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December 2018

PROJECT MANAGEMENT

DOE and NNSA Should Improve Their Lessons-Learned Process for Capital Asset Projects

Accessible Version

GAO-19-25

GAO Highlights

Highlights of GAO-19-25, a report to the Ranking Member, Committee on Homeland Security and Governmental Affairs, U.S. Senate

December 2018

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DOE and NNSA Should Improve Their Lessons-Learned Process for Capital Asset Projects

Why GAO Did This Study

The MOX project, located at DOE's Savannah River Site in South Carolina and overseen by NNSA, experienced significant cost increases and schedule delays following the start of construction in 2007. After spending nearly $6 billion, NNSA terminated the project in October 2018. While DOE and NNSA have made some recent progress, they have historically struggled to complete, within their original cost and schedule estimates, other major construction projects intended to help maintain the nuclear security complex.

GAO was asked to review issues related to oversight of the MOX project. This report examines (1) when NNSA's project management oversight processes recognized cost and schedule problems at the MOX project and the actions the agency took to address them and (2) the extent to which DOE requires that project management lessons learned from MOX and other projects be documented and shared. GAO reviewed agency documents, visited the MOX project, and interviewed DOE and NNSA officials and representatives of the MOX contractor.

What GAO Recommends

GAO is making three recommendations, including that DOE and NNSA develop requirements for defining how and where project management lessons learned for capital asset projects should be documented and shared routinely and in a timely manner, and for evaluating the effectiveness of corrective actions taken in response to lessons learned. DOE agreed with GAO's recommendations.

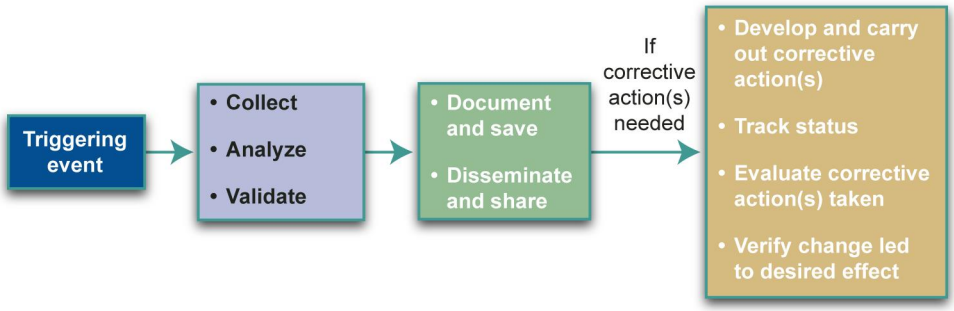
View GAO-19-25. For more information, contact David C. Trimble at (202) 512-3841 or trimbled@gao.gov.

What GAO Found

The Department of Energy's (DOE) National Nuclear Security Administration (NNSA) has strengthened its oversight of the Mixed Oxide Fuel Fabrication Facility (MOX) project since 2011 and, as a result, began recognizing cost and schedule problems. The project, begun in 1997, was intended to dispose of large quantities of weapons-grade plutonium no longer required for national security. Prior to 2011, NNSA's project staff failed to recognize signs that the project would not be completed on time or within its approved cost. An independently conducted analysis, prepared in 2014 in response to a GAO recommendation, determined that NNSA staff did not recognize early problems because they were inexperienced in project management. To strengthen oversight, NNSA in late 2010 and 2011 began actions, such as conducting additional reviews and transferring oversight of the project to a newly established office specializing in project management. NNSA continued to identify the contractor's performance problems, such as the lack of credible, reliable cost and schedule data. These continued problems contributed to NNSA's decision to terminate the project.

DOE requires that project staff document and share project management lessons learned on capital asset projects like the MOX project, but not all lessons are to be documented consistently or shared in a timely manner. GAO found that DOE's and NNSA's offices document project management lessons learned differently and that not all of the documented lessons learned are readily accessible to other staff. Additionally, GAO found that DOE does not require that project staff share lessons learned for capital asset projects until the start of construction, which can occur many years after the start of the project. Under key practices, such lessons should be stored in a logical, organized manner, be easily retrievable, and be submitted in a timely manner (see fig.). By developing requirements that clearly define how and where project management lessons learned should be documented and requiring that the lessons be shared in a timely manner, DOE could improve its lessons-learned process and help improve the success of future capital asset projects. Also, for capital asset projects, DOE does not require the evaluation of the results of all corrective actions to respond to lessons learned to ensure that problems are resolved, consistent with key practices. By developing requirements to evaluate the effectiveness of corrective actions, DOE could better verify whether the actions had the intended outcome.

Key Practices of a Lessons-Learned Process



Source: Analysis of prior GAO reports and the Center for Army Lessons Learned report, *Establishing a Lessons Learned Program: Observations, Insights, and Lessons.* | GAO-19-25

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Abbreviations

CD	critical decision
DOE	Department of Energy
EVM	earned value management
MOX	Mixed Oxide Fuel Fabrication Facility
MOX Services	MOX Services, LLC
NNSA	National Nuclear Security Administration
PARS II	Project Assessment and Reporting System
UPF	Uranium Processing Facility

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U.S. GOVERNMENT ACCOUNTABILITY OFFICE
441 G St. N.W.
Washington, DC 20548

December 21, 2018

The Honorable Claire McCaskill
Ranking Member
Committee on Homeland Security and Governmental Affairs
United States Senate

Dear Senator McCaskill:

The Department of Energy (DOE) and the National Nuclear Security Administration (NNSA), a separately organized agency within DOE, are spending billions of dollars on numerous construction projects that, among other things, are used to help maintain the nuclear weapons stockpile, process nuclear waste into forms suitable for long-term storage or permanent disposal, and conduct research and development in the areas of high-energy physics and nuclear physics. DOE and NNSA use the capital asset acquisition process to undertake many of these projects.[1] The cost of these projects can vary greatly, with projects estimated to cost less than $750 million designated as nonmajor, and those estimated to cost greater than or equal to $750 million designated as major.[2] Some of the more complex, first-of-a-kind, major nuclear construction projects can cost several billions of dollars.

For many years, NNSA has encountered numerous cost, schedule, and technical challenges that resulted in a reassessment of alternatives and,

[1]DOE defines capital assets as land, structures, equipment, and intellectual property that are used by the federal government and that have an estimated useful life of 2 years or more, and the acquisition cost exceeds the capitalization threshold. The acquisition of capital assets typically includes projects involving the design and construction of facilities with specialized equipment, such as facilities needed to maintain the nuclear weapons stockpile, conduct research and development, or process nuclear materials.

[2]DOE also refers to these projects as nonmajor system and major system projects. For the purposes of our report, we refer to such projects as nonmajor or major projects.

in some cases, the cancellation of entire projects or portions thereof.[3] NNSA terminated one such project—the Mixed Oxide Fuel Fabrication Facility (MOX) project—after experiencing numerous cost, schedule, and technical challenges. DOE initiated the MOX project in 1997 at its Savannah River Site in South Carolina as a key component of NNSA's strategy to dispose of large quantities of weapons-grade plutonium deemed no longer required for national security.[4] Construction began in 2007 after DOE formally approved the project's cost estimate of $4.8 billion and estimated completion date of September 2016. Since construction began in 2007, DOE's cost estimate for the MOX project increased significantly to about $17.2 billion, and the estimated completion date for the project was extended to as late as 2048, a potential delay of nearly 32 years.[5]

In February 2016, DOE proposed terminating the MOX project in favor of an alternative, referred to as "dilute and dispose," which was expected to

[3]When NNSA is acquiring capital assets, the use of the analysis of alternatives process included in DOE's requirements and guidance is a key first step to help ensure that the selected alternative best meets the agency's mission need. In September 2009, we noted this process is an analytical study that is intended to compare the operational effectiveness, cost, and risks of a number of potential alternatives to address valid needs and shortfalls in operational capability. See GAO, *DOE and NNSA Project Management: Analysis of Alternatives Could Be Improved by Incorporating Best Practices*, GAO-15-37 (Washington: D.C.: Dec. 11, 2014) and *Defense Acquisitions: Many Analyses of Alternatives Have Not Provided a Robust Assessment of Weapon System Options*, GAO-09-665 (Washington, D.C.: Sept. 24, 2009).

[4]Plutonium—a manmade, radioactive element produced by irradiating uranium in nuclear reactors—is a key ingredient in the production of nuclear weapons and poses a risk of proliferation and risks to human health and the environment if not managed safely. After its completion, the facility would be used to create mixed-oxide fuel, a mixture of plutonium and uranium oxides that can be used in modified commercial nuclear reactors. Once used and removed from a reactor, the plutonium can no longer be readily used to make a nuclear weapon.

[5]In 2007, DOE formally approved a cost estimate of $4.8 billion for construction of the MOX project, with a scheduled completion date of September 2016. The $17.2 billion cost estimate and 2048 schedule estimate are based on an August 2016 estimate developed by DOE and the U.S. Army Corps of Engineers for the construction of the MOX project. We reported in September 2017 that DOE's August 2016 revised cost estimate did not fully meet all the best practices in the GAO cost-estimating guide, but it did substantially meet all four characteristics of a high-quality, reliable cost estimate (comprehensive, well-documented, accurate, and credible) and therefore could be considered reliable. A cost estimate is considered reliable if the overall assessment ratings for each of the four characteristics are substantially or fully met. GAO, *Plutonium Disposition: Proposed Dilute and Dispose Approach Highlights Need for More Work at the Waste Isolation Pilot Plant,* GAO-17-390 (Washington, D.C.: Sept. 5, 2017).

be less expensive than the MOX project.[6] Congress continued funding the MOX project. For example, the National Defense Authorization Act for Fiscal Year 2018 required DOE to proceed with MOX construction unless, among other things, the Secretary certified that the life-cycle cost of the dilute and dispose option would be less than half the life-cycle cost of the MOX project. In May 2018, the Secretary of Energy submitted the certification and reported that the life-cycle cost estimate was $19.9 billion for the dilute and dispose option compared with $49.4 billion for the MOX project.[7] In October 2018, NNSA terminated the MOX project. At the time of its termination, NNSA had spent nearly $6 billion on the MOX project.

Significant cost increases and schedule delays are not unique to the MOX project, as DOE and NNSA have historically struggled to complete projects within their initial cost and schedule estimates. Since 1990, we have designated DOE's management of major contracts and projects, including those executed by NNSA, as an area at high risk for fraud, waste, abuse, and mismanagement.[8] In response, DOE and NNSA have undertaken a number of efforts to improve their management of contracts and projects, and in February 2013, we narrowed the focus of the high-risk designation to major projects within DOE's Office of Environmental Management and NNSA to acknowledge progress made in managing nonmajor projects.[9] However, not all of the actions taken by DOE and NNSA have resulted in improved project management. As we found in April 2015, NNSA has had a long history of identifying corrective actions and declaring them successfully resolved, only to identify additional

[6]Under the alternative "dilute and dispose" approach, plutonium would be diluted with inert material to inhibit its future use in weapons. It would then be packaged and shipped to a repository for permanent disposal, most likely DOE's Waste Isolation Pilot Plant, an underground repository located near Carlsbad, New Mexico, that is used for disposing of defense transuranic waste.

[7]The MOX contractor stated that DOE's cost estimates are not comparable because they rely on different assumptions and that DOE underestimated the cost of the dilute and dispose approach. The state of South Carolina has challenged the adequacy of DOE's certification in federal court.

[8]GAO designated DOE contract management as a high-risk area in 1990. See GAO, *Government Financial Vulnerability: 14 Areas Needing Special Review*, GAO/OCG-90-1 (Washington, D.C.: Jan. 23, 1990). See GAO's most recent report on high-risk areas: GAO, *High-Risk Series: Progress on Many High-Risk Areas, While Substantial Efforts Needed on Others,* GAO-17-317 (Washington, D.C.: February 2017).

[9]GAO, *High-Risk Series: An Update*, GAO-13-283 (Washington, D.C.: February 2013).

actions to address the same problems that had reemerged.[10] The repeat nature of some of these problems and their considerable effect on the cost and schedule of DOE and NNSA projects has raised concerns that lessons from past experiences on projects are not being identified and applied to current and future projects.

Given NNSA's shift in focus from the MOX project to the alternative dilute and dispose approach, you requested that we review issues related to DOE's and NNSA's oversight of the MOX project. This report examines (1) when NNSA's project management oversight processes recognized cost and schedule problems at the MOX project and the actions the agency took to address them and (2) the extent to which DOE requires that project management lessons learned from MOX and other projects be documented and shared.

To examine when NNSA's project management oversight processes recognized cost and schedule problems at the MOX project and to examine what actions the agency took to address them, we reviewed DOE and NNSA documents outlining the agencies' overall direction for, and oversight of, the MOX project. In addition, we reviewed DOE's, NNSA's, and MOX Services, LLC's (MOX Services) documents,[11] as well as independent reviews and assessments, concerning the performance and status of the MOX project, including a May 2014 report prepared for DOE that identified and analyzed the root causes behind the cost increases for the MOX project through 2012.[12] Additionally, we interviewed officials from DOE and NNSA to discuss how and when they identified the MOX project's cost and schedule problems. We conducted a site visit at the Savannah River Site to tour the MOX project before the project was terminated and interviewed officials from NNSA's MOX

[10]GAO, *National Nuclear Security Administration: Observations on Management Challenges and Steps Taken to Address Them*, GAO-15-532T (Washington, D.C.: Apr. 15, 2015).

[11]MOX Services, LLC is the contractor constructing the MOX facility and was formally known as CB&I AREVA MOX Services, LLC.

[12]Parsons, Longenecker & Associates, *Root Cause Analysis of Cost Increases: Mixed Oxide Fuel Fabrication Facility and Waste Solidification Building, Savannah River Site, South Carolina* (May 23, 2014). This report was prepared for DOE in response to a recommendation we made in February 2014. GAO, *Plutonium Disposition Program: DOE Needs to Analyze the Root Causes of Cost Increases and Develop Better Cost Estimates,* GAO-14-231 (Washington, D.C.: Feb. 13, 2014).

Project Management Office and representatives from MOX Services. We also monitored the status of the MOX project.

To examine the extent to which DOE requires that project management lessons learned from MOX and other projects be documented and shared,[13] we reviewed DOE's Order 413.3B, which outlines the primary set of project management requirements governing DOE's and NNSA's capital asset projects that have a total project cost of greater than $50 million.[14] We also reviewed documents from NNSA and DOE's Offices of Environmental Management and Science. In addition, we collected examples of capital asset project-management lessons learned from DOE and NNSA, including those from the MOX project, from a variety of sources.[15] Further, we reviewed reports by us,[16] the U.S. Army's Center for Army Lessons Learned,[17] and the Project Management Institute[18] that

[13]For the purposes of our report, we are focusing on project management lessons learned, which include those lessons learned associated with the non-operational phase of a facility during construction (i.e., throughout the project life cycle from preconceptual planning through completion of the project). We did not examine lessons learned as they relate to non-capital asset projects or operations activities, such as the operations activities performed by DOE's Office of Environmental Management that include decontaminating and decommissioning contaminated nuclear facilities and sites.

[14]Department of Energy, *Program and Project Management for the Acquisition of Capital Assets*, DOE Order 413.3B, Chg 5 (Washington, D.C.: Apr. 12, 2018). DOE Order 413.3B defines lessons learned as the project-management-related input and output devices that represent the knowledge, information, or instructional knowledge that have been garnered through the process of actually completing the ultimate performance of the respective project and that benefit future endeavors and ideally prevent any negative happenings from taking place in the future.

[15]Examples of these sources included lessons-learned reports, project peer reviews, entries stored in DOE's Project Assessment and Reporting System (PARS II) and NNSA's internal databases, monthly lessons-learned bulletins, and presentations.

[16]For example, GAO, *Telecommunications: GSA Needs to Share and Prioritize Lessons Learned to Avoid Future Transition Delays*, GAO-14-63 (Washington, D.C.: Dec. 5, 2013); *Combatting Nuclear Smuggling: Lessons Learned from Cancelled Radiation Portal Monitor Program Could Help Future Acquisitions*, GAO-13-256 (Washington, D.C.: May 13, 2013); *Federal Real Property Security: Interagency Security Committee Should Implement a Lessons-Learned Process*, GAO-12-901 (Washington, D.C.: Sept. 10, 2012); and *NASA: Better Mechanisms Needed for Sharing Lessons Learned*, GAO-02-195 (Washington, D.C.: Jan. 30, 2002).

[17]Department of the Army, Combined Arms Center, Center for Army Lessons Learned, *Establishing a Lessons Learned Program: Observations, Insights, and Lessons* (Fort Leavenworth, KS: June 2011).

identify and discuss key practices for lessons learned. We then compared the project management lessons-learned requirements in DOE Order 413.3B against these key practices. We also discussed project management lessons-learned requirements and processes with officials from DOE's Offices of Environmental Management, Project Management, and Science and NNSA's Office of Acquisition and Project Management. See appendix I for additional information on our objectives, scope, and methodology.

We conducted this performance audit from May 2017 to December 2018 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

This section discusses (1) the history and status of the MOX project; (2) the roles of DOE, NNSA, and the contractor in managing and overseeing the MOX project; (3) project management lessons learned; and (4) DOE's and NNSA's recurring project management problems.

History and Status of the MOX Project

DOE began the MOX project over 20 years ago, in 1997, as part of a strategy to manage the disposition of large quantities of surplus,

[18]Project Management Institute, Inc., *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)*, Sixth Edition (2017), and Project Management Institute, Inc., *Implementing Organizational Project Management: A Practice Guide*, First Edition (2014). *PMBOK* is a trademark of Project Management Institute, Inc. The *PMBOK® Guide* provides guidelines for managing individual projects, including collecting requirements and defining the project's scope. The Project Management Institute is a not-for-profit association that provides global standards for, among other things, project and program management. These standards are utilized worldwide and provide guidance on how to manage various aspects of projects, programs, and portfolios.

weapons-grade plutonium no longer needed for defense purposes.[19] This strategy, now undertaken through NNSA's Plutonium Disposition program, originally planned to dispose of the plutonium through a dual approach—(1) conversion into mixed-oxide fuel and (2) immobilization in glass or ceramic material—but NNSA later cancelled the immobilization approach in favor of the approach for only mixed-oxide fuel.[20] In 1999, DOE awarded a contract to design, construct, and operate a MOX facility to the contractor consortium of Duke, Cogema, Stone & Webster, LLC—now called MOX Services, LLC (MOX Services).

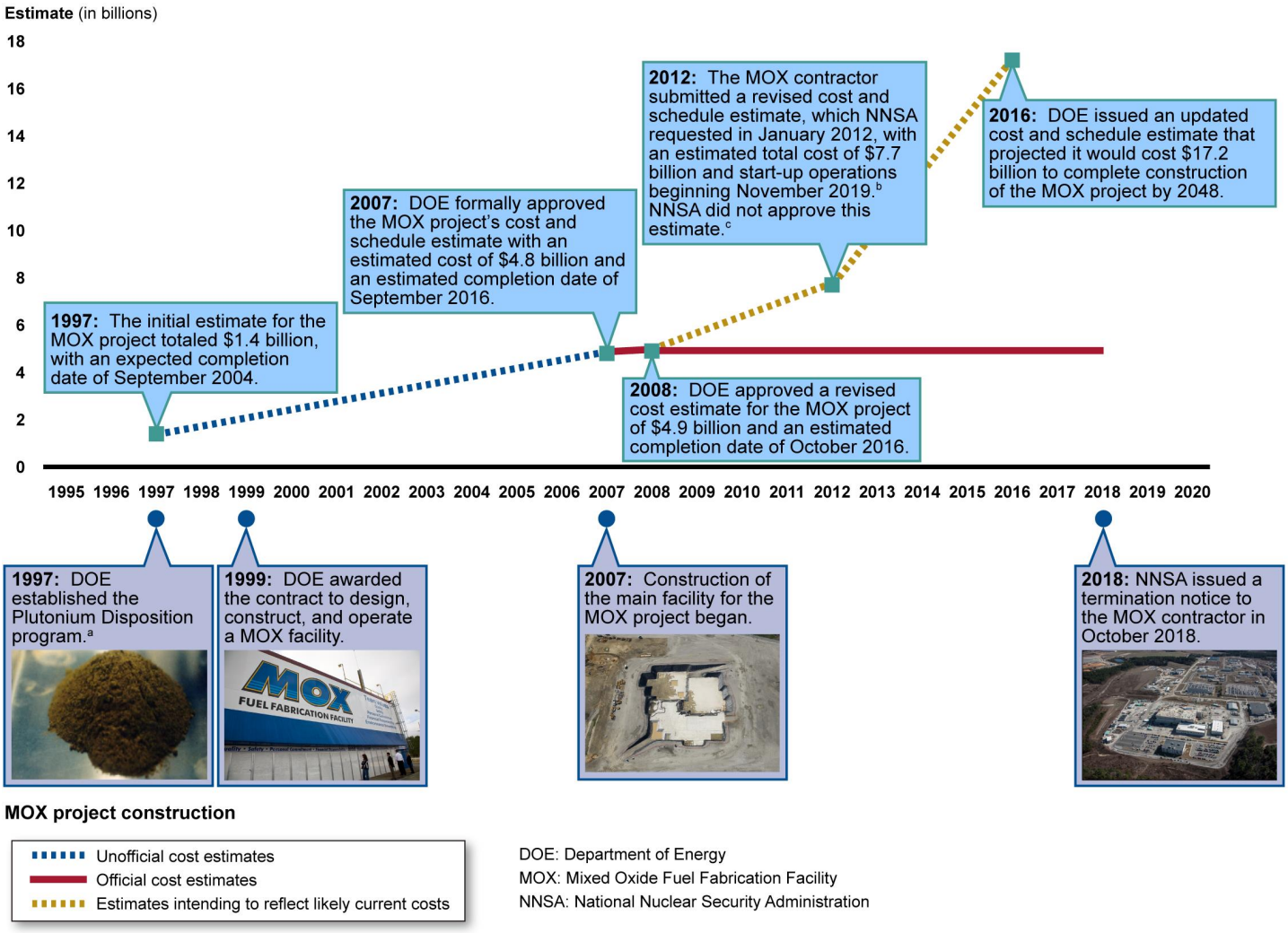
In February 2002, NNSA reported to Congress that the construction of the MOX project would begin in fiscal year 2004, with operations set to begin in fiscal year 2007, and cost nearly $1 billion to design and construct.[21] However, as figure 1 shows, construction of the MOX project did not begin until 2007 after DOE formally approved the project's estimated cost of about $4.8 billion and estimated completion date of September 2016.

[19]This strategy was linked to a larger, international nuclear nonproliferation effort with Russia. In 2000, the United States and Russia entered into a Plutonium Management and Disposition Agreement, under which each country pledged to dispose of at least 34 metric tons of surplus, weapons-grade plutonium. Through a protocol to the agreement signed in 2010, the United States and Russia reaffirmed their commitment to dispose of surplus, weapons-grade plutonium as mixed-oxide fuel in nuclear reactors, and the agreement entered into force in 2011.

[20]The immobilization approach would entail incorporating plutonium into a corrosion-resistant ceramic matrix and then encasing the immobilized plutonium in glass along with highly radioactive nuclear wastes that already existed at DOE sites, thereby rendering the plutonium as inaccessible and unattractive for reuse in nuclear weapons. In 2002, NNSA cancelled the immobilization portion of its surplus plutonium disposition strategy due to budgetary constraints.

[21]National Nuclear Security Administration, Office of Fissile Materials Disposition, *Report to Congress: Disposition of Surplus Defense Plutonium at Savannah River Site* (Feb. 15, 2002).

Figure 1: Timeline of Selected Events and Cost and Schedule Estimates Related to the MOX Facility Construction Project



Source: GAO analysis of DOE, NNSA, and MOX contractor documents, and NNSA and MOX Services, LLC (images). | GAO-19-25

Notes: The photos, from left to right, illustrate (1) an example of plutonium oxide, the material with which uranium oxides would be blended to create mixed-oxide fuel; (2) a sign for the MOX project at DOE's Savannah River Site; (3) an aerial overview that reflects early concrete work performed for the MOX project following the start of construction in 2007; and (4) an aerial overview that details the MOX project and affiliated buildings as of 2017.

[a]DOE established the program to address the disposition of surplus weapons-grade plutonium at the end of the Cold War.

[b]The MOX contractor's proposed 2012 cost estimate of $7.7 billion included additional scope of work to provide the MOX project with a plutonium metal oxidation capability, referred to as direct metal oxidation, which is a procedure to convert plutonium and uranium metal into plutonium and uranium oxide. According to the contractor's proposal, it would cost about $7.4 billion to complete the MOX project without the direct metal oxidation by November 2019. The addition of the direct metal

oxidation scope of work would cost an additional $262.3 million, which would be completed in June 2023 after the completion of the MOX project and the start-up of operations by November 2019.

[c]NNSA did not approve the MOX contractor's proposed 2012 cost and schedule estimate but directed the contractor to use its proposed estimate as a provisional baseline for the purposes of monthly reporting.

In December 2008, DOE approved a revised cost estimate for completing construction of the MOX project of $4.9 billion and a 1-month delay in the start of operations to October 2016.[22] From 2009 through 2011, the estimated cost to complete construction of the MOX project remained at $4.9 billion. However, the MOX project's cost and schedule estimate changed significantly in 2012. That year, at NNSA's direction to update the estimate, the MOX contractor submitted a proposal to increase the cost of the facility to about $7.7 billion—an increase of about $2.8 billion from the 2008 estimate—with the start of operations delayed by about 3 years, to November 2019.[23]

After receiving the MOX contractor's revised estimate that indicated significant cost increases and schedule delays to the project, NNSA stated in its fiscal year 2014 budget request that pursuing the MOX approach might be unaffordable and proposed to slow down construction while the agency assessed alternative approaches for plutonium disposition. After a series of reviews, DOE ultimately concluded that pursuing an alternative disposition approach—referred to as "dilute and dispose"—could significantly reduce the life-cycle cost of the Plutonium Disposition program, compared with continuing the program using the MOX approach.[24] Following the identification of a potentially less costly approach to plutonium disposition, in February 2016, DOE's fiscal year

[22]According to DOE's December 2008 memorandum approving the revised cost estimate, funding restrictions for fiscal year 2008 contributed to the project's cost increase and schedule delay.

[23]As previously discussed, NNSA expanded the scope of work to include the addition of the direct metal oxidation capability to the MOX project. This expanded scope also allowed NNSA to cancel its previous plans for producing plutonium feedstock for the MOX project through the Pit Disassembly and Conversion Facility in January 2012. NNSA estimated in January 2011 that the cost of the facility could range from $4.5 billion to $4.8 billion. Prior to its cancellation, NNSA had already spent $730.1 million on the Pit Disassembly and Conversion Facility.

[24]These reviews included the following: Oak Ridge National Laboratory, *Final Report of the Plutonium Disposition Red Team* (Oak Ridge, TN: Aug. 13, 2015); Aerospace Corporation, *Plutonium Disposition Study Options Independent Assessment Phase 1 Report*, TOR-2015-01848 (Washington, D.C.: Apr. 13, 2015); and Department of Energy, *Report of the Plutonium Disposition Working Group: Analysis of Surplus Weapon-Grade Plutonium Disposition Options* (April 2014).

2017 budget request proposed terminating the MOX project in favor of pursuing the dilute and dispose approach.[25] Congress appropriated funding for the MOX project for fiscal years 2017 and 2018 and directed DOE to continue work on the project.

In August 2016, DOE issued a revised cost estimate of approximately $17.2 billion to complete construction of the MOX project by 2048.[26] In the face of this significant cost increase, the National Defense Authorization Act for Fiscal Year 2018 authorized the Secretary of Energy to terminate the MOX project if, among other things, he could certify that the remaining life-cycle cost for an alternative option for carrying out plutonium disposition would be less than approximately half of the estimated remaining life-cycle cost of carrying out the MOX project.[27] In May 2018, DOE completed this certification and notified Congress of its intention to terminate construction of the MOX project and to instead pursue the dilute and dispose option. The Secretary of Energy reported that the life-cycle cost estimate was $19.9 billion for the dilute and dispose option compared to $49.4 billion for the MOX project. In October 2018, NNSA terminated the project. Additional information on the history and status of the MOX project is in appendix II.

Roles of DOE, NNSA, and the Contractor in Managing the MOX Project

DOE and NNSA are responsible for providing overall direction to, and oversight of, the contractor for the MOX project. The contractor, MOX

[25]As we found in September 2017, according to an official from the Department of State, the United States sent a letter to start discussions with the Russian government on whether dilute and dispose could be added as a disposition method under the Plutonium Management and Disposition Agreement in June 2016. Russia suspended its implementation of the agreement in October 2016, citing delays in the United States' implementation of the agreement, among other reasons, but DOE officials stated that they planned to continue to seek safe disposition of surplus U.S. plutonium. GAO-17-390.

[26]See GAO-17-390 for our review of DOE's cost estimate.

[27]Pub. L. No. 115-91, § 3121(b), 131 Stat. 1892 (2018).

Services, is responsible for the design, construction, and operation of the MOX facility.[28]

- **DOE.** The Office of Project Management participates in a number of the MOX project's oversight activities.[29] In particular, the office has led independent reviews of the MOX project to validate its cost and schedule estimates and has conducted certification and surveillance reviews of the MOX contractor's earned value management (EVM) system.[30]
- **NNSA.** Subsequent to its establishment in 2000,[31] several NNSA offices have provided overall direction to, and oversight of, the contractor for the MOX project, including the Office of Fissile Materials Disposition and the Office of Defense Nuclear Nonproliferation.[32] In November 2011, after starting to place increased emphasis on improving its management of projects, the newly created Office of Acquisition and Project Management began providing overall direction to, and oversight of, the contractor for the MOX project. In March 2013, the Office of Acquisition and Project Management established the NNSA MOX Project Management Office at the Savannah River

[28]The Nuclear Regulatory Commission, an independent oversight agency, has general licensing and related regulatory authority over the construction and operation of the MOX project. 42 U.S.C. § 5842 (2018). For example, the Nuclear Regulatory Commission issued a construction authorization for the facility in 2005.

[29]From 1999 through 2015, DOE's oversight activities related to project management were carried out by a number of different offices, including the Office of Field Management, the Office of Engineering and Construction Management, and the Office of Acquisition and Project Management. DOE's Office of Project Management was created in fiscal year 2015 after the DOE Under Secretary for Management and Performance reorganized and consolidated project and contract management oversight.

[30]An EVM system is a project management tool that, among other things, measures the value of work accomplished in a given period and compares it with the planned value of work scheduled for that period and the actual cost of work accomplished. Within EVM, personnel can use a variety of data and indicators to monitor a project's cost and schedule performance. According to DOE's current project management requirements, an EVM system is required for all projects not being performed under a firm fixed-price contract and that are expected to have a total project cost greater than $50 million.

[31]NNSA was established under Title 32 of the National Defense Authorization Act for Fiscal Year 2000—the National Nuclear Security Administration Act—in the wake of a highly critical report on security problems at the nation's nuclear weapons laboratories and significant cost overruns on major projects. Pub. L. No. 106-65, § 3211, 113 Stat. 957 (1999) (codified as amended at 50 U.S.C. § 2401 (2018)).

[32]Beginning in fiscal year 2016, the Office of Fissile Materials Disposition moved to NNSA's Office of Material Management and Minimization.

Site to lead the onsite project and contract management direction, administration, and oversight of the MOX project.[33]

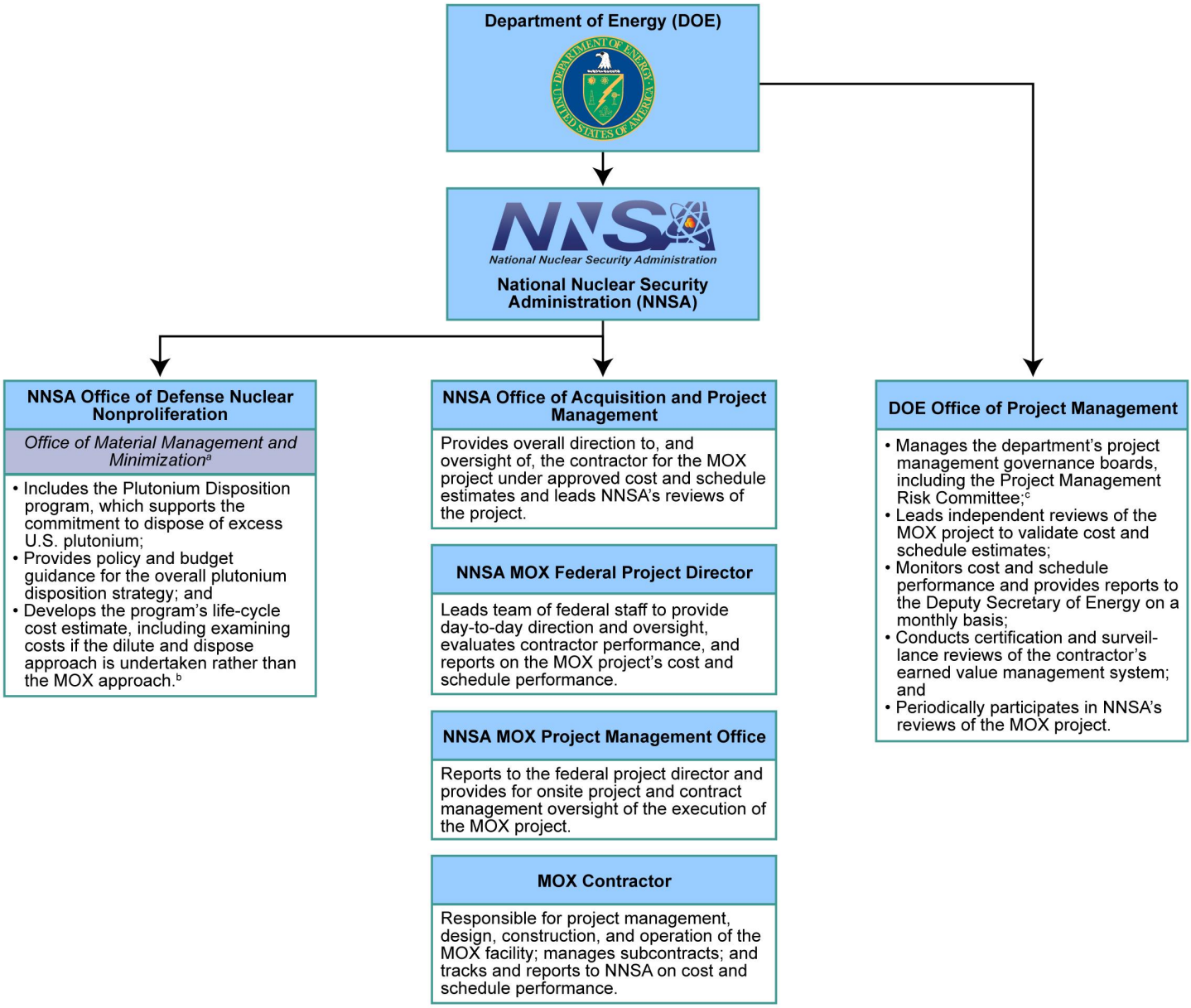
- **MOX Services.** As the contractor for the MOX project, MOX Services is responsible for designing, constructing, and operating the MOX facility. MOX Services has also subcontracted work to complete certain construction activities, such as the fabrication of specific types of equipment, including the complex gloveboxes needed for handling plutonium and the heating, ventilation, and air conditioning systems.[34]

Figure 2 depicts the roles of, and interrelation among and between, DOE, NNSA, and the MOX contractor in overseeing the MOX project.

[33]Prior to 2013, NNSA had a small number of staff located at the Savannah River Site to oversee the MOX project. NNSA officials said they could not provide us with a specific number of staff assigned to the MOX project during the early years prior to construction because the staffing levels pertained to the entire Fissile Materials Disposition program, which included the MOX project, the Waste Solidification Building, and the Pit Disassembly and Conversion Facility. However, they estimated that 4 or 5 staff oversaw the MOX project based on the Fissile Materials Disposition program's staff levels from 2005 to 2007.

[34]A glovebox is a sealed, protectively lined compartment having holes to which are attached gloves for use in handling especially dangerous materials inside the compartment.

Figure 2: DOE's and NNSA's Organizational Structure for Oversight of the Mixed Oxide Fuel Fabrication Facility (MOX) Project



Source: GAO analysis of prior GAO reports and DOE and NNSA documents. | GAO-19-25

[a]The Office of Material Management and Minimization, which was established in fiscal year 2016, includes what was formerly known as the Office of Fissile Materials Disposition. Prior to 2011 and the creation of the Office of Acquisition and Project Management, this office provided overall direction to, and oversight of, the MOX project.

[b]Under the dilute and dispose approach, plutonium would be diluted with inert material to inhibit its future use in weapons. It would then be packaged and shipped to a repository for permanent

disposal, most likely DOE's Waste Isolation Pilot Plant, an underground repository located near Carlsbad, New Mexico, that is used for disposing of defense transuranic waste.

[c]The Project Management Risk Committee provides ongoing monitoring and assessments of projects as well as enterprise-wide project management risk assessment and expert advice to the Secretary of Energy and others in the department on cost, schedule, and technical issues regarding capital asset projects with a total project cost of $100 million or greater, among other things.

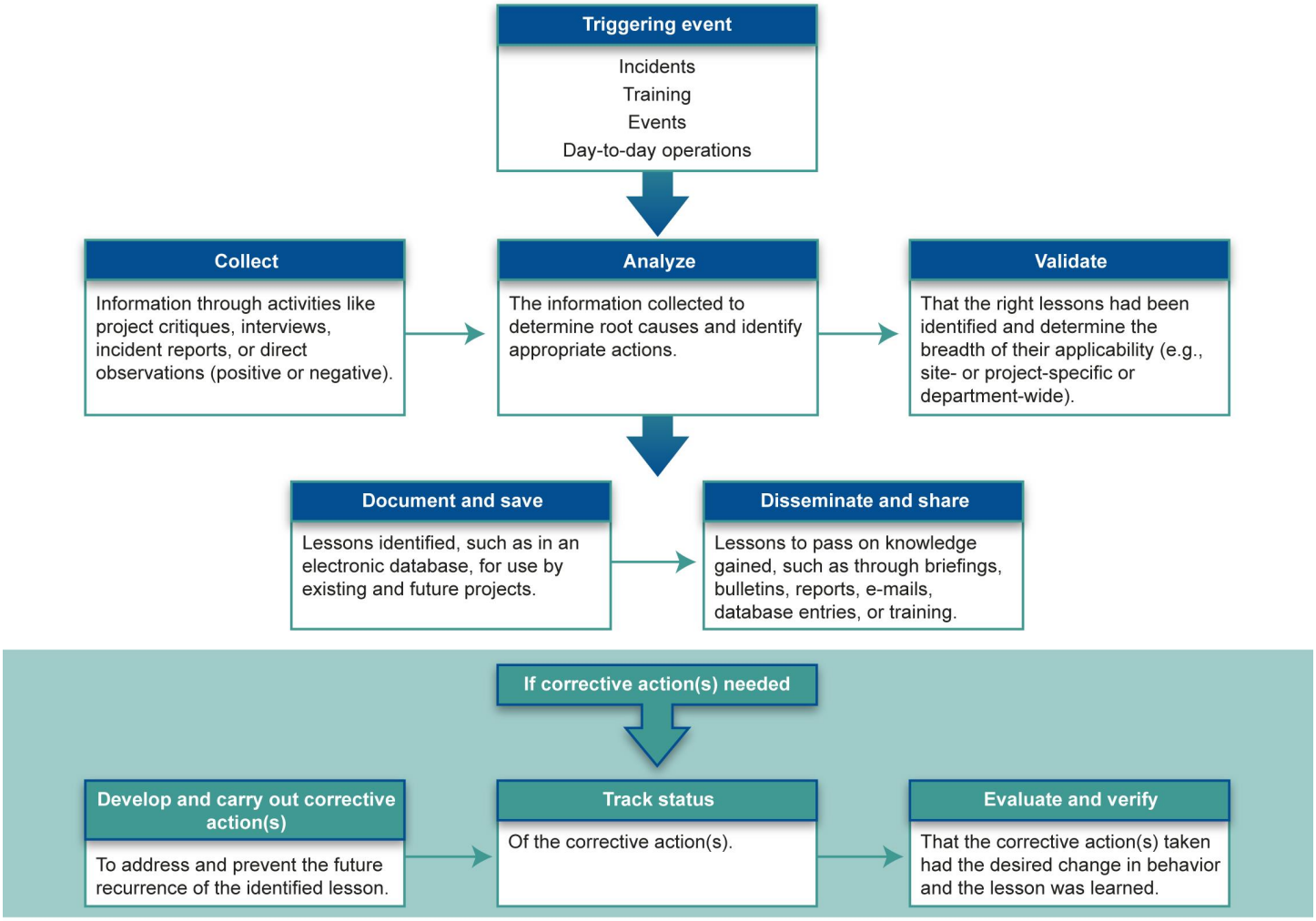
Project Management Lessons Learned

According to key practices that we and others have identified for both program and project management, it is important to identify and apply lessons learned from programs, projects, and missions to limit the chance of recurrence of previous failures or difficulties.[35] As such, the use of lessons learned—such as project management lessons learned—is a principal component of an organizational culture committed to continuous improvement. Lessons learned, therefore, serve to communicate knowledge more effectively and to ensure that beneficial information is factored into planning, work processes, and activities. They also provide a powerful method of sharing ideas for improving work processes, facility or equipment design and operation, quality, and cost-effectiveness. Moreover, as we and others have previously found, agencies can learn lessons from an event and make decisions about when and how to use that knowledge to change behavior. Key practices of a lessons-learned process include collecting, analyzing, saving or archiving, and sharing and disseminating information and knowledge gained on positive and negative experiences (see fig. 3).[36]

[35]GAO-14-63, GAO-12-901, and GAO-02-195. We also identified lessons-learned practices from reports by both the Project Management Institute and the Center for Army Lessons Learned. Project Management Institute, Inc., *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)*, Sixth Edition (2017); Project Management Institute, Inc., *Implementing Organizational Project Management: A Practice Guide*, First Edition (2014); and Center for Army Lessons Learned, *Establishing a Lessons Learned Program*.

[36]GAO-14-63, GAO-12-901, GAO-02-195, and the Center for Army Lessons Learned's *Establishing a Lessons Learned Program*.

Figure 3: Key Practices of a Lessons-Learned Process



Source: Analysis of prior GAO reports and the Center for Army Lessons Learned report, *Establishing a Lessons Learned Program: Observations, Insights, and Lessons.* | GAO-19-25

DOE and NNSA Have Faced Recurring Project Management Problems

For more than 2 decades, we and others have reported on the recurring nature of the problems affecting DOE's and NNSA's ability to manage contracts and projects effectively. Many of these problems have related to DOE's and NNSA's struggles with managing projects, such as the MOX project, within their initial cost and schedule estimates, including the following:

- In 1999, the National Academy of Science's National Research Council reported that recurring problems with project management had raised questions about the credibility of DOE's conceptual designs and cost estimates.[37]
- In a March 2007 report, we found that 9 of 12 major projects we reviewed—including the MOX project—had exceeded their original cost estimates, schedule estimates, or both, principally because of ineffective project oversight and contractor management.[38]
- In a November 2014 report, the Congressional Advisory Panel on the Governance of the Nuclear Security Enterprise (Augustine-Mies Panel) stated that NNSA's inability to estimate costs and execute projects according to plan has been a major source of dissatisfaction among the national leadership and had significantly undermined NNSA's credibility.[39]

Further, in April 2015, we found that NNSA has had a long history of identifying corrective actions for problems and declaring them successfully resolved, only to then identify additional actions needed to address the problems.[40] As we found, the recurrence of such problems suggests that NNSA did not have a full understanding of the root causes of its contract- and project-management challenges. Moreover, our 2017 high-risk report found that DOE had taken several important steps that demonstrate its commitment to improving contract and project management, but that DOE's efforts had not fully addressed several areas where the department continues to have shortcomings. Areas with shortcomings include acquisition planning for major contracts and the

[37]National Research Council of the National Academies, *Improving Project Management in the Department of Energy* (Washington, D.C.: National Academy Press, 1999).

[38]GAO, *Department of Energy: Major Construction Projects Need a Consistent Approach for Assessing Technology Readiness to Help Avoid Cost Increases and Delays*, GAO-07-336 (Washington, D.C.: Mar. 27, 2007).

[39]Mr. Norman R. Augustine and Admiral Richard W. Mies served as the Co-Chairmen of the Congressional Advisory Panel on the Governance of the Nuclear Security Enterprise (known as the "Augustine-Mies Panel"). Section 3166 of the National Defense Authorization Act for Fiscal Year 2013 established the Congressional Advisory Panel on the Governance of the Nuclear Security Enterprise and tasked the advisory panel with offering a recommendation "with respect to the most appropriate governance structure, mission, and management of the nuclear security enterprise." The panel's November 2014 report summarizes the panel's findings on the current health of the enterprise, examines the root causes of its governance challenges, and offers its recommendations to address the identified problems.

[40]GAO-15-532T.

quality of enterprise-wide cost information available to DOE managers and key stakeholders.[41] Additional information on our prior work highlighting selected DOE and NNSA project management problems is in appendix III.

NNSA Recognized Certain Indicators of Cost and Schedule Problems after Strengthening Its Oversight in 2010 and 2011

Prior to 2011, NNSA project staff had failed to recognize and fully resolve certain cost and schedule problems that indicated that the MOX project would not be completed on time or within its approved cost estimates. However, after taking actions to strengthen its project management oversight in late 2010 and 2011, NNSA recognized indicators of a number of problems with the MOX project that contributed to NNSA's decision to terminate the project.

NNSA Failed to Recognize and Fully Resolve Certain Cost and Schedule Problems Affecting the MOX Project Prior to 2011

Prior to 2011, NNSA's staff responsible for overseeing the MOX project failed to recognize and fully resolve certain cost and schedule problems that indicated that the project would not be completed on time or within its approved cost estimates. The NNSA staff responsible for overseeing the MOX project at that time were generally inexperienced in overseeing complex nuclear construction projects. From 2007 through 2011, staff overseeing the MOX project were primarily familiar with large programmatic initiatives and operations but had little experience in managing large, complex first-of-a-kind nuclear construction projects,

[41]GAO, *Department of Energy: Continued Actions Needed to Address Management Challenges*, GAO-17-651T (Washington, D.C.: May 24, 2017) and GAO-17-317.

according to a May 2014 root cause analysis.[42] Although information available to the NNSA staff showed that there were cost and schedule problems that indicated the increasing likelihood that the project would not be completed within its approved total cost estimate of $4.9 billion, the staff did not recognize and fully resolve four key problems.

First, information about the contractor's use of inaccurate rates to estimate the time needed to complete certain construction activities—commonly referred to as unit rates or planned production rates—indicated that the project would not be completed within its approved cost estimate. These rates are used to reflect levels of productivity during construction and to help develop projects' cost and schedule estimates, including updates to annual forecasted estimates.[43] Following the start of construction in August 2007, the MOX contractor began to experience lower-than-estimated productivity rates for key construction activities, according to the May 2014 root cause analysis report.[44] Despite this issue, the contractor did not incorporate more realistic assumptions regarding the unit and production rates, such as by updating the estimated costs and time needed to complete specific construction activities, when developing the contractor's annual forecasted estimates of the project's total cost for 2008 through 2011. MOX contractor representatives told us that the unit rates they used to develop cost and schedule estimates were realistic based on assumptions at that time and that DOE was involved in the development of the unit rates. In addition, the MOX contractor's representatives told us that expected improvements

[42]Parsons, Longenecker & Associates, *Root Cause Analysis of Cost Increases: Mixed Oxide Fuel Fabrication Facility and Waste Solidification Building, Savannah River Site, South Carolina*. Both DOE and NNSA have frequently experienced challenges in ensuring that they have staff with the appropriate experience in project management. For example, in July 2008, DOE cited not having enough federal and contracting management personnel with the appropriate skills (e.g., cost estimating, scheduling, risk management, and technical) to plan, direct, and oversee project execution as one of the 10 most significant issues contributing to the department's contract and project management challenges.

[43]GAO, *GAO Schedule Assessment Guide: Best Practices for Project Schedules*, GAO-16-89G (Washington, D.C.: Dec. 22, 2015) and *GAO Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Capital Program Costs*, GAO-09-3SP (Washington, D.C.: Mar. 2, 2009).

[44]Parsons, Longenecker & Associates, *Root Cause Analysis of Cost Increases: Mixed Oxide Fuel Fabrication Facility and Waste Solidification Building, Savannah River Site, South Carolina*.

in unit rates did not materialize because of higher than expected levels of worker turnover.

NNSA staff overseeing the project at that time did not recognize that the unit rates for calculating and updating unit rate estimates should be realistic and reflect levels of productivity during construction, as called for in project management principles, or resolve the issues.[45] As a result, the staff did not take action to resolve the MOX contractor's continued use of unrealistic unit rates that did not reflect actual construction progress being made. Furthermore, NNSA staff did not recognize the extent to which decreased productivity by the contractor created future cost increases and schedule delays or resolve the issue. Consequently, from 2008 to 2011, the MOX contractor continued to use its overly optimistic and unrealistic unit rate estimates when developing its annual forecasted cost estimates.

Second, the MOX contractor's annual forecasted estimates for the project consistently increased from 2008 through 2011, and the level of confidence in those estimates decreased, indicating that the project would not be completed within its approved cost estimate.[46] Beginning in 2008, the MOX contractor submitted an annual update to its forecasted estimate for the project. These estimates increased each year, rising by about $140 million to $280 million annually, with the estimated total project cost increasing from about $4.1 billion in 2008 to about $4.7 billion in 2011 (an increase of about 15 percent). The MOX contractor's representatives said they attempted to mitigate the increases, such as by identifying cost savings on the project. Additionally, as the May 2014 root-cause analysis report stated, the level of confidence for completing the MOX project within the approved $4.9 billion total project cost estimate declined each year, from an 85 percent likelihood of completing the project within the estimate in 2009 to 45 percent in 2011. Both the annual increases in forecasted estimates and the annual decline in level of confidence illustrated the increasing likelihood that the MOX contractor would not complete the project for $4.9 billion.

[45]GAO-16-89G and GAO-09-3SP.

[46]According to our March 2009 cost guide, forecasted estimates of a project's total cost—also referred to as estimates at completion—are used to formulate the potential final cost of a project when all work is completed and to monitor whether that projection remains within the project's approved total cost estimate. GAO-09-3SP.

As a result of inexperience, the NNSA staff overseeing the project at that time did not adequately examine the potential consequences of such cost performance trends over the future schedule and through project completion or resolve the issues. As the May 2014 root-cause analysis report stated, NNSA staff did not fully recognize how the risks and challenges the MOX project faced negatively affected not only the project's performance but also its cost and schedule. For example, that report found that the staff were unable to determine that there were fundamental problems with completing the MOX project's design and with maintaining construction efficiency and progress; both of which contributed to schedule delays and cost increases. The May 2014 root-cause analysis report stated that because of inexperience in project management, NNSA staff did not direct the MOX contractor to develop a more realistic and achievable forecasted estimate for the total cost to complete the MOX project until January 2012.

Third, information about procuring materials out of sequence and the resulting rework indicated that the project would not be completed on schedule or within its approved cost estimate. According to NNSA officials, the MOX contractor's method for measuring earned value incentivized the contractor to purchase and procure materials early and, in a number of cases, out of sequence, as this helped demonstrate progress.[47] For example, figure 4 shows outdoor "laydown yards" and an offsite warehouse storing large amounts of commodities,[48] such as pipes and electrical panels, that NNSA officials said the MOX contractor procured earlier than needed. The May 2014 root-cause analysis report stated that between 2007 and 2011, the equipment and material procured out of sequence resulted in the need for rework in some cases because later design changes required changes to the equipment or the need to procure different items, leading to additional costs for the project.

[47]According to the Project Management Institute and our March 2009 cost guide, the methods used to measure earned value performance are the means by which progress, such as achieving project milestones, is evaluated and reported upon. Organizations should have explicit guidelines or processes, also referred to as rules of measurement or rules of credit, for selecting measurement methods. This standard allows for the most objective and accurate assessment of the earned value, in part because the earned value data are used to calculate estimates of the percentage of project completion. Project Management Institute, Inc., *Practice Standard for Earned Value Management*, Second Edition (2011), and GAO-09-3SP.

[48]Construction companies utilize local storage yards to store large, high-value assets for construction projects. Storage yards, often referred to as "laydown yards," may extend for hundreds of acres in which materials are stored in close proximity to a job site.

Figure 4: Laydown Yards and Warehouse Storing Large Amounts of Commodities Procured by the MOX Contractor

Source: National Nuclear Security Administration (NNSA). | GAO-19-25

Notes: The first row shows fabricated pipe and reinforcing steel (rebar) that NNSA officials said the contractor of the Mixed Oxide Fuel Fabrication Facility (MOX) project procured too early and are now stored at outdoor laydown yards as of May 7, 2018. The second row shows electrical panels and wireways that NNSA officials said the contractor also procured prematurely and that as of January 31, 2018, were stored in an offsite warehouse.

The MOX contractor's representatives told us they disagreed with NNSA's characterization that they procured material too early. According to the contractor representatives, they purchased materials in support of both the project schedule and planned construction end date of 2016, as well as to achieve the efficiencies through bulk pricing or reduced delivery charges from procuring larger quantities of items or multiple items at the same time. Additionally, the MOX contractor representatives disagreed that they structured the methods for measuring earned value performance to claim earned value in ways that did not reflect actual progress. In particular, the MOX contractor representatives said that NNSA staff were involved in the development of the original methods used for measuring earned value.

NNSA staff did not take steps to resolve the issues with the disproportionate value earned by the MOX contractor for purchasing, procuring, and placing certain commodities until 2015 when the MOX

contractor revised its methods for measuring earned value. Consequently, the reported commodity installation data based on the MOX contractor's methods for measuring claimed earned value inflated the amount of progress being made on the construction of the MOX project compared with the amount of work completed.

Fourth, information about the use of management reserve funds early in the project indicated that the project would not be completed within its approved baseline. To address cost increases experienced early in the project, the MOX contractor began to use the project's management reserve funds.[49] A May 2010 surveillance review of the MOX contractor's EVM system prepared for DOE by an independent contractor identified this issue and concluded that the rate at which the MOX contractor was using its management reserve indicated that it was unlikely that there would be any reserve left to address any risks that were expected to be encountered later in the project.[50] DOE's June 2011 follow-up review of the MOX contractor's EVM system found that the MOX contractor was no longer covering cost variances by using management reserve; however, the MOX contractor's previous use of management reserve to cover cost overruns had resulted in inaccurate, inflated cost performance and understated forecasted cost estimates.[51] The MOX contractor's representatives told us they disagreed with the premise that the management reserve was used to obscure cost performance. Moreover, they noted that NNSA's cost-accounting and management staff worked with the contractor on all EVM issues, including the use of management reserve.

NNSA staff did not recognize and resolve issues with the contractor's use of the management reserve to mitigate cost overruns or the effect on the

[49]According to our March 2009 cost guide, management reserve funds are for "known unknowns" that are tied to the contractor's scope and managed at the contractor level. The cost guide further states that such funds should be included in the budget to cover uncertainties such as unanticipated effort resulting from accidents, errors, technical redirections, or contractor-initiated studies. However, they cannot be used to offset or minimize existing cost variances but can be applied only to in-scope work. GAO-09-3SP.

[50]Tecolote Research, Inc., *Shaw-AREVA MOX Services, LLC (SAMS) Earned Value Management System (EVMS) Surveillance Report*, CONTRACT NO.: GS-23F-0105K (May 21, 2010).

[51]Department of Energy, *EVMS Surveillance Implementation and Validation Report of the Earned Value Management System utilized by Shaw AREVA MOX Services, LLC, Savannah River Site, Aiken, SC* (June 14, 2011).

project's cost performance and forecasted cost estimates in part because, as the May 2014 root cause analysis report stated, the staff possessed little experience in project management. According to project management principles, management reserve should be prevented from being consumed too early so as to ensure that enough reserve remains available to address any problems that may arise late in the project.[52] The inexperienced NNSA staff also did not recognize that certain problems were creating cost overruns because, as stated in the May 2010 surveillance review, the MOX contractor's use of the management reserve to cover such overruns hid the problems and did not alleviate their root causes. As a result of not recognizing or resolving the MOX contractor's inappropriate use of the management reserve earlier, NNSA reported inaccurate measurements of cost performance to DOE and other stakeholders.

DOE's Project Management Changes Strengthened Oversight of the MOX Project

In late 2010 and 2011, DOE began to implement actions to strengthen project management across the department, including NNSA. These actions, which agency officials said were primarily undertaken in response to project management problems we and others had identified, contributed to the steps NNSA began to take to strengthen its project management and oversight of the MOX project. Changes that strengthened NNSA's oversight of the MOX project included: (1) initiating project peer reviews and (2) making several organizational changes to improve project oversight. These changes to DOE's and NNSA's oversight of the MOX project contributed to the decision to terminate the project.

First, in its November 2010 update to requirements for capital asset projects, DOE established a requirement to conduct peer reviews at least once a year for large or high-visibility projects with a total project cost of $100 million or greater. The update required peer reviews more frequently for complex projects or those experiencing performance challenges. According to DOE and NNSA officials, they added the requirement in

[52] GAO-09-3SP.

response to a recommendation in our May 2008 report.[53] According to NNSA officials, as a result of this requirement, NNSA began conducting peer reviews of the MOX project in 2011. These reviews led NNSA to identify significant cost and schedule problems at the MOX project and included a number of recommendations to improve project performance. For example, a March 2012 NNSA peer review found that the MOX project's total cost may have been understated by anywhere from $600 million to $900 million, in part because the contractor's estimated unit rates and planned production rates were not reflective of the actual performance at that time.[54] Moreover, the peer review found that the estimated completion date of October 2016 was also at risk. As a result, the peer review team recommended, among other things, that the MOX contractor develop an update to its formal cost and schedule estimate.

As a result of the findings and recommendations from its peer reviews, NNSA requested and the MOX contractor submitted in September 2012 a proposal that included a revised cost estimate for the MOX project of about $7.7 billion and an estimated completion date of November 2019.[55] In response to the significant cost increases, schedule delays, and project risks captured in the MOX contractor's updated cost and schedule estimate, NNSA proposed a slowdown of MOX project construction activities in its fiscal year 2014 budget request to begin assessing alternative plutonium disposition strategies.

Second, NNSA carried out several organizational changes starting in 2011 that led to improved oversight of the MOX project in some areas

[53]In May 2008, we found that the DOE Office of Science's more frequent and rigorous internal project reviews, or peer reviews, played a key role in helping to identify and resolve potential difficulties before they could begin to affect cost, schedule, or technical goals. As a result, we recommended that DOE consider whether other program offices would benefit from adopting similar, selected practices from the Office of Science's peer reviews, such as the frequency and focus of reviews for technically complex projects. GAO, *Department of Energy: Office of Science Has Kept Majority of Projects within Budget and on Schedule, but Funding and Other Challenges May Grow*, GAO-08-641 (Washington, D.C.: May 30, 2008).

[54]The March 2012 peer review also stated that the final project cost could increase by more than $1 billion if NNSA staff did not exercise firm management control over the remaining project duration, including taking steps to ensure an optimized schedule and to efficiently conduct testing and startup processes.

[55]In February 2014, we found that the MOX contractor's 2012 revised cost estimate did not fully reflect the characteristics of a high-quality estimate and could not be considered reliable, in part because it was a proposal that was not reviewed and accepted by DOE. GAO-14-231.

and the continued identification of cost and schedule problems. Specifically, NNSA transitioned management and oversight of the MOX project from the Office of Defense Nuclear Nonproliferation to the Office of Acquisition and Project Management, an office newly created in January 2011 to improve project oversight through the application of project management principles. In 2013, the Office of Acquisition and Project Management created the MOX Project Management Office at the Savannah River Site to provide project and contract management oversight for the MOX project.[56]

After establishing the MOX Project Management Office, the Office of Acquisition and Project Management sought to better address long-standing staffing challenges.[57] For example, a May 2006 external independent review conducted for DOE found that, among other things, NNSA understaffed the oversight of the MOX project and recommended that DOE acquire sufficient personnel with the proper skills to manage and perform oversight of the project.[58] However, NNSA did not address this issue until after the creation of the Office of Acquisition and Project Management. The Office of Acquisition and Project Management increased the number of staff with specific project management skillsets at the MOX Project Management Office from 20 for fiscal years 2010 to

[56]Additional organizational changes included reassigning the contracting officer for the MOX project from the DOE Savannah River field office to the MOX Project Management Office in May 2013 and the appointment of a new federal project director to this office in June 2013.

[57]The challenge NNSA faced with providing a sufficient number of staff to provide program direction and oversight was not unique to the MOX project. Both DOE and NNSA have experienced challenges in ensuring that they have the staffing capacity to mitigate risks with project and contract management, and we have made several recommendations calling for improvements. For example, in May 2015, we recommended that NNSA assess its staffing needs to determine whether it has sufficient, qualified personnel to conduct oversight activities consistent with comprehensive policies and guidance. NNSA concurred with this recommendation. As of November 2018, the recommendation remained open. We further highlighted our ongoing concerns as part of our 2017 high-risk report, noting that DOE will need to commit sufficient people and resources to resolve its project, program, and contract management problems. GAO-17-317 and *National Nuclear Security Administration: Actions Needed to Clarify Use of Contractor Assurance Systems for Oversight and Performance Evaluation*, GAO-15-216 (Washington, D.C.: May 22, 2015).

[58]Burns and Roe Enterprises, Inc., *External Independent Review of the Mixed Oxide Fuel Fabrication Facility (MFFF) Project Critical Decision (CD) 2/3 Baseline: Performance Baseline (CD-2) and Start of Construction (CD-3) Review*, BREI-LSP-R-06-03 (Oradell, NJ: July 2006).

2012 to 36 (18 federal employees and 18 support service contractors) for fiscal years 2016 to 2018.[59]

As a result of the staffing changes, the NNSA MOX Project Management Office strengthened its oversight of the MOX project, which contributed to the identification of additional problems, as described below.

- **Conducted more in-depth assessments of the MOX contractor's EVM system**. After initially certifying the MOX contractor's EVM system in May 2008, a May 2010 surveillance review of the MOX contractor's EVM system prepared for DOE by an independent contractor identified a number of issues. The MOX contractor addressed the issues, according to DOE's June 2011 review, resulting in the recertification of the EVM system at that time. According to NNSA officials, NNSA's MOX Project Management Office conducted more in-depth assessments of the MOX contractor's EVM system starting in 2013. These assessments led NNSA staff to identify a number of concerns with the contractor's EVM system, such as earned value data errors; overstatements of the data on the percentage of work completed in certain areas; and in one instance, about $300 million in known cost growth that was not incorporated into the MOX project's forecasted estimate of total project cost.

  According to NNSA officials, in March 2016, the NNSA federal project director requested an in-depth review of the contractor's EVM system because of the continued identification of issues with the system, and the MOX contractor not adequately addressing them. According to its October 2016 review, DOE's Office of Project Management identified significant deficiencies representing systematic and material internal control weaknesses and concluded that the MOX contractor's EVM system could not be relied upon to provide credible and reliable cost and schedule performance data for either the project's current status or its forecasted cost and schedule estimates. As a result, DOE's Office of Project Management rescinded the MOX contractor's EVM

[59]We did not assess whether these changes were sufficient or in accordance with DOE's staffing guide for project management. A February 2017 report by the U.S. Army Corps of Engineers found that the NNSA MOX Project Management Office's staffing level of approximately 29 at the time of that review was not sufficient for the purposes of providing government oversight for the project and that the office needed additional staff—in particular, auditors and quality assurance personnel. U.S. Army Corps of Engineers, *U.S. Army Corps of Engineers Report: Assessment of the MOX Facility Contract* (Washington, D.C.: February 2017).

system certification because the system was no longer in compliance with the relevant standards.

- **Implemented a more rigorous invoice review process.** According to NNSA officials, prior to 2014, NNSA did not have a rigorous process in place to review the contractor's invoices. The officials said that NNSA staff did not review all invoices and, for the reviews that were completed, they did not always thoroughly examine the details behind the invoices, such as reviewing invoices to verify that costs were allowable under DOE regulations.[60] The NNSA officials told us that as part of their efforts to improve oversight of the MOX contractor's invoice submissions, NNSA's MOX Project Management Office staff developed a more rigorous invoice review process that resulted in a September 2014 guide.[61] In addition, the NNSA MOX Project Management Office assigned an additional staff member to (1) help conduct invoice reviews due to the volume of work needed to review the MOX contractor's invoices and (2) ensure that payments were made within the 14 days generally required by regulation.[62] According to NNSA officials, as a result of the changes implemented by the office, NNSA identified a number of potentially unallowable costs ranging from less than $1,000 to more than $2 million.
- **Reviewed the MOX contractor's annual incurred costs.** NNSA officials said that incurred cost audits were supposed to be conducted at least annually for the MOX project and that the Defense Contract Audit Agency was supposed to conduct the audits.[63] However, these officials explained that due to a significant backlog, the Defense

[60]Allowable costs are costs that are reasonable, allocable to the contract, subject to proper accounting, and in compliance with contractual terms and any limitations set forth in 48 C.F.R. subpart 31.2. E.g. United States ex rel. McBride v. Halliburton Co., 848 F.3d 1027, 1028 n.2 (D.C. Cir. 2017).

[61]NNSA updated the guide in December 2017.

[62]The due date for making progress payments based on the contracting officer's approval of the estimated amount and value of work or services performed, including payments for reaching milestones in any project, is 14 days after the designated billing office receives a proper payment request. 48 C.F.R. § 32.904(d)(i).

[63]Incurred cost audits are reviews used to determine whether costs incurred by a contractor and charged to the government are allowable and reasonable. According to the DOE Office of Inspector General, they are a key control for improving contract management and reducing financial risk to the government in cost reimbursable contracts.

Contract Audit Agency did not complete all of the required audits.[64] In light of the Defense Contract Audit Agency's significant backlog—as well as a requirement prohibiting the agency from conducting non-defense agency audits—the NNSA MOX Project Management Office arranged to have a third party conduct an audit of the MOX contractor's fiscal year 2010 incurred costs.[65] This third-party audit identified more than $30 million in potentially unallowable costs.

The significant cost and schedule problems that NNSA staff identified after strengthening its oversight of the MOX project contributed to NNSA's decision to terminate it. Project management principles state that effective project management helps organizations to, among other things, increase the chances of success; resolve problems and issues; and identify, recover, or terminate failing projects.[66] After NNSA's project peer reviews and the MOX contractor's proposed update to the project's cost and schedule estimate showed the significant likelihood of additional cost growth and schedule delays, NNSA proposed slowing down construction of the MOX facility in 2013 and ultimately terminated the project in October 2018.

DOE Has Requirements for Documenting and Sharing Lessons Learned, but They Do Not

[64]According to NNSA officials, the Defense Contract Audit Agency had initiated audits for fiscal years 2008 and 2009 but did not formally complete them due to the agency's significant backlog. We have previously reported on the Defense Contract Audit Agency's incurred cost audit backlog. See GAO, *Federal Contracting: Additional Management Attention and Action Needed to Close Contracts and Reduce Audit Backlog*, GAO-17-738 (Washington, D.C.: Sept. 28, 2017), and *Defense Contracting: DOD Initiative to Address Audit Backlog Shows Promise, but Additional Management Attention Needed to Close Aging Contracts*, GAO-13-131 (Washington, D.C.: Dec. 18, 2012).

[65]In February 2015, the DOE Office of Inspector General recommended that DOE develop a comprehensive strategy to supplement the Defense Contract Audit Agency's audit coverage to ensure the necessary and required audit of incurred costs until the elimination of the backlog of Defense Contract Audit Agency audits. Further, in November 2015, the National Defense Authorization Act for Fiscal Year 2016 prohibited the Defense Contract Audit Agency from conducting audits for non-defense agencies until the Secretary of Defense certified that the agency's backlog for incurred cost audits is less than 18 months of incurred cost inventory. Pub. L. No. 114-92, § 893, 129 Stat. 952 (2015).

[66]Project Management Institute, Inc., *A Guide to the Project Management Body of Knowledge* (PMBOK® Guide), Sixth Edition (2017).

Ensure Consistent or Timely Documentation or the Evaluation of Corrective Actions

As outlined in DOE Order 413.3B, DOE requires that project management staff document and share project management lessons learned on capital asset projects like MOX but does not require that all project management lessons learned from capital asset projects be documented consistently or shared in a timely manner. Moreover, DOE Order 413.3B does not require the evaluation of the results of corrective actions taken in response to lessons learned that are identified during the course of capital asset projects such as the MOX project to ensure that the problems experienced are resolved department-wide.

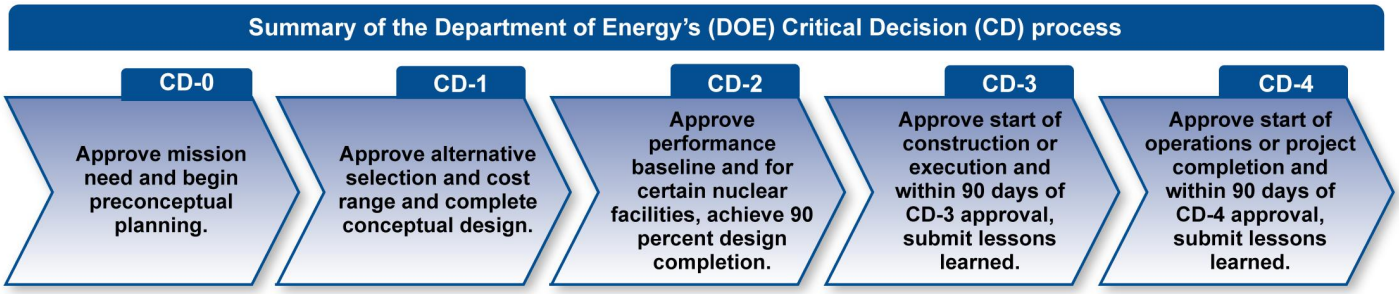
DOE's Requirements for Documenting and Sharing Lessons Learned for Capital Asset Projects

DOE's requirements for capital asset projects, as outlined in Order 413.3B, specify that project management lessons learned should be captured—that is, documented—throughout the continuum of a project.[67] According to the order, there are five critical decisions (CD) that structure the life of a project. The CDs, which are summarized in figure 5, include approving: mission need (CD-0); alternative selection and cost range (CD-1); project performance baseline (CD-2); the start of construction or execution (CD-3); and the start of operations or project completion (CD-4). DOE Order 413.3B requires project staff to submit project management lessons learned to DOE's Office of Project Management within 90 days of two critical decision points: (1) upfront planning and design lessons learned are to be submitted within 90 days of CD-3

[67]Our review focuses on project management lessons learned for DOE's and NNSA's capital asset projects, which are those covered under DOE Order 413.3B. We did not examine lessons learned as they relate to non-capital asset projects or operations activities, such as the operations activities performed by DOE's Office of Environmental Management that include decontaminating and decommissioning contaminated nuclear facilities and sites. Moreover, DOE Order 210.2A, *DOE Corporate Operating Experience Program*, which is applicable to DOE and NNSA management of operating experience and the prevention of adverse operating incidents, includes some requirements related to operating experience lessons learned; however, we did not assess these requirements as part of our review.

approval and (2) project execution and facility startup lessons learned are to be submitted within 90 days of CD-4 approval.[68]

Figure 5: Summary of DOE's Critical Decision Phases and Milestones, Including Lessons Learned Requirements



Source: GAO analysis of DOE Order 413.3B. | GAO-19-25

Notes: The alternative selection process involves defining, analyzing, and refining project concepts and alternatives. At the end of CD-1, the project team selects and DOE approves the selected approach for the project. The cost range developed at CD-1 is the preliminary cost estimate for the selected approach. The cost range is refined through the other steps in the CD process.

DOE Order 413.3B also requires that lessons learned for capital asset projects be collected, analyzed, and disseminated by project management support offices. These offices consist of DOE or NNSA staff who provide support to federal project directors and are established exclusively to oversee and manage the activities associated with projects. Additionally, DOE Order 413.3B states that the Project Management Risk Committee should support project management activities within DOE by enabling the sharing of lessons learned on a routine basis.[69]

DOE and NNSA officials told us that program and project offices document and save project management lessons learned for capital asset projects in different ways. In particular, DOE and NNSA officials told us that peer reviews, which are saved in DOE's Project Assessment and

[68]DOE Order 413.3B also requires lessons learned to be submitted to the Program Secretarial Officer, who holds line accountability for applicable capital asset project execution and implementation of policy. Under the order, references to a Program Secretarial Officer also apply to NNSA Deputy and Associate Administrators, such as the Deputy Administrator of NNSA for Defense Nuclear Nonproliferation.

[69]The Project Management Risk Committee provides ongoing monitoring and assessments of capital asset projects as well as enterprise-wide project management risk assessment and expert advice to the Secretary of Energy and others in the department on cost, schedule, and technical issues regarding capital asset projects with a total project cost of $100 million or greater. Upon request, the committee also addresses projects with a total project cost less than $100 million that are at risk of not meeting their performance baseline.

Reporting System (PARS II) database,[70] are a primary source of project management lessons learned.[71] The officials also said that project management lessons learned are saved through monthly project reports, monthly staff meetings, Project Management Risk Committee meeting notes, and project management workshops and training courses. In addition, DOE and NNSA officials told us that some lessons learned are shared through informal person-to-person discussions that allow lessons learned to be shared among staff. Further, the officials said that they address project management problems identified in lessons learned by making changes to DOE Order 413.3B.[72]

In addition, while not required, DOE may capture some lessons learned for projects during the project review process.[73] For example, DOE's standard-operating procedures for conducting external independent

[70]DOE implemented the first version of PARS in 2001 for the purposes of collecting and analyzing performance data for projects costing more than $5 million. DOE implemented an updated version of PARS—PARS II—in 2010. DOE Order 413.3B as of April 2018 requires that projects with a total project cost of greater than $50 million report progress and provide documentation in PARS II starting after a project receives mission need approval (critical decision (CD)-0). This documentation includes key departmental-level project information such as cost and schedule data and general project performance data. Lessons learned required to be submitted to DOE's Office of Project Management after CD-3 and CD-4 approval are entered into the PARS II database, according to DOE officials.

[71]According to DOE Order 413.3B, peer reviews are required throughout the life of a project. Specifically, DOE Order 413.3B states that for projects estimated to cost $100 million or greater (or lower as deemed appropriate by the Under Secretaries), peer reviews shall be conducted once between CD-0 and CD-1, annually between CD-1 and CD-2, at least annually between CD-2 and CD-4, and more frequently for the most complex projects or those experiencing performance challenges. However, the order does not specifically require that lessons learned be captured or shared through such reviews.

[72]For example, the November 2010 version of DOE Order 413.3B required program support offices to conduct a technology readiness assessment and develop a technology maturation plan prior to CD-2 for major system projects where new critical technologies are being deployed. In June 2015, the Secretary of Energy issued a memorandum stating that DOE needed to clearly codify certain requirements, including those related to technology development and readiness. In response to this memorandum, DOE issued in May 2016 an update to DOE Order 413.3B that required for major projects and first-of-a-kind endeavors a technology readiness assessment, a technology maturation plan, and that critical technologies must achieve a specific readiness level prior to CD-1 and CD-2.

[73]DOE's project reviews provide peer review and subject matter expert opinion and feedback on the project readiness to proceed to the next stage in the project decision-making process. The types of reviews performed in support of DOE projects can include monthly reviews, peer reviews, baseline validation and critical-decision readiness reviews, independent project reviews, and external independent reviews.

reviews state that the scope of such reviews can include assessing whether project teams are documenting and sharing lessons learned from their projects internally and externally.[74] However, as noted in the standard-operating procedures, this is an example of an area that can be included as part of an external independent review, although there is no requirement to do so.

DOE's Lessons-Learned Requirements for Capital Asset Projects Do Not Ensure Consistent or Timely Documentation and Sharing or the Evaluation of Corrective Actions

DOE Order 413.3B requires project management lessons learned for capital asset projects to be documented throughout the life of a project but does not specifically require lessons learned to be documented and saved in a consistent manner or shared routinely or in a timely manner. Moreover, the order does not require all corrective actions related to these lessons learned to be evaluated for effectiveness.

DOE Does Not Require That Lessons Learned for Capital Asset Projects Be Documented and Saved Consistently

Although DOE and NNSA use multiple means to document and save lessons learned, we found DOE and NNSA program and project offices do not document and save such lessons consistently so that they are readily accessible by other staff. For example, NNSA uses an internal

[74]External independent project reviews, which are distinct from peer reviews, are performed by personnel from DOE's Office of Project Management and primarily seek to assess whether a capital asset project can be executed within its proposed scope, schedule, and cost commitments while demonstrating the achievement of key performance parameters prior to CD-4 to confirm that the project is fulfilling its associated mission need. For example, according to DOE Order 413.3B, such external independent reviews are required prior to CD-2 (approve performance baseline) for projects with a total project cost equal to or greater than $100 million, with independent project reviews being required for projects with a total project cost of less than $100 million. External independent reviews (construction or execution readiness reviews) are required prior to CD-3 for major projects but are optional for nonmajor projects when justification is provided and waiver is granted by the relevant acquisition executive authority. Department of Energy, *External Independent Review (EIR) Standard Operating Procedures (SOP)*, Rev. 3.5 (Washington, D.C.: May 2016).

database to save project management lessons learned for its projects.[75] However, NNSA officials told us that DOE staff outside of NNSA must request access to the database before they can read and examine the lessons learned that are documented and saved in the database. Officials from DOE's Office of Science told us that their office submits some lessons learned to the PARS II database and maintains some project management lessons-learned reports on a publicly available webpage. A senior official from DOE's Office of Environmental Management told us that some lessons learned from its projects are sent to its staff through monthly lessons-learned bulletins, but the bulletins are not entered into PARS II. In addition, DOE and NNSA officials said that project staff can enter specific lessons learned gleaned from their project in a lessons-learned repository within PARS II. For example, as of November 2017, PARS II contained 20 entries for project management lessons learned from the MOX project.[76]

According to key practices for lessons learned identified by us and the Center for Army Lessons Learned, a central component of a successful lessons-learned process is to ensure that lessons learned are stored in a logical, organized manner. Specifically, as we have previously found, lessons learned should be stored in a manner—such as an electronic database—that allows users to perform information searches using key words and functional categories.[77] Moreover, information in the database should be updated regularly and provide a logical system for organizing information that is easily retrievable and made available to any requester. We have also found that relying on person-to-person discussions to share lessons learned can be problematic because personal networks can dissolve—for example, through attrition or retirement—and informal

[75]In June 2018, NNSA officials said they were developing a database to collect and share lessons learned generated from monthly project reviews. The database will be updated monthly and contains fields that can be filtered and sorted by project title, critical decision phase, and category or subcategory. NNSA also discussed the development of a project lessons-learned workbook that project teams can use to collect lessons learned.

[76]Our review of the PARS II database in November 2017 of entries for the MOX project showed 20 entries from April 2009 to June 2016. The entries covered a variety of project activities, including some related to health and safety, quality assurance, and oversight of the contractor's supervision of its vendors. However, our analysis of these entries did not identify any related to the cost and schedule problems that contributed to the MOX project's cost increases and schedule delays. There is no formal CD-3 lessons learned report for the MOX project among these entries because the project reached CD-3 before this became a requirement in 2010.

[77]GAO-14-63.

information sharing does not ensure everyone is benefiting from the lessons that are gleaned.[78] Further, by not documenting and saving all lessons learned (e.g., those shared through person-to-person exchanges), there is also generally no way to ensure the validation of the information shared.[79] This is not consistent with the key practice from the Center for Army Lessons Learned, which states that by documenting and saving project management lessons learned in a logical, organized manner such as an electronic database, lessons learned can be archived, managed, and made available for review by other projects and applied to them at a future date.[80]

Because DOE Order 413.3B does not indicate where all project management lessons learned should be documented and saved in a consistent manner, the department cannot ensure that future capital asset projects will be able to take advantage of experiences from past projects. We found that DOE and NNSA did not document all lessons learned in a consistent manner, and DOE officials acknowledged that DOE Order 413.3B does not require documenting or saving lessons learned that are presented through various formal or informal means in a common location. By developing requirements that clearly define how and where all project management lessons learned should be documented and saved to make them readily accessible across the department, such as in a database, DOE—including NNSA—could improve the agency's existing lessons-learned process.

DOE Does Not Require That Lessons Learned for Capital Asset Projects Be Submitted and Shared Routinely or in a Timely Manner

DOE Order 413.3B's requirements for project management lessons learned do not require that all lessons learned be shared routinely or in a timely manner. In particular, the order does not require that lessons learned be submitted and shared routinely until CD-3—the start of construction. Consequently, DOE and NNSA staff are not required to submit lessons learned during the CD-0, CD-1, and CD-2 phases of a project. These earlier phases, which involve upfront planning and design for the selected project, often occur many years before the approval and

[78]GAO-12-901.

[79]Ensuring the validation of lessons learned is important because this allows for the verification of the accuracy of the lessons and their applicability to other projects.

[80]Center for Army Lessons Learned, *Establishing a Lessons Learned Program*.

start of construction. Notably, both the MOX and Uranium Processing Facility (UPF) projects took about 10 years to reach the start of construction (CD-3) and experienced cost increases and schedule delays.[81]

We and others have previously found that lessons learned should be submitted in a timely manner so as to ensure that key information is available to identify and address problems or incorporate successful activities as early and quickly in the process as possible. For example, we found that lessons-learned reports (i.e., reports documenting lessons-learned reviews) should be prepared promptly so that knowledgeable personnel are available to contribute to the reports, important details are recalled accurately, and there are no delays in the dissemination of lessons learned.[82] Moreover, according to the Center for Army Lessons Learned, the guiding principle in executing a sharing strategy for lessons learned is to get the right information to the right person at the right time.[83] Such a strategy can entail developing a process for creating timelines for

[81]The MOX project received approval for CD-0 and CD-1 in October 1997 but did not receive CD-3 approval to begin construction until April 2007, with construction starting in August 2007. Similarly, NNSA began developing the UPF project—a more modern facility that would consolidate the uranium processing capabilities of the Y-12 National Security Complex in Oak Ridge, Tennessee, and built in the 1940s and 1950s into a single facility—in 2004, but due to design problems, revised the project's cost, scope, and schedule baselines in 2014. In March 2018, NNSA authorized the start of construction for the main buildings of the UPF project. Both projects, however, began before DOE issued Order 413.3B in November 2010, and previous versions of the order did not require that lessons learned be submitted until after CD-4 approval.

[82]GAO-13-256.

[83]Center for Army Lessons Learned, *Establishing a Lessons Learned Program*.

sharing lessons learned that are tied to the urgency of the information and a means to disseminate that information.[84]

Because DOE Order 413.3B does not require lessons learned to be submitted prior to CD-3, the department is limiting its ability to promptly evaluate and address early issues with projects and apply such lessons learned to other projects department-wide. This approach could affect the successful completion of capital asset projects, particularly those that experience prolonged upfront planning and design phases similar to those the MOX and UPF projects experienced. By developing requirements for sharing project management lessons learned from early in the CD phases of projects (i.e., prior to CD-3) routinely and in a timely manner to improve the ability to identify and evaluate problematic practices and positive experiences, DOE—including NNSA—could help improve the success of future capital asset projects and avoid the problems encountered overseeing the MOX project.

DOE Does Not Require the Evaluation of the Effectiveness of Corrective Actions Taken

DOE Order 413.3B does not require the evaluation of the results of corrective actions taken to address project management lessons learned that are identified during the course of capital asset projects such as MOX. According to DOE guidance and statements, officials track whether lessons identified through reviews or other efforts are implemented. For example, according to DOE's standard-operating procedures for conducting external independent reviews and officials from DOE's Office of Project Management, DOE staff conducting external independent reviews of projects should assess whether project teams are reviewing

[84]As an example, the Center for Army Lessons Learned described a rapid-sharing process that distinguished different timelines for sharing immediate (5 days), urgent (30 days), and routine (90 days) lessons learned and noted that the terms immediate, urgent, and routine would need to be specifically defined to meet the goals of the supported organizations and their missions. This process is similar to one outlined in the 1995 DOE handbook on implementing DOE lessons-learned programs, but which was cancelled in October 2001 after a fiscal year 2001 review. The handbook stated that the distribution—that is, sharing—of lessons learned to appropriate staff should be determined by its nature and urgency, and the desired audience. Further, the guide stated that timeliness is an important element of distribution and that, in general, any lesson learned that is urgent (color-coded red for DOE-wide distribution) should be distributed immediately. Department of Energy, *DOE Handbook: Implementing U.S. Department of Energy Lessons Learned Programs, Volume I* (Washington, D.C.: August 1995).

and incorporating applicable lessons learned.[85] In addition, DOE project management officials told us that peer review recommendations and the corrective actions to be taken to address them are tracked until the closure of each recommendation.[86] However, DOE has not evaluated whether corrective actions taken have led to the resolution of the problematic practices identified in the lessons learned because DOE Order 413.3B does not require this type of evaluation.

According to key practices for lessons learned identified by the Center for Army Lessons Learned and us, a central component of a successful lessons-learned process is to establish a means to ensure that issues are being resolved as intended. The Center for Army Lessons Learned states that while not all issues require a formal process to resolve, there should be a process in place to identify and prioritize the most important things that need to be fixed.[87] For example, this process could entail addressing only those problems that may necessitate the need for department-wide improvements, as some issues may be narrowly focused and be specific to one project or site. The Center for Army Lessons Learned further states that an organization's ability to change behavior by implementing a lesson is ineffective unless the organization observes changes in behavior and verifies that the lesson is learned. Additionally, we have found that if agency management decides to take action to apply an identified lesson, then it should take subsequent action to observe that the change in behavior actually occurred and collect additional information to verify that the change had the desired effect.[88]

Although DOE Order 413.3B does not require DOE to evaluate the effectiveness of corrective actions other than those associated with peer reviews, other DOE orders and guidance require the evaluation of the effectiveness of other types of corrective actions. For example, DOE Order 226.1B requires that DOE's organizations and contractors implement oversight processes that ensure they evaluate and correct relevant quality assurance problems on a timely basis to prevent their

[85]Department of Energy, *External Independent Review (EIR) Standard Operating Procedures (SOP)*, Rev. 3.5.

[86]According to DOE Order 413.3B, the Project Management Risk Committee also evaluates results of the peer reviews and related corrective actions for projects with a total cost of $100 million or greater.

[87]Center for Army Lessons Learned, *Establishing a Lessons Learned Program*.

[88]GAO-12-901.

recurrence.[89] In addition, DOE's order and guide for implementing an effective quality assurance program highlight the importance of undertaking corrective actions to prevent the recurrence of problems, including determining the effectiveness of the corrective actions for significant problems.[90] By developing requirements for evaluating the effectiveness of corrective actions taken in response to project management problems in capital asset projects, particularly those that necessitate the need for department-wide improvements, DOE—including NNSA—could verify that changes made as a result of lessons learned had the intended outcome as the agency does for contractors.

Conclusions

DOE and NNSA made changes that strengthened oversight of large capital asset projects. These changes helped NNSA better identify cost and schedule problems affecting the MOX project and contributed to NNSA's decision to ultimately terminate the project.

DOE's Order 413.3B includes certain requirements for documenting and sharing project management lessons learned. However, the requirements in DOE Order 413.3B do not fully incorporate several key practices for lessons learned. For example, the order does not require that DOE or NNSA document project management lessons learned for capital asset projects consistently or that such lessons learned are shared in a timely manner. By developing requirements that clearly define how and where all project management lessons learned should be documented and saved to make them readily accessible across the department, such as in a database, DOE—including NNSA—could improve the existing lessons-

[89]For example, in April 2018, we found that such oversight may entail assessing the effectiveness of a contractor's corrective action management program by identifying, documenting, planning, addressing, and tracking actions required to resolve or correct problems. GAO, *Hanford Waste Treatment Plant: DOE Needs to Take Further Actions to Address Weaknesses in Its Quality Assurance Program*, GAO-18-241 (Washington, D.C.: Apr. 24, 2018).

[90]Under an approved quality assurance program, a contractor must, among other things, identify the causes of problems and, as part of correcting the problems, work to prevent their recurrence. The contractor also must conduct an independent assessment to measure the adequacy of work performance and to promote improvement. Department of Energy, *Quality Assurance*, DOE Order 414.1D, Chg 1 (Washington, D.C.: May 8, 2013) and *Quality Assurance Program Guide*, DOE Guide 414.1-2B, Chg 2 (Washington, D.C.: May 8, 2013).

learned process and enable future projects across the department to take advantage of experiences from past projects.

In addition, because DOE Order 413.3B does not require lessons learned for capital asset projects to be submitted prior to the start of construction (CD-3), the department is limiting its ability to promptly evaluate and address early issues with projects as well as applying such lessons learned to other projects department-wide. By developing requirements for sharing project management lessons learned from the beginning of a project routinely and in a timely manner to improve DOE's ability to identify and evaluate problematic practices and positive experiences, DOE—including NNSA—could help improve the success of future capital asset projects and avoid the problems the agency encountered on the MOX project.

Moreover, while DOE tracks the implementation of certain project management lessons learned for capital asset projects, DOE Order 413.3B does not require that DOE—including NNSA—evaluate corrective actions identified outside the peer review process and taken in response to lessons identified to verify that the changes made had the desired effect. By developing requirements for evaluating the effectiveness of corrective actions taken in response to project management problems in capital asset projects, particularly those that necessitate the need for department-wide improvements, DOE could verify that changes made as a result of lessons learned had the intended outcome as the agency does for contractors.

Recommendations for Executive Action

We are making the following three recommendations to DOE:

- The Secretary of Energy, in coordination with DOE's Office of Project Management and NNSA's Office of Acquisition and Project Management, should develop requirements that clearly define how and where project management lessons learned for capital asset projects should be documented and saved to make them readily accessible across the department. (Recommendation 1)
- The Secretary of Energy, in coordination with DOE's Office of Project Management and NNSA's Office of Acquisition and Project Management, should develop requirements for sharing project management lessons learned for capital asset projects from the beginning of a project (i.e., prior to the start of construction at CD-3)

routinely and in a timely manner to improve DOE's ability to identify and evaluate problematic practices and positive experiences. (Recommendation 2)

- The Secretary of Energy, in coordination with DOE's Office of Project Management and NNSA's Office of Acquisition and Project Management, should develop requirements for evaluating the effectiveness of corrective actions taken in response to project management problems for capital asset projects, with a focus on those lessons that necessitate the need for department-wide improvements. (Recommendation 3)

Agency Comments, Third-Party Views, and Our Evaluation

We provided a draft of this report to DOE, NNSA, and MOX Services for review and comment. In written comments, which are reproduced in full in appendix IV, DOE concurred with the report's recommendations and described actions that it intends to take in response to our recommendations.

In response to our first recommendation, DOE intends to issue a policy memorandum by December 2019 and revise DOE Order 413.3B to identify the project management lessons learned repository and outline the kinds of information the repository will collect. In response to our second recommendation, DOE intends to issue a policy memorandum by December 2019 and revise DOE Order 413.3B to collect lessons learned as part of its peer review process. Because DOE Order 413.3B requires that peer reviews for projects of $100 million or greater be conducted once between CD-0 and CD-1, annually between CD-1 and CD-2, at least annually between CD-2 and CD-4, and more frequently for the most complex projects or those experiencing performance challenges, this action is responsive to our recommendation and should help DOE begin to identify lessons learned in a more routine and timely manner. In response to our third recommendation, DOE plans to revise the Project Management Risk Committee charter by assigning it the responsibility to qualitatively evaluate the effectiveness of corrective actions taken in response to project management lessons learned from projects with a total cost greater than $750 million having department-wide implications. We are encouraged that DOE agrees with our recommendation and view this change as a positive first step. However, this action may not fully address the recommendation. For example, the planned action states that

the Project Management Risk Committee would evaluate the effectiveness of corrective actions for projects with total costs of $750 million or more, but there may be some lessons learned with applicability department-wide from projects that do not meet this cost threshold. Additionally, DOE's planned action as described in its response does not discuss who would be responsible for evaluating the effectiveness of corrective actions or a timeline for performing the assessments. The Project Management Risk Committee has typically served as a review group and has not itself performed such evaluations.

DOE and MOX Services also provided technical comments, which we incorporated in our report as appropriate.

We are sending copies of this report to the appropriate congressional committees, the Secretary of Energy, the Administrator of NNSA, and other interested parties. In addition, the report is available at no charge on the GAO website at http://www.gao.gov.

If you or your staff members have any questions about this report, please contact me at (202) 512-3841 or trimbled@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made major contributions to this report are listed in appendix V.

Sincerely yours,

David C. Trimble
Director, Natural Resources and Environment

Appendix I: Objectives, Scope, and Methodology

Our report examined (1) when the National Nuclear Security Administration's (NNSA) project management oversight processes recognized cost and schedule problems at the Mixed Oxide Fuel Fabrication Facility (MOX) project and the actions the agency took to address them and (2) the extent to which the Department of Energy (DOE) requires that project management lessons learned from MOX and other projects be documented and shared.

To address both objectives, we reviewed relevant documents from DOE, NNSA, and MOX Services, LLC (MOX Services), the contractor constructing the MOX project. We reviewed past reports by GAO and the National Academy of Sciences' National Research Council to examine previously identified weaknesses in DOE project management, contractor performance, and federal oversight of individual projects, as well as DOE's efforts to make improvements. We also reviewed DOE reports focused on analyzing the root causes of contract- and project-management issues affecting DOE and NNSA and identifying potential corrective actions and other general improvements. We visited the Savannah River Site to tour the MOX project while it was under construction and interviewed officials from NNSA's MOX Project Management Office, including the federal project director, and representatives from MOX Services. We also monitored the status of the MOX project.

To examine when NNSA's project management oversight processes recognized cost and schedule problems at the MOX project and the actions the agency took to address them, we identified and reviewed DOE and NNSA documents outlining the agencies' management and oversight roles and responsibilities and the processes the agencies used to monitor the cost and schedule of the MOX project. We also examined NNSA guidance and memorandums detailing the 2011 transition of oversight responsibilities for the construction of the MOX project from NNSA's Office of Defense Nuclear Nonproliferation to its Office of Acquisition and Project Management and the effect this change had on NNSA's efforts to oversee the project. In addition, we reviewed DOE, NNSA, and MOX Services documents, as well as independent reviews

and assessments, concerning the performance and status of the MOX project. In particular, we reviewed a May 2014 report prepared for DOE that identified and analyzed the root causes behind the cost increases that affected the MOX project through 2012, after the formal approval of its cost and schedule estimates in 2007.[1] We also reviewed surveillance reviews and a May 2013 assessment of the MOX contractor's earned value management (EVM) system, which the contractor and NNSA used to monitor project performance and status, including cost and schedule, after construction began.[2] Moreover, we examined project cost and budget information that DOE, NNSA, MOX Services, and others developed—such as the contractor's September 2012 baseline change proposal and DOE's August 2016 revised cost and schedule estimate—to determine when they began to identify the MOX project's cost increases and schedule delays and why such problems might have occurred. We also reviewed reports by GAO and DOE's Office of Inspector General that identified and discussed cost and schedule problems affecting the MOX project. Additionally, we interviewed officials from DOE and NNSA to discuss how and when they identified the MOX project's cost and schedule problems.

To examine the extent to which DOE requires that project management lessons learned from MOX and other projects be documented and shared,[3] we reviewed DOE's Order 413.3B, which outlines the primary set

[1]Parsons, Longenecker & Associates, *Root Cause Analysis of Cost Increases: Mixed Oxide Fuel Fabrication Facility and Waste Solidification Building, Savannah River Site, South Carolina* (May 23, 2014). This report was prepared for DOE and NNSA in response to a recommendation GAO made in February 2014. GAO, *Plutonium Disposition Program: DOE Needs to Analyze the Root Causes of Cost Increases and Develop Better Cost Estimates,* GAO-14-231 (Washington, D.C.: Feb. 13, 2014).

[2]An EVM system is a project management tool that, among other things, measures the value of work accomplished in a given period and compares it with the planned value of work scheduled for that period and the actual cost of work accomplished. Within EVM, personnel can use a variety of data and indicators to monitor a project's cost and schedule performance. According to DOE's current requirements for capital asset projects, an EVM system is required for all projects not being performed under a firm fixed-price contract and that are expected to have a total project cost greater than $50 million.

[3]For the purposes of our report, we are focusing on project management lessons learned, which include those lessons learned associated with the non-operational phase of a facility during construction (i.e., throughout the project life cycle from preconceptual planning through completion of the project). We did not examine lessons learned as they relate to non-capital asset projects or operations activities, such as the operations activities performed by DOE's Office of Environmental Management that include decontaminating and decommissioning contaminated nuclear facilities and sites.

of project management requirements governing DOE and NNSA capital asset projects that have a total project cost of greater than $50 million.[4] We also reviewed DOE guidance documents, such as those related to DOE Order 413.3B, to further understand DOE's suggested approaches for meeting its existing lessons learned requirements.[5] Similarly, we reviewed documents from NNSA and DOE's Offices of Environmental Management and Science, such as those found in business-operating procedures and standard-operating policies and procedures, to examine how those documents supplement the lessons learned requirements included in DOE Order 413.3B.[6] In addition, we collected examples of capital asset project-management lessons learned from DOE and NNSA, including those from the MOX project, from a variety of sources, such as lessons-learned reports, project peer reviews, entries stored in DOE's Project Assessment and Reporting System (PARS II)[7] and NNSA's internal databases, monthly lessons-learned bulletins, and presentations, among others. To better understand lessons learned and their role within

[4]Department of Energy, *Program and Project Management for the Acquisition of Capital Assets*, DOE Order 413.3B, Chg 5 (Washington, D.C.: Apr. 12, 2018). DOE Order 413.3B defines lessons learned as the project-management-related input and output devices that represent the knowledge, information, or instructional knowledge that have been garnered through the process of actually completing the ultimate performance of the respective project, and that benefit future endeavors and ideally prevent any negative happenings from taking place in the future. In addition, in some circumstances, the $50 million threshold can be reduced to $10 million for nuclear projects or complex first-of-a-kind projects.

[5]DOE guides are not requirements but describe acceptable non-mandatory approaches for meeting requirements.

[6]For example, we reviewed NNSA's August 2016 business-operating procedure, *Project Management for the Acquisition of Capital Assets*, which describes NNSA's roles, responsibilities, and authorities as they relate to capital asset project management in accordance with DOE Order 413.3B and which is intended to highlight key factors that contribute to construction project management success. The document, which is to be applied in conjunction with DOE Order 413.3B but will not supersede any requirements established by the current version of that order, does not include any additional requirements for lessons learned.

[7]DOE implemented the first version of PARS in 2001 for the purposes of collecting and analyzing current performance data for projects costing more than $5 million. DOE implemented an updated version of PARS—PARS II—in 2010. DOE Order 413.3B now requires that projects with a total project cost of greater than $50 million report progress and provide documentation in PARS II starting after a project receives mission need approval (critical decision (CD)-0). This includes key departmental-level project information such as cost and schedule data and general project performance data.

project management, we reviewed reports by GAO,[8] the U.S. Army's Center for Army Lessons Learned,[9] and the Project Management Institute[10] that identify and discuss key practices for lessons learned. We selected these sources because they are widely recognized for key practices on lessons learned. We then compared the project management lessons learned requirements outlined in DOE Order 413.3B against these key practices. We also discussed project management lessons learned requirements and processes with officials from DOE's Offices of Environmental Management, Project Management, and Science and NNSA's Office of Acquisition and Project Management.

We conducted this performance audit from May 2017 to December 2018 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

[8]For example, GAO, *Telecommunications: GSA Needs to Share and Prioritize Lessons Learned to Avoid Future Transition Delays*, GAO-14-63 (Washington, D.C.: Dec. 5, 2013); *Combatting Nuclear Smuggling: Lessons Learned from Cancelled Radiation Portal Monitor Program Could Help Future Acquisitions*, GAO-13-256 (Washington, D.C.: May 13, 2013); *Federal Real Property Security: Interagency Security Committee Should Implement a Lessons-Learned Process*, GAO-12-901 (Washington, D.C.: Sept. 10, 2012); and *NASA: Better Mechanisms Needed for Sharing Lessons Learned*, GAO-02-195 (Washington, D.C.: Jan. 30, 2002).

[9]Department of the Army, Combined Arms Center, Center for Army Lessons Learned, *Establishing a Lessons Learned Program: Observations, Insights, and Lessons* (Fort Leavenworth, KS: June 2011).

[10]Project Management Institute, Inc., *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)*, Sixth Edition (2017), and Project Management Institute, Inc., *Implementing Organizational Project Management: A Practice Guide*, First Edition (2014). *PMBOK* is a trademark of Project Management Institute, Inc. The *PMBOK® Guide* provides guidelines for managing individual projects, including collecting requirements and defining the project's scope. The Project Management Institute is a not-for-profit association that provides global standards for, among other things, project and program management. These standards are utilized worldwide and provide guidance on how to manage various aspects of projects, programs, and portfolios.

Appendix II: Timeline of Selected Information and Events Pertaining to the MOX Project

Table 1: Timeline of Selected Information and Events Pertaining to the Mixed Oxide Fuel Fabrication Facility (MOX) Project at the Department of Energy's (DOE) Savannah River Site

Phases	Year	Details
Mission need approved and upfront planning and project design begins	1997	DOE announced a plan to dispose of surplus, weapons-grade plutonium through a dual approach that would include constructing a facility for the purposes of converting the plutonium into mixed-oxide fuel for use in modified commercial reactors. The initial estimate for the MOX project—that is, not an approved baseline—totaled $1.4 billion, with completion of construction expected to be in September 2004.
Mission need approved and upfront planning and project design begins	1999	DOE awarded the contract for designing, constructing, and operating a MOX facility to the consortium of Duke, Cogema, Stone & Webster, LLC—now MOX Services, LLC, or MOX Services. According to a December 2005 DOE Inspector General report, in 1999, an independent team reviewed the MOX contract and warned of the potential for escalating costs because the contractor had no incentives to minimize costs nor penalties for overruns or poor performance.
Mission need approved and upfront planning and project design begins	2000	DOE announced that it would construct the MOX project (as well as two other facilities) at the Savannah River Site located in Aiken, South Carolina.
Mission need approved and upfront planning and project design begins	2001	A February 2001 independent cost estimate of the MOX contractor's preliminary cost estimate for the MOX project concluded that it would cost about $2.4 billion to construct and operate it. The independent cost estimate concluded that it would cost about $1.1 billion to construct the facility.
Mission need approved and upfront planning and project design begins	2002	The National Nuclear Security Administration's (NNSA) February 2002 report to Congress on the disposition of surplus defense plutonium at the Savannah River Site concluded that the facility component of the mixed-oxide fuel option identified would cost about $2.2 billion to implement over about 20 years. According to the report, about $1 billion of these costs would be for designing and constructing the facility, with construction being completed during fiscal year 2007.
Mission need approved and upfront planning and project design begins	2003	According to DOE's fiscal year 2004 budget request, a preliminary estimate of the MOX project's total cost totaled about $1.8 billion.

Phases	Year	Details
Mission need approved and upfront planning and project design begins	2004	A July 2004 independent review found that the MOX project had experienced a cost increase of about 300 percent for the design and development phase compared to what was preliminarily planned for in 1999, in part to due to a number factors, including design changes and underestimates. Moreover, the report cited the MOX project as an example of a DOE project greater than $500 million that should have had an approved performance baseline many years prior given that it had reached critical decision (CD)-1 approval, or the approval of alternative selection and cost range, in 1997.
Mission need approved and upfront planning and project design begins	2005	According to a December 2005 report by DOE's Office of Inspector General, as of July 2005, NNSA's not-yet-validated estimate for the design and construction of the MOX project was about $3.5 billion ($2.8 billion for construction).
Mission need approved and upfront planning and project design begins	2006	In February 2006, DOE's fiscal year 2007 budget request reported a preliminary estimate for the MOX project totaling about $3.6 billion, but the department reiterated that the estimate would be finalized following the completion of the project's performance baseline. The request also noted that design costs for the MOX project increased from $243 million to $765 million, primarily due to the decision to fund some design work for gloveboxes and enhanced aqueous polishing during the design phase as opposed to the construction phase and increased design work to adapt the facility to handle and treat several tons of pure plutonium resulting from the cancelation of plutonium immobilization, which would have entailed incorporating plutonium into a corrosion-resistant ceramic matrix and then encasing the immobilized plutonium in glass along with highly radioactive nuclear wastes that already existed at DOE sites, thereby rendering the plutonium as inaccessible and unattractive for reuse in nuclear weapons. However, NNSA canceled this approach in 2002. A July 2006 external independent review of the MOX project's preliminary cost and schedule estimate projected the MOX project's total cost to be about $4.7 billion, with the project expected to be completed in April 2016. The review's estimated total project cost reflected an increase of $352 million over the proposed total project cost of $4.3 billion due to increases in the cost of some construction activities and contingency.
Mission need approved and upfront planning and project design begins	2007	In February 2007, DOE's fiscal year 2008 budget request reported that the revised total cost for the MOX project totaled about $4.7 billion and that the estimate was in the final stages of validation as part of the department's critical decision process. The request stated that the revised cost was a change from the prior not-yet-validated $3.6 billion estimate in DOE's fiscal year 2007 budget request, with over 50 percent of the $1.1 billion cost increase attributed to an increase in contingency funds for the project during construction and cold startup. Also in February 2007, responsibility for the MOX contract was officially transferred to the Savannah River Site Office.
Performance baseline approved and construction begins		In April 2007, DOE formally approved a cost estimate, or baseline, for the MOX project of $4.8 billion and start of operations in September 2016. In August 2007, construction of the MOX project began.
Performance baseline approved and construction begins	2008	In May 2008, DOE certified the MOX contractor's earned value management (EVM) system. A July 2008 independent project review identified a number of concerns, including that only one person was dedicated to the development and upkeep of the MOX project's procurement status information and that the project's procurement strategy would require additional procurement and engineering staff to meet future demands. In December 2008, as a result of funding reductions for fiscal year 2008, DOE approved a revised cost estimate for the MOX project of $4.9 billion and a 1-month delay in the start of operations to October 2016.

Phases	Year	Details
Performance baseline approved and construction begins	2009	According to a July 2009 report, the MOX contractor's 2009 annual forecasted estimate for completing the MOX project totaled approximately $4.4 billion, an increase of about $283.8 million from the 2008 annual forecasted estimate.
Performance baseline approved and construction begins	2010	In May 2010, an independent review of the MOX contractor's EVM system found that the contractor's performance data could not be used to accurately assess the cost performance of the project, in part because the contractor was inappropriately using management reserve funds to cover cost overruns. The MOX contractor began to implement a number of corrective actions in response to the report's findings. According to an August 2010 report, the MOX contractor's 2010 annual forecasted estimate for completing the MOX project totaled approximately $4.6 billion, an increase of about $207.1 million from the 2009 annual forecasted estimate.
Performance baseline approved and construction begins	2011	In February 2011, DOE's Office of Acquisition and Project Management—now the Office of Project Management—changed the overall status of the MOX project from green to yellow, indicating that the project was at risk of breaching its approved cost estimate (i.e., performance baseline). A May 2011 project peer review found that the MOX project faced expected cost growth and would be challenged in identifying approximately $364 million in cost savings necessary to deliver the project at its total project cost (of $4.9 billion). A June 2011 follow-on to the May 2010 independent review of the MOX contractor's EVM system found that the project was likely to exceed the total project cost by anywhere from $104 million to $699 million, with an estimated most likely cost overrun of $493 million. Nonetheless, DOE recertified the MOX contractor's EVM system after the MOX contractor completed a number of corrective actions. According to a July 2011 report, the MOX contractor's 2011 annual forecasted estimate for completing the MOX project totaled approximately $4.7 billion, an increase of about $142.4 million from the 2010 annual forecasted estimate.
Performance baseline approved and construction begins	2012	In January 2012, NNSA directed the MOX contractor to add additional scope for plutonium metal oxidation capability and to include updates to the project's current cost and schedule projections, with a baseline change proposal due by the end of May 2012. A March 2012 project review found that the MOX project's cost and schedule baselines had a very low probability of being met, and estimated that the total project cost was likely underestimated by anywhere from $600 to $900 million when compared to the project's approved total cost of $4.9 billion. The review team recommended that the project should develop an updated and more realistic baseline. Also in March 2012, DOE changed the overall status of the MOX project from yellow to red, indicating that the project was expected to breach its approved cost estimate (i.e., its performance baseline). A July 2012 project peer review found that the MOX project's likely total project cost would fall within the range of $6.9 billion to $7.3 billion as opposed to the project's approved total cost of $4.9 billion. In September 2012, the MOX contractor submitted its revised baseline change proposal to update the MOX project's cost and schedule projections, including additional scope of work that would provide the MOX project with a plutonium metal oxidation capability, referred to as direct metal oxidation. According to the contractor's proposal, it would cost about $7.4 billion to complete the MOX project without the direct metal oxidation by November 2019. The addition of the direct metal oxidation scope of work would cost an additional $262.3 million, which would be completed in June 2023 after the completion of MOX project and the start-up of operations by November 2019.

Phases	Year	Details
Performance baseline approved and construction begins	2013	In April 2013, DOE's fiscal year 2014 budget request proposed a slowdown of construction of the MOX project while NNSA took steps to assess alternative plutonium disposition strategies. According to the request, NNSA cited the increase to the contractor's total estimated cost for the project and the budget environment as factors in its decision to pursue a slowdown of the MOX project while conducting an assessment of potential alternative plutonium disposition strategies. According to NNSA, a May 2013 estimate prepared by the U.S. Army Corps of Engineers estimated that, not including contractor fee, it would cost $9.4 billion to construct the MOX project by 2024 at an annual funding level of $630 million. According to NNSA, a June 2013 estimate prepared by the MOX contractor estimated that it would cost between $8.5 and $9.7 billion to construct the MOX project, with completion from 2023 to 2032 depending on whether the annual funding level totaled $350 million or $500 million. In September 2013, NNSA estimated it would cost about $10.5 billion to construct the MOX project by 2027 at an annual funding level of $500 million. According to NNSA, a November 2013 estimate prepared by the U.S. Army Corps of Engineers estimated that it would cost from $10 to $11.7 billion to construct the MOX project, with completion from 2026 to 2036 depending on whether the annual funding level totaled $350 million or $500 million.
Performance baseline approved and construction begins	2014	In March 2014, DOE's fiscal year 2015 budget request stated that ongoing analysis led to the determination that the MOX project would be significantly more expensive than anticipated and concluded that, due to cost increases, the MOX approach was not viable within available resources. The request, therefore, called for placing the facility in cold stand-by so NNSA could further study more efficient options for plutonium disposition. A May 2014 root cause analysis report found that some of the cost drivers that contributed to the MOX project's cost increases since 2007 included not having sufficiently experienced project teams in place, basing the approved cost and schedule estimates on incomplete front-end planning, not sufficiently developing designs to support the project's fast-track procurement and construction, experiencing greater than expected inefficient execution of construction activities, not implementing effective corrective actions, and not adequately applying federal oversight to identify and address project performance issues Also in May 2014, the DOE Office of Inspector General reported continuing concerns about the achievability of the estimated cost and completion date for the MOX project. The report also noted that the MOX project no longer had an approved cost and schedule estimate and in light of the project continuing to receive significant funding, recommended that the MOX contractor develop a new cost and schedule estimate. In September 2014, in light of certain insufficient project data, NNSA directed the MOX contractor to conduct a review to determine and validate the work completion status—that is, state of completeness—for all commodities being installed in the MOX project. In December 2014, both the Carl Levin and Howard P. McKeon National Defense Authorization Act for Fiscal Year 2015 and the Consolidated and Further Continuing Appropriations Act, 2015 directed DOE to continue construction and project or program support activities related to the MOX project. However, the National Defense Authorization Act also directed DOE to report on, among other things, alternatives to the MOX project, including cost estimates for each alternative, and how such alternatives would conform to the Plutonium Management and Disposition Agreement.

Phases	Year	Details
Performance baseline approved and construction begins	2015	In February 2015, DOE's fiscal year 2016 budget request called for the continued construction of the MOX project, in part because all four congressional committees of jurisdiction directed that construction on the MOX project continue in fiscal year 2015 while NNSA conducted additional cost studies and technology alternative studies. In March 2015, NNSA's MOX Project Management Office assessed the MOX contractor's use of level of effort versus the discrete method of earned value and determined a disproportionate use of level of effort—around 56 percent—was masking the performance of the contractor's discrete work and therefore affecting the accurate measurement of the project's progress. In April 2015, the Aerospace Corporation completed a report on the MOX project and estimated that the MOX project's total cost would be about $21.5 billion, with projected completion in 2045 at an annual funding level of $500 million. In June 2015, the MOX contractor finished its completeness verification review and found that it had over-reported on the results of certain commodities being installed in the MOX project. As a result of this review, the MOX contractor revised the amount of earned value claimed for these commodities to address the over-reporting and provide a more realistic accounting of the selected commodities.
Performance baseline approved and construction begins	2016	In February 2016, DOE's fiscal year 2017 budget request proposed terminating the MOX project in favor of the dilute and dispose option as the path forward for the disposition of the nation's surplus, weapons-grade plutonium. According to the request, the MOX project was found to be significantly more expensive than anticipated and would require approximately $800 million to $1 billion annually for decades. A May 2016 report prepared for the MOX contractor by High Bridge Associates, Inc., estimated that completing the construction of the MOX project could cost about $5.2 billion and be completed in 10 years, with an annual funding level of about $520 million. In July 2016, the MOX contractor submitted its annual forecasted estimate for completing construction of the MOX project and estimated the total project cost to be about $10 billion, with completion in 2029, with an annual funding level of $350 million. In August 2016, DOE issued an updated performance baseline estimating that it would cost approximately $17.2 billion to complete construction of the MOX project by 2048 assuming an annual funding level of $350 million. DOE further estimated that it would cost about $14.3 billion to complete construction of the MOX project by 2035 assuming an annual funding level of $500 million. In October 2016, DOE rescinded the MOX contractor's EVM system certification of compliance in response to an August 2016 surveillance review that identified material non-compliances such as the overstatement of earned value and percentage complete.

Phases	Year	Details
Performance baseline approved and construction begins	2017	A February 2017 report by the U.S. Army Corps of Engineers found that there is likely to be a substantial amount of rework at the MOX project but noted that the magnitude of the likely rework has yet to be determined. The report stated that some of the rework is attributed to design constructability issues as well as procuring, fabricating, and completing work out of sequence. In May 2017, DOE's fiscal year 2018 budget request reiterated for the second consecutive year, a plan to terminate the MOX project in favor of pursuing the dilute and dispose option for plutonium disposition. Also in May 2017, a DOE Office of Inspector General report stated that NNSA was not aware of the total cost of rework at the MOX project because the time and cost of rework were not definitively tracked prior to fiscal year 2014. In December 2017, section 3121 of the National Defense Authorization Act for Fiscal Year 2018 authorized the Secretary of Energy to terminate the MOX project if, among other things, the Secretary certified that the remaining life-cycle cost for an alternative option for carrying out plutonium disposition would be less than approximately half of the estimated remaining life-cycle cost of carrying out the plutonium disposition approach utilizing the MOX project.
Performance baseline approved and construction begins	2018	In February 2018, DOE's fiscal year 2019 budget request reiterated for the third consecutive year a plan to terminate the MOX project in favor of pursuing the dilute and dispose option for plutonium disposition. In May 2018, the Secretary of Energy waived existing requirements to continue MOX construction, but the state of South Carolina obtained an injunction in federal district court temporarily blocking the waiver in June, which NNSA subsequently appealed. In October 2018, a federal appellate court granted a stay of the federal district court's injunction that prohibited termination of the MOX contract and cessation of construction operations. NNSA subsequently issued a notice of termination to the MOX contractor.

Sources: GAO analysis of past GAO reports; documents from DOE, DOE Office of Inspector General, NNSA, U.S. Army Corps of Engineers, the MOX contractor, and third parties; annual budget requests; *Federal Register* notices; and statutes. | GAO-19-25

Appendix III: Selected GAO Recommendations from Prior Reports

We have made numerous agency recommendations in prior reports to improve contract and project management in the Department of Energy (DOE) and the National Nuclear Security Administration (NNSA). Some reports contain recommendations for department and agency policies, and others address project management problems for specific projects or also address other agencies besides NNSA. A description of some of our key recommendations, with the status of implementation as of December 2018, is provided below in table 2. For the most up-to-date status of these agency recommendations, see our website: http://www.gao.gov.

Table 2: Selected GAO Recommendations for Improvements to Department of Energy (DOE) and National Nuclear Security Administration (NNSA) Project Management

GAO report	Agency recommendation	Status (as of December 2018)
Program Management: DOE Needs to Develop a Comprehensive Policy and Training Program (GAO-17-51)	We recommended that DOE establish (1) a program management policy addressing internal control standards and leading practices and (2) a training program for program managers.	Open DOE did not comment on the recommendations, but DOE subsequently stated that it will address our recommendations after the Office of Management and Budget adopts government-wide standards, policies, and guidelines for program and project management for agencies, as required by the Program Management Improvement Accountability Act of 2016.
Nuclear Waste: Waste Isolation Pilot Plant Recovery Demonstrates Cost and Schedule Requirements Needed for DOE Cleanup Operations (GAO-16-608)	We recommended that DOE require cleanup operations to follow best practices for cost and schedule estimates and require projects, including the Waste Isolation Pilot Plant ventilation system, to implement recommendations from independent analysis of alternatives reviews or document the reasons for not doing so. We also recommended that DOE revise program and project management Order 413.3B to implement recommendations from independent analysis of alternatives reviews or document the reasons for not doing so.	Partially implemented DOE concurred with the recommendations. DOE implemented our best practices recommendation by adopting a new policy that specifies the use of GAO best practices for developing cost and schedule estimates for cleanup operations. The two recommendations for the Waste Isolation Pilot Plant ventilation system and revision of Order 413.3B are open.

GAO report	Agency recommendation	Status (as of December 2018)
DOE Project Management: NNSA Needs to Clarify Requirements for Its Plutonium Analysis Project at Los Alamos (GAO-16-585)	We recommended that the Secretary of Energy direct the Under Secretary for Nuclear Security, in his capacity as the NNSA Administrator, to take two actions in the development of future schedules for the revised Chemistry and Metallurgy Research Replacement Facility project that are consistent with current DOE project management policy and scheduling best practices: • Develop and maintain an integrated master schedule that includes all project activities under all subprojects prior to approving the project's critical decision 2 (CD-2). • Conduct a comprehensive schedule risk analysis that applies to the integrated master schedule to identify the likelihood the project can meet its completion dates.	Open NNSA generally neither agreed nor disagreed with the recommendations but described some actions it was taking.
DOE and NNSA Project Management: Analysis of Alternatives Could Be Improved by Incorporating Best Practices (GAO-15-37)	We recommended that the Secretary of Energy direct DOE's Office of Acquisition and Project Management to update its project management order requirements to incorporate best practices for conducting an analysis of alternatives.	Implemented DOE agreed with our recommendation. In May 2016, DOE updated Order 413.3B to require that the analysis of alternatives for capital asset acquisition projects be consistent with published GAO best practices. DOE issued an analysis of alternatives handbook in April 2017.
Project and Program Management: DOE Needs to Revise Requirements and Guidance for Cost Estimating and Related Reviews (GAO-15-29)	We recommended that the Secretary of Energy take the following five actions: • Revise DOE's project management order to require that DOE, NNSA, and its contractors develop cost estimates in accordance with the 12 cost-estimating best practices. • Revise DOE's cost-estimating guide so that it fully reflects the 12 cost-estimating best practices. • Revise DOE's project management order to include references to the DOE cost-estimating guide, where applicable. • Revise DOE directives that apply to programs to require that DOE and NNSA and its contractors develop cost estimates in accordance with the 12 cost-estimating best practices, including developing life-cycle cost estimates for programs. • Revise DOE requirements and guidance that apply to programs to ensure that program reviews are conducted periodically, including reviews of the life-cycle cost estimates for programs.	Partially Implemented DOE agreed with the recommendations. DOE implemented the three recommendations for cost-estimating best practices in its project management order and cost-estimating guide. The recommendations to revise DOE directives that apply to programs to require that DOE, NNSA, and its contractors develop cost estimates in accordance with cost-estimating best practices and to revise DOE requirements and guidance that apply to programs to ensure that program reviews are conducted periodically remain open.

GAO report	Agency recommendation	Status (as of December 2018)
Plutonium Disposition Program: DOE Needs to Analyze the Root Causes of Cost Increases and Develop Better Cost Estimates (GAO-14-231)	We recommended that the Secretary of Energy take two actions to revise DOE's project management order or otherwise implement a department-wide requirement: • Require a root cause analysis of all projects that experience cost increases or schedule delays exceeding a certain threshold established by DOE. • Require life-cycle cost estimates covering the full cost of programs that include both construction projects and other efforts and activities not related to construction.	Partially Implemented DOE generally agreed with our recommendations. DOE implemented our recommendation for a root cause analysis requirement through a memorandum issued by the Secretary in June 2015 that required a root cause analysis to determine the underlying causes of cost overruns, schedule delays, and performance shortcomings and to identify corrective actions. DOE stated that a comprehensive life-cycle cost analysis is required as part of its analysis of alternatives and, therefore, no changes to the project management order are needed. This recommendation focused on requiring a life-cycle cost estimate for the program. DOE's action was related to the analysis for an individual project. However, because DOE does not intend to take additional action on this recommendation, it was closed as not implemented.
Department of Energy: Better Information Needed to Determine If Nonmajor Projects Meet Performance Targets (GAO-13-129)	We recommended that Environmental Management and NNSA clearly define, document, and track the scope, cost, and completion date targets for each of their nonmajor projects and that Environmental Management clearly identify critical occupations and skills in its workforce plans.	Implemented Environmental Management and NNSA agreed with the recommendations. DOE, Environmental Management, and NNSA implemented the recommendations with, among other actions, the documentation of decisions that included clearly defined performance targets for scope, cost, and schedule. Environmental Management issued workforce plans for the fiscal year 2013 planning cycle that used consistent terms to describe mission-critical occupations and skills.
Modernizing the Nuclear Security Enterprise: NNSA's Reviews of Budget Estimates and Decisions on Resource Trade-offs Need Strengthening (GAO-12-806)	We recommended that, among other things, the Secretary of Energy should direct the Administrator of NNSA to complete and formally issue the *Program Managers' Guide to Understanding and Reviewing Cost Estimates for Operations and Sustainment Activities* so that program managers will be better equipped to evaluate the reasonableness of cost estimates.	Not Implemented DOE agreed with the recommendation, but NNSA's Budget Office and Office of Acquisition and Project Management determined that this document is no longer needed because NNSA and DOE have already produced sufficient guidance in this area and any additional information should be included as updates to existing guides and policies. The only document that was identified was the draft document that was the focus of this recommendation. NNSA's reference to other guides and policies does not satisfy the intention of this recommendation.

GAO report	Agency recommendation	Status (as of December 2018)
Nuclear Weapons: National Nuclear Security Administration's Plans for Its Uranium Processing Facility Should Better Reflect Funding Estimates and Technology Readiness (GAO-11-103)	We recommended that the Secretary of Energy should: • Include in the cost-estimating policy specific guidance for reconciling differences, if any, between the results of independent cost estimates and other project cost estimates. • Evaluate where DOE's guidance for gauging the maturity of new technologies is inconsistent with best practices and, as appropriate, revise the guidance to ensure consistency or ensure the guidance contains justification why such differences are necessary or appropriate. • Direct the Administrator of NNSA to ensure new technologies being developed for the Uranium Processing Facility project reach the level of maturity called for by best practices prior to critical decisions being made on the project.	Implemented NNSA generally agreed with our recommendations. DOE implemented our recommendations through a memorandum issued by Secretary Moniz in June 2015. The memorandum directed (1) that cost estimates be developed consistent with best practices detailed in GAO-09-3SP, *Cost Estimating and Assessment Guide* and (2) that DOE comply with technology readiness level best practices.
Nuclear Nonproliferation: DOE Needs to Address Uncertainties with and Strengthen Independent Safety Oversight of Its Plutonium Disposition Program (GAO-10-378)	We recommended that NNSA develop a technology maturation plan for the pit disassembly and conversion mission that (1) includes all critical technologies to be used in pit disassembly and conversion operations and (2) provides details (including preliminary cost and schedule estimates) on planned testing and development activities to bring each critical technology up to a sufficient level of maturity.	Implemented NNSA agreed with our recommendation. DOE changed its overall strategy for plutonium disposition and pit disassembly and conversion capability in the 2013 time frame, but DOE's actions (e.g., as reflected in a May 2011 technology maturation plan for the former Pit Disassembly and Conversion project at K-Area) were responsive to our recommendation.
Department of Energy: Actions Needed to Develop High-Quality Cost Estimates for Construction and Environmental Cleanup Projects (GAO-10-199)	We recommended that DOE should: • Ensure its new policy and guide fully reflect cost-estimating best practices, in part by requiring independent cost estimates for its major projects and that the policy requires DOE and its contractors to generate cost estimates in accordance with best practices. • Create a centralized, independent cost-estimating capability within the department. • Conduct independent cost estimates for future major projects and for major projects that have not received one.	Partially Implemented DOE generally agreed with our recommendations. DOE implemented our recommendations for cost-estimating best practices and for conducting independent cost estimates for major projects when it issued a new cost-estimating guide in May 2011 and revised its project management order to require an independent cost estimate at CD-2 for major projects. DOE also consolidated cost-estimating functions within the department. DOE, however, did not revise its policy to include a requirement that DOE and its contractors generate cost estimates in accordance with best practices.

GAO report	Agency recommendation	Status (as of December 2018)
Department of Energy: Major Construction Projects Need a Consistent Approach for Assessing Technology Readiness to Help Avoid Cost Increases and Delays (GAO-07-336)	We recommended that the Secretary of Energy evaluate and consider adopting a disciplined and consistent approach to assessing technology readiness levels for projects with critical technologies that includes the following three actions: • Develop comprehensive standards for systematically measuring and communicating the readiness of project technologies. At a minimum, these standards should (1) specify consistent metrics for determining technology readiness department-wide, (2) establish terminology that can be consistently applied across projects, and (3) detail the oversight protocols to be used in reporting and reviewing technology readiness levels. In preparing these standards, DOE should consider lessons learned from the National Aeronautics and Space Administration and the Department of Defense, and its own experience in measuring technology readiness. If DOE's evaluation results in the decision to adopt these standards, it should incorporate them into DOE Order 413.3A and Manual 413.3-1, and provide the appropriate training to ensure their proper implementation. • Direct DOE Acquisition Executives to ensure that projects with critical technologies reach a level of readiness commensurate with acceptable risk—analogous to technology readiness level 7—before deciding to approve the preliminary design and commit to definitive cost and schedule estimates, and at least technology readiness level 7 or, if possible, technology readiness level 8 before committing to construction expenses. • Inform the appropriate committees and Members of Congress of any DOE decision to approve definitive cost and schedule estimates, or to begin construction, without first having ensured that project technologies are sufficiently ready (at technology readiness level 7 or 8). This information should include specific plans for mitigating technology risks, such as developing backup technologies to offset the effects of a potential technology failure, and appropriate justification for accepting higher technological risk.	Implemented DOE agreed with our recommendations. DOE implemented our recommendations when it issued its *Technology Readiness Assessment Guide* in October 2009—DOE G 413.3-4. The guide presents a tailored version of the National Aeronautics and Space Administration's and Department of Defense's technology assessment model to address technology issues and commits DOE to include technology assessment as part of the documented acquisition process.

GAO report	Agency recommendation	Status (as of December 2018)
National Nuclear Security Administration: Additional Actions Needed to Improve Management of the Nation's Nuclear Programs (GAO-07-36)	We recommended that the Secretary of Energy and the Administrator, NNSA, should • Develop a human capital strategy that includes standards for determining long-term staffing needs. • Implement a professional development program for security staff to ensure the completion of training needed to effectively perform oversight responsibilities. • Establish formal mechanisms for sharing and implementing lessons learned across the weapons complex. • Establish an NNSA-specific project management policy to ensure application of the DOE project management manual. • Should prepare a project management improvement plan. • Reinstitute annual reporting to the Congress on project management accomplishments. • Include major projects, such as the Stockpile Life Extension refurbishments, in DOE's Project Assessment and Reporting System (PARS). • Complete a comprehensive database of all projects' reports on management lessons learned to improve project management throughout NNSA. • Develop benchmark data on individual contractors' project management performance to assist managers in improving contractor performance. • Require that contractors' project managers receive project manager training and attain project manager certification. • Prepare periodic reports that show the status of NNSA's program management improvement efforts to determine how much progress is being made. • Complete a best practices guide for program management. • Identify, train, and certify all program managers in accordance with NNSA's program management policy.	Implemented NNSA generally agreed with our recommendations. DOE and NNSA implemented our recommendations through eight actions: • DOE issued standards that define training competencies. • NNSA conducted an Annual Workforce Analysis and Staffing plan for headquarters federal staff, and field elements conducted a similar review that projected staffing shortages and surpluses over the next 5 years. • NNSA issued a plan that committed it to collecting and validating lessons learned for its nuclear security program. • DOE conducted a root cause analysis in April 2008 that examined project management challenges across the department, including NNSA. DOE issued a corrective action plan for this analysis in July 2008 that detailed specific measures it planned to take to improve project management. DOE issued a closure report on its July 2008 corrective action plan that detailed progress on accomplishing the measures in the plan. • DOE issued a new program and project management policy (Order 413.3B) in November 2010 that includes required and suggested program management procedures based on best practices. • NNSA met regularly with GAO, the Office of Management and Budget, and congressional staff on progress in improving contract and project management. • DOE introduced the new PARS database (PARS II) which includes all DOE and NNSA capital asset projects and includes a data field that names prime contractors and will enable NNSA to compile benchmark data on prime contractors' performance. • DOE and NNSA developed a Project Management Career Development Program which was based on best practices to standardize training and ensure NNSA project managers have appropriate level of training required to manage their projects.

Source: GAO. | GAO-19-25

Appendix IV: Comments from the Department of Energy

Department of Energy
Washington, DC 20585

December 10, 2018

Mr. David C. Trimble
Director, Natural Resources and Environment
U. S. Government Accountability Office
441 G Street, N.W.
Washington, DC 20548

Dear Mr. Trimble:

Thank you for the opportunity to respond to the Government Accountability Office (GAO) report titled *DOE and NNSA Should Improve Their Lessons Learned Process for Capital Asset Projects* (GAO-19-25) that concerns collecting, sharing, and tracking the status of project management lessons learned (PMLL).

While DOE recognizes that GAO selected the Mixed Oxide Fuel Fabrication Facility (MOX) project as the example to support its recommendations on the potential broader implications of lessons learned, DOE has successfully incorporated lessons learned from the project with department-wide implications in its project management policy. The project chronology supplied by GAO includes the submission of PMLL by the MOX project team, the publishing of a report by the Secretary of Energy on improving project management in 2014, and the subsequent related revisions to DOE Order 413.3B, *Program and Project Management for the Acquisition of Capital Assets* ("the Order"), most notably the requirements to (1) achieve 90 percent design for nuclear projects prior to establishing the performance baseline at Critical Decision (CD)-2, *Approve Performance Baseline*, and (2) follow a more rigorous and independent analysis of alternatives process.

After reviewing the Center for Army Lessons Learned procedures, the Department's conclusion is that DOE's current policies adhere to its basic tenets. As noted in GAO's report, DOE projects have several outlets for conveying their lessons over and above requirements in the Order: peer reviews, monthly or quarterly progress reviews, and at meetings of the Project Management Risk Committee and Energy Systems Acquisition Advisory Board. The Order empowers project management support offices, such as the ones interviewed for the report serving the Office of Environmental Management, the National Nuclear Security Administration, and the Office of Science, "to collect, analyze and disseminate lessons learned and best practices."

Not all lessons learned provided by DOE projects have department-wide implications. Those that do, have become institutionalized through reference in policy documents and best practice guides. GAO refers to the 2014 Secretary of Energy report on improving project management as an example. Lessons learned referenced in this report stemming from MOX and other projects, and later incorporated in the Order, demonstrate the effectiveness of the current process.

2

The report includes a review of the evolution of project management at the Department. DOE appreciates that GAO recognizes its improvements in project management. For example, since 2012, NNSA has delivered $1.9 billion worth of work eight percent under budget. Due to its recent performance, coupled with organizational, procedural, and professional development changes since 2012, GAO removed NNSA from its high risk list for projects under $750 million.

DOE remains committed to continuously seeking ways to enhance its project management performance through improved processes and the implementation of best practices. Enclosed please find responses to the report's recommendations. DOE has concurred with the three recommendations GAO made. DOE has separately provided technical comments for consideration in improving the clarity and accuracy of the report. DOE thanks GAO for revising the text of the report accordingly.

If you have any questions regarding this response, please contact Mr. Ivan Graff, Division Director, Office of Policy and Program Support, at (202) 586-0421.

Sincerely,

Michael A. Peek
Director, Office of Project Management

Enclosures

ENCLOSURE

GAO DRAFT REPORT RECEIVED NOVEMBER 7, 2018
GAO-19-25 (GAO CODE 102062)

"PROJECT MANAGEMENT: DOE and NNSA Should Improve Their Lessons Learned Process for Capital Asset Projects"

DEPARTMENT OF ENERGY RESPONSE TO GAO RECOMMENTATIONS

RECOMMENDATION 1: Develop requirements that clearly define how and where project management lessons learned for capital asset projects should be documented and saved to make them readily accessible across the department.

DOE RESPONSE: Concur. The Department will issue a policy memorandum in advance of revising DOE Order 413.3B, *Program and Project Management for the Acquisition of Capital Assets* ("the Order") identifying the project management lessons learned (PMLL) repository and outlining the kinds of information the repository will collect. DOE will issue the policy memorandum no later than December 2019.

RECOMMENDATION 2: Develop requirements for sharing project management lessons learned for capital asset projects from the beginning of a project (i.e., prior to the start of construction at CD-3) routinely and in a timely manner to improve DOE's ability to identify and evaluate problematic practices and positive experiences.

DOE RESPONSE: Concur. The Department will issue a policy memorandum in advance of revising the Order to have those conducting peer reviews elicit PMLL with department-wide applicability and submit any discerned. Since up to a year may elapse between the most recent peer review and Critical Decision (CD)-4, and peer reviews are not conducted post CD-4, the Federal Project Director (FPD) will remain responsible for the collection and submission of PMLL covering this timeframe within 90 days of attaining CD-4. Lastly, due to the limitations of the current PMLL definition included in the Order, the policy memorandum will replace the current definition of PMLL with a standard industry definition. DOE will issue the policy memorandum no later than December 2019.

RECOMMENDATION 3: Develop requirements to evaluate the effectiveness of corrective actions taken in response to project management problems for capital asset projects, with a focus on those lessons that necessitate the need for department-wide improvements.

DOE RESPONSE: Concur. The Department will revise the Project Management Risk Committee (PMRC) Charter by assigning it the responsibility to qualitatively evaluate the effectiveness of corrective actions taken in response to project management lessons learned from projects with a total project cost greater than $750 million having department-wide implications since some lessons learned may focus too narrowly on one project or site.

Appendix V: GAO Contact and Staff Acknowledgments

GAO Contact

David C. Trimble, (202) 512-3841 or trimbled@gao.gov

Staff Acknowledgments

In addition to the contact named above, Hilary Benedict (Assistant Director), Rodney Bacigalupo, Antoinette Capaccio, Tara Congdon, Pamela Davidson, Richard P. Johnson, Eleni Orphanides, Kevin Remondini, Karen Richey, Sara Sullivan, and Tatiana Winger made key contributions to this report.

Appendix VI: Accessible Data

Data Tables

Accessible Data for Key Practices of a Lessons-Learned Process

Triggering event (step 1)

*Collect (step 2)

*Analyze (step 2)

*Validate (step 2)

*Document and save (step 3)

*Disseminate and share (step 3)

*Develop and carry out corrective action(s) (step 4)

*Track status (step 4)

*Evaluate corrective action(s) taken (step 4)

*Verify change led to desired effect (step 4)

Accessible Data for Figure 1: Timeline of Selected Events and Cost and Schedule Estimates Related to the MOX Facility Construction Project

1997: The initial estimate for the MOX project totaled $1.4 billion, with an expected completion date of September 2004.

2007: DOE formally approved the MOX project's cost and schedule estimate with an estimated cost of $4.8 billion and an estimated completion date of September 2016.

2008: DOE approved a revised cost estimate for the MOX project of $4.9 billion and with an estimated completion date of October 2016.

2012: The MOX contractor submitted a revised cost and schedule estimate, which NNSA requested in January 2012, with an estimated total

cost of $7.7 billion and start-up operations beginning November 2019.b NNSA did not approve this estimate.c

2016: DOE issued an updated cost and schedule estimate that it would cost $17.2 billion to complete construction of the MOX project by 2048

MOX project construction.

1997: DOE established the Plutonium Disposition program.a

1999: DOE awarded the contract to design, build, and operate a MOX facility.

2007: Construction of the main facility for the MOX project began.

2018: NNSA issued a termination notice to the MOX contractor in October 2018.

DOE: Department of Energy

MOX: Mixed Oxide Fuel Fabrication Facility

NNSA: National Nuclear Security Administration

Accessible Data for Figure 2: DOE's and NNSA's Organizational Structure for Oversight of the Mixed Oxide Fuel Fabrication Facility (MOX) Project

- NNSA Office of Defense Nuclear Nonproliferation
    - Includes the Plutonium Disposition program, which supports the commitment to dispose of excess U.S. plutonium;
    - Provides policy and budget guidance for the overall plutonium disposition strategy; and
    - Develops the program's life-cycle cost estimate, including examining costs if the dilute and dispose approach is undertaken rather than the MOX approach.b
- NNSA Office of Acquisition and Project Management

Provides overall direction to, and oversight of, the contractor for the MOX project under approved cost and schedule estimates and leads NNSA's reviews of the project.

- NNSA MOX Federal Project Director

Leads team of federal staff to provide day-to-day direction and oversight, evaluates contractor performance, and reports on the MOX project's cost and schedule performance.

- NNSA MOX Project Management Office

Reports to the federal project director and provides for onsite project and contract management oversight of the execution of the MOX project.

- MOX Contractor

Responsible for project management, design, construction, and operation of the MOX facility; manages subcontracts; and tracks and reports to NNSA on cost and schedule performance.

- DOE Office of Project Management
    - Manages the department's project management governance boards, including the Project Management Risk Committee;c
    - Leads independent reviews of the MOX project to validate cost and schedule estimates;
    - Monitors cost and schedule performance and provides reports to the Deputy Secretary of Energy on a monthly basis;
    - Conducts certification and surveillance reviews of the contractor's earned value management system; and
    - Periodically participates in NNSA's reviews of the MOX project.

Accessible Data for Figure 3: Key Practices of a Lessons-Learned Process

Triggering event

- *incidents
- *training
- *events
- *day-to-day operations

Collect information through activities like project critiques, interviews, incident reports, or direct observations (positive or negative).

Analyze the information collected to determine root causes and identify appropriate actions.

Validate that the right lesson had been identified and determine the breadth of its applicability (e.g., site- or project-specific or department-wide).

Document and save lessons identified, such as in an electronic database, for use by existing and future projects.

Disseminate and share lessons to pass on knowledge gained, such as through briefings, bulletins, reports, e-mails, database entries, or training.

If corrective action(s) needed

- Develop corrective action(s) to address and prevent the future recurrence of the identified lesson.
- Carry out the corrective action(s).
- Track status of the corrective action(s).
- Evaluate the corrective action(s) taken to observe that the change in behavior actually did occur.
- Verify that the change had the desired effect and the lesson was learned.

Accessible Data for Figure 5: Summary of DOE's Critical Decision Phases and Milestones, Including Lessons Learned Requirements

- **Approve mission need and begin preconceptual planning..**

- **Approve alternative selection and cost range and complete conceptual design.**
- **Approve performance baseline and for certain nuclear facilities, achieve 90 percent design completion.**
- **Approve start of construction or execution and within 90 days of CD-3 approval, submit lessons learned.**
- **Approve start of operations or project completion and within 90 days of CD-4 approval, submit lessons learned.**

Agency Comment Letter

Accessible Text for Appendix IV: Comments from the Department of Energy

Page 1

December 10, 2018

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U.S. Government Accountability Office

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Director, Office of Project Management

Enclosures

Page 3

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