore, a major component of the high-energy density physics activities planned by the Stockpile Stewardship Program. In a 1996 review by the independent defense advisory panel known as "JASON," the members agreed about the value of the NIF for stockpile stewardship.[339] The facility was designed to achieve ignition within two to three years of project completion.

In 1994 and 1997 internal program documents, DOE also noted the significant potential commercial application of ICF in electric power generation over the long term and referenced NIF's potential for unique and valuable experiments relevant to areas of basic science.[340] Instead of simply proposing the project with the main goal of stewardship of the nuclear weapons stockpile, DOE stressed the inertial confinement fusion energy program, with a focus on achieving ignition as the first step to creating a new energy source.

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339 JASON, *Inertial Confinement Fusion (ICF) Review, JSR-96-300*, (McLean, VA: The MITER Corporation, March 1996).

340 DOE, *The Role of the NIF in Science-Based Stockpile Stewardship*, (Washington, DC: DOE, 1997); DOE, *Memorandum to the Secretary from Victor Reis on key decision one for the National Ignition Facility,* (Washington, DC: DOE, 1994).

The approved baseline cost for NIF in 1994 was $1.2 billion. After the project ran into unforeseen technical difficulties and the project director was replaced in 1999, DOE subsequently required a new baseline of $3.5 billion ($2.25 billion plus another $1.25 billion for a NIF demonstration program). This more comprehensive figure was almost three times the original baseline cost. The project stayed within the new baseline cost, and the Project Management Institute awarded NIF the 2010 Project of the Year award, citing groundbreaking technical achievement and exemplary management.

At the request of Congress, GAO reviewed the NIF in 2010,[341] and NNSA implemented GAO's recommendations. GAO pointed out that achieving ignition was not likely. From conversations with NNSA and laboratory officials, GAO also concluded that this would not be a critical gap in the Stockpile Stewardship Program in the short run, although it could become more serious over time. In September 2009, Livermore scientists began using NIF to validate NNSA's data and models on weapon performance under non-ignition conditions. Between 2010 and 2012, the facility tried but failed to achieve ignition.

Since 2013, experimental shots of the 192 lasers have reproduced fusion at least four times. NIF was the first facility to reach the milestone of achieving fuel gains greater than one (where the energy generated through the fusion reaction exceeds the amount of energy deposited into the fusion fuel, an important step towards realizing ignition, but a long way from showing overall system energy gain). Scientists in the program consider the agreement between their experimental results and those from the modeling/simulation efforts to be of the greatest importance. The review of the National Ignition Campaign, initiated in October 2010, highlighted the importance of this validation, because it supports the use of the computer models in the weapons program.

The early emphasis on NIF achieving ignition, thereby opening a potential pathway for fusion energy, and the subsequent failure to do so, has overshadowed the remarkable technical achievements of this project for both science and stockpile stewardship. This situation can serve as a lesson to DOE and the laboratory about the important role of marketing in project management.

b. Superconducting Super Collider (SSC)

Another large project, SSC, was an SC project that was cancelled before completion. It had an optimistic beginning followed by 5 years of conflict and problems. Had it been completed, SSC would have been the largest, most costly scientific machine ever constructed. It could have led scientists into unknown territory beyond the "Standard

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[341] GAO, *Actions Needed to Address Scientific and Technical Challenges and Management Weaknesses at the National Ignition Facility*. GAO-10-488, (Washington, DC: GAO, April 8, 2010).

Model" of particles and fields.[342] The realm of "inner space" was considered a new frontier at the time, and the SSC was going to help discover and understand this world. The project was also supposed to help restore U.S. competitiveness with Europe in high-energy physics.[343]

The SSC was designed between 1983 and 1988. Cornell University physicist, Maury Tigner, led the Reference Designs Study from 1983–1984, which was followed by the efforts of the Central Design Group (CDG). The CDG completed their report in 1986, concluding that the SSC was technically feasible and that cost and schedule estimates were reasonable. Once the U.S. President announced the Administration's support for SSC, DOE started the process of finding an appropriate site. In April 1987, DOE invited proposals from around the country and received 43—a measure of the excitement generated by this project— and it determined 36 were qualified. The National Academy of Engineering reviewed the proposals and found 8 of the 36 to be "best qualified." One proposer (from New York) withdrew, leaving seven (those from Arizona, Colorado, Illinois, Michigan, North Carolina, Tennessee, and Texas).

The Texas proposal ultimately won the competition. It described an accelerator that would collide two beams of high-energy protons from opposite directions within a race-track ring of about 53 miles. The accelerator, which was to operate for 25 to 30 years, circled the town of Waxahachie, Texas.

The SSC's original cost was $4.4 billion in 1987. By 1991, it had almost doubled; DOE's official baseline cost was $8.25 billion and it projected that the SSC would be completed by 1999.[344] One of the cost drivers was a single design change concerning the aperture of the magnets. The aperture size was a critical decision from a cost perspective because of the number of magnets involved.[345] The CDG originally decided on 4 centimeters, but later increased it to 4 to 5 centimeters, which amounted to a billion dollar change.[346]

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342 L. Hoddeson, L.M. Bron, M. Riordan, and M. Dresden (eds.), *The Rise of the Standard Model: Particle Physics in the 1960s and 1970s*, (New York: Cambridge University Press, 1997).

343 Fermilab History Collection (Batavia, Illinois), *SSC Papers, Afterwards FHC: The Superconducting Super Collider, pamphlet of the Central Design Group,* (Washington, DC: Universities Research Association, 1988).

344 GAO, *Federal Research: Supercollider is Over Budget and Behind Schedule,* (Washington, DC: GAO, 1993).

345 From interview with Professor Roy Schwitters. See also Lillian Hodeson and Adrienne W. Kolb, *The Superconducting Super Collider' Frontier Outpost, 1983–1988.*

346 From interview with Professor Roy Schwitters of University of Texas and former SSC director in Waxahachie, Texas.

Project management issues emerged, particularly during the transition from the CDG efforts to the execution of the project.[347] Differences in operating styles of key players negatively affected the project's smooth progress. An article in *Scientific American* in 2013 concluded that the project's scale was 20 times bigger than anything physicists had ever managed before, and cultural differences between the scientific side of the accelerator's management and DOE led to conflicts and an overall lack of trust."[348] Until 1987, the SSC had largely been controlled by laboratory physicists. By late 1988, it was clear that their approach to managing "their large project" was competing with congressional concerns about cost, the need for competition, and abiding by various acquisition or other Federal requirements, such as producing an Environmental Impact Statement.[349]

By 1993, the cost estimate had ballooned to $11 billion because of further cost escalations and a loss of funding from non-Federal sources, including an expected $2.6 billion from foreign governments. Japan was potentially a significant contributor (as much as $2 billion), but ultimately decided not to provide financial assistance. The momentum to bring international participants into the SSC evaporated. Congress was also facing a decision about funding the International Space Station, which had a similar cost. Arguments surfaced that many smaller scientific experiments of equal merit could be funded for the same cost, and the project was canceled.

At the point of cancellation, around $2 billion had been spent ($1.6 in Federal monies and $400 million in Texas funds) and about 20 percent of the project was completed. Two dozen kilometers of tunnel were drilled, with 17 access shafts built and 18,600 square meters of buildings erected. Today, the SSC buildings are occupied by a Waxahachie, Texas chemical manufacturer. Shafts have been filled in, but the tunnels remain.

c. National Synchrotron Light Source (NSLS) II

NSLS at Brookhaven is a research facility that has been serving about 2,500 academic, industrial, and government users annually.[350] Using the peer-review-based

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[347] See, Frank T. Anbari et al., *Case Studies in Project Management, Superconducting Super Collider Project,* by Frank T. Anbari, et al., (Washington, DC: Project Management Institute, 2002); also GAO, *Status of DOE's Superconducting Super Collider, GAO/RCED-91-116,* 1991.

[348] David Appell, "The Supercollider That Never Was," *Scientific American,* October 15, 2013.

[349] L. Hodeson and A. W. Kolb, "The Superconducting Super Collider's Frontier Outpost, 1983-1988," *Minerva* 38 (271-310), (Netherlands: Kluwer Academic Publishers, 2000).

[350] V. Peña, S. V. Howieson, and S. S. Shipp, *Federal Partnerships for Facilities, Infrastructure, and Large Instrumentation*, IDA Document D-4937 (Alexandria, VA: Institute for Defense Analyses, 2013).

processes described earlier, it was decided to build a second NSLS, referred to as NSLS-II, to take advantage of new developments in light source technology. This SC project was completed in March 2015 $2 million below its planned budget of $912 million and slightly ahead of schedule. Additionally, the scope (within the original design) was adjusted *upward*, according to an SC official. Two primary factors enabled significant scope enhancement. A depressed regional construction environment in 2008–2009 resulted in awarding a contract for much less than estimated and the receipt of significant American Recovery and Reinvestment Act (ARRA) funds allowed the project to accelerate schedule. The ARRA funds did not add to the TPC but offset the need for planned base funds later on.[351]

NSLS-II is a state-of-the-art, medium-energy electron storage ring that offers scientific and industrial researchers an array of beamlines with x–ray, ultraviolet, and infrared light. The facility enables multi-disciplinary discoveries in clean and affordable energy, high-temperature superconductivity, molecular electronics, environmental science and medical research.[352] All research proposals are subject to peer review and ranked against competing proposals based on scientific merit.

The success of NSLS-II highlights the quality of the SC's project oversight. Further, the project benefited cost-wise from the depressed economic environment and supplemental ARRA funds during initial construction. Another contributing factor to project success was SC's relationship with the National Institutes of Health (NIH). SC involved NIH early in its planning for the project. Because a prominent research priority for the NSLS-II was the field of life sciences,[353] NIH became a key partner and helped evaluate what research capabilities were necessary at NSLS-II. NIH and DOE signed a memorandum of agreement on their mutual responsibilities, whereby NIH agreed to fund additional beamlines while DOE was the main steward of operations. Given that the precursor NSLS led to Nobel prizes in chemistry in 2003, 2008, and 2009, the likelihood is high for further discoveries in the life sciences with NSLS-II.

[351] Interview with Steve Meador, Director, Office of Project Assessment, Office of Science

[352] See Brookhaven National Laboratory website, "About National Synchrotron Light Source II," http://www.bnl.gov.

[353] Peña, Howieson, and Shipp, *Federal Partnerships for Facilities, Infrastructure, and Large Instrumentation*.

C. Review of Ongoing DOE Projects

1. Overview of DOE's Capital Asset Process

DOE Order 413.3B describes DOE's current project life-cycle process from start to finish, which involves five critical decisions.[354] DOE's first project guidance actually dates back to 1987 when DOE Order 4700.1 was issued, before being replaced by DOE Order 413.3 in 2000. The project guidance evolution will continue as APM incorporates recent Secretarial policy memoranda into DOE Order 413.3B.

DOE Order 413.3B became mandatory across DOE for all capital asset projects with a total project cost equal to or greater than $10 million on June 8, 2015. Exemptions are allowed for those DOE offices meeting certain criteria. Even though SC is the only office that has met the criteria, it has still opted to comply with the order's requirements.

For projects, the five critical decision points (CDs) are:

> **CD-0**: Approve mission need for project—DOE certifies that the project is needed for a DOE mission.
>
> **CD-1**: Approve selection of alternative and cost range—DOE decides on the preferred alternative and its cost and schedule and confirms that it is the optimal solution. As CD-1 progresses to CD-2, the cost estimate is refined. If the cost estimate increases either by 50 percent or more above the top end of the CD-1 cost range or by more than $100 million, the acquisition executive must review the selection of the alternative and confirm a new alternative or reaffirm the existing alternative showing the higher cost range.
>
> **CD-2**: Approve Performance Baseline—DOE approves a definitive scope, schedule, and cost baseline with all cost components adding to the Total Project Cost (TPC). A CD-2 decision requires enough solid information to establish a performance baseline. *The CD-2 becomes the official cost and schedule plan against which the project is assessed from then on—the project is not assessed against earlier cost estimates at CD-0 or CD-1*.
>
> **CD-3**: Approve Start of Construction or Execution—DOE confirms the project is ready for implementation.
>
> **CD-4**: Approve Project Completion—DOE confirms the project is ready for turnover or transition to operations.

The CD-0 and CD-1 stages of the project planning process are crucial for up-front planning, examining alternatives, reviewing technical feasibility issues, and developing

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[354] https://www.directives.doe.gov/directives-documents/400-series/0413.3-BOrder-b.

solid cost and schedule estimates that will ultimately feed into the CD-2 performance baseline against which the project will be evaluated.

Problems with large projects, in particular, occur prior to CD-2 because of inadequate up-front planning and design detail, poor-quality cost estimates, and insufficient analysis of alternatives. Projects are more likely to be successful if more time and focused effort is spent on these early stages. The costs of pre-CD-2 activities do not represent a major share of the TPC. According to DOE officials, for complex nuclear facilities or projects with significant outside stakeholder involvement, such as those in EM, these costs range from 8 to 15 percent of the TPC. For less complex, non-nuclear projects, they range from 3 to 7 percent.

For CD-2 projects, DOE's APM Director issues monthly assessments after consulting with the program offices and taking into account various earned value indicators, reports, reviews, and other information. The assessments use a straightforward stoplight metric:

- Green means that the project is expected to meet its performance baseline as established at CD-2.
- Yellow means that the project is at risk of breaching its performance baseline.
- Red means that the project is expected to breach its performance baseline.

For transparency, project assessments are placed on the DOE website and the information is shared with GAO and OMB.

2. Analysis of DOE's Current Project Data

a. All DOE Projects

As of May 2015, DOE's APM is reporting a total construction portfolio of 79 projects costing a little over $73 billion in aggregate, as shown in Table 38. Of the 79 current capital projects, 46 projects are in the earlier stages (referred to in the table as "pre CD-2" or "on hold") and have a total estimated cost of over $48 billion. These 46 projects do not have officially approved scope, cost, or schedule baselines. The largest portion of the pipeline sits within EM, which has 19 projects with a total preliminary cost of $34 billion waiting in the wings.

The remaining 33 projects total just over $25 billion. They are referred to as post-CD-2, meaning they have officially approved cost and schedule baselines against which DOE judges their performance. The $25 billion figure for post-CD-2 projects represents a major decline from 2008 when there were 121 projects (with a total cost of $65 billion) in post CD-2 status. A funding spike in 2008 was due to the ARRA, under which EM received a one-time infusion of $6 billion for environmental cleanup and was able to complete 123 projects at 17 sites.

According to DOE in May 2015, 11 of the post CD-2 projects (1/3) were at risk of breaching or were expected to breach their performance baseline. Three of the most infamous of the “red” projects are very large and are managed by commercial contractors, not laboratories. One is an NNSA project, and the other two are EM legacy projects. The following sections give in-depth background on these three projects to highlight the management challenges they pose, though they are unrelated to laboratory management. As discussed further in Section b, there are no “red” laboratory projects.

Table 38. **Current DOE Project Summary: Laboratory and Non-Laboratory Projects**

Program	Total Project Portfolio		Total On-Hold Projects Pre CD-2		Total Active Projects Pre CD-2		Total Active Projects Post CD-2		Total Projects Post CD-2 Green		Total Projects Post CD-2 Yellow		Total Projects Post CD-2 Red		% of Post CD-2 Projects or Total Program $ with Acceptable Status	
SC	27	$6.2B	4	$1.8B	10	$3.2B	13	$1.2B	13	$1.2B					100%	100%
NNSA	19	$14.9B			11	$9.1B	8	$5.8B	4	$285M	3	$652M	1	$4.9B	88%	16%
EM	30	$51.6B	6	$1.7B	13	$31.9B	11	$18.0B	4	$2.6B			7	$15.5B	36%	14%
EERE/NE	3	$563M			2	$485M	1	$78M	1	$78M					100%	100%
Total	79	$73.2B	10	$3.5B	36	$44.6B	33	$25.1B	22	$4.1B	3	$652M	8	$20.3B	76%	19%

Note: The last column has two sub-columns with percentages based on two measures of success provided by APM. On the left is the percentage of a *program office’s projects that are successful*. On the right is the *percentage of program dollars in successful projects*. DOE includes yellow projects in the “successful” category.

1) Mixed Oxide (MOX) Fuel Fabrication Facility

In 2000, the U.S. and Russia signed a Plutonium Management and Disposition Agreement for the disposal of surplus weapons grade plutonium. Under the agreement, each country was to dispose of at least 34 metric tons of plutonium by converting it to mixed oxide fuel that can be used in commercial nuclear power reactors. To carry out the U.S. responsibilities under the agreement, NNSA constructed the MOX facility at the Savannah River Site near Aiken, South Carolina. The MOX facility is currently managed and operated by Shaw AREVA MOX Services, LLC.

DOE recently delineated the problems of the MOX facility: (l) inadequately experienced Federal or contractor staff on the project teams; (2) inadequate nuclear experience and expertise due to atrophy of the nuclear industry; and (3) inadequate contract structure and incentives, including misalignment of contract incentives to best support project execution.[355]

Potential new cost estimates for construction are much higher than the official CD-2 cost baseline of $4.9 billion. The contract estimates construction cost of $6.7 billion, while DOE's APM forecasts $12 billion. NNSA estimates a MOX facility life-cycle cost of $30 billion or more when including both construction and 30 years of operations (but not decommissioning and demolition). The current facility must be critically examined alongside other options and associated costs in order to complete the important plutonium disposition mission in the most cost effective manner. DOE has completed a preliminary review of these options, but has not decided on the path forward.[356]

2) Waste Treatment and Immobilization Plant (WTP)

The purpose of this EM multi-facility legacy project in Richland, Washington is to design, construct, and transition to an operating contractor a chemical processing plant. The plant will treat 56 million gallons of hazardous chemical and radiological waste to prepare it for disposal at a permanent national geological repository. In general, most of the cleanup activities at Hanford are carried out under the Hanford Federal Facility Agreement and Consent Order, to which DOE, the Washington State Department of Ecology, and the Environmental Protection Agency are parties.

The agreement, initially signed in 1989, establishes a series of legally enforceable milestones for completing many major waste treatment and clean-up activities at Hanford. Due to continuing delays in the WTP project, Washington State sued DOE in Federal court and, in 2010, the Department and the State entered into a consent decree that included various milestones leading up to completion of WTP construction by 2019 and initial operation by 2022. Primarily because of unresolved technical issues, many of these dates are unlikely to be met. Beginning in 2013, DOE and Washington State attempted to negotiate a modification to the consent decree, but agreement could not be reached and both sides have since submitted motions to Federal court with different versions of a modification. The parties are waiting for the court's ruling, which may be followed by further hearings on work scope and schedule. The court's ruling on the motions could substantially affect the path forward for the project. Because of the existing consent decree, DOE cannot unilaterally deviate from the plan to complete the WTP.

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[355] DOE, *Root Cause Analysis of Cost Increases for the Mixed Oxide Fuel Fabrication Facility and Waste Solidification Building Projects, and Other Cost Information, Report to Congress,* (Washington, DC: DOE, January 2015).

[356] DOE. *Report of the Plutonium Disposition Working Group: Analysis of Surplus Weapons-Grade Plutonium Disposition Options*. (Washington, DC: DOE, April 2014).

The WTP's CD-2 cost baseline—revised in 2006—has an estimated cost of $12.3 billion with a completion date of November 2019 (the original approved cost in 2003 was $5.8 billion with a completion date of July 2011). Even with the new baseline, APM scores this project "red" on scope, schedule, and cost. Due to the uncertainties of the legal process, no official new cost or schedule has been developed for the project.[357]

3) River Corridor Closure Project

This EM project at the Hanford, Washington site has a CD-2 baseline cost of $2.3 billion. The purpose of this project is to clean up areas of the Hanford site located in the Columbia River Corridor to a condition suitable for preservation, recreation and industrial uses, as appropriate. Over 500 contaminated waste sites need to be remediated, 480 facilities demolished, and 5 plutonium production reactors put in interim safe storage. According to APM, the project remains red because of significant anticipated delays and cost growth. The project is in the process of being re-baselined.[358]

The following additional findings stem from the DOE project data:

- The number of projects in the Department at the CD-2 stage has dropped significantly over the last 7 or 8 years, largely because of the decline in budget resources after the one-time spike of almost $6 billion in ARRA funding.
- About 42 percent of all projects are at the post CD-2 stage, that is, they have officially approved cost and performance baselines. The subset of post CD-2 laboratory projects is performing well.
- Of the post CD-2 projects, there is a distinct performance pattern along size lines, consistent with GAO's high-risk assessment report that removed smaller EM and NNSA projects off of its High-Risk list. Based on APM's data, smaller NNSA and EM projects are faring well, while larger ones are not.
- Forty-six (58 percent) of the pre-CD-2 projects are on hold or in an earlier stage of development. Six of these pre-CD-2 projects are large (equal to or over $750 million). The two most costly are EM projects: the Calcine Disposition Project at Idaho ($2 billion to $16 billion cost range); and the Integrated Facility disposition Project ($9.3 billion to $14.1 billion cost range) at Oak Ridge.

[357] DOE Office of Acquisition and Project Management, *May 2015 Monthly DOE Project Portfolio Status Report*, (Washington, DC: DOE, 2015). Also, information received in email from APM.

[358] *Ibid.*

b. Laboratory-Only Projects

As shown in Table 39, laboratory-only projects constitute 47 (just under 60 percent) of the 79 total projects. Nineteen of these 47 are post CD-2 active projects. There is a single "yellow" laboratory project, and all other laboratory projects have green scores from DOE as of May 2015. One smaller project at Los Alamos was assessed by DOE to be at risk of breaching its baseline (see yellow column). Moreover, in contrast with non-laboratory projects, none of the post CD-2 laboratory projects are expected to breach their performance baseline. The total cost of the 19 post-CD-2 laboratory projects is just $1.6 billion, with an average cost of about $84 million.

Table 39. Current DOE Project Summary: Laboratory Projects Only

Program	Total Project Portfolio		Total On-Hold Projects Pre CD-2		Total Active Projects Pre CD-2		Total Active Projects Post CD-2		Total Projects Post CD-2 Green		Total Projects Post CD-2 Yellow		Total Projects Post CD-2 Red	% of Post CD-2 Projects or Total Program $ with Acceptable Status	
SC	27	$6.2B	4	$1.8B	10	$3.2B	13	$1.2B	13	$1.2B				100%	100%
NNSA	10	$2.5B			6	$2.2B	4	$299M	3	$207M	1	$92.7M		100%	100%
EM	7	$16.7B	1	$560M	5	$16.1B	1	$31M	1	$31.0M				100%	100%
EERE/NE	3	$563M			2	$485M	1	$78M	1	$78M				100%	100%
Total	47	$26.0B	5	$2.3B	23	$22.0B	19	$1.6B	18	$1.5B	1	$92.7M		100%	100%

Note: The last column has two sub-columns with percentages based on two measures of success provided by APM. On the left is the percentage of a *program office's projects that are successful*. On the right is the *percentage of program dollars in successful projects*. DOE includes yellow projects in the "successful" category.

Another 28 laboratory projects are pre-CD-2 (both active and on hold) and they have an aggregate preliminary cost of just over $24 billion—almost $17 billion of that is devoted to six EM projects. Fourteen of the pre-CD-2 projects are in SC at a combined cost of $4 billion, highlighting their smaller average project size.

3. Case Studies of Earlier-Stage (pre-CD-2) Large Projects

Below are descriptions of two ongoing large projects that are in earlier stages of development. A fundamental challenge posed by such large projects is their need for high levels of resources, especially when juxtaposed against a constrained budget environment.

One of these is located at a laboratory and the other is located at a production plant. Both have received high levels of scrutiny.

a. Chemistry and Metallurgy Replacement Research (CMRR) Facility at Los Alamos National Laboratory

NNSA has considered CMRR critical to maintaining the Nation's plutonium infrastructure capability, a key part of the nuclear Stockpile Stewardship Program. Some critics concerned about non-proliferation have raised questions about the need for CMRR, in particular, voicing concerns about its link to increased pit production, and whether that is necessary or desirable.

The original plan for the CMRR facility was to proceed in three phases at Los Alamos. The first phase was to construct the Radiological Laboratory, Utility, and Office Building (RLUOB); the original 2005 cost for this phase was $164 million. The final cost to finish it in 2010 was $199 million.

The second phase for the RLUOB equipment installation was completed in 2013 with a final cost of $197 million (original cost in 2009 was $199 million). The third phase was the Nuclear Facility (CMRR-NF), the costs of which increased significantly in a short period. In 2009, the cost range was $745 to $975 million; by 2010, Los Alamos estimated it to be $3.7 billion to $5.9 billion. The purpose of this facility was to increase the capacity to produce plutonium pits, provide replacement laboratory space for activities currently occurring in aging facilities at Los Alamos, and provide additional storage space for plutonium and other nuclear material.

Given the high costs of CMRR-NF, construction was first deferred for 5 years and then the project was cancelled in 2014. In lieu of constructing the Nuclear Facility, NNSA developed a new plutonium infrastructure strategy, with the first two steps of this strategy funded in the FY 2015 President's budget. This strategy was endorsed in a case analysis jointly conducted by DOE/NNSA and DOD's Office of Cost Assessment and Program Evaluation. The new strategy will maximize use of the RLUOB, reuse the existing 35-year-old plutonium facility, and evaluate options for modular additions to the existing facility. According to NNSA, the total cost of the project under the new strategy will be between $2.4 billion and $2.9 billion.[359]

b. Uranium Processing Facility (UPF)

UPF will be located at NNSA's Y-12 National Security Complex to store and process enriched uranium in a single centralized area. This will support nuclear nonproliferation and provide uranium as feedstock for fuel for naval reactors. The UPF

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[359] See DOE Office of Acquisition and Project Management, *May 2015 Monthly DOE Project Portfolio Status Report*; see also DOE, *FY 2016 Budget Request – National Nuclear Security Administration*, (Washington, DC: DOE, February 2015), 343.

cost estimates have escalated: at CD-0, the cost range was $600 million to $1.1 billion; at CD-1, the range estimate was $4.1 billion to $6.4 billion.[360]

While UPF is not located at a laboratory, NNSA tasked a group of laboratory staff members to review the project's cost, schedule, and scope challenges. In its final report, the laboratory "Red Team" concluded that the facility did not have to be a single big box facility but rather could be a series of smaller, segregated facilities designed and constructed to meet individual safety and security criteria.[361] The "Red Team" recommended minimizing the nuclear footprint, building non-nuclear buildings where appropriate, and using existing infrastructure at Y-12. The report concludes that the cost of the new approach will be at the high end of the CD-1 cost range—$6.4 billion. NNSA plans to continue to refine the final project cost and schedule baseline following 90-percent completion of the design.

D. Why Office of Science Has Better Performance

Both historical and current project performance data underscore SC's superior performance, even with having constructed the world's largest collection of 27 scientific user facilities.[362]

To explain their successful record, SC officials credited their disciplined culture, which dates back several decades. SC's Office of Project Assessment has played and continues to play a significant and effective role in project oversight. SC also engages in a collaborative peer review process within the scientific community. These peer reviews are regular, recognized by the science community, and facilitate active sharing of lessons learned from other projects. Internal project advisory committees and users of science facilities also provide valuable input throughout the project life-cycle.

NNSA established a similar project management office only recently, staffing it in August 2011. Furthermore, due to its national security mission, NNSA is a more closed environment than SC. It also has to have a close working relationship with DOD in carrying out its mission, which complicates project management and can lead to disagreements about who sets the requirements and who pays the bill. Furthermore, high levels of classification in nuclear security issues can hinder transparency and independent high-quality peer reviews.

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[360] *Ibid*.

[361] Thom Mason (chair), *Final Report of the Committee to Recommend Alternatives to the Uranium Processing Facility Plan in Meeting the Nation's Enriched Uranium Strategy*, (Oak Ridge, TN: ORNL, April 2014).

[362] Meador, "Office of Science, Projects Perspective."

SC projects are technically complex; they can involve high energies, extreme temperatures, strong magnetic fields, exotic materials, demanding tolerances and high-reliability requirements. However, generally they do not have to meet nuclear facility safety standards because they do not involve handling of special nuclear materials. Nor is SC building projects in response to or compliance with consent decrees, as is the case with EM. Consent decrees can reduce flexibility in defining project requirements or, at a minimum, require EM to obtain buy-in from other stakeholders such as the State where the site is located or the Environmental Protection Agency.

SC projects are typically "designed to cost" with a goal of maximizing science capability. According to one NNSA official, SC's scope requirements are more malleable, "they can build one rather than two beamlines in their accelerator if necessary. We do not usually have that kind of flexibility." SC counters this argument by pointing to the fact that it had no major de-scoping of projects after final approved baselines at CD-2 from 2002 to 2014 (as far back as it has data). SC also engages in careful up-front planning and the estimation and execution of contingency funds as a way of protecting cost, schedule, and scope. Contingency funds can be released only by a Federal Project Director in order to maintain the integrity of the process.

Despite notable differences in the nature of SC projects and their operating contexts, other offices can still learn from SC experience:[363]

- Clarity of project purpose and benefits in tandem with clear communication to all stakeholders.
- Strong working and personal relationships within the project team.
- Front-end planning to mitigate risk and the use of contingencies to address what risk remains.
- Stable project funding.
- Project reviews to keep the project on track and build credibility.

While some of the above are not wholly within the program office's control – such as stable project funding – a disciplined approach to what can be controlled has been critical to SC's successful record.

[363] From Daniel R. Lehman, Office of Project Assessment, Office of Science, February 2011, http://www.science.doe.gov/opa.

E. Recent Efforts by DOE Senior Management to Improve Project Management

The level of effort by senior DOE officials to improve project and program management has intensified recently. In December 2012, the former Deputy Secretary of DOE issued a DOE-wide memorandum that emphasized: (l) upfront planning and requirements definition; (2) using fixed-price contracts as an initial default or using objective performance measures and linking fee to final outcome in the case of cost-reimbursable contracts; and (3) documenting contractor performance.

More recently, the Secretary of Energy has given considerable high-level attention to project management through three major actions:

1. Reorganized DOE to create an Under Secretary for Management and Performance focused specifically on improving project management and performance. As of the writing of this report, the nominee for this position has not yet been confirmed.
2. Requested an internal working group with representatives from across DOE to examine project management issues within the Department. In November 2014, this group produced a report on project and contract management with 21 recommendations[364].
3. Issued mandatory guidance to the Department on December 1, 2014, and June 8, 2015, with key components stemming from the internal working group's recommendations. APM will amend DOE's Order 413.3B to incorporate the guidance to institutionalize these changes. The requirements now apply to all projects having a TPC equal to or more than $10 million (formerly it was $50 million).

Highlights of the Secretary's guidance follow:

- **Strengthens the role of the Energy Systems Acquisition Advisory Board (ESAAB)**. The ESAAB provides enterprise-wide expertise and perspective on individual projects to the Deputy Secretary. For capital projects with a TPC of $750 million or greater, the ESAAB supplies recommendations as projects move through DOE's critical decision process. The ESAAB also convenes at least quarterly to review all capital asset projects with a TPC of $100 million or greater, especially targeting those at risk of not meeting baselines.

[364] DOE, *Improving Project Management: Report of the Contract and Project Management Working Group*, (Washington, DC: DOE, November 2014).

- **Establishes a new Project Management Risk Committee comprised of DOE's project management experts across its major program offices**. This committee provides project management risk assessment and expert advice to the Secretary, other senior DOE officials, and the ESAAB, on cost, schedule, and technical issues for capital asset projects with a TPC of $100 million or greater. Based on interviews with key members across DOE, this process appears to be working well.
- **Designates a clear project owner for each project** (the person who identifies the mission need and is responsible for the budget to support the mission need). Each Under Secretary is also to establish a clear line of functional responsibility that extends from the Under Secretary to the project owner to the Federal Project Director.
- **Establishes, if it does not exist, a project assessment office within each program office.** These offices do not have line management responsibility for project execution, but have a direct line of responsibility to the appropriate Under Secretary. Within their program purview, they are responsible for conducting peer reviews of projects that have a TPC of $100 million or greater.
- **Conducts an alternatives analysis for projects independently of the contractor organization responsible for the proposed project.** Program Offices must conduct the alternatives analysis at a minimum at CD-1, but may also perform one if there is a deviation from the performance baseline or if new technologies or solutions become available.
- **Requires that nuclear construction projects achieve at least 90 percent design completion before approval of a performance baseline, which must include up-to-date and detailed cost estimates.** For non-nuclear project construction designs, the requirement is less specific. The designs must be sufficiently mature for the program to ensure, with at least 80 percent confidence, a complete and accurate project baseline. All projects greater than $100 million still go through a review at CD-1 by the DOE-wide Project Management Risk Committee.
- **Uses established methods and best practices in developing and communicating project costs**. Such estimates will be consistent with methods and the best GAO practices and, when applicable, with requirements of the Federal Acquisition Regulation.
- **Fully funds projects of $50 million or less**. Full funding was not requested in DOE's FY 2016 budget request because it was too late. DOE officials report that this new policy will begin with the FY 2017 request.

- **Establishes a Project Leadership Institute.** The goal of this institute is to create and sustain a culture of project delivery excellence within the entire Department. Unsurprisingly, SC has the lead.

F. DOE Program Management

The management of large programs, as opposed to construction projects or acquisition of capital assets, presents both different and similar management challenges. The range of challenges include: achieving goals that may take years or even decades; addressing extraordinary technical complexity; meeting nuclear safety standards; maintaining and developing needed workforce capability; managing organizational complexity both within and outside DOE (contractors, State and local governments, other Federal agencies); estimating out-year program costs and schedules; and implementing programs within an increasingly difficult budget environment both in terms of the processes and overall fiscal constraints.

The Commission did not review all programs across DOE, nor is there a centralized data set available on program management, as there is for project management. The Commission instead focused on two large multi-billion-dollar program areas administered by the Department: Environmental Management (EM) and the group of Life Extension Programs (LEPs) for nuclear weapons. Combined, they represent about one half of the DOE budget (approximately $15 billion in the 2016 request). The EM program is primarily administered by non-laboratory contractors within a highly regulated framework of consent decrees. The LEP programs are executed by the NNSA laboratories – Lawrence Livermore, Los Alamos, and Sandia.

1. Environmental Management

One of the major missions of the Department is the clean-up of the legacy of nuclear weapons production and government-sponsored nuclear research. DOE has spent almost $160 billion to date on cleanup and has completed restoring 91 of 107 major sites, although many of the completed sites are small with only slight contamination. EM is still working on the most challenging and high-risk sites. Deferral of this work has significantly increased the life-cycle cost of the EM program.

DOE estimates that the cost of this work could range from $187 to $223 billion over the next 10 years but that assumes expenditures consistent with a “compliance budget” (that is, meeting all requirements and milestones of DOE-signed consent decrees). However, the resource needs of a full “compliance budget” considerably exceeds the annual funding that EM has received in recent years (about $5 to $6 billion annually).[365]

According to SEAB, the current EM budget for technology development is about 0.2 percent of the EM budget, or around $13 million. Yet, direct funding for technology development is not the only source of funds for EM R&D. For example, Savannah River National Laboratory reported its FY 2015 budget was $215 million, stemming from NNSA and other Federal agencies, among other sources.[366]

Completion of the most-difficult-to-clean-up sites will depend greatly on new technology. In 1995, the NRC noted that an effective technology-development program should focus on new technology and processes to reduce the costs of, or risks associated with, remediation and waste management. The authors also underscored the need for more basic science researchers to be involved in the challenges of DOE's remediation effort, with more interaction between creative and innovative researchers and the "customers" with the remediation or waste minimization problems.[367] In a similar vein, a recent SEAB report recommended:

- more budgetary resources for new technology development and new research programs focused on EM challenges (bringing the research and development share of the EM budget to about 3 percent or between $140 to $185 million);
- broad participation of universities, national laboratories, and industry in these programs;
- rigorous peer reviews; and,
- periodic evaluations of program effectiveness.

The SEAB review concluded that there is a need for a comprehensive reexamination of the EM program because of fundamental conflicts among deadlines in compliance agreements, regulatory requirements, budget resources, and available technology.[368]

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365 SEAB, *Report of the Task Force on Technology Development for Environmental Management*, (Washington, DC: DOE, 2014); also*, Presentation to the Task Force by the Office of Environmental Management* (July 15, 2014).

366 From information provided to Commission by Savannah River.

367 National Research Council, Committee to Evaluate the Science, Engineering, and Health Basis of the DOE's Environmental Management Program, *Improving the Environment: An Evaluation of DOE's Environmental Management Program*," (Washington DC: NRC, 1995), 21.

368 SEAB, *Report of the Task Force on Technology Development for Environmental Management*.

2. Life Extension Programs (LEPs)

DOE, through NNSA, has responsibility for overseeing the nuclear weapons cycle, including development, production, maintenance, and retirement. DOE/NNSA carries out these activities in partnership with DOD. The primary challenge is to repair or replace components of nuclear weapons thereby ensuring reliability of the aging stockpile. By extending the "life" of nuclear weapons for 20 to 30 years, NNSA can maintain a meaningful nuclear deterrent without producing new weapons. Each facility in the nuclear weapons complex contributes to this process.

NNSA's leadership asked the Aerospace Corporation to conduct an independent assessment of the LEPs, which was completed in 2012. The assessment focused on: (1) plans in place to manage staffing and workforce; (2) cost and schedule estimating and budgeting processes; (3) technology and manufacturing readiness; and (4) systems engineering and risk management.[369] The final report provides in-depth observations about some of the management challenges in this program. Selected observations and findings emphasize:

- Strong concern about the adequacy of skills and experience of the workforce. The report notes a high percentage of the workforce is eligible for retirement and that challenges in recruiting and retaining those with sufficient critical skills put the mission at risk.[370]
- Need for improved cost estimation and program-budget presentation.
- Need for weapons focused technology development. One recommendation states: "Establish a program, open to all sites and laboratories, and commercial industry to allow for competition on a selected set of targeted technology developments."[371]
- Inadequate validation of requirements by an *independent* entity.[372]
- A disconnect between DOD and NNSA that increases the possibility of the NNSA contractor teams working towards different goals and objectives than those officially recognized by the relevant DOD organizations.

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369 Aerospace Corporation, *Independent Assessment of Life Extension Program Phase 6.X Process*, Report No. ATR-2012(5709), (Washington, DC: NNSA, 2012).

370 Aerospace Corporation, *Independent Assessment*, 23.

371 Aerospace Corporation, *Independent Assessment*.

372 GAO also criticized NNSA for inadequate validation of requirements. See GAO, *Nuclear Weapons: NNSA and DOD Need to More Effectively Manage the Stockpile Life Extension Program*, GAO-09-385, (Washington, DC: GAO, 2009).

The 2014 report by the Augustine-Mies panel also noted year-to-year variation in costs and schedules for the delivery of several major LEPs and nuclear facilities.[373] GAO pointed to a $27 billion increase in the estimates from 2014 compared with the 2012 estimates for the same twenty year time period. GAO has recommended that DOE require the use of widely accepted best practices in cost estimating.[374] As an example, it noted that NNSA did not require NNSA program managers or its contractors to follow any DOE or NNSA requirements or guidance for the development of a program cost estimate when developing the estimate for the B-61 LEP.[375]

NNSA has taken steps to address some of these concerns. NNSA designated a Federal program manager for the major LEP activities underway. NNSA has also recently implemented earned value management principles for LEP activities. According to NNSA, its organizations will "work closely with the laboratories and plants to detail work scope and schedules for specific activities needed to support the LEPs." These actions will "improve NNSA's LEP management, coordination and decision-making rigor."[376]

In response to a requirement in the National Defense Authorization Act for FY 2014, NNSA also established the Office of Cost Estimating and Program Evaluation (CEPE) to provide independent, data-driven analysis of all aspects of the nuclear security enterprise. CEPE's functions are intended to parallel those of the office in DOD referred to as Cost Assessment and Program Evaluation (CAPE).

CEPE must build capability in the areas of cost estimation, program evaluation, cost data collection, and system engineering. It is slated to lead analyses of alternatives for major programs and projects, which will serve as the basis for assessing and validating program requirements. But how these activities will be implemented and their effect on program and project decision-making are yet to be determined.

G. Findings and Recommendations

The Commission has formulated the following findings for DOE project and program management:

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373 Augustine-Mies, *A New Foundation for the Nuclear Enterprise*.

374 GAO. *Project and Program Management: DOE Needs to Revise Requirements and Guidance for Cost Estimating and Related Reviews*. (Washington, DC: GAO, November 2014).

375 GAO, *Department of Energy's Contract Management for the National Nuclear Security Administration and Office of Environmental Management," 2015 High Risk Report.* Washington, DC: GAO, February 2015).

376 NNSA. *Comments on the Final Report of the Congressional Advisory Panel on the Governance of the Nuclear Security Enterprise, Report to Congress,* (Washington, DC: NNSA, May 2015).

- The subject of DOE project and program management has been addressed in various reviews and reports over many years. DOE has responded to concerns with a series of policy and organizational changes. Such efforts have intensified recently.
- The primary challenge going forward is one of institutionalizing the policy changes from headquarters and making sure that changes are implemented in a disciplined manner throughout DOE and its contractor community. If they are not, DOE's progress toward continued improvement will be at risk.
- DOE's efforts are having some success as measured by the data analysis presented here. GAO has acknowledged the good management performance of SC overall and of NNSA and EM for smaller projects. Current CD-2 projects managed by National Laboratories also indicate a positive record.
- DOE is moving in the direction of building capacity for project and program management and developing a more singular management culture across the Department, but sustained effort is needed.
- Funding instability adds to project management challenges and can hurt project performance. A good part of meeting this challenge is outside the purview of those running the programs or projects and points to the need for more certainty of funding.
- Significant or potential performance issues still exist for large EM and NNSA projects (equal to or over $750 million in cost) that often have both technical and organizational complexity. Such projects may deal with special nuclear materials for weapons or radioactive waste and sometimes involve two major departments or other levels of government that do not always work well together. Mostly, these projects are managed by non-laboratory contractors.
- DOE is moving in the direction of building capacity for project and program management and developing a more singular management culture across the Department, but sustained effort is needed.
- Funding instability adds to project management challenges and can hurt project performance. A good part of meeting this challenge is outside the purview of those running the programs or projects and points to the need for more certainty of funding.

Based on these findings, the Commission has formulated the following major recommendations for DOE project and program management:

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.

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.

The Commission has the following additional recommendations:

- DOE should consider adopting a lower cost threshold to trigger reexamination of the selected alternative. Conducting serious, independent, and informed analyses of alternatives has been a continual theme in previous reports with which the Commission heartily concurs. Currently, DOE uses two thresholds: either a 50 percent or $100 million increase in the selected alternative's cost triggers a review. A lower threshold of 25 percent would be more in line with other Federal agencies engaged in similar projects.
- DOE should improve the adequacy and security of project funding through full funding, management reserves and contingencies, and more transparent budget presentations.
  - Full funding: given the importance of stable and secure funding for effective project management cited by several DOE officials, the Commission applauds the Department's move to a full funding policy for projects over $50 million. The Commission would support raising the threshold even higher (such as $200 million). Moving to full funding would also bring DOE more in line with practices at the OMB policy and DOD. An alternative to upfront funding that achieves the same benefits for project management is to request advance appropriations where DOE would request the amount of annual budget authority needed annually over a multi-year period and Congress would appropriate in advance those annual amounts for future years. DOE would have the assurance of funding for the project as needed in future years but only be able to obligate the amounts of advance-appropriated funds in those subsequent years. (A description of how this works can be found in OMB Circular 11.) This approach reduces the need for a major spike in resources in the first year that creates more difficult tradeoffs in an era of constrained discretionary resources.
  - Management reserves and contingencies: DOE needs to improve its estimation of contingencies according to DOE's own internal working group report on project management in 2014. The Office of Science has a good

practice in this regard of setting aside funds for contingencies (see earlier discussion). DOE should also provide strong incentives to contractors to increase their management reserves. An APM official indicates that this is beginning to happen. Underestimating project costs occurs for several reasons but a key one is fear that DOE, OMB, or Congress will reject the project if they know the full cost. There is a corollary incentive to keep costs down in order to spread scarce resources around to a larger number of projects so that they can all be funded at least partially. However, in the longer run, these practices undermine project performance, raise costs, and delay completion.

  – Capital assets, program plans and budget presentation: Lastly, DOE budget presentations could be more transparent manner and show the out-year costs of all department-wide projects and programs. Such information would clarify existing programmatic baseline costs and multi-year costs of projects at all stages to clarify the implications for budget topline. Recent guidance by DOE that requires each program office to develop an integrated capital asset project priority list is a first step in this direction as it enables DOE leadership to make more informed decisions within constrained resources.

- DOE should consider whether a new process bringing high-level DOE attention to <u>project</u> management should be extended, in some form, to <u>program</u> management. This process could focus on selected programs where outside reviews point to management or other issues that impede or risk satisfactory performance. For example, the department should consider a high-level review process recently initiated by Secretary Moniz for capital assets and construction projects to examine, on an on-going basis, how programmatic issues identified by these outside reviews (such as for LEP efforts) are being addressed. This is especially merited in programs such as EM and LEPs that involve extensive inter-departmental or inter-governmental relationships.

16. Lack of Meaningful Change after Previous Reports

A. Introduction

The Commission recognizes that an abundance of studies focused on DOE mission and management have been conducted by various external commissions or panels over the past two decades. This Commission's effort falls within the context of no less than four recently released studies specific to DOE or NNSA.[377] The Commission is therefore concerned about the steady accumulation of lengthy reports with different scopes, diverse objectives, and various political drivers. 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.[378] The Commission's approach has included in-depth analysis and use of previous studies.

The Commission's charge is distinct relative to most other studies in its review of the effectiveness of all 17 of the DOE laboratories, including their alignment with DOE's strategic priorities; their unique or duplicative missions and core capabilities; and their ability to evolve, plan, and prepare for the future. Of the reports the Commission reviewed, only the 1995 Galvin Report, *Alternative Futures for the Department of Energy National Laboratories*, and the 2013 National Academy of Public Administration (NAPA) report, *Positioning DOE's Laboratories for the Future: A Review of DOE's*

[377] Congressional Advisory Panel on the Governance of the Nuclear Security Enterprise (Augustine/Mies panel), *A New Foundation for the Nuclear Security Enterprise*; National Research Council (NRC), *Aligning the Governance Structure of the NNSA Laboratories to Meet 21st Century National Security Challenges* (Washington, DC: National Academies Press, 2015); Secretary of Energy Advisory Board (SEAB), *Interim Report of the Task Force on Nuclear Nonproliferation* (Washington, DC: DOE, 2014); NRC, *Peer Review and Design Competition in the NNSA National Security Laboratories* (forthcoming).

[378] While not instigating Department-wide reform, these earlier reports have had some influence on important elements of the Department's mission. For example, the Foster Panel reports positively impacted the technical processes relevant to certification of the nuclear weapons stockpile and the Blue Ribbon Commission on the Use of Competitive Procedures for Department of Energy Laboratories, in part, catalyzed important improvements to the evaluation processes adopted by the Office of Science beginning in 2004. See Panel to Assess the Reliability, Safety, and Security of the United States Nuclear Stockpile ("Foster Panel"), *FY 2001 Report of the Panel to Assess the Reliability, Safety, and Security of the United States Nuclear Stockpile* (Washington, DC: 2002), 2 and 23–24; and Blue Ribbon Commission on the Use of Competitive Procedures for Department of Energy Laboratories, *Competing the Management and Operations Contracts for DOE's National Laboratories* (Washington, DC: DOE, 2003), 17.

Management and Oversight of the National Laboratories covered all of the DOE laboratories in such a sweeping fashion. Of note, despite being almost 20 years apart and having different emphases, some of the findings of these two reports are remarkably similar to each other with respect to the lack of a strategic, integrated "laboratory system" approach and the breakdown of the FFRDC model. This latter issue is associated with highly compliance-focused government oversight, which has negative implications for the scientific enterprise, as subsequently discussed in more detail.[379]

Each of the studies conducted since the Galvin Report has had a different scope or focus related to the mission, management, and future of the national laboratories. Not unlike the current Commission's study, previous studies were catalyzed by a specific issue of the time, such as mission execution, security breaches, and budgetary concerns. Most of the studies to date have focused on the nuclear weapons mission and its associated laboratories or production sites, but even the importance of the weapons mission has, at times, yielded to overarching concerns regarding the management of the laboratories or the effectiveness of security within the Department.

In the late 1990s, mounting concerns regarding the management of the weapons enterprise, combined with security scandals and allegations of espionage,[380] culminated in Congress establishing the NNSA in 2000 as a "separately organized" entity within the Department of Energy.[381] However, this change has done little to address the enterprise's challenges in mission execution or its significant failings in program management and security, major concerns highlighted by studies prior to NNSA's establishment.[382] As the most recent study on NNSA, the Augustine/Mies panel report. noted, the "unmistakable conclusion is that NNSA governance reform, at least as it has been implemented, has

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[379] SEAB, *Alternative Futures for the Department of Energy National Laboratories*, 6; and NAPA, *Positioning DOE's Laboratories for the Future*, 13, 23 and 75.

[380] Concern surrounding the nuclear weapons mission were encapsulated by the first Foster Panel Report: Panel to Assess the Reliability, Safety, and Security of the United States Nuclear Stockpile, *FY 1999 Report of the Panel to Assess the Reliability, Safety, and Security of the United States Nuclear Stockpile*. Fears of Chinese espionage were advanced by the so-called Cox Commission Report (U.S. House of Representatives Select Committee on U.S. National Security and Military/Commercial Concerns with the People's Republic of China, *Final Report* (Washington, DC: 1999)). Laboratory security came to the fore in President's Foreign Intelligence Advisory Board (PFIAB) report entitled *Science at its Best, Security at its Worst: A Report on Security Problems at the US Department of Energy* (Washington, DC: 1999). All this was in the midst of a scandal surrounding Wen Ho Lee, a Taiwanese-born scientist at Los Alamos National Laboratory who was accused of espionage ("Trade Secrets," *The Economist*, February 7, 2002. http://www.economist.com/node/975548).

[381] National Nuclear Security Administration Act (Title XXXII of the National Defense Authorization Act for Fiscal Year 2000, P. L. 106-65).

[382] These include the 1999 Chiles Commission, the 2000 Foster Panel, and the 1999 PFIAB.

failed to provide the effective, mission-focused enterprise that Congress intended."[383] Although focused primarily on NNSA, the report noted that there are five systemic disorders that permeate the Department's culture and corresponding management challenges that must be addressed to achieve effective and efficient mission execution.[384]

Many of the reports, although heavily focused on the NNSA, emphasize that strategic priority setting and enforcement remain weaknesses within DOE. Effective execution of the mission is frequently hindered by problems in contractual oversight, unclear roles and responsibilities and the erosion of the trust upon which the FFRDC model is based. The reports that underscore ineffective establishment and enforcement of mission priorities suggest that this tendency is a result of inadequate planning and program management throughout the Department. Effective resource management is stymied by budgetary fragmentation, which is further aggravated by excessive costs for compliance-focused processes and duplicative oversight. These reports also make evident the lack of effective planning and program management capabilities with respect to long-term human capital and facility and infrastructure needs.[385]

Overall, the discontinuities among the previous reports on DOE largely stem from the scope and particular focus of each report. Despite this diversity in scope, there is remarkable convergence regarding the challenges that continue to plague the Department. Moreover, this convergence gives rise to recurring recommendations designed to address the identified challenges. Despite the recurrence of the same themes and the strength of the recommendations to help resolve the challenges they evoke, few reports have brought about the enduring, positive change intended.

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383 Augustine/Mies panel, *A New Foundation for the Nuclear Security Enterprise*, x.

384 The five disorders identified by the Nuclear Security Enterprise Governance Panel include: (1) the loss of sustained national leadership focus and priority, starting with the end of the Cold War; (2) inadequate implementation of the legislation establishing NNSA as a separately organized sub-element of DOE; (3) the lack of proven management practices; (4) dysfunctional relationships between the government and its M&O site operators, and; (5) insufficient collaboration with DOD customers. Ibid, 6.

385 For example, the reports focused on the weapons program couch this as stewardship readiness/responsiveness. See successive Foster Panel Reports from FY 1999, 2000, and 2001. The S&T reports focus on the multi-faceted nature of the mission or the importance of LDRD and want the laboratories to be given more discretion in setting the priorities. See NRC, *Managing for High Quality of Science and Engineering at the NNSA National Security Laboratories* (Washington, DC: National Academies Press, 2012). The security studies note the lack of long-term planning for tools and technologies to adequately address security and CI. PFIAB, *Science at its Best, Security at its Worst* (Washington, DC: PFIAB, 1999) and Richard Mies, *NNSA Security: An Independent Review* (Washington, DC: Sage/LMI, 2005).

B. Major Recurring Themes Produce Little Change

Even at this preliminary stage of its efforts, the Commission observes recurring themes that have emerged from its review of prior reports, the public meetings, and its laboratory visits to date.

Several reports describe a dysfunctional relationship between DOE and its laboratories, generically couched as the erosion or loss of the mutual trust required by the FFRDC model. Based on our initial observations, this difficulty is not uniformly experienced across the laboratories, and its severity varies widely. The primary factors affecting severity of the challenges faced are which office within DOE acts as the laboratory's sponsor and the role assumed by the leadership and personnel at each laboratory's field office. The operational manifestations of an eroded FFRDC model are generally characterized by DOE's "micromanagement" of the laboratories and a focus on compliance as opposed to mission outcomes. This is exacerbated by confused roles and responsibilities in conjunction with ambiguous or conflicting DOE Orders and Directives which compel a focus on transactional compliance rather than effective risk management.[386] This cursory overview of recurring themes and their interrelationship has shaped the Commission's understanding and its approach. In addition, concerns over the lack of impact from all these studies weighed heavily in the Commission's considerations regarding its focus and objectives in Phase 2.

1. Broken Trust Undermines Fulfillment of the FFRDC Promise

Previous studies repeatedly underscore the breakdown of the FFRDC model as the fundamental impediment to a productive relationship between DOE and its laboratories. As stated previously, the FFRDC model is based on the premise that these entities act as "trusted advisors" to their government sponsors; the ideal relationship is that the government sponsor defines "what" problem or challenge needs to be addressed and the FFRDC delineates "how" to work towards a solution. Instead DOE engages in prescriptive management and focuses on transactional compliance. This has resulted in the imposition of additional cost due to greater oversight and in a deleterious environment for innovation.[387] The Galvin Report found that "increasing overhead cost, poor morale and gross inefficiencies as a result of overly prescriptive congressional management and excessive oversight by the Department" and an "(in)ordinate internal

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[386] See NRC, *Managing for High Quality of Science and Engineering at the NNSA National Security* Laboratories; and Augustine/Mies panel, *A New Foundation for the Nuclear Security Enterprise*.

[387] See, for example, Augustine/Mies panel, *A New Foundation for the Nuclear Security Enterprise*.

focus at every level of these laboratories on compliance issues and questions of management processes…takes a major toll on research performance."[388]

This theme of overly prescriptive management and emphasis on transactional compliance can be found in almost every report over the past two decades and represents the antithesis of how the FFRDC model was designed to operate. For example, in a detailed depiction of specific management processes and the Department's approach to oversight, the 2013 NAPA study concluded that a successful transition to a more outcome-based evaluation approach would require that DOE staff in both headquarters and the site offices "change the way they conduct business." Such a transition would also require that DOE staff "step back from overseeing and evaluating the laboratories at the transaction level and embrace a systems approach to managing the laboratories…"[389] Prescriptive management and a focus on tactical compliance rather than outcomes are but two manifestations of the breakdown in the FFRDC construct.

2. Broken Trust Fuels Operational Impediments

In an attempt to identify the most important issues for Phase 2, the Commission categorized recommendations from all the major studies, as well as relevant Government Accountability Office (GAO) and DOE Office of the Inspector General (OIG) reports from 1995 to 2014. The recommendations were then prioritized, based on frequency of the recommendation; potential impact on the enterprise; DOE-wide or NNSA specific; range of actors required for implementation (Office of Management and Budget [OMB], Congress, DOE, etc.); and unambiguous regarding the desired outcome.

The following five issues stood out in terms of the criteria (with actors involved in parenthesis):

- Budget atomization, which impedes flexibility and innovation (requires OMB, congressional, and DOE action);
- DOE Orders and Directives, which drive transactional, compliance-focused behavior at high cost and impede innovation (requires DOE action with the Defense Nuclear Facilities Safety Board as a significant "stakeholder");
- Excessive and redundant audits and inspections, which partially result from DOE Orders and Directives, but represent an issue broader than just DOE (requires multiple actors beyond DOE: non-DOE OIG, GAO, Defense Nuclear

[388] SEAB, *Alternative Futures for the Department of Energy National Laboratories,* 6.

[389] NAPA, *Positioning DOE's Laboratories for the Future: A Review of DOE's Management and Oversight of the National Laboratories,* 75.

Facilities Safety Board, Occupational Safety and Health Administration, state regulatory agencies, etc.);

- Enterprise-wide information management lacks comprehensive, reliable data, which hinders planning for workforce needs, preparing budget requests, identifying costs for activities, and ensuring validity of cost estimates (requires DOE and M&O contractor action); and
- Confused roles, responsibilities, accountability, and authority stymie a "line management" approach to NNSA's mission execution, frequently with operational support elements (safety, security, and environment) skewing incentives toward delay or excessively conservative approaches to risk (requires DOE action, both headquarters and site office).

The first three of these issues fall readily under the rubric of "transactional compliance" and could be viewed as specific, but interrelated, manifestations of a tarnished (or forgotten) FFRDC model. The impacts of these issues, individually and combined, include a further erosion of the trust requisite for proper functioning of the FFRDC construct, an assumed cost for compliance that detracts from science, and the opportunity costs to the mission. The Commission took up the fourth issue regarding enterprise-wide data as it pertains to laboratory overhead rates; these rates are a partial reflection of the transactional tasks requisite for compliance and highly relevant to the Commission's charge. The final issue is handled in a comprehensive fashion by the recent Augustine/Mies panel report.[390] The Commission fully endorses that report and urges swift action to clarify the roles, responsibilities, accountability and authorities throughout the Department, whether or not Congress legislates the statutory changes called for by the report.

The first four issues have been investigated in greater detail during Phase 2 of the Commission's work. Although earlier reports have referenced these problems and have argued for their resolution, the Commission believes that through the collection of the relevant data and extensive examination of these issues, it can proffer comprehensive, specific recommendations that will have an enduring and positive impact on DOE's management of its laboratories. Resolving these challenges also would help rebuild the relationship requisite for proper functioning of the FFRDC model.

C. Why Past Reports Have Failed to Bring About Change

Past reports have failed to catalyze needed changes for a variety of reasons. One obvious reason is that many of the recurring themes are systemic problems, both beyond

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[390] Augustine/Mies, *A New Foundation for the Nuclear Enterprise*, 21–35.

and within the DOE itself. As noted in the listing of entities relevant to the compliance issues outlined above, some of the Department's enduring challenges can be addressed only through a coordinated effort on the part of Congress and the Department's leadership, at a minimum. As the foremost historic example, the establishment of NNSA underscores that legislation is often a blunt instrument and that successful outcomes hinge on implementation.

A second prominent problem is lack of awareness or understanding of the DOE's missions and the role of the laboratories in our Nation's S&T endeavors. This is true for a broad swath of the general public as well as for Congress. Congressional attention on DOE frequently focuses on either a parochial issue or is embedded in larger divisive debates such as the role of the Nation's nuclear deterrent in today's international security environment or the role of government in advancing energy technology.

Another prominent problem, mentioned previously, is that despite the recurrence of themes and recommendations, the diverse drivers for these reports have led to voluminous, sometimes duplicative, assessments. However, there is still no persistent mechanism for assessing the implementation of appropriate recommendations or metrics to measure improvements for actions taken in response to any given report. Lastly, the rotating leadership of the Department requires institutionalizing those high-level activities that prove successful in remedying major problems. The Commission is mindful of several positive steps taken by the current Secretary and has examined possible ways to institutionalize these activities.

The Commission is intent on ensuring its final recommendations are sufficiently detailed and specify every party accountable for any action required. To the extent feasible, the Commission offers approaches to measure successful implementation of each recommendation with the hope of avoiding other pitfalls regarding report recommendations; namely, lack of accountability for implementation and misunderstandings with respect to the outcome sought. To achieve this objective the Commission has examined each of the issues listed in the previous section to identify specific reasons for the failure to act on them or why any earlier attempts at implementation failed.

D. Findings and Recommendations

Over 50 prior studies and reports published over the past 40 years detail shortcomings in the relationship between the DOE and its laboratories. Though the mandates for each assessment diverge in scope, objectives, and the members charged to fulfill them, they present a strikingly consistent pattern of criticism and recommendations for improvement. These themes include:

- Micromanagement of the laboratories by DOE headquarters and site offices.

- Excessive budget controls, which restrict the laboratories' abilities to manage resources flexibly to achieve mission responsibilities effectively and efficiently.
- Oversight practices that involve excessive numbers of site inspections, transactional oversight, and burdensome data calls.
- Past recommendations for improvement have, for the most part, had limited impact, as demonstrated by the fact that the same problems recur in report after report.
- Because root causes of these problems are hard to ascertain, recommendations from past commissions have proven difficult, if not impossible, to implement.
- There is no standing body, either within DOE or outside, to advocate for implementation, perform systematic assessments, and evaluate progress over time. Simultaneously, DOE has no institutionalized internal mechanism to assimilate, assess, and act on appropriate recommendations.

The Commission has explored options regarding future commissions, their mandates, frequency and makeup, and a systematic way to monitor and evaluate progress. Also, as part of its lessons-learned exercise regarding the failed implementation of past recommendations, the Commission evaluated what institutional mechanisms might best address this shortfall and recommends the following:

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.

Appendix A.
Commissioner Biographies

Jared L. Cohon, Co-Chair

Dr. Jared L. Cohon is President Emeritus and University Professor of Civil and Environmental Engineering and Engineering and Public Policy at Carnegie Mellon University.

Dr. Cohon served as president of Carnegie Mellon for 16 years (1997–2013). He came to Carnegie Mellon from Yale, where he was Dean of the School of Forestry and Environmental Studies from 1992 to 1997. He started his teaching and research career in 1973 at Johns Hopkins, where he was a faculty member in the Department of Geography and Environmental Engineering for 19 years. He also served as Assistant and Associate Dean of Engineering and Vice Provost for Research at Johns Hopkins. Dr. Cohon earned a B.S. degree in civil engineering from the University of Pennsylvania in 1969 and a Ph.D. in civil engineering from the Massachusetts Institute of Technology in 1973.

An author, coauthor, or editor of one book and more than 80 professional publications, Dr. Cohon is an authority on environmental and water resource systems analysis, an interdisciplinary field that combines engineering, economics and applied mathematics. He has worked on water resource problems in the United States, South America and Asia and on energy facility siting, including nuclear waste shipping and storage. In addition to his academic experience, he served in 1977 and 1978 as legislative assistant for energy and the environment to the late Honorable Daniel Patrick Moynihan, United States Senator from New York. President Bill Clinton appointed Dr. Cohon to the Nuclear Waste Technical Review Board in 1995 and appointed him as chairman in 1997. His term on the Board ended in 2002. President George W. Bush appointed Dr. Cohon in 2002 to the Homeland Security Advisory Council and President Barack Obama reappointed him in 2009. His term on the Council ended in 2013.

In 2009, Dr. Cohon was named a Distinguished Member of the American Society of Civil Engineers. He was elected to the National Academy of Engineering and to the American Academy of Arts and Sciences in 2012. He has received honorary degrees from the Korean Advanced Institute for Science and Technology, the University of Pittsburgh and Carnegie Mellon.

TJ Glauthier, Co-Chair

TJ Glauthier, President of TJG Energy Associates, LLC, is an advisor to energy companies and public agencies. He held two Presidential appointments in the Clinton Administration: at the White House as Associate Director of the Office of Management and Budget from 1993–1998, and as the Deputy Secretary and COO of the Department of Energy from 1999–2001. He also served on President Obama's transition team in 2008.

Mr. Glauthier was a member of the Congressional Advisory Panel on the Governance of the Nuclear Security Enterprise in 2013-2014.

He currently serves on two corporate boards of directors: EnerNOC, a provider of energy intelligence software, and VIA Motors, a manufacturer of electric drive pickup trucks and vans. He is an advisor to Booz Allen Hamilton's energy practice and has also served on advisory boards for numerous energy technology companies.

In addition, he is a member of the National Research Council's Policy and Global Affairs Committee, the Precourt Institute at Stanford University, and the Lawrence Berkeley National Laboratory Advisory Board.

Earlier, Mr. Glauthier was CEO of the Electricity Innovation Institute, an affiliate of EPRI, and spent twenty years in management consulting. He is a graduate of Claremont McKenna College and the Harvard Business School.

Norman R. Augustine

Norman R. Augustine was raised in Colorado and attended Princeton University where he graduated with a BSE in Aeronautical Engineering, magna cum laude, and an MSE. He was elected to Phi Beta Kappa, Tau Beta Pi and Sigma Xi.

In 1958 Mr. Augustine joined the Douglas Aircraft Company in California where he worked as a Research Engineer, Program Manager and Chief Engineer. Beginning in 1965, he served in the Office of the Secretary of Defense as Assistant Director of Defense Research and Engineering. He joined LTV Missiles and Space Company in 1970, serving as Vice President, Advanced Programs and Marketing. In 1973 he returned to the government as Assistant Secretary of the Army and in 1975 became Under Secretary of the Army, and later Acting Secretary of the Army. Joining Martin Marietta Corporation in 1977 as Vice President of Technical Operations, he was elected as CEO in 1987 and chairman in 1988, having previously been President and COO. He served as president of Lockheed Martin Corporation upon the formation of that company in 1995, and became CEO later that year. He retired as chairman and CEO of Lockheed Martin in August 1997, at which time he became a Lecturer with the Rank of Professor on the faculty of Princeton University where he served until July 1999.

Mr. Augustine was Chairman and Principal Officer of the American Red Cross for nine years, Chairman of the Council of the National Academy of Engineering, President and Chairman of the Association of the United States Army, Chairman of the Aerospace Industries Association, and Chairman of the Defense Science Board. He is a former President of the American Institute of Aeronautics and Astronautics and the Boy Scouts of America. He is a current or former member of the Board of Directors of ConocoPhillips, Black & Decker, Proctor & Gamble and Lockheed Martin, and was a member of the Board of Trustees of Colonial Williamsburg. He is a Regent of the University System of Maryland, Trustee Emeritus of Johns Hopkins and a former member of the Board of Trustees of Princeton and MIT. He is a member of the Advisory Board to the Department of Homeland Security, was a member of the Hart/Rudman Commission on National Security, and has served for 16 years on the President's Council of Advisors on Science and Technology. He is a member of the American Philosophical Society and the Council on Foreign Affairs, and is a Fellow of the National Academy of Arts and Sciences and the Explorers Club.

Mr. Augustine has been presented the National Medal of Technology by the President of the United States and received the Joint Chiefs of Staff Distinguished Public Service Award. He has five times received the Department of Defense's highest civilian decoration, the Distinguished Service Medal. He is co-author of *The Defense Revolution* and *Shakespeare In Charge* and author of *Augustine's Laws* and *Augustine's Travels*. He holds 23 honorary degrees and was selected by Who's Who in America and the Library of Congress as one of "Fifty Great Americans" on the occasion of Who's Who's fiftieth anniversary. He has traveled in over 100 countries and stood on both the North and South Poles of the earth.

Wanda M. Austin

Dr. Wanda M. Austin is president and chief executive officer of The Aerospace Corporation, a leading architect for the Nation's national security space programs. The Aerospace Corporation has nearly 4,000 employees and annual revenues of more than $850 million. She assumed this position on January 1, 2008. She is internationally recognized for her work in satellite and payload system acquisition, systems engineering, and system simulation.

Dr. Austin served on President Obama's Review of Human Spaceflight Plans Committee in 2009, was appointed to the Defense Science Board in 2010, and was appointed to the NASA Advisory Council in 2014.

Dr. Austin earned a bachelor's degree in mathematics from Franklin & Marshall College, master's degrees in systems engineering and mathematics from the University of Pittsburgh, and a doctorate in systems engineering from the University of Southern California.

Dr. Austin is a fellow of the AIAA, and is a member of the National Academy of Engineering, the International Academy of Astronautics, and the American Academy of Arts and Sciences. She also serves on the Board of Directors of the Space Foundation, and on the Board of Trustees for the University of Southern California and the National Geographic Society.

Dr. Austin has received numerous awards and citations. Among them are the National Intelligence Medallion for Meritorious Service, the Air Force Scroll of Achievement, and the National Reconnaissance Office Gold Medal. In 2010 she received the AIAA von Braun Award for Excellence in Space Program Management, and is a recipient of the 2012 Horatio Alger Award, the 2012 NDIA Peter B. Teets Industry Award, and the 2014 USC Viterbi Distinguished Alumni Award.

Dr. Austin is committed to inspiring the next generation to study the STEM disciplines and to make science and engineering preferred career choices. Under her guidance, the corporation has undertaken a number of initiatives in support of this goal, including participation in MathCounts, US FIRST Robotics, and Change the Equation.

Charles Elachi

Dr. Charles Elachi is the Director of the Jet Propulsion Laboratory and Vice President of California Institute of Technology. He is a Professor of Electrical Engineering and Planetary Science at Caltech.

Dr. Elachi was born April 18, 1947, in Lebanon. He received a B.S. in physics from the University of Grenoble, France and the Diplome Ingenieur in engineering from the Polytechnic Institute, Grenoble in 1968 where he graduated first in the class, and M.S. and Ph.D. degrees in electrical sciences from the California Institute of Technology, Pasadena in 1969 and 1971, respectively. He later received an MBA from USC (1979) and an M.S. degree in geology from UCLA (1983).

Dr. Elachi taught "The Physics of Remote Sensing" at the California Institute of Technology from 1982 to 2000. Dr. Elachi was Principal Investigator on numerous research and development studies and flight projects sponsored by the National Aeronautics and Space Administration (NASA). He was Principal Investigator for the Shuttle Imaging Radar series (SIR-A in 1981, SIR-B in 1984, and SIR-C in 1994), was a Co-Investigator on the Magellan imaging radar, is presently the Team Leader of the Cassini Titan Radar experiment, and a Co-Investigator on the Rosetta Comet Nucleus Sounder Experiment. He is the author of over 230 publications in the fields of space and planetary exploration, Earth observation from space, active microwave remote sensing, electromagnetic theory and integrated optics, and he holds several patents in those fields. In addition, he has authored three textbooks in the field of remote sensing. One of these textbooks has been translated into Chinese.

In his 40 year career at JPL, Dr. Elachi played the lead role in developing the field of spaceborne imaging radar which led to Seasat, SIR-A, SIR-B, SIR-C, Magellan, SRTM and the Cassini Radar. He received numerous national and international awards for his leadership in this field.

During the late 1980s and 1990s as the Director of Space and Earth Science programs, Dr. Elachi was responsible for the definition and development of numerous JPL flight instruments and missions for Solar System Exploration, the Origins program, Earth Observation and Astrophysics.

In the mid- to late 1990s, Dr. Elachi chaired a number of national and international committees which developed NASA roadmaps for the exploration of neighboring Solar Systems (1995), our Solar System (1997) and Mars (1998).

Paul A. Fleury

Dr. Paul A. Fleury is the Frederick William Beinecke Professor of Engineering and Applied Physics, and Professor of Physics at Yale University. He is the founding Director of the Yale Institute for Nanoscience and Quantum Engineering. He served as Dean of Engineering at Yale from 2000 until 2008. Prior to joining Yale Dr. Fleury was Dean of the School of Engineering at the University of New Mexico from January 1996, following 30 years at AT&T Bell Laboratories. At Bell Laboratories he was director of three different research divisions covering physics, materials and materials processing research between 1979 and 1996. During 1992 and 1993 he was Vice President for Research and Exploratory Technology at Sandia National Laboratories.

Dr. Fleury is the author of more than 130 scientific publications on non-linear optics, spectroscopy and phase transformations in condensed matter systems and has co-edited three books. He is a Fellow of the American Physical Society and the American Association for the Advancement of Science; and a member of the National Academy of Engineering, the National Academy of Sciences and a Fellow of the American Academy of Arts and Sciences. He received the 1985 Michelson-Morley Award and the 1992 Frank Isakson Prize of the American Physical Society for his research on optical phenomena and phase transitions in condensed matter systems.

Dr. Fleury has been a member of numerous National Research Council (NRC) study panels, including that of the 2007 National Nanotechnology Initiative review, “A Matter of Size,” as well as the 2013 NNI triennial review committee. He has served on the Secretary of Energy’s “Laboratory Operations Board” and the University of California President’s Council on the National Laboratories. He has also served on review committees for Brookhaven, Lawrence Berkeley, Oak Ridge, Sandia and Los Alamos National Laboratories and for 6 years as a member of the Visiting Committee for Advanced Technology for NIST. He is currently active Sandia, Oak Ridge and Los

Alamos advisory committees in addition to his service on the Board on Physics and Astronomy and the Laboratory Assessment Board of the National Academy of Sciences. He received his Bachelor of Science and Master of Science degrees in 1960 and 1962 from John Carroll University, and his doctorate from the Massachusetts Institute of Technology in 1965, all in physics.

Susan J. Hockfield

A noted neuroscientist, Dr. Susan J. Hockfield was the first life scientist to serve as President of the Massachusetts Institute of Technology, where she holds a faculty appointment as Professor of Neuroscience in the Department of Brain and Cognitive Sciences. Before assuming the presidency of MIT in 2004, she was Provost at Yale University, where she had taught since 1985 and had also served as Dean of the Graduate School of Arts and Sciences. A graduate of the University of Rochester, Dr. Hockfield received her Ph.D. from the Georgetown University School of Medicine, carrying out her dissertation research in neuroscience at the National Institutes of Health. An elected member of the American Academy of Arts and Sciences and an elected fellow of the American Association for the Advancement of Science, Dr. Hockfield holds honorary degrees from Brown University, Duke University, Mount Sinai School of Medicine, Tsinghua University (Beijing), University of Edinburgh, University of Massachusetts Medical School, University of Pierre and Marie Curie (Paris), University of Rochester and the Watson School of Biological Sciences at Cold Spring Harbor Laboratory in New York. Additionally, she holds a jointly-awarded honorary degree from the New University of Lisbon, the Technical University of Lisbon and the University of Porto, Portugal. She serves as a director of the General Electric Company and Qualcomm Incorporated, a trustee of the Boston Symphony Orchestra and the Council on Foreign Relations, and is a member of the board of the World Economic Forum Foundation.

In 2006 under Dr. Hockfield's leadership, MIT launched a major energy initiative, capitalizing on the Institute's deep strength in science, engineering, architecture, management and economics to pioneer the leading edge of energy and environmental research, from visionary policy recommendations to technological breakthroughs.

Richard A. Meserve

Dr. Richard A. Meserve is Senior of Counsel with Covington & Burling LLP, a large multi-national law firm. He recently stepped down as the President of the Carnegie Institution for Science after 11 years at the helm. The Carnegie Institution conducts basic research in biology, astronomy and geophysics.

Dr. Meserve served as Chairman of the U.S. Nuclear Regulatory Commission from 1999 to 2003. He was the principal executive officer of the Federal agency with responsibility for ensuring public health and safety in the operation of nuclear power plants and in the usage of nuclear materials. He served as Chairman under both Presidents Clinton and Bush and lead the Nuclear Regulatory Commission in responding to the terrorism threat that came to the fore after the 9/11 attacks. Before joining the Nuclear Regulatory Commission, Dr. Meserve was a partner in Covington & Burling LLP. With his Harvard law degree, received in 1975, and his Ph.D. in applied physics from Stanford, awarded in 1976, he devoted his legal practice to technical issues arising at the intersection of science, law, and public policy. Early in his career, he served as legal counsel to the President's science adviser, and was a law clerk to Justice Harry A. Blackmun of the United States Supreme Court and to Judge Benjamin Kaplan of the Massachusetts Supreme Judicial Court. He received his undergraduate degree from Tufts University in 1966.

Dr. Meserve has served on numerous legal and scientific committees over the years, including many established by the National Academies of Sciences and Engineering. He served on the Blue-Ribbon Commission on America's Nuclear Future established by DOE Secretary Chu at the direction of the President and currently serves as Chairman of the International Nuclear Safety Group, which is chartered by the International Atomic Energy Agency. Among other affiliations, he is a member of the National Academy of Engineering, American Philosophical Society, and Sigma Xi, and he is a Fellow of the American Academy of Arts and Sciences, the American Association for the Advancement of Science, the American Physical Society, and the Phi Beta Kappa Society. He is a Foreign Member of the Russian Academy of Sciences.

Dr. Meserve also serves on the Council of the National Academy of Engineering and of the American Academy of Arts and Sciences. He is on the Board of Directors of PG&E Corporation, Duke Energy Corporation, and the Universities Research Association, Inc. He is a member of the Visiting Committee to the MIT Department of Nuclear Science and Engineering and to the Harvard School of Engineering and Applied Physics.

Cherry A. Murray

Dr. Cherry A. Murray is Benjamin Peirce Professor of Technology and Public Policy and Professor of Physics at Harvard University. She was Dean of Harvard University's School of Engineering and Applied Sciences; John A. and Elizabeth S. Armstrong Professor of Engineering and Applied Sciences; and Professor of Physics from 2009 to 2014. Previously, Murray served as principal associate director for science and technology at Lawrence Livermore National Laboratory from 2004–2009 and was president of the American Physical Society in 2009. Before joining Lawrence Livermore, Murray was Senior Vice President of Physical Sciences and Wireless Research after a 27 year long career at Bell Laboratories Research.

Dr. Murray was elected to the National Academy of Sciences in 1999, to the American Academy of Arts and Sciences in 2001, and to the National Academy of Engineering in 2002. She received the National Medal of Technology and Innovation in 2014. She has served on more than 100 national and international scientific advisory committees, governing boards and National Research Council panels and as a member of the National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling. She chaired the National Research Council Division of Engineering and Physical Science from 2008 to 2014.

As an experimentalist, Dr. Murray is known for her scientific accomplishments in condensed matter and surface physics. She received her B.S. in 1973 and her Ph.D. in physics in 1978 from the Massachusetts Institute of Technology. She has published more than 70 papers in peer-reviewed journals and holds two patents in near-field optical data storage and optical display technology.

Appendix B. Congressional Charge

The following is the language from the Consolidated Appropriations Act, 2014:

Sec. 319. (a) Establishment—The Secretary shall establish an independent commission to be known as the "Commission to Review the Effectiveness of the National Energy Laboratories." The National Energy Laboratories refers to all Department of Energy and National Nuclear Security Administration national laboratories.

(b) Members-

(1) The Commission shall be composed of nine members who shall be appointed by the Secretary of Energy not later than May 1, 2014, from among persons nominated by the President's Council of Advisors on Science and Technology.

(2) The President's Council of Advisors on Science and Technology shall, not later than March 15, 2014, nominate not less than 18 persons for appointment to the Commission from among persons who meet qualification described in paragraph (3).

(3) Each person nominated for appointment to the Commission shall—

(A) be eminent in a field of science or engineering; and/or

(B) have expertise in managing scientific facilities; and/or

(C) have expertise in cost and/or program analysis; and

(D) have an established record of distinguished service.

(4) The membership of the Commission shall be representative of the broad range of scientific, engineering, financial, and managerial disciplines related to activities under this title.

(5) No person shall be nominated for appointment to the Board who is an employee of—

(A) the Department of Energy;

(B) a national laboratory or site under contract with the Department of Energy;

(C) a managing entity or parent company for a national laboratory or site under contract with the Department of Energy; or

(D) an entity performing scientific and engineering activities under contract with the Department of Energy.

(c) Commission Review and Recommendations—

(1) The Commission shall, by no later than February 1, 2015, transmit to the Secretary of Energy and the Committees on Appropriations of the House of Representatives and the Senate a report containing the Commission's findings and conclusions.

(2) The Commission shall address whether the Department of Energy's national laboratories—

(A) are properly aligned with the Department's strategic priorities;

(B) have clear, well understood, and properly balanced missions that are not unnecessarily redundant and duplicative;

(C) have unique capabilities that have sufficiently evolved to meet current and future energy and national security challenges;

(D) are appropriately sized to meet the Department's energy and national security missions; and

(E) are appropriately supporting other Federal agencies and the extent to which it benefits DOE missions.

(3) The Commission shall also determine whether there are opportunities to more effectively and efficiently use the capabilities of the national laboratories, including consolidation and realignment, reducing overhead costs, reevaluating governance models using industrial and academic bench marks for comparison, and assessing the impact of DOE's oversight and management approach. In its evaluation, the Commission should also consider the cost and effectiveness of using other research, development, and technology centers and universities as an alternative to meeting DOE's energy and national security goals.

(4) The Commission shall analyze the effectiveness of the use of laboratory directed research and development (LDRD) to meet the Department of Energy's science, energy, and national security goals. The Commission shall further evaluate the effectiveness of the Department's oversight approach to ensure LDRD-funded projects are compliant with statutory requirements and congressional direction, including requirements that LDRD projects be distinct from projects directly funded by appropriations and that LDRD projects derived from the Department's national security programs support the national security mission of the Department of Energy. Finally, the Commission shall quantify the extent to which LDRD funding supports recruiting and retention of qualified staff.

(5) The Commission's charge may be modified or expanded upon approval of the Committees on Appropriations of the House of Representatives and the Senate.

(d) Response by the Secretary of Energy—

(1) The Secretary of Energy shall, by no later than April 1, 2015, transmit to Committees on Appropriations of the House of Representatives and the Senate a report containing the Secretary's approval or disapproval of the Commission's recommendations and an implementation plan for approved recommendations.

Appendix C. Letter from Secretary of Energy Moniz to Senator Feinstein

The Secretary of Energy
Washington, DC 20585

May 20, 2014

The Honorable Dianne Feinstein
Chairman
Subcommittee on Energy and Water Development
Senate Committee on Appropriations
United States Senate
Washington, DC 20510

Dear Chairman:

The Department of Energy has been working to stand up the Commission to Review the Effectiveness of the National Energy Laboratories (the "Commission") pursuant to section 319 of the Consolidated Appropriations Act, 2014 (Public Law No. 113-76). In vetting availability, willingness, and conflicts of interest of proposed Commission members, the desired timeline has emerged as a focus of concern. Being sensitive to the full scope of the study and the overall availability of the Commission members, we are now planning to address the study in two phases.

In Phase 1, which the Commission plans to complete by February 1, 2015, the Commission will develop a baseline of information by focusing its review and recommendations on the matters set forth in section 319, subsection (c)(2) of the Consolidated Appropriations Act, 2014. Laboratory Directed Research and Development (LDRD) will be considered in Phase 1 as it is found to inform (c)(2)(a) and (c)(2)(c). Following the completion of Phase 1, the Commission will submit an interim report on the results of its Phase 1 work.

In Phase 2, the Commission will address the scope of subsection (c)(3), as well as an analysis of LDRD pursuant to subsection (c)(4) of the statute. After submission of the Phase 1 interim report, conversations with the Committees will inform the final scope and timeline of Phase 2.

We believe this plan will address Commission members' workload constraints and will allow the Department to deliver the intended information to the Congress. Should you have any questions or need additional information, please contact me or Mr. Joseph Levin, Associate Director for External Coordination, at (202) 586-3098.

Sincerely,

Ernest J. Moniz

cc: The Honorable Lamar Alexander
Ranking Member

Printed with soy ink on recycled paper

Appendix D. Organizations Represented in Interviews and Public Meetings

Department of Energy (DOE)

- Advanced Research Projects Agency-Energy
- National Nuclear Security Administration
- Office of Acquisition and Project Management
- Office of the Chief Financial Officer
- Office of Environmental Management
- Office of Fossil Energy
- Office of Inspector General
- Office of Independent Enterprise Assessments
- Office of Nuclear Energy
- Office of Science
- Office of the Secretary
- Office of the Under Secretary for Management and Performance
- Office of the Under Secretary for Science and Energy
- Albuquerque Complex
- Ames Site Office
- Argonne Site Office
- Brookhaven Site Office (same management as the Princeton Site Office)
- Chicago Office of the Integrated Support Center
- Environmental Management Consolidated Business Center
- Fermi Site Office
- Idaho Operations Office
- Golden Field Office
- Livermore Field Office
- Los Alamos Field Office
- Oak Ridge Site Office
- Oak Ridge Office of the Integrated Support Center
- Pacific Northwest Site Office
- Sandia Field Office
- Savannah River EM Site Office
- Savannah River NNSA Site Office
- SLAC Site Office (same management as the Berkeley Site Office)
- Thomas Jefferson Site Office

Laboratory and other M&O Contractor Personnel

- Argonne National Laboratory
- Battelle Memorial Institute
- Bechtel Corporation
- Brookhaven Science Associates/Stony Brook University
- Fermi National Laboratory
- Idaho National Laboratory
- Kansas City Plant
- Lawrence Berkeley National Laboratory

- Lawrence Livermore National Laboratory
- Lockheed Martin Corporation
- Los Alamos National Laboratory
- National Laboratories Director's Council
- National Renewable Energy Laboratory
- Savannah River National Laboratory
- Savannah River Nuclear Solutions
- SLAC National Accelerator Laboratory
- University of Chicago

Other Federal Agencies

- Central Intelligence Agency
- Department of Defense
- Department of Homeland Security
- Department of State
- Defense Threat Reduction Agency
- Federal Bureau of Investigation
- Government Accountability Office
- Intelligence Advanced Research Projects Activity
- National Aeronautics and Space Administration
- National Research Council
- Naval Facilities Engineering Command
- Navy Strategic Systems Programs
- Nuclear Regulatory Commission
- National Science Foundation
- Office of Information Resources
- Office of Management and Budget
- Office of Science and Technology Policy
- Office of the Director of National Intelligence
- Office of the Secretary of Defense (OSD)-Acquisition, Technology, and Logistics (AT&L), Installations & Environment
- OSD-AT&L, Research & Engineering
- OSD-Operational Energy Plans and Programs
- United States European Command
- United States House of Representatives, Subcommittee on Energy and Water Development
- United States Pacific Command
- United States Senate, Subcommittee on Energy and Water Development
- United States Southern Command

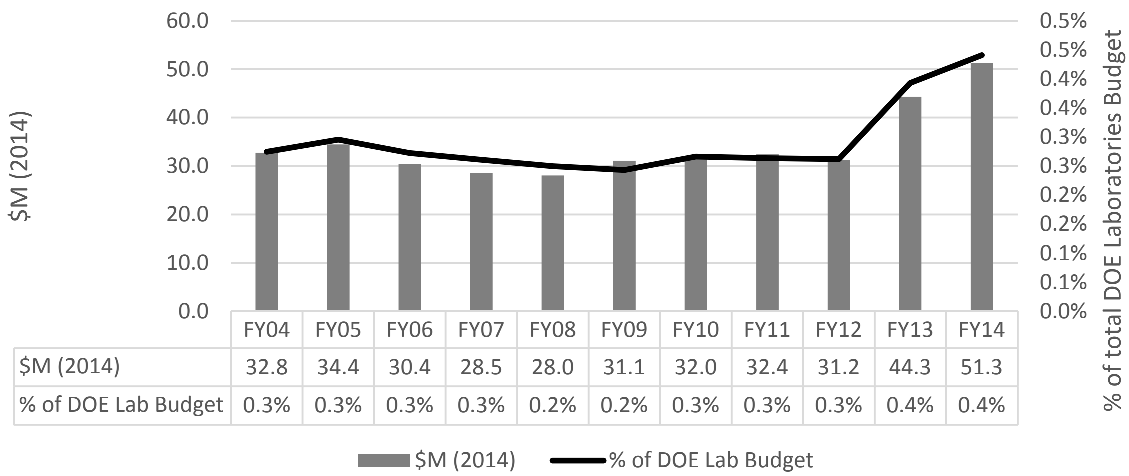
Other Stakeholders

- AKHAN Technologies, Inc.
- American Association for the Advancement of Science
- American Federation of Labor and Congress of Industrial Organizations
- BASF Corporation
- Booz Allen Hamilton Inc.
- Brookings Institution
- Center for Protection of Workers' Rights
- Decker, Garman, Sullivan & Associates LLC
- Dow Chemical Company
- Eli Lilly and Company
- Energy Efficient Buildings Hub, Philadelphia Navy Yard
- Forum on Industrial and Applied Physics, of the American Physical Society
- General Atomics
- Harvard Kennedy School
- Henry L. Stimson Center
- Howard Hughes Medical Institute
- Institute for Molecular Engineering, University of Chicago
- Institute of Applied Research, University of Illinois at Urbana-Champaign
- Johnson Controls Power Solutions
- Metal Improvement Corporation
- Michigan State University
- Nanosys, Inc.
- National Academy of Public Administration
- Natural Resources Defense Council
- Nuclear Watch New Mexico
- Project on Government Oversight
- Sentient Energy
- The Heritage Foundation
- The Information Technology & Innovation Foundation
- Tri-Valley Communities Against a Radioactive Environment
- United States Council for Automotive Research
- University of Texas, Austin

Appendix E. Descriptions of Department of Energy National Laboratories

Ames National Laboratory

Established in 1947, Ames is managed by Iowa State University and stewarded by the Department of Energy (DOE) Office of Science.



	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14
$M (2014)	32.8	34.4	30.4	28.5	28.0	31.1	32.0	32.4	31.2	44.3	51.3
% of DOE Lab Budget	0.3%	0.3%	0.3%	0.3%	0.2%	0.2%	0.3%	0.3%	0.3%	0.4%	0.4%

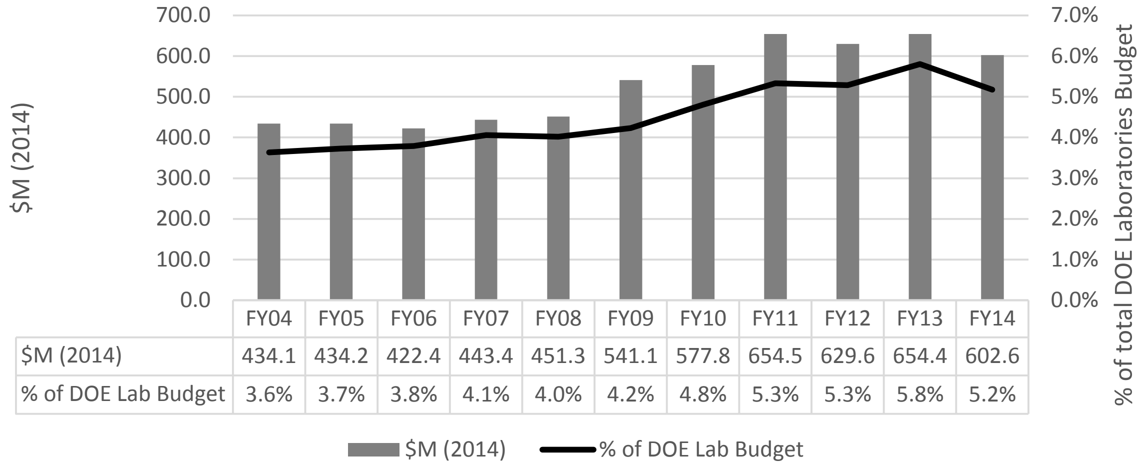
Figure 45. Ames National Laboratory: Total Spending and Budget as Percentage of DOE National Laboratories Budget, FY 2004-FY 2014

Core Capabilities

- Condensed Matter Physics and Materials Science
- Chemical and Molecular Science
- Applied Materials Science and Engineering

Argonne National Laboratory

Established in 1946, Argonne National Laboratory is managed by the University of Chicago, Argonne LLC and stewarded by the DOE Office of Science.



	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14
$M (2014)	434.1	434.2	422.4	443.4	451.3	541.1	577.8	654.5	629.6	654.4	602.6
% of DOE Lab Budget	3.6%	3.7%	3.8%	4.1%	4.0%	4.2%	4.8%	5.3%	5.3%	5.8%	5.2%

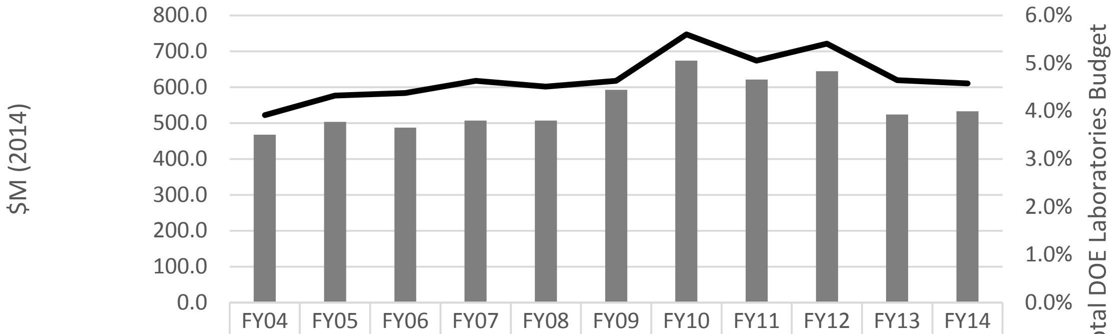
Figure 46. Argonne National Laboratory: Total Spending and Budget as Percentage of DOE National Laboratories Budget, FY 2004–FY 2014

Core Capabilities

- Particle Physics
- Nuclear Physics
- Accelerator Science and Technology
- Condensed Matter Physics and Materials Science
- Chemical and Molecular Science
- Applied Mathematics
- Advanced Computer Science, Visualization, and Data
- Applied Nuclear Science and Technology
- Applied Materials Science and Engineering
- Chemical Engineering
- Systems Engineering and Integration
- Large Scale User Facilities / Advanced Instrumentation

Brookhaven National Laboratory

Established in 1947, Brookhaven National Laboratory is managed by Brookhaven Science Associates, LLC and is stewarded by the DOE Office of Science.



	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14
$M (2014)	467.9	503.7	487.7	506.6	507.0	592.5	673.6	620.8	644.6	523.9	532.7
% of DOE Lab Budget	3.9%	4.3%	4.4%	4.6%	4.5%	4.6%	5.6%	5.1%	5.4%	4.6%	4.6%

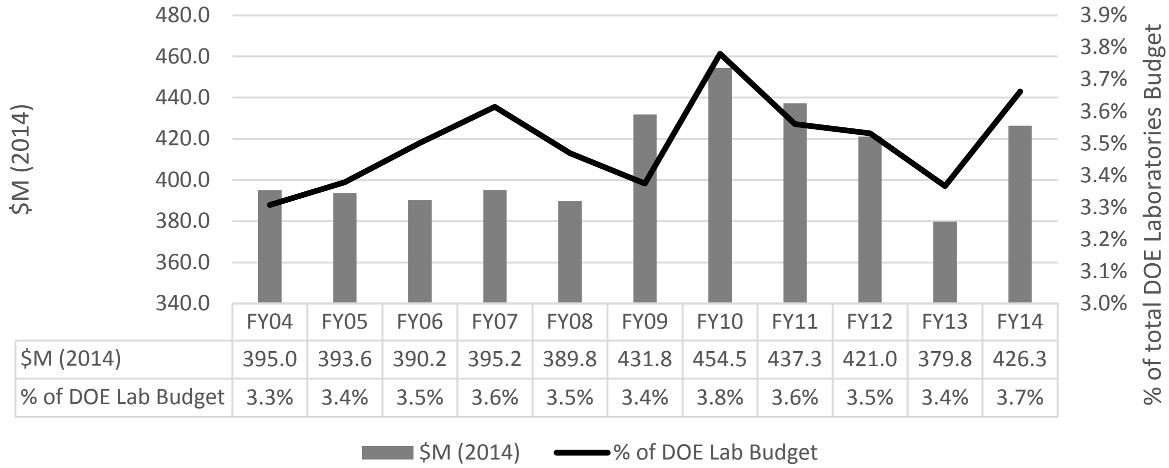
Figure 47. Brookhaven National Laboratory: Total Spending and Budget as Percentage of DOE National Laboratories Budget, FY 2004–FY 2014

Core Capabilities

- Particle Physics
- Nuclear Physics
- Accelerator Science and Technology
- Condensed Matter Physics and Materials Science
- Chemical and Molecular Science
- Climate Change Science
- Biological Systems Science
- Applied Nuclear Science and Technology
- Applied Materials Science and Engineering
- Chemical Engineering
- Systems Engineering and Integration
- Large Scale User Facilities / Advanced Instrumentation

Fermi National Accelerator Laboratory

Established in 1967, Fermi National Accelerator Laboratory (Fermilab) is managed by the Fermi Research Alliance, LLC and stewarded by the Office of Science.



	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14
$M (2014)	395.0	393.6	390.2	395.2	389.8	431.8	454.5	437.3	421.0	379.8	426.3
% of DOE Lab Budget	3.3%	3.4%	3.5%	3.6%	3.5%	3.4%	3.8%	3.6%	3.5%	3.4%	3.7%

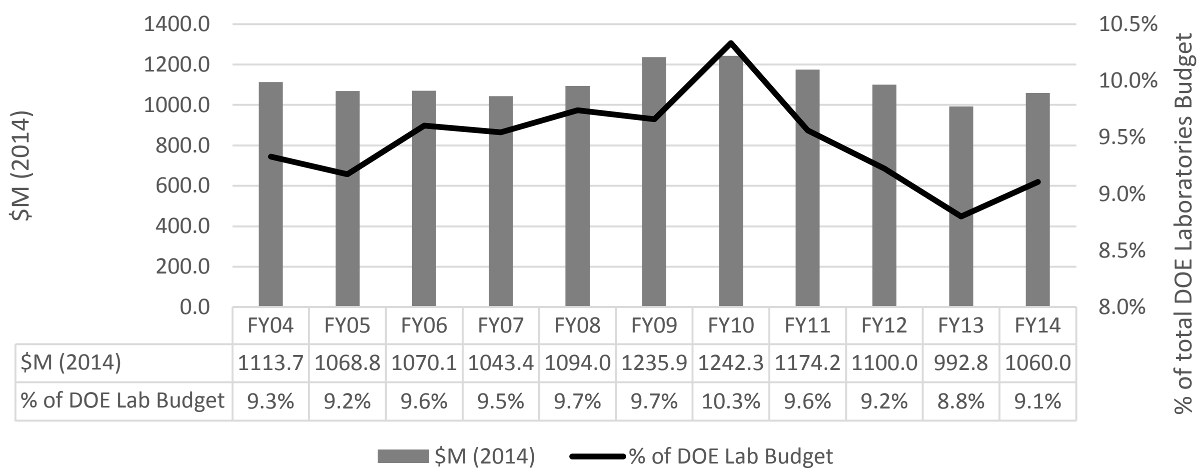
Figure 48. Fermi National Accelerator Laboratory Total Spending and Budget as Percentage of DOE National Laboratories Budget, FY 2004-FY 2014

Core Capabilities

- Particle Physics
- Accelerator Science and Technology
- Large Scale User Facilities / Advanced Instrumentation

Idaho National Laboratory

Established in 1949, Idaho National Laboratory is managed by the Battelle Energy Alliance, LLC and stewarded by the DOE Office of Nuclear Energy.



	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14
$M (2014)	1113.7	1068.8	1070.1	1043.4	1094.0	1235.9	1242.3	1174.2	1100.0	992.8	1060.0
% of DOE Lab Budget	9.3%	9.2%	9.6%	9.5%	9.7%	9.7%	10.3%	9.6%	9.2%	8.8%	9.1%

Figure 49. Idaho National Laboratory: Total Spending and Budget as Percentage of DOE National Laboratories Budget, FY 2004–FY 2014

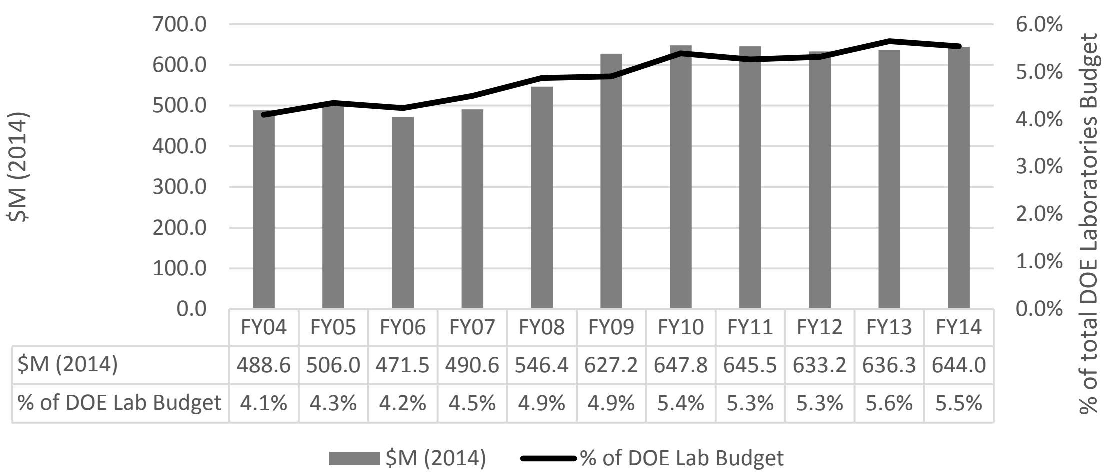
Core Capabilities

- Modeling and Simulation

- Fuel Cycle Research and Development
- Light Water Reactor Sustainability
- Advanced Reactor Research and Development
- Space Nuclear Systems and Technology
- Next Generation Nuclear Program Research and Development
- Nuclear Nonproliferation
- Critical Infrastructure Protection
- Industrial Control Systems Cyber Security
- Electric Grid Resiliency
- Explosives Detection and Testing
- Armor and Defense Systems
- Hybrid Energy Systems
- Non-traditional Hydrocarbons
- Advanced Energy Storage Performance Science
- Clean Energy and Water
- Biofuels Feedstock Science and Engineering
- Energy Critical Materials
- Clean Energy Grid Integration Modeling and Validation
- Energy Systems Diagnostics and Control
- Materials Performance Science

Lawrence Berkeley National Laboratory

Established in 1931, Lawrence Berkeley National Laboratory is managed by the University of California and stewarded by the DOE Office of Science.



	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14
$M (2014)	488.6	506.0	471.5	490.6	546.4	627.2	647.8	645.5	633.2	636.3	644.0
% of DOE Lab Budget	4.1%	4.3%	4.2%	4.5%	4.9%	4.9%	5.4%	5.3%	5.3%	5.6%	5.5%

Figure 50. Lawrence Berkeley National Laboratory: Total Spending and Budget as Percentage of DOE National Laboratories Budget, FY 2004–FY 2014

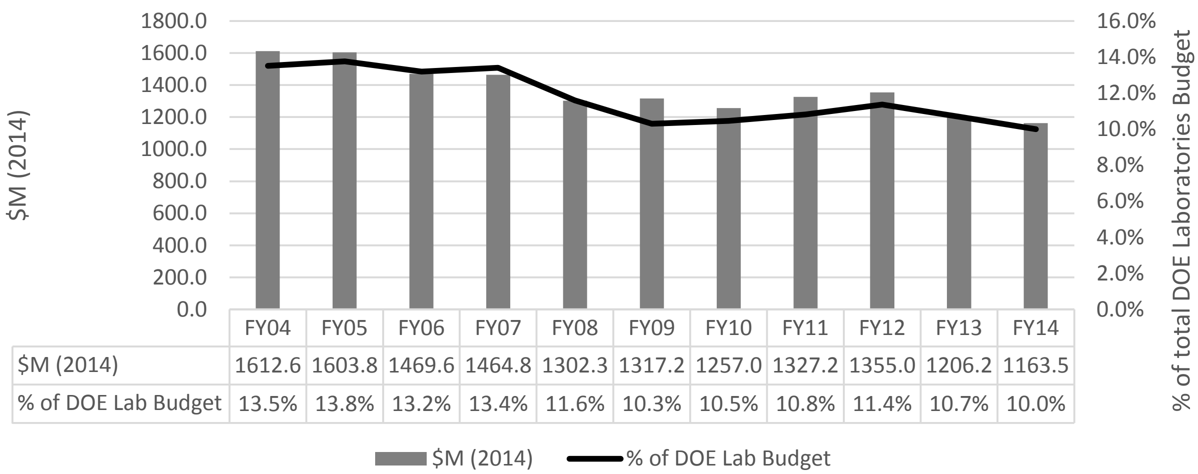
Core Capabilities

- Particle Physics
- Nuclear Physics
- Accelerator Science and Technology
- Condensed Matter Physics and Materials Science
- Chemical and Molecular Science
- Biological Systems Science

- Environmental Subsurface Science
- Climate Change Science
- Applied Mathematics
- Advanced Computer Science, Visualization, and Data
- Computational Science
- Applied Nuclear Science and Technology
- Applied Materials Science and Engineering
- Chemical Engineering
- Systems Engineering and Integration
- Large Scale User Facilities / Advanced Instrumentation

Lawrence Livermore National Laboratory

Established in 1952, Lawrence Livermore National Laboratory is managed by Lawrence Livermore National Security, LLC and stewarded by the National Nuclear Security Administration.



	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14
$M (2014)	1612.6	1603.8	1469.6	1464.8	1302.3	1317.2	1257.0	1327.2	1355.0	1206.2	1163.5
% of DOE Lab Budget	13.5%	13.8%	13.2%	13.4%	11.6%	10.3%	10.5%	10.8%	11.4%	10.7%	10.0%

Figure 51. Lawrence Livermore National Laboratory: Total Spending and Budget as Percentage of DOE National Laboratories Budget, FY 2004–FY 2014

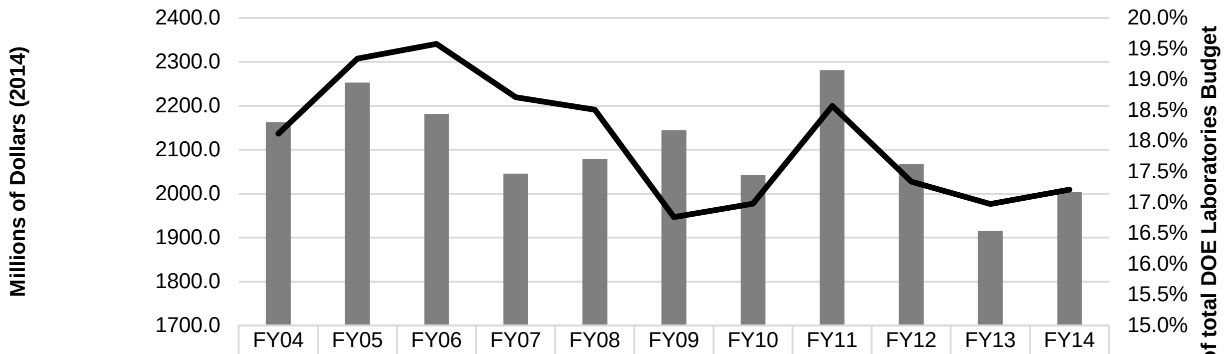
Core Capabilities

- High Performance Computing
- High Energy-Density Science
- Nuclear Physics and Radiochemistry
- Radiation Detection Systems
- Actinide Materials
- Energetic Materials
- Computational Geomechanics and Seismology
- Computational Mathematics
- Computational Engineering
- Climate Change and Atmospheric Science
- Biodetection and Diagnostics

- Computational Materials and Chemistry
- Engineered Materials
- Chemical and Isotopic Signatures
- Lasers and Optical Materials
- All-Source Intelligence Analysis
- Nuclear Design

Los Alamos National Laboratory

Established in 1943, Los Alamos National Laboratory is managed by Los Alamos National Security, LLC and stewarded by the National Nuclear Security Administration.



	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14
$M (2014)	2163.0	2252.9	2181.5	2045.8	2079.0	2144.5	2041.7	2281.0	2067.1	1915.1	2003.1
% of DOE Lab Budget	18.1%	19.3%	19.6%	18.7%	18.5%	16.8%	17.0%	18.6%	17.3%	17.0%	17.2%

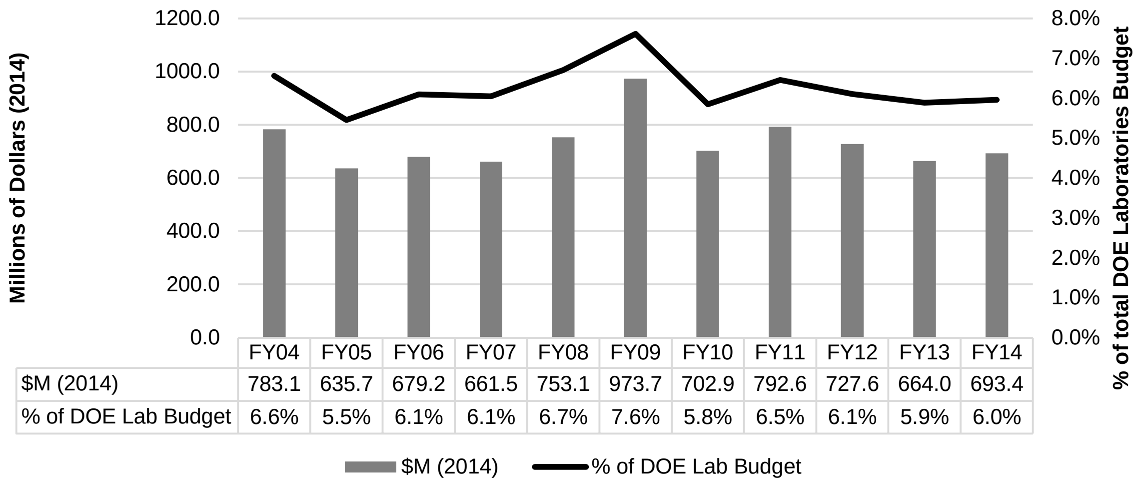
Figure 52. Los Alamos National Laboratory: Total Spending and Budget as Percentage of DOE National Laboratories Budget, FY 2004–FY 2014

Core Capabilities

- Nuclear Weapons Stockpile
- Nuclear Nonproliferation
- Emerging Global Threats
- Energy Security
- Physics
- Astrophysics and Cosmology
- Materials Science
- Sensors and Materials Signatures
- Plutonium and Actinide Science
- High-Performance Computing

National Energy Technology Laboratory

Established in 1910, the National Energy Technology Laboratory is a government-owned, government-operated laboratory with no managing contractor. It is operated by the DOE Office of Fossil Energy.



	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14
$M (2014)	783.1	635.7	679.2	661.5	753.1	973.7	702.9	792.6	727.6	664.0	693.4
% of DOE Lab Budget	6.6%	5.5%	6.1%	6.1%	6.7%	7.6%	5.8%	6.5%	6.1%	5.9%	6.0%

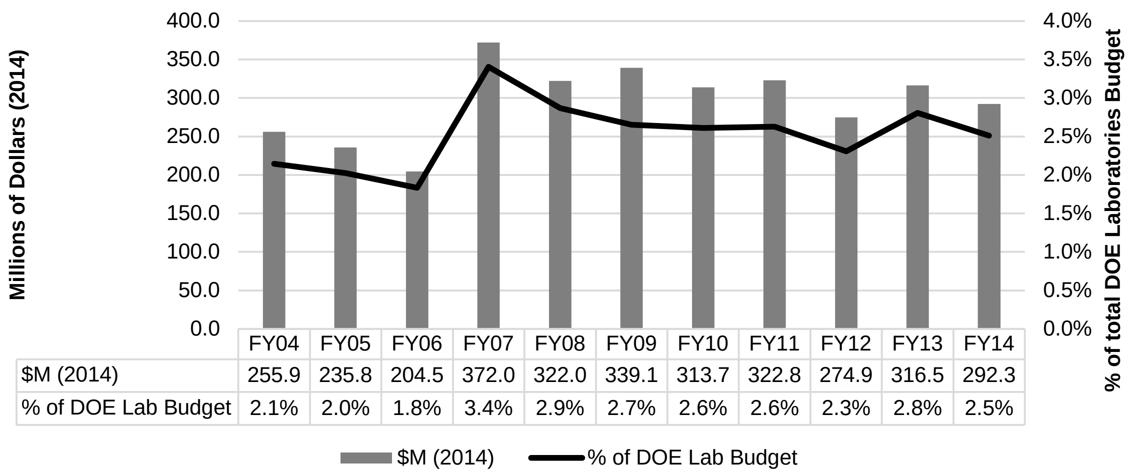
Figure 53. National Energy Technology Laboratory: Total Spending and Budget as Percentage of DOE National Laboratories Budget, FY 2004–FY 2014

Core Capabilities

- Chemical and molecular science
- Computational science
- Applied geosciences and engineering
- Applied materials science and engineering
- Chemical engineering
- Mechanical design and engineering
- Cyber and information sciences
- Decision science and risk analysis
- Systems Engineering and Integration

National Renewable Energy Laboratory

Established in 1977, NREL is managed by the Alliance for Sustainable Energy, LLC and stewarded by the DOE Office of Energy Efficiency and Renewable Energy.



	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14
$M (2014)	255.9	235.8	204.5	372.0	322.0	339.1	313.7	322.8	274.9	316.5	292.3
% of DOE Lab Budget	2.1%	2.0%	1.8%	3.4%	2.9%	2.7%	2.6%	2.6%	2.3%	2.8%	2.5%

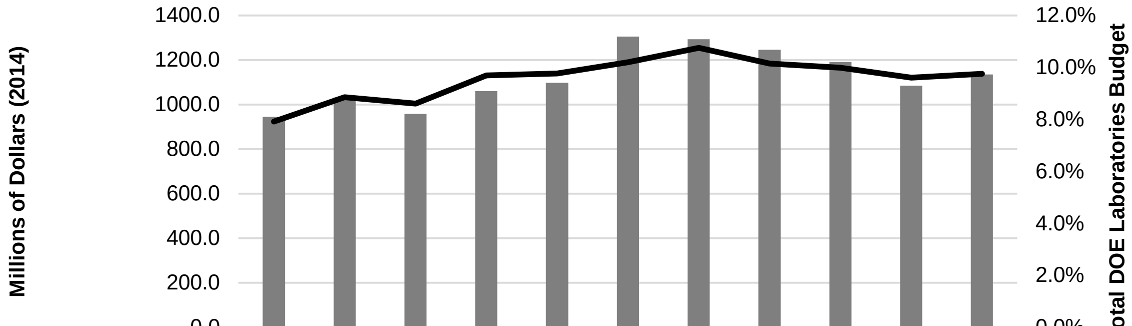
Figure 54. National Renewable Energy Laboratory: Total Spending and Budget as Percentage of DOE National Laboratories Budget, FY 2004–FY 2014

Core Capabilities

- Energy Systems Integration
- Materials & Chemistry Science and Technology
- Energy Systems Integration
- Materials and Chemistry Science and Technology
- Bioenergy Science and Technology
- Mechanical and Thermal Engineering
- Strategic Energy Analysis

Oak Ridge National Laboratory

Established in 1943, Oak Ridge National Laboratory is managed by UT-Battelle, LLC and stewarded by the DOE Office of Science.



	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14
$M (2014)	944.7	1031.9	958.7	1059.7	1097.4	1305.2	1293.1	1245.8	1191.5	1084.0	1135.4
% of DOE Lab Budget	7.9%	8.9%	8.6%	9.7%	9.8%	10.2%	10.8%	10.1%	10.0%	9.6%	9.8%

Figure 55. Oak Ridge National Laboratory: Total Spending and Budget as Percentage of DOE National Laboratories Budget, FY 2004-FY 2014

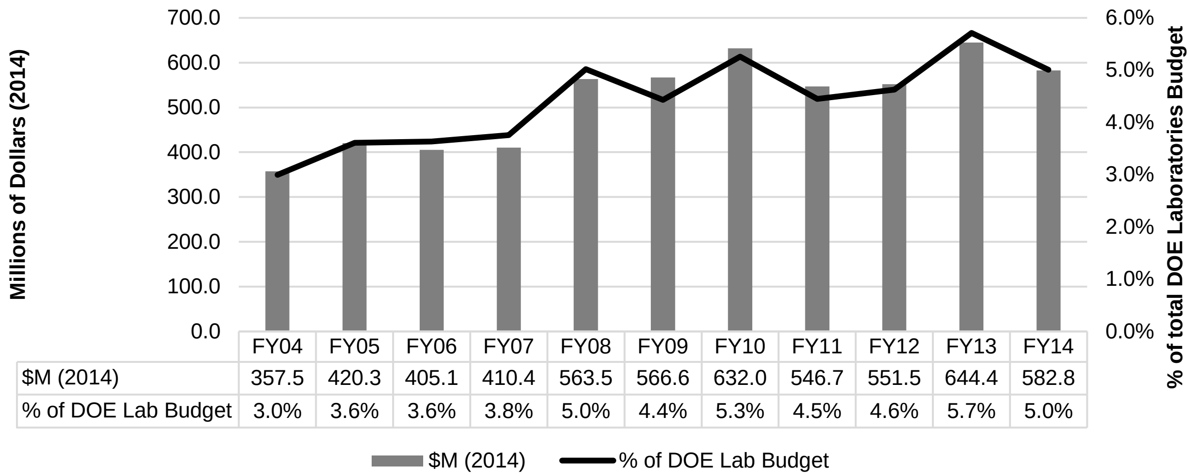
Core Capabilities

- Nuclear Physics
- Accelerator Science and Technology
- Plasma and Fusion Energy Sciences
- Condensed Matter Physics and Materials Science
- Chemical and Molecular Science
- Climate Change Science
- Biological Systems Science
- Environmental Subsurface Science
- Advanced Computer Science, Visualization, and Data
- Computational Science
- Applied Nuclear Science and Technology

- Applied Materials Science and Engineering
- Chemical Engineering
- Systems Engineering and Integration
- Large Scale User Facilities/Advanced Instrumentation

Pacific Northwest National Laboratory

Established in 1965, Pacific Northwest National Laboratory is managed by Battelle Memorial Institute and stewarded by the DOE Office of Science.



	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14
$M (2014)	357.5	420.3	405.1	410.4	563.5	566.6	632.0	546.7	551.5	644.4	582.8
% of DOE Lab Budget	3.0%	3.6%	3.6%	3.8%	5.0%	4.4%	5.3%	4.5%	4.6%	5.7%	5.0%

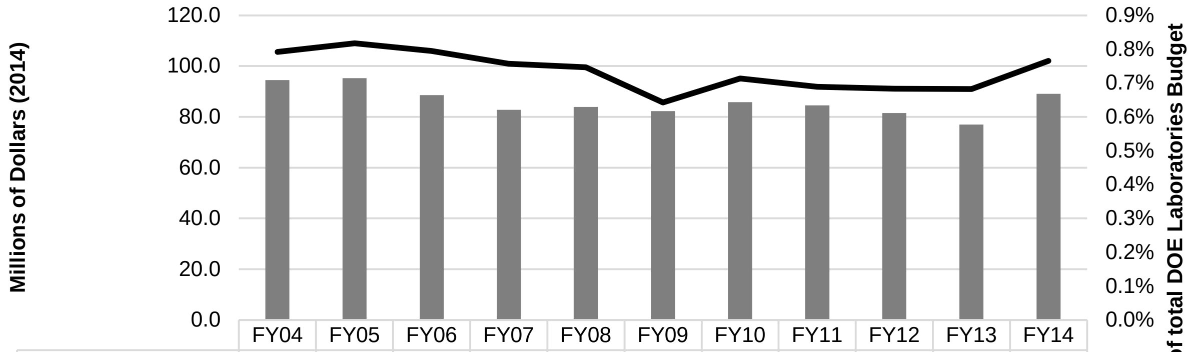
Figure 56. Pacific Northwest National Laboratory: Total Spending and Budget as Percentage of DOE National Laboratories Budget, FY 2004–FY 2014

Core Capabilities

- Chemical and Molecular Science
- Climate Change Science
- Biological Systems Science
- Environmental Subsurface Science
- Advanced Computer Science, Visualization, and Data
- Applied Nuclear Science and Technology
- Applied Materials Science and Engineering
- Chemical Engineering
- Systems Engineering and Integration
- Large Scale User Facilities / Advanced Instrumentation

Princeton Plasma Physics Laboratory

Established in 1951, Princeton Plasma Physics Laboratory is managed by Princeton University and stewarded by the DOE Office of Science.



	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14
$M (2014)	94.5	95.3	88.6	82.8	83.9	82.2	85.8	84.6	81.5	77.0	89.1
% of DOE Lab Budget	0.8%	0.8%	0.8%	0.8%	0.7%	0.6%	0.7%	0.7%	0.7%	0.7%	0.8%

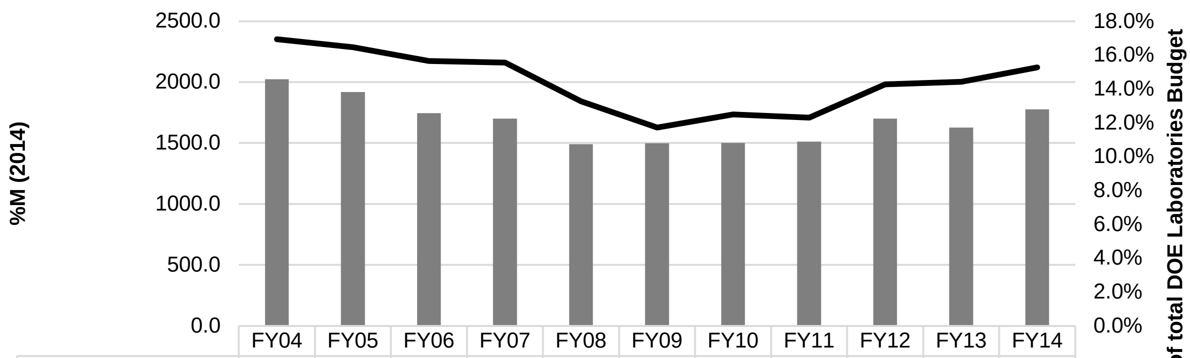
Figure 57. Princeton Plasma Physics National Laboratory: Total Spending and Budget as Percentage of DOE National Laboratories Budget, FY 2004–FY 2014

Core Capabilities

- Plasma and Fusion Energy Sciences
- Large Scale User Facilities / Advanced Instrumentation

Sandia National Laboratory

Established in 1949, Sandia National Laboratory is managed by Sandia Corporation and stewarded by the National Nuclear Security Administration.



	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14
$M (2014)	2022.9	1918.7	1744.6	1700.7	1490.3	1498.3	1501.6	1510.9	1701.0	1627.9	1777.5
% of DOE Lab Budget	16.9%	16.5%	15.7%	15.6%	13.3%	11.7%	12.5%	12.3%	14.3%	14.4%	15.3%

Figure 58. Sandia National Laboratory: Total Spending and Budget as Percentage of DOE National Laboratories Budget, FY 2004–FY 2014

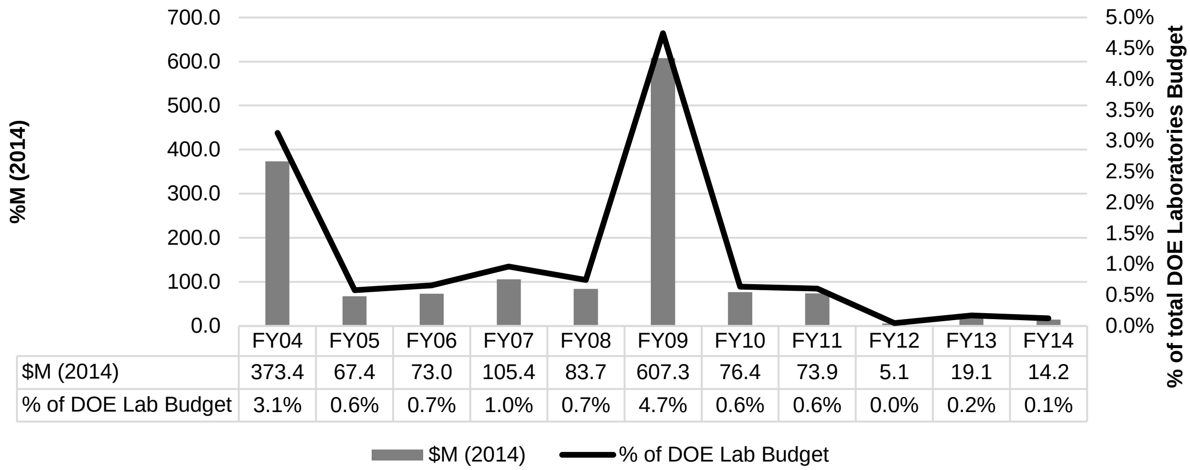
Core Capabilities

- High Reliability Engineering
- Sensors and Sensor Systems
- Microsystems
- Natural and Engineered Materials

- Safety, Risk and Vulnerability Analysis
- Cyber Technology
- Reverse Engineering
- Modeling and Simulation
- Pathfinders

Savannah River National Laboratory

Established in 1951, Savannah River National Laboratory is managed by Savannah River Nuclear Solutions, LLC and stewarded by the DOE Office of Environmental Management.



	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14
$M (2014)	373.4	67.4	73.0	105.4	83.7	607.3	76.4	73.9	5.1	19.1	14.2
% of DOE Lab Budget	3.1%	0.6%	0.7%	1.0%	0.7%	4.7%	0.6%	0.6%	0.0%	0.2%	0.1%

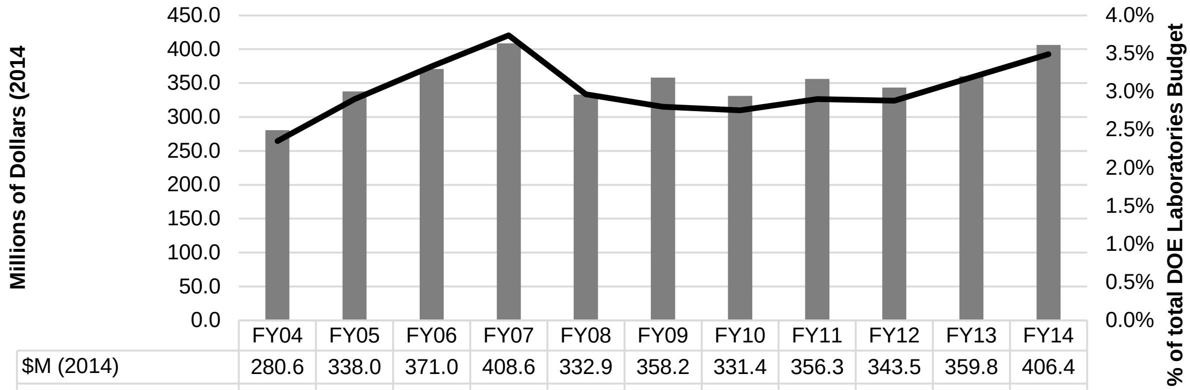
Figure 59. Savannah River National Laboratory: Total Spending and Budget as Percentage of DOE National Laboratories Budget, FY 2004–FY 2014

Core Capabilities

- Environmental Remediation and Risk Reduction
- Nuclear Materials Processing and Disposition
- Nuclear Detection, Characterization and Assessments
- Gas Processing, Storage and Transfer Systems

SLAC National Accelerator Laboratory

Established in 1962, SLAC National Accelerator Laboratory is managed by Stanford University and is stewarded by the DOE Office of Science.



	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14
$M (2014)	280.6	338.0	371.0	408.6	332.9	358.2	331.4	356.3	343.5	359.8	406.4
% of DOE Lab Budget	2.4%	2.9%	3.3%	3.7%	3.0%	2.8%	2.8%	2.9%	2.9%	3.2%	3.5%

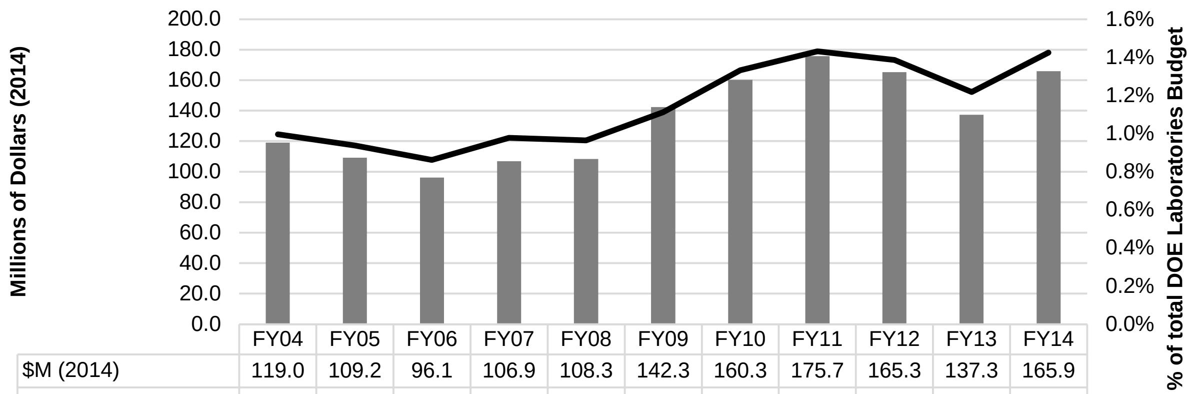
Figure 60. SLAC National Accelerator Laboratory: Total Spending and Budget as Percentage of DOE National Laboratories Budget, FY 2004–FY 2014

Core Capabilities

- Particle Physics
- Accelerator Science and Technology
- Condensed Matter Physics and Materials Science
- Chemical and Molecular Science
- Large Scale User Facilities / Advanced Instrumentation

Thomas Jefferson National Accelerator Facility

Established in 1984, Thomas Jefferson National Accelerator Facility is managed by Jefferson Science Associates, LLC, and stewarded by the DOE Office of Science.



	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14
$M (2014)	119.0	109.2	96.1	106.9	108.3	142.3	160.3	175.7	165.3	137.3	165.9
% of DOE Lab Budget	1.0%	0.9%	0.9%	1.0%	1.0%	1.1%	1.3%	1.4%	1.4%	1.2%	1.4%

Figure 61. Thomas Jefferson National Accelerator Facility: Total Spending and Budget as Percentage of DOE National Laboratories Budget, FY 2004–FY 2014

Core Capabilities

- Nuclear Physics
- Accelerator Science and Technology
- Applied Nuclear Science and Technology
- Large Scale User Facilities / Advanced Instrumentation

Appendix F.
Laboratory Contract Award Fees

Laboratory	Budget from DOE (FY 2014)*	Available Award Fee ($M)	Award Fee Earned ($M)	Base Amount	Total Available Fee	Total Fee Received	Available Fee as % of DOE Budget	
Ames National Laboratory	50.00	0.34	0.31	0.5	0.84	0.81	1.68	
Argonne National Laboratory	600.00	5.3	4.98	0	5.3	4.98	0.88	
Brookhaven National Laboratory	530.00	7.4	6.96	0	7.4	6.96	1.40	
Fermi National Accelerator Laboratory	430.00	3.88	3.65	0	3.88	3.65	0.90	
Idaho National Laboratory	1100.00	18.7	18.14	0	18.7	18.14	1.70	
Lawrence Berkeley National Laboratory	640.00	4.5	4.17	0	4.5	4.17	0.70	
Lawrence Livermore National Laboratory	1200.00	27.6	23.9	18.3	45.9	23.9	3.83	
Los Alamos National Laboratory	2000.00	40	0	6.2	63.4	6.2	3.17	
National Energy Technology Laboratory	690.00	NA	NA	NA	NA	NA	NA	
National Renewable Energy Laboratory	290.00	7	6.5	0	7	6.5	2.41	
Oak Ridge National Laboratory	1100.00	11.2	10.53	0	11.2	10.53	1.02	
Pacific Northwest National Laboratory	580.00	11.9	11.19	0	11.9	11.19	2.05	
Princeton Plasma Physics Laboratory	90.00	1.86	1.69	0	1.86	1.69	2.07	
Sandia National Laboratories	1800.00	9.8	7.96	18.3	28.1	26.26	1.56	
Savannah River National Laboratory	14.00	4.75	4.71	0	4.75	4.71	33.93	SR Contract

SLAC National Accelerator Laboratory (SLAC)	410	4.85	4.56	0	4.85	4.56	1.18
Thomas Jefferson National Accelerator Facility (TJNAF)	170	3.1	2.91	0	3.1	2.91	1.82

Source: DOE Office of Management and Savannah River National Laboratory

Appendix G.
Summary of Findings and Recommendations on Contract Requirements from Past Studies

The Commission reviewed 15 studies published over two decades—from 1995 to 2015—by previous Commissions, task forces, and other independent groups. The Commission compiled the findings and recommendations relevant to contract requirements, including those related to governance, management, and oversight of the DOE national laboratories.

Table G-1. Summary of Findings and Recommendations Relevant to Contract Requirements from 15 Commission and Other Studies

Year	Study	Findings	Recommendations
1995	Task Force on Alternative Futures for the Department of Energy National Laboratories ("Galvin Report"). Prepared by the Secretary of Energy Advisory Board. February.	Inordinate internal focus at every level on compliance issues and questions of management processes, which takes a major toll on research performance and costs Management systems at the laboratories that do not exhibit best business practices, and thus compound the management challenges of these complex institutions	Develop a "far-less-federal system" and empower laboratories to take on greater discretion and responsibility Sustained improvements in DOE management and leadership are needed both at senior levels in the Department and in positions below the Deputy Assistant Secretary level Move towards a "not-for-profit framework for governance of the laboratories" (implementation not discussed in detail)
1997	The Organization and Management of the Nuclear Weapons Complex. Alexandria, Virginia: Institute of Defense Analysis.	Defense Programs'-and, more generally, DOE's-practices for managing environmental, safety, and health concerns are constipating the system DOE's practices undermine accountability and prevent timely decisions No systematic process to assess programmatic and functional requirements with resource implications and weigh decisions	Senior DOE leadership should trust but verify and fulfill the appropriate roles and responsibilities for guidance and oversight of requirements Fewer people in the oversight role can streamline the organization and improve results

Year	Study	Findings	Recommendations
1999	Commission on Maintaining United States Nuclear Weapons Expertise (“Chiles Commission”). March.	DOE’s management structure “exhibits fuzzy lines of authority, no accountability, and inconsistent direction, stemming from a lack of a defined oversight process and the fact that government overseers have not established a common understanding of what it means to be safe” Program line management is operating in parallel to an operations chain of command Excessive oversight staff and environmental, health and safety problems are undermining workplace morale and the shared sense of mission Contractors lack flexibility in personnel practices to recruit and retain critical personnel	Establish clear lines of authority within DOE • Eliminate excessive oversight and overlapping, unclear roles • Assistant Secretary for Defense Programs should be given direct line management authority over all aspects of the weapons complex Provide contractors with greatly expanded latitude and flexibility in personnel matters • Allows contractors to compete more effectively in today’s market for scientific and technical personnel • DOE and its contractors need to review contemporary industry initiatives and those of comparable federally funded organizations for recruitment and retention so as to identify and implement the best practices
2002	Science and Security in the 21st Century: A Report to the Secretary of Energy on the Department of Energy Laboratories. Commission on Science and Security. April.	Continuing management dysfunction, including DOE headquarter, field, contractor, and laboratory relationship that created a complicated layered structure in which identifying accountability is difficult Policy development and management, including strong leadership, lack clarity, consistency, and strategic planning There is no system-wide approach for assessing risks to establish priorities and effective management practices, which in turn has an adverse impact on science and DOE’s missions	DOE leadership should clarify line management responsibilities for security, safety, and operational matters between federal and laboratory line managers DOE must change the management culture that supports and encourages micromanagement of DOE’s laboratories To remedy staff usurping line management responsibilities, layers of management and excesses of staff must be eliminated from the field and headquarters Commit to the true GOCO model giving laboratory directors responsibility to manage the laboratory and supplement with strong and effective oversight
2005	Report of the Nuclear Weapons Complex Infrastructure Task Force. Recommendations for the Nuclear Weapons Complex of the Future. Secretary of Energy Advisory Board. July.	Many administrative orders and procedures designed for the DOE civilian research and science laboratories are not well suited to the risks of the NNSA complex NNSA laboratories face substantial quasi-regulatory influence from the Defense Nuclear Facilities Safety Board on safety operations; stemming from DOE’s lack of mechanisms to assess implementation of DNFSB recommendations	Support organizations (e.g., DOE, NNSA and field offices) who issue rules should also help NNSA line organizations and contractors identify effective implementation DOE orders and regulations be issued on a risk-informed basis, with due consideration of potential costs weighed against benefits; including DNFSB recommendations

Year	Study	Findings	Recommendations
2009	Stimson Center Task Force. Leveraging Science for Security. Congressional Commission on the Strategic Posture of the United States. America's Strategic Posture, United States Institute for Peace. March.	The laboratories operate within a highly complex bureaucratic relationship between DOE and NNSA Rather than NNSA telling the laboratories "what" and the laboratories responding with "how", the laboratories are defining "what" and NNSA is micromanaging "how" Laboratories require greater strategic guidance from NNSA without unnecessarily curtailing their management and operational flexibility DOE/NNSA compliance and process requirements increase the percentage of employees' time that is spent on administrative tasks rather than technical and scientific pursuits	Create a new and full autonomous agency Conduct internal (laboratory) and external reviews, strategic prioritization and oversight to address mission growth, creep, and redundancy
2009	America's Strategic Posture: The Final Report of the Congressional Commission on the Strategic Posture of the United States, United States Institute for Peace.	The governance structure and heavily bureaucratic approach of NNSA is not delivering the needed results The regulatory burden on the laboratories is excessive and should be rationalized	NNSA should adopt a management approach consistent with the requirements of the effectiveness of research and development organizations; a less bureaucratic approach is required
2012	National Research Council. Managing for High Quality Science and Engineering at the NNSA National Security Laboratories (Phase I report).	There is conflict and confusion over management roles and responsibilities of organizations and individuals The erosion of trust between laboratories and NNSA shapes the oversight and operation of the laboratories, resulting in excessive bureaucracy governing laboratory activities at a deep level of detail There is a perception among the three laboratories that NNSA has moved from partnering to solve scientific and engineering problems and providing oversight of safety, business, security and operations, to assigning tasks and specific solutions with detailed implementation instructions	NNSA and laboratories should rebalance the managerial and governance relationship to build in a higher level of trust in program execution and Laboratory operations in general NNSA should reduce reporting and administrative burdens on the laboratory directors NNSA and Laboratory management should explore ways by which the administrative, safety, and security costs can be reduced, so that they not impose an excessive burden on essential research and development activities

Year	Study	Findings	Recommendations
	Institute for Defense Analyses. Federal Security Laboratory Governance Panels: Observations and Recommendations. January.	There are increased regulatory requirements and oversight affecting Federal security laboratories Often requirements represent the cumulative effects of multiple remedial actions for publicized safety and security incidents In response to crises at single site, system-level policies are implemented No mechanism for laboratory feedback on oversight agency	Rationalize the oversight burden on the laboratories Implement oversight standards that are in line with other laboratory systems, such as industry standards Develop an adaptive oversight mechanism, implement increased oversight on site-by-site basis as needed, or relax oversight on historically high performing laboratories Establish policy review before implementing new oversight policies to understand whether system level or site-specific policy is required Develop policy for laboratories to provide regular feedback to site offices and headquarters level to make those offices accountable as well
2013	National Academy of Public Administration. Positioning DOE's Labs for the Future: A Review of DOE's Management and Oversight of the National Laboratories.	DOE's national laboratories and the benchmarked non-DOE FFRDCs face fairly common risks that require their sponsoring organizations to have appropriate management control and oversight to ensure that those risks are being minimized The Panel supports DOE's efforts to move towards the contractor assurance system to manage operational risks DOE must "trust but verify" that laboratory systems are able to identify problems before they occur	DOE should evaluate the staffing, skill mix, and oversight practices of its offices and identify the changes required to rely primarily on contractor assurance systems and risk management practices for laboratory operational oversight DOE should revise its order on contractor assurance system, as necessary, to provide explicit guidance on the requirements needed for a mature system; the types of information and data sharing expected to ensure sufficient transparency; the timeframe for contractors to develop and site offices to review and approve a mature system; and incentives
	National Research Council. The Quality of Science and Engineering at the NNSA Laboratories (Phase II report).	Overlapping safety requirements (DOE, DNFSB, etc.) escalate costs, slow and/or impede experimental work associated at the NNSA laboratories, and no cost-benefit analysis is done regarding the value of mediating the risk	DOE, NNSA and laboratory management should review overall system for assessing and managing risk and drive out costs associated with unnecessary safety measures; formulate an approach for weighing costs versus benefit of experimentation

Year	Study	Findings	Recommendations
	Information Technology and Innovation Foundation, the Center for American Progress, and the Heritage Foundation. Turning the Page: Reimagining the National Labs in the 21st Century Innovation Economy. June.	DOE has replaced contractor accountability with direct regulation of lab decisions—including hiring, worker compensation, facility safety, travel, and project management DOE has added duplicative layers of safety, security, human-relations and environmental regulations in addition to those already mandated by federal and state law Laboratories face a dislocation of decision-making authority	The Department of Energy, together with the Office of Science and Technology Policy, should lead a top-to-bottom review of the lab-stewardship system with the goal of identifying and reducing redundant bureaucratic processes DOE should rely on decision-making responsibilities at the laboratory instead of micromanaging the laboratories
	National Research Council. Managing for High-Quality Science and Engineering at the NNSA National Security Laboratories.	Site Offices are organized and staffed largely for monitoring compliance of the laboratories with DOE and other operational regulations	Implement a balanced approach that maximizes scientific flexibility within requirements for Federal regulations and environmental, health, safety, and security Reexamine roles and responsibilities of Federal oversight and resolve differences in execution of laboratory operations
2014	Congressional Advisory Panel on the Governance of the Nuclear Security Enterprise. A New Foundation for the Nuclear Enterprise: Report of the Congressional Advisory Panel on the Governance of the Nuclear Security Enterprise. November.	Lack of clearly defined roles and responsibilities of the M&Os and Federal officials has led to friction in relationships Transition of laboratories towards a more diversified customer base and for-profit parent organizations has eroded trust and perception from Federal personnel that M&Os are primarily driven by growth and profit Trust is further deteriorated by the award fee structure Insufficient influence of the M&O parent organization cultures Unaligned mission-support staff has created confusing, layered oversight leading to costly and ineffective transactional oversight	Adopt market-based fixed fees for new M&O contracts considering risks, M&O investments in the enterprise, and scale of the work to be managed Reinforce the M&O parent organizations' obligations to contribute to enterprise management improvement M&O organizations to identify and assess management improvement opportunities, both for mission execution and for mission-support functions Eliminate transactional oversight in areas in which better mechanisms for certifying contractor performance exist

Year	Study	Findings	Recommendations
2015	Secretary of Energy Task Force on DOE National Laboratories. Report of the Secretary of Energy Task Force on DOE National Laboratories. Draft. March.	Laboratories and M&O contractors face burdensome operating environment caused by increasing number and complexity of oversight from internal and external entities	Roles and responsibilities of DOE headquarters, field elements, M&O contractors, and laboratories should be continually clarified and communicated Evaluate options to change the M&O contracting model Assess need and options for contract requirements that are most problematic for M&O contractors Authorize control authority for certain operational procedures to laboratories

Appendix H.
Examples of Burdensome Policies and Practices Identified from Past Reform Efforts

NLDC Prioritization of Burdensome Policies and Practices

In response to a request from the Secretary of Energy, the National Laboratory Directors Council (NLDC), which consists of DOE and NNSA national laboratory directors, conducted an analysis of the most burdensome DOE policies. The NLDC identified over 120 burdensome policies and practices across the laboratories over a three month period in 2011. The NLDC focused on issues that DOE could address internally without legislative action or coordination with other agencies. The policies and practices were rated and prioritized by 42 senior managers across the national laboratories. The NLDC submitted a white paper in May 2011 to the Secretary of Energy with 18 prioritized policies and practices that were deemed the most burdensome.[391] The issues are summarized in Table H-1.

Table H-1.

Issue	Problem	Comments/Suggestions
Unneeded Approvals	M&O activities which require DOE approval can be at a tedious level and should be saved for high risk, high value transactions	DOE approvals are required for all CRADA and WFOs. Except for high value approvals, M&Os should be given autonomy and be held accountable. Some DOE review and approvals related to salary actions limit the contractors flexibility to address salary needs. There are consistent delays and risk aversion in DOE approval of higher value subcontracts/procurements. The threshold for review should be raised. Foreign travel approval process is costly/time consuming. DOE O 441.1c requirements for official foreign travel should be reevaluated for elimination or revision
Excessive Oversight	There are excessive audits and assessments without clear risk-prioritization,	Reduce the scope of audit activities, and rely on independent audit functions at the laboratories. There should be improved management of "corrective

[391] National Laboratory Directors Council (NLDC). *NLDC Prioritization of Burdensome Policies and Practices*. (May 31, 2011).

Issue	Problem	Comments/Suggestions
	coordination, or value.	action" responses
Unnecessary Reporting	The Laboratories are required to submit a variety of reports to DOE	Many of the reports the laboratories are required to submit to DOE are duplicative or provide information that does not contribute to better management or oversight. The reporting is often time consuming and not used in a meaningful way towards the mission of the laboratories.
Striving Towards Best Practices	There are many areas where DOE does not follow best/industry practices	Increase the dollar threshold for the capitalization of assets to reduce the cost and effort to cap the items at the lower threshold
Over-Regulation	DOE has created requirements that are duplicative and often go beyond national standards. They sometimes are imposed with little flexibility and contradict existing national standards	The DOE Worker Safety and Health Program uses 10 CFR 851 which creates requirements far beyond OSHA standards and that were not intended for enforcement as a regulatory rule. DOE Orders 430.1B and 413.3B impose multilayered rules and regulations which can lead to inconsistent interpretation and implementation. This confusion often leads to delays and increased costs.
Improving Policy Making	Policy can be created in many places besides the directive system including acquisition letters, DEAR, FAR, and through referencing external standards	Policies failed to make distinctions between the M&Os and other types of contractors/Federal employees. Acquisition letters bypass normal review and considerations other requirements receive.
General Issues and Quick Fixes	General problems that do not fall in to the other categories	Allow the labs to participate on a nonexclusive basis, with research teams and institutions responding to research request for proposals. The current DOE interpretation of FFRDC restrictions has not allowed this. Quarterly apportionments for funding lead to delays and increased costs.

Mission First Reform Initiative

In 2012, the National Academies conducted a study that provided a number of findings related to management of the NNSA laboratories. As a result, NNSA established the Mission First Reform Initiative with the laboratories to examine ways to improve management and requirements. The laboratories formed a working group and created a list of burdensome requirements, which endorsed changes to 39 requirements with 25 to be removed from the M&O contracts.[392] (See Table H-2.)

Table H-2.

Subject	Issues
Human Resources	Limit of 36-months on relocation of work site (Change of Station (COS))
	Report monthly on COS to DOE Contracting Officer is currently not in the contract, but is required
	Contract requires DOE Contracting Officer (CO) approval of benefits plan changes, including those that have no cost.
	Pension plan audit requirements vary between sites.
	Contract requires DOE Contracting Officer pre-approval on personnel policies that are inherent M&O FFRDC responsibilities.
	Concerns with general application of the FAR and DEAR to laboratory personnel and procurement practices (DEAR 970.5232-2, Payments and Advances). A key element of the FFRDC model/value is the ability to use best academic and private practices rather than Federal norms. There is a provision, FAR cost principle 31.205-44(i), that allows "notwithstanding the provisions of the FAR," which other laboratories exercise in order to make payments to educational institutions for tuition and fees, or institutional allowances in connection with fellowship or other research, education, and training.
Finance	DOE Order 413.1B is duplicative with OMB Circular A-123, Management Accountability and Control.
Personal Property Program	DOE Order 580.1, Personal Property Management Program defines process that broadens scope of controls beyond reasonable costs (e.g., all property is to be marked, tracked in database, and subject to annual inventory). It is suggested that property management industry standards be used.
Environmental Safety and Health	Majority of requirements in DOE Order 420.2C, Safety of Accelerator Facilities, are duplicative with 10CFR835 Additionally, Safety Analysis Documents (SADs) are additional DOE requirements that are very expensive to develop and do not add an increase in safety.
	The Biosafety in Microbiological and Biomedical Laboratories is a guidance document issued by the Centers for Disease Control (CDC) and National Institutes of Health (NIH), but was added as a requirements document to laboratory contracts. Not all "should statements" should be implemented based on the risk analysis completed by the Institutional Biosafety Committees.
Nuclear Operations	Current Authorization Agreements for Lab Hazard Category II Nuclear Facilities are redundant with authorizations provided in other DOE approved documents.
Quality	DOE Order 414.1D, Quality Assurance Requirements for Nuclear Facility Applications, requires burdensome documentation that drives costs. It is proposed that laboratories operate under 10CFR830 and ANSI/ASQZ1.13 (preferable) or ISO 9001 industry standards.
	DOE Order 414.1D, Safety Software Quality Assurance Requirements for Nuclear Facilities, requires a broad scope across all laboratory software. However, it should

392 Information received from Lawrence Livermore National Laboratory.

Subject	Issues
	apply only to software associated with a safety system or one that performs a safety function.
Conduct of Operations	Many of the requirements in DOE O 422.1 are redundant to other contractual requirements such as DOE O 414.1C, Quality Assurance. It is proposed that only requirements that are unique to DOE O 422.1 be included in laboratory contracts. DOE Order 150.1 directs DOE approval of Lab Continuity of Operations Programs at a very limited set of DOE identified mission essential functions at the laboratories. It is recommended the broader Business Continuity Program – NFPA 1600 Standard on Disaster/Emergency Management and Business Continuity Program be used to focus on laboratory identified essential functions.
Historic Preservation	National Historic Preservation Act (NHPA) is burdensome because it requires the DOE Site Office be the “middleman” between the lab and the State historic Preservation Officer for every modification to a laboratory building considered historic.
Government Relations	DOE Order 350.2b requires a formal real estate plan for moving remote offices from one lease to another. It is suggested FFRDC management assumes risk within assigned budget. DOE Order 151.K requires DOE Site Office to approve all external communications during emergency operations. It is suggested an emergency press releases would be shared with Site Office/NNSA upon release, and FFRDC management would assume the risk for emergency communications with the public.
External Oversight	Coordinate oversight by all overseers, and examine current level of assessment which often exceed compliance requirements, and ask lab to be accountable to impractical risk avoidance. External auditors often dictate over-reactive corrective action plans. Some of the problem directives included: • DOE M 140.1-1B, CRD, Interface with DNFSB • DOE M 221.2A, CRD, Cooperation with the Office of Inspector General • DOE O 226.1A, Implementation of DOE Oversight Policy • DOE O 227.1, CRD, Independent Oversight Program

DOE Safety and Security Reforms

In 2009, following the then Secretary’s direction, DOE began self-examining its approach to safety and security management. One of the main efforts was to eliminate directives that were considered unclear, duplicative, or too prescriptive. DOE eventually reduced the number of safety directives from 80 to 42. However, DOE did not examine the directives changed if they were actually burdensome or costly and did not have any metrics to measure the outcome of the changes. A reduction in the number of directives does not necessarily indicate any benefits in terms of cost savings, efficiency, or performance.[393] DOE's reform effort focused on modifying 18 DOE requirements (See Table H-3.)

Table H-3.

Directive	Title
DOE O 110.3A	Conference Management
DOE O 200.1A	Information Technology Management
DOE O 210.2	Operating Experience
DOE O 225.1B	Accident Investigations
DOE 226.1B	DOE Oversight Policy
DOE O 243.1	Records Management
DOE 243.2	Vital Records
DOE O 252.1A	Technical Standards Program
DOE O 350.1	Contractor HR Management Programs - Substance Abuse and Employee Assistance
DOE O 414.1D	Quality Assurance
DOE O 430.2B	Energy Renewable
DOE O 436.1	Energy/Environment Sustainability
DOE O 442.1A	DOE Employee Concerns Program
DOE M 450.2	ISM
DOE M 482.1	Facilities Technology Partnering
DOE M 483.1	Cooperative R&D Agreement
DOE M 484.1	Reimbursable Work for DHS
DOE M 522.1	Pricing of Departmental Materials and Services

Secretary Energy Advisory Board (SEAB) Management Concerns

The Secretary Energy Advisory Board (SEAB) includes a standing Task Force on National Laboratories. The Task Forces' responsibilities include reviewing changes that could improve laboratory performance in areas where the DOE Secretary has authority. In 2015, the Task Force requested that the Office of Science examine what changes could be made to M&O contracts to improve laboratory performance. This process included requesting from laboratories and consolidating concerns with management and

[393] GAO. *Nuclear Safety: DOE Needs to Determine the Costs and Benefits of Its Safety Reform Effort*. (Washington, DC: GAO, 2015). Available at http://www.gao.gov/products/GAO-12-347.

governance of the laboratories. The Task Force identified 98 concerns, which the Office of Science categorized into 7 themes.[394] (See Table H-4)

Table H-4.

Themes	Summary of Issues
Audits, Oversight, Data Request	Assessments and data requests are duplicative, time consuming, and require extensive resources for response
	There is a lack of clear roles and responsibilities which also leads to officials deferring to the most risk adverse options.
	It is suggested that the Federal oversight on research misconduct should be decreased if the laboratories are complying with DOE Orders.
Environmental Safety, and Health	Environmental, Safety, and Health requirements such as 10 CFR 851 adopt safety standards beyond OSHA that were not even meant to be requirements but guidance.
	Environmental oversight may be duplicative with state standards and provides little additional value.
	DOE expectations encourage corrective action plans that rely on increased processes and rules.
	A one size fits all approach can be used that does not optimize to each laboratory
	Reporting thresholds can be too low so as to be an inefficient use of resources
Financial Controls	Reporting and pre-approval of all Laboratory conference expenses requires extensive effort
	Issues with WFO management including variability of WFO allotments, ambiguity over decision authority, restrictions on WFO agreements due to inflexibility in the terms and conditions, and extensive time required to process foreign WFO contracts
	DOE approval of foreign travel is burdensome
	Funding has transition from block funding with great flexibility to many small buckets with more oversight. The funding control points are so low they restrict the labs ability to effectively manage
	No direct funds for tech maturation to assist in tech transfer
Human Resources	HR processes are such as compensation management are overly long and there are too many DOE reviews
	HR restrictions create barriers to hiring and retaining a world-class workforce
	Interpersonal assignments require extensive paperwork
Legal	The 2016 Policy on foreign MOUs and its subsequent review and approval process creates unnecessary oversight and delays on the Lab’s ability to develop and maintain broad international programs and relationships

[394] Information provided by the DOE Office of Science.

Themes	Summary of Issues
	Cost of doing business (both time and resources) is impacted by dealing with very minor issues and one-time errors of small dollar value. . DOE or Congress should consider establishing a de minimis level at which an error is considered not worthy of reporting nor recouping the costs.
Procurements and Facility Management	MIE and IGPP threshold are too low for laboratories to effectively manage their facilities
	Facility management orders are burdensome and interpreted inconsistently
	Current property management practices require duplicative reporting and inventorying of obsolete or “low value” equipment.
	Large RFQ and contract awards require several reviews
Public Affairs	Communications reports are duplicative
	Laboratories must get DOE approval for press releases

Appendix I. Apportionment Categories

OMB defines Apportionment categories in Circular A-11 Section 120:[395]

An amount is *apportioned* for obligation in the current fiscal year when it appears on the Category A, Category B, or Category AB lines. Amounts apportioned for obligation in future fiscal years appear on the Category C lines. The Application of Budgetary Resources section also includes lines for amounts that are exempt from apportionment or not apportioned for either current or future fiscal years.

An *automatic apportionment* is approved by the OMB Director in the form of a Bulletin or provision in Circular A-11, and typically describes a formula that agencies will use to calculate apportioned amounts. An automatic apportionment is in contrast to the written apportionments, which typically include specific amounts, and which are approved by an OMB Deputy Associate Director (or designee). *Carryover amounts* are unobligated balances that are available from the prior fiscal year(s) in multi-year and no-year accounts. See section 120.24 regarding the submission, for OMB approval, of requests for the apportionment of carryover amounts. Pursuant to sections 120.7 and 120.57, carryover amounts are automatically apportioned at zero until a written apportionment is issued for such amounts. *Category A, Category B, Category AB or Category C*—Apportioned amounts appear on different groups of lines in the application of budgetary resources section of an apportionment. Amounts are identified in an apportionment-

- by time (Category A),
- program, project, or activity (Category B),
- a combination of program, project, or activity and time period (Category AB),
- for future years (only for multi-year/no-year accounts) (Category C).

[395] https://www.whitehouse.gov/sites/default/files/omb/assets/a11_current_year/a11_2014.pdf.

Appendix J.
User Facilities by Laboratory

The following user facilities have been self-identified by individual laboratories. The Office of Science in DOE provides an official definition of user facilities in an official memorandum,[396] as well as a list of some user facilities at SC laboratories.[397] DOE's official list includes some but not all of the user facilities listed in Table 40.

Table 40. User Facilities

National Laboratory	User Facility
Global network	Atmospheric Radiation Measurement (ARM) Climate Research Facility–Argonne, Brookhaven, Lawrence Berkeley, Lawrence Livermore, Los Alamos, NREL, Oak Ridge, Pacific Northwest, and Sandia participate (1,000 users)
Argonne	Advanced Photon Source (APS), (4,500 users)
http://science.energy.gov/~/media/_/pdf/user-facilities/Office_of_Science_User_Facility_Definition_Memo.pdf	Argonne Leadership Computing Facility (ALCF), (1,000 users)
	Argonne Tandem Linac Accelerator System (ATLAS), (400 users)
	Center for Nanoscale Materials (CNM), (400 users)
	Transportation Research Analysis Computing Center (TRACC) funded by Department of Transportation
Brookhaven	Accelerator Test Facility (ATF)
http:/www.bnl.gov/guv/facilities.asp	Center for Functional Nanomaterials (CFN), (400 users)
	Computational Science Center (CSC)
	NASA Space Radiation Laboratory (NSRL)
	National Synchrotron Light Source II (NSLS-II), (over 250 users)*
	Relativistic Heavy Ion Collider (RHIC), (1,200 users)
	Tandem Van de Graaf Facility (TANDEM)
Fermilab	Proton Accelerator Complex (1,400 users)
Idaho	Advanced Test Reactor (ATR)
https://inlportal.inl.gov/portal/server.pt/community/renewable_energy_home/419/user_facility	Biomass Feedstock National User Facility (BFNUF)†
	Wireless National User Facility
https://inlportal.inl.gov/portal/server.pt	

[396] Patricia Dehmer, "Definition of a User Facility."

[397] The list, last updated in October 2014, is available at http://science.energy.gov/~/media/_/pdf/user-facilities/Office_of_Science_User_Facilities_FY_2015.pdf.

National Laboratory	User Facility
?open=514&objID=1555&mode=2&featurestory=DA_605130	
Lawrence Berkeley http://www2.lbl.gov/LBL-Programs/nuf.html	Advanced Light Source (ALS), (1,800 users) Energy Sciences Network (ESNet), (27,000 users) Joint Genome Institute (JGI), (1,000 users) The Molecular Foundry (400 users) National Center for Electron Microscopy (NCEM) National Energy Research Scientific Computing Center (NERSC), (5,000 users)
Lawrence Livermore‡	Livermore program-focused facilities • Contained Firing Facility (CFF) • High Explosives Applications Facility (HEAF) • High Performance Computing (HPC), including Sequoia • Joint Actinide Shock Physics Experimental Research (JASPER) • National Ignition Facility (NIF) • Livermore Facilities accessed by External R&D Community • B194 Accelerator Facility • Center for Accelerator Mass Spectrometry (CAMS) • Jupiter Laser Facility (JLF) • National Atmospheric Release Advisory Center (NARAC) • National Ignition Facility (NIF)
Los Alamos http://www.lanl.gov/collaboration/user-facilities/index.php	Center for Integrated Nanotechnologies (CINT), (400 users with Sandia National Laboratories) Lujan Neutron Scattering Center (LANSCE), (150 users) National High Magnetic Field Laboratory (NHMFL)
NREL§ http://www.nrel.gov/research_facilities/user_facilities.html	Energy Systems Integration Facility (ESIF) Thermochemical Users Facility
Oak Ridge http://www.ornl.gov/user-facilities	Building Technologies Research & Integration Center (BTRIC) Center for Nanophase Materials Sciences (CNMS), (400 users) Center for Structural Molecular Biology (CSMB) Carbon Fiber Technology Facility (CFTF) High Flux Isotope Reactor (HFIR), (400 users) Manufacturing Demonstration Facility (MDF) National Transportation Research Center (NTRC) Oak Ridge Leadership Computing Facility (OLCF), (1,300 users) Spallation Neutron Source (SNS), (750 users)
Pacific Northwest http://www.pnnl.gov/about/facilities.asp	Environmental Molecular Sciences Laboratory (EMSL), (750 users)
Princeton Plasma http://nstx-u.pppl.gov/	National Spherical Torus Experiment (NSTX), (165 users)
Sandia	Center for Integrated Nanotechnologies (CINT), (400 users

National Laboratory	User Facility
http://www.sandia.gov/research/facilities/technology_deployment_centers/	with Los Alamos National Laboratory) • Technology Deployment Centers • Advanced Power Sources Laboratory • Combustion Research Facility • Design, Evaluation, and Test Technology Facility • Distributed Energy Technology Laboratory • Engineering Sciences Experimental Facilities (ESEF) • Explosive Components Facility • Explosive Technology Group • Geomechanics Laboratory • Ion Beam Laboratory • Materials Science and Engineering Center • Mechanical Test Evaluation Facility • Microsystems and Engineering Sciences Applications • National Solar Thermal Test Facility (NSTTF) • Nuclear Energy Safety Technologies (NEST) • Nuclear Facilities Resource Center (NUFAC) • Photovoltaic Laboratories • Plasma Materials Test Facility • Pulsed-Power and Systems Validation Facility • Primary Standards Laboratory • Radiation Detection Materials Characterization Laboratory • Shock Thermodynamic Applied Research Facility (STAR) • Weapon and Force Protection Center
SLAC https://www6.slac.stanford.edu/facilities https://news.slac.stanford.edu/tags/programs-facilities/lightsources/lcls-ii	Facility for Advanced Acceleratory Experimental Tests (FACET), (48 users) Linac Coherent Light Source (LCLS), (500 users) Linac Coherent Light Source II (LCLS-II) Stanford Synchrotron Radiation Light Source (SSRL), (1,700 users)
Thomas Jefferson http://education.jlab.org/pol/user-facility.html	Continuous Electron Beam Accelerator Facility (CEBAF), (1,245 users)

* NSLS served over 2,000 users, and the upgrade is expected to serve a similarly sized user community.

† The BFNUF was designated a user facility in the summer of 2013 for “scientific and technical investigation of biomass feedstock,” http://www.innovation-america.org/you-can-call-it-%E2%80%9Cbfnuf%E2%80%9D.

‡ Information was supplied to the Commission by Lawrence Livermore. Not listed are Lawrence Livermore’s facilities that are “run for the benefit of several Federal agencies.” Facilities like this include the Forensics Sciences Center, the Biodefense Knowledge Center, and the Counterproliferation Analysis and Planning System. This is not an exhaustive list of Lawrence Livermore’s capabilities.

§ NREL has 15 testing facilities in addition to ESIF that allow industry and other organizations to collaborate with the laboratory. The other facilities are not considered “user,” but they have similar properties to user facility collaborations.

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Abbreviations

ACI	Asset Condition Index
ACT	Agreement for Commercializing Technology
ACTS	Audit Coordination & Tracking System
ALS	Advanced Light Source
AMES	Ames National Laboratory
ANL	Argonne National Laboratory
APL	Advanced Physics Laboratory
APM	Office of Acquisition and Project Management
APS	Advanced Photon Source
APS-U	Advanced Photon Source (upgrade)
ARRA	American Recovery and Reinvestment Act
ASC	Advanced Simulation and Computing
ASCR	Advanced Scientific Computing Research
ASME	American Society of Mechanical Engineers
ASO	Argonne Site Office
AU	Office of Environment, Health, Safety and Security
B&R	budget and reporting (code)
B61	life extension program
BES	Basic Energy Sciences
BESAC	Basic Energy Sciences Advisory Committee
BNL	Brookhaven National Laboratory
BNNT	Boron Nitride Nanotubes
BRC	Bioenergy Research Center
BSA	Brookhaven Science Associates
BUILDER	facilities and infrastructure data management system, used by Army Corps of Engineers
CAPE	DOD Office of Cost Assessment and Program Evaluation
CAS	Contractor Assurance System
CAS	Cost Accounting Standards
CBFI	Capabilities Based Facilities and Infrastructure
CBO	Congressional Budget Office
CD	Critical Decision
CDG	Central Design Group
CEBAF	Continuous Electron Beam Accelerator Facility
CEPE	Office of Cost Estimating and Program Evaluation
CERN	European Organization for Nuclear Research
CFN	Center for Functional Nanomaterials
CFO	Chief Financial Officer
CFR	Code of Federal Regulations

CIAD	Contractors Internal Audit Directors Steering Committee
CINT	Center for Integrated Nanotechnologies
CMRR	Chemistry and Metallurgy Replacement Research Facility
CMRR-NF	Nuclear Facility of the CMRR
CMRR-PF	Plutonium Facility at Technical Area 55 of the CMRR
CMRR-RLUOB	Radiological Laboratory, Utility, and Office Building of the CMRR
CNM	Center for Nanophase Materials Science
CNMS	Center for Nanoscale Materials
COO	Chief Operating Officer
CORAL	Collaboration of Oak Ridge, Argonne, and Lawrence Livermore National Laboratories
COV	Committee of Visitors
CR	Continuing Resolution
CRADA	cooperative research and development agreement
CRD	contractor requirements document
CRENEL	Commission to Review the Effectiveness of the National Energy laboratories
D&D	deactivation and decommissioning
DEAR	Department of Energy Acquisitions Regulation
DHHS	Department of Health and Human Services
DHS	Department of Homeland Security
DM	deferred maintenance
DNFSB	Defense Nuclear Facility Safety Board
DOD	Department of Defense
DOE	Department of Energy
DOE-EA (EA)	Office of Enterprise Assessments
DOE-IG (IG)	Office of the Inspector General
DPC	Directives Points of Contacts
DRB	Directives Review Board
EBI	Energy Bioscience Institute
EE	Office of Economic Impact and Diversity
EERE	Office of Energy Efficiency and Renewable Energy
EFCOG	Working Group of Energy Facility Contractors Group
EFRC	Energy Frontier Research Centers
EHSS	Office of Environment, Health, Safety, and Security
EIR	Entrepreneur in Residence program
EM	Office of Environmental Management
ERM	Enterprise Risk Management
ES&H	Environmental Safety and Health
ESAAB	Energy Systems Acquisition Advisory Board
ESIF	Energy Systems Integration Facility
ESPC	energy savings performance contracts
EUL	Enhanced Use Lease

F&A	facilities and administrative rate
F&I	facilities and infrastructure
FAR	Federal Acquisition Regulation
FBI	Federal Bureau of Investigation
FE	Office of Fossil Energy
FERMI	Fermi National Accelerator Laboratory
FERMILAB	Fermi National Accelerator Laboratory
FFRDC	federally-funded research and development center
FIMS	Facilities Information Management System
FIRP	Facilities Infrastructure Recapitalization Program
FMC	Field Management Council
FMFIA	Federal Managers' Financial Integrity Act
FNAL	Fermi National Accelerator Laboratory
FTE	full-time equivalent
FY	fiscal year
GAO	Government Accountability Office
GOGO	government-owned, government operated
GPP	general plant project
HEP	Office of High Energy Physics
HEPAP	High Energy Physics Advisory Panel
HERD	Higher Education Research and Development survey
HPC	high performance computing
HQ	headquarters
HSS	Office of Health, Safety, and Security
HVAC	heating, ventilating, air conditioning
IBM	International Business Machines
IC	Intelligence Community
ICF	Inertial Confinement Fusion program
ICR	Institutional Cost Report
IGPP	institutional general plant project
INL	Idaho National Laboratory
IOO	Idaho Operations Office
IP	intellectual property
ISC	Integrated Support Center
ISMS	integrated safety management system
ISO	International Organization for Standardization
JASON	independent scientific advisory group
JBEI	Joint Bioenergy Institute
JLAB	Thomas Jefferson National Accelerator Laboratory
JPL	Jet Propulsion Laboratory
KCP	Kansas City Plant
LANL	Los Alamos National Laboratory
LBNL	Lawrence Berkeley National Laboratory
LCLS	Linac Coherent Light Source
LCLS-II	Linac Coherent Light Source-II (upgrade)
LDRD	Laboratory Directed Research & Development

LEP	life extension program
LFO	Livermore Field Office
LLC	limited liability company
LLNL	Lawrence Livermore National Laboratory
LOB	Laboratory Operations Board
LP	laboratory protection
LVOC	Livermore Valley Open Campus
M&O	managing and operating (contractor)
MEC	Mission Executive Council
MIT	Massachusetts Institute of Technology
MOU	memorandum of understanding
MOX	Mixed Oxide Fuel Fabrication Facility
MTDC	modified total direct costs
NA-10	NNSA Defense Programs
NA-20	NNSA Defense Nuclear Non-Proliferation Office
NA-80	Office of Counterterrorism and Counterproliferation
NAP	NNSA-specific policy
NAPA	National Academy of Public Administration
NAS	National Academy of Sciences
NASA	National Aeronautics and Space Administration
NDAA	National Defense Authorization Act
NE	Office of Nuclear Energy
NEC	National Electric Code
NERSC	National Energy Research Scientific Computing Center
NETL	National Energy Technology Laboratory
NFPA	National Fire Protection Association
NGLS	Next Generation Light Source
NIF	National Ignition Facility
NIH	National Institutes of Health
NISP	National Industrial Security Program
NIST	National Institute of Standards and Technology
NLDC	National Laboratory Director's Council
NNI	National Nanotechnology Initiative
NNSA	National Nuclear Security Administration
NOAA	National Oceanic and Atmospheric Administration
NP	Office of Nuclear Physics
NRC	Nuclear Regulatory Commission or National Research Council
NREL	National Renewable Energy Laboratory
NSF	National Science Foundation
NSLS	National Synchrotron Light Source
NSLS-II	National Synchrotron Light Source (upgrade)
NSRC	Nanoscale Science Research Center
NSTX-U	National Spherical Torus Experiment upgrade
NUFO	National User Facility Organization

NUREG	regulatory guides released by the Nuclear Regulatory Commission
OCFO	Office of the CFO
OCL	obligation control level
ODNI	Office of the Director of National Intelligence
OECM	Office of Engineering and Construction Management
OFFM	Office of Financial and Field Management
OIG	Office of the Inspector General
OLCF	Oak Ridge Leadership Computing Facility
OMB	Office of Management and Budget
OPC	other project costs
OPI	Office of primary interest
ORNL	Oak Ridge National Laboratory
OSF	other structures and facilities
OSHA	Occupational Safety and Health Administration
OSTP	Office of Science and Technology Policy
P-5	Particle Physics Project Prioritization Panel
PARS	Project Assessment Rating System
PEMP	Performance Evaluation and Measurement Plan
PF-4	Plutonium Facility at Technical Area 55 of the CMRR
PLA	project labor agreement
PNNL	Pacific Northwest National Laboratory
PNSO	Pacific Northwest Site Office
PPA	Program, Project, and Activities legal control level
PPPL	Princeton Plasma Physics Laboratory
PRA	Probabilistic Risk Assessment
QA	quality assurance
R&D	research and development
R1	Research I university, as designated by the Carnegie Foundation
R2A2	roles, responsibilities, authorities, and accountabilities
RAMP	Roof Asset Management Program
RFI	request for information
RPV	replacement plant value
RTBF	Readiness in Technical Base and Facilities program
S&T	science and technology
SBIR	Small Business Innovation Research program
SC	Office of Science
SC-SLI	Science Laboratory Infrastructure Program
SCMS	Office of Science Management System
SD	supplemental directives
SEAB	Secretary of Energy Advisory Board
SES	Senior Executive Service
SF	square feet
SLAC	Stanford Linear Accelerator Laboratory
SME	subject matter experts

SNL	Sandia National Laboratory
SPP	Strategic Partnership Project
SRNL	Savannah River National Laboratory
SRS	Savannah River Site
SSC	Superconducting Super Collider
ST&E	science, technology, and engineering
STARS	DOE-wide cost reporting system
STTR	Small Business Technology Transfer program
TEC	total estimated costs
TJNL	Thomas Jefferson National Accelerator Laboratory
TPC	total project costs
UARC	university-affiliated research center
UPF	Uranium Processing Facility
VCS	voluntary consensus standards
VPP	Voluntary Protection Program
W-80-4	life extension program
W70-4	life extension program
W76-1	life extension program
W80	life extension program
W88 ALT 370	life extension program
WBS	work breakdown structure
WFO	Work for Others
WMD	weapons of mass destruction
WTP	Waste Treatment and Immobilization Plant