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August 2016

DOE PROJECT MANAGEMENT

NNSA Needs to Clarify Requirements for Its Plutonium Analysis Project at Los Alamos

GAO-16-585

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GAO Highlights

Highlights of GAO-16-585, a report to the Committee on Armed Services, U.S. Senate

Why GAO Did This Study

In recent years, NNSA has spent billions of dollars designing large construction projects, only to revisit options after cost increases and schedule delays. At Los Alamos, NNSA reversed its prior decision to build a nuclear facility as part of the CMRR project after spending $450 million. The facility was to provide analysis equipment needed to support the production of pits as part of nuclear weapons life extension programs. Instead, NNSA approved a revised CMRR project to install plutonium analysis equipment in existing facilities.

Senate report 113-44 includes a provision for GAO to review NNSA's revised CMRR project. GAO's report assesses (1) the extent to which the revised CMRR project is expected to meet plutonium analysis needs, (2) how its cost and scope compare to the previously approved project, and (3) the extent to which its schedule and cost estimates reflect best practices, among other objectives. GAO reviewed project documentation, assessed cost and schedule estimates against GAO-identified best practices, and interviewed NNSA and DOE officials and CMRR contractor representatives.

What GAO Recommends

GAO is making seven recommendations to NNSA, including that it identify a pit production-related parameter for the revised CMRR project and develop a CMRR project schedule that includes all necessary work activities. NNSA generally neither agreed nor disagreed with the recommendations but described some actions it was taking. GAO continues to believe that the recommendations are valid, as discussed in this report.

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What GAO Found

The Department of Energy's (DOE) National Nuclear Security Administration (NNSA) defined requirements for the revised Chemistry and Metallurgy Research Replacement (CMRR) project to provide plutonium analysis equipment at its Los Alamos site but did not specify the capacity for analyzing plutonium that the project should provide, making it possible that the project would not meet plutonium analysis needs. NNSA policy states that project requirements should include key performance parameters, which describe how well a project will perform its functions, expressed in terms such as processing rate or capacity. However, NNSA did not identify a key parameter that addresses a primary function of the project's analysis equipment—to analyze plutonium in support of producing an essential part of a nuclear weapon, known as a pit. NNSA has determined that it needs sufficient analysis capacity to support producing pits, including at planned rates of 10 pits per year in 2024 and 50 to 80 pits per year by 2030, but an NNSA analysis shows that the revised CMRR project may not support these rates. NNSA officials said the project's requirements do not include a pit production-related parameter because NNSA only tasked the CMRR project with replacing analysis equipment used in an aging facility, regardless of analysis capacity. Not identifying this parameter likely contributed to the project potentially not providing sufficient analysis capacity to support planned pit production and may have contributed to different understandings among senior agency officials about how well the project will support pit production. By identifying a pit production-related parameter that describes the analysis capacity that the revised CMRR project is to provide, NNSA could clarify the extent to which the project will support such pit production.

NNSA's total estimated cost for the revised CMRR project is lower than the cost of the previously approved CMRR project, which included a large nuclear facility, but NNSA may have overstated its cost savings. NNSA's estimated savings from cancelling the previously approved nuclear facility did not account for work that the agency deferred to future projects, including a storage vault and tunnel. NNSA's approach for the revised CMRR project allows costs to be spread out over time, improving NNSA's ability to concurrently fund other work. However, the revised CMRR project includes less scope and is likely to provide less plutonium analysis capacity than the previously approved nuclear facility.

The revised CMRR project schedule and cost estimates only partially met best practices. For example, the schedule did not include most of the work needed to complete the project. According to best practices, agencies should develop and maintain a schedule that contains all necessary work activities, but the revised project's schedule was limited to near-term work ending in 2017. When NNSA created the revised CMRR schedule, DOE did not specifically require projects to maintain complete schedules after project approval. Since then, DOE has issued a memorandum directing that all schedules contain the entire scope of work, but NNSA does not plan to develop a complete schedule for the entire CMRR project until mid-2017. Continuing to rely on a partial schedule limits managers' insight into how current activities might affect future completion dates, including NNSA's goal to end plutonium work in an aging facility at Los Alamos.

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Abbreviations

ARIES	Advanced Recovery and Integrated Extraction System
CD	Critical Decision
CMRR	Chemistry and Metallurgy Research Replacement
DOE	Department of Energy
NASA	National Aeronautics and Space Administration
NNSA	National Nuclear Security Administration

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The Honorable John McCain
Chairman
The Honorable Jack Reed
Ranking Member
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To accomplish its nuclear security missions, the National Nuclear Security Administration (NNSA)—a separately organized agency within the Department of Energy (DOE)—manages numerous efforts to design and construct new facilities through a process known as capital asset acquisition.[1] In recent years, NNSA has spent billions of dollars designing and partially constructing several one-of-a-kind major capital asset projects (i.e., facilities with an estimated cost of $750 million or more), only to later reassess alternatives for each project in the wake of significant cost increases and schedule delays. In some cases, the reassessments led to NNSA's cancellation of an entire project or major portions thereof, as we found in the case of the Chemistry and Metallurgy Research Replacement (CMRR) project at NNSA's Los Alamos National Laboratory in New Mexico.[2]

[1]DOE defines a capital asset as land, structures, equipment, and intellectual property that are used by the federal government and have an estimated useful life of 2 years or more.

[2]In addition to the CMRR project at Los Alamos, other projects that were reassessed after significant cost increases and schedule delays include the Mixed Oxide Fuel Fabrication Facility and Pit Disassembly and Conversion Facility at NNSA's Savannah River Site in South Carolina and the Uranium Processing Facility at NNSA's Y-12 National Security Complex in Tennessee. See GAO, *Department of Energy: Observations on Efforts by NNSA and the Office of Environmental Management to Manage and Oversee the Nuclear Security Enterprise,* GAO-16-422T (Washington, D.C.: Feb. 23, 2016); *Nuclear Weapons: Some Actions Have Been Taken to Address Challenges with the Uranium Processing Facility Design*, GAO-15-126 (Washington, D.C.: Oct. 10, 2014); *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); *Modernizing the Nuclear Security Enterprise*: *Observations on NNSA's Options for Meeting Its Plutonium Research Needs*, GAO-13-533 (Washington, D.C.: Sept. 11, 2013); and *Modernizing the Nuclear Security Enterprise: New Plutonium Research Facility at Los Alamos May Not Meet All Mission Needs,* GAO-12-337 (Washington, D.C.: Mar. 26, 2012).

In 2005, NNSA approved the CMRR project to replace the aging Chemistry and Metallurgy Research facility that had supported Los Alamos's plutonium work since the 1950s.[3] Plutonium work at Los Alamos contributes to multiple DOE and NNSA program missions, including NNSA's mission to maintain the nation's nuclear weapons stockpile. Meeting NNSA's stockpile mission includes certifying the safety of existing nuclear weapons' plutonium pits and producing new pits to extend the life of nuclear weapons in the stockpile,[4] and NNSA conducts plutonium analysis in the Chemistry and Metallurgy Research facility to support these efforts. NNSA's *Fiscal Year 2016 Stockpile Stewardship and Management Plan* stated that the agency will increase its capability to produce new pits over time,[5] from 10 pits per year in fiscal year 2024 to 30 pits per year in fiscal year 2026 and as many as 50 to 80 pits per year by 2030.[6]

A set of aging facilities provides the backbone of NNSA's plutonium work at Los Alamos. The 64-year-old Chemistry and Metallurgy Research facility at Los Alamos houses unique equipment for analyzing plutonium through various techniques, including analytical chemistry and materials characterization.[7] NNSA uses plutonium analysis to run tests on existing nuclear weapon pits to ensure their reliability and safety and to support

[3]Plutonium is a man-made radioactive element produced by irradiating uranium in nuclear reactors.

[4]A "pit" is the central core of a nuclear weapon that is commonly produced using plutonium.

[5]NNSA's *Stockpile Stewardship and Management Plan*, updated annually, is the agency's formal means of communicating to Congress information on stockpile modernization and operations plans and budget estimates over the next 25 years.

[6]The Nuclear Weapons Council, a joint body made up of the Department of Defense and DOE, affirmed to Congress in 2014 that it needs NNSA to develop a capability to produce 50 to 80 pits per year. In addition, under the Carl Levin and Howard P. "Buck" McKeon National Defense Authorization Act for Fiscal Year 2015, NNSA must be able to produce not less than 10 war reserve pits during 2024, not less than 20 war reserve pits during 2025, not less than 30 war reserve pits during 2026, and demonstrate the ability to produce 80 pits per year during 2027 for no less than a 90-day period. The act also gave the Secretaries of Energy and Defense the option of delaying the 80-pits-per-year demonstration date to 2029 if the Department of Defense and DOE justify the delay in a joint report.

[7]For the purposes of this report, we are using the term plutonium analysis to include analytical chemistry and materials characterization techniques.

other activities, including efforts to dismantle surplus nuclear weapons. Analytical chemistry, in particular, supports nuclear weapon pit production, because it allows scientists to assess the plutonium used in new pits to identify any defects. However, the Chemistry and Metallurgy Research facility, which was built in 1952, is not sustainable in the long term, because of its aging infrastructure and because it sits on a seismic fault line, which raises concerns about the safety and security of the public and those who work with plutonium at the facility in the event of an earthquake. NNSA produces pits in a separate facility at Los Alamos—Plutonium Facility 4—the only high-hazard, high-security, fully operational plutonium facility in the country for producing pits. Plutonium Facility 4 has been in operation for 38 years and also supports other DOE and NNSA programs' work with plutonium, such as producing heat sources for space exploration used by the National Aeronautics and Space Administration (NASA).

When NNSA approved the CMRR project in 2005, the project included the design and construction of two new facilities at Los Alamos—a large nuclear facility and a combination radiological laboratory and office building (radiological lab)—to house plutonium analysis equipment that would replace the analysis equipment that remained in the Chemistry and Metallurgy Research facility. NNSA planned to install most of the plutonium analysis equipment in the CMRR nuclear facility. In 2005 NNSA estimated that the two facilities would be completed by 2017, with a cost ranging from $745 million to $975 million. NNSA constructed the radiological lab and within it installed a set of plutonium analysis equipment in 2013, for a total cost of about $400 million. In March 2012, we found that NNSA's cost estimate for the CMRR nuclear facility, which remained in the preliminary design phase after nearly 7 years, had increased to as much as $5.8 billion, and included an operational date as late as 2022.[8] Also in 2012, after spending more than $450 million, NNSA deferred the remaining design and construction of the CMRR nuclear facility for at least 5 years, stating that the deferral was intended to free up funds for other higher priority projects, including the Uranium

[8]GAO-12-337.

Processing Facility in Tennessee.[9] In a March 2013 memorandum, the NNSA Administrator directed the agency to conduct an analysis to compare the deferred CMRR nuclear facility with other options to meet near- and long-term plutonium requirements, including a modular facility concept that could be built in phases to meet additional capacity needs or new mission requirements. NNSA also committed to ending plutonium operations in the aging Chemistry and Metallurgy Research facility by the end of 2019, given the safety concerns. In September 2013, we found that deferring construction of the CMRR nuclear facility could create a gap in the nation's plutonium analysis capabilities if NNSA ended operations in the Chemistry and Metallurgy Research facility before it established them elsewhere.[10] In particular, we found that the delay in establishing new plutonium analysis capabilities could affect Los Alamos's ability to produce nuclear weapon pits.

In January 2014, NNSA's Office of Defense Programs, responsible for implementing NNSA's stockpile mission, adopted a new strategy for maintaining the ability to perform plutonium analysis and providing plutonium infrastructure without constructing the CMRR nuclear facility.[11] The strategy included two parts: (1) maximizing the use of existing space in two facilities at Los Alamos—the radiological lab and Plutonium Facility 4—by purchasing and installing plutonium analysis equipment in them to support ending plutonium operations in the Chemistry and Metallurgy Research facility and (2) evaluating options to build an undetermined number of modular nuclear facilities to add more high-hazard, high-security laboratory space at Los Alamos.

In August 2014, DOE formally cancelled plans to construct the CMRR nuclear facility and approved the implementation of the first part of

[9]We found in March 2012 that a number of reasons contributed to the CMRR nuclear facility's cost increases. For example, to address concerns about seismic activity, the project design was modified to strengthen the facility to withstand a potential earthquake. NNSA's CMRR contractor estimated that seismic related design changes increased the project costs by almost $500 million. See GAO-12-337.

[10]GAO-13-533.

[11]NNSA, Office of Defense Programs, *Plutonium Infrastructure Strategy for Defense Programs (For Official Use Only)* (Washington, D.C.: Jan. 10, 2014). Before NNSA issued the plutonium infrastructure strategy, the Department of Defense's Office of Cost Assessment and Program Evaluation independently reviewed the proposed strategy.

NNSA's new plutonium strategy—the revised CMRR project. The revised CMRR project contained two subprojects: (1) the Radiological Laboratory Utility Office Building Equipment Installation Phase 2 subproject, which would involve purchasing and installing more plutonium analysis equipment in the radiological lab than NNSA originally planned, and (2) the Plutonium Facility 4 Equipment Installation subproject, which would involve removing contaminated equipment that was no longer in use in Plutonium Facility 4 and installing new plutonium analysis equipment.[12] NNSA estimated that the revised CMRR project would cost from $1.5 billion to $2.0 billion and be completed by 2024. In addition, in November 2015, DOE approved the mission need for the implementation of the second part of the strategy: to build modular nuclear facilities to add more high-hazard, high-security laboratory space at Los Alamos (the Plutonium Modular Approach). NNSA estimated that the Plutonium Modular Approach could cost from $1.5 billion to $3.0 billion and be completed by the end of 2027.

In light of concerns about NNSA's long-term plutonium plans given the decision not to construct the CMRR nuclear facility at Los Alamos, the Senate Armed Services Committee report accompanying S. 1197, the National Defense Authorization Act for Fiscal Year 2014, includes a provision for us to review the cost estimate for NNSA's modular building strategy.[13] Our report assesses (1) the extent to which the revised CMRR project is expected to meet NNSA and DOE programs' plutonium analysis needs at Los Alamos, (2) the extent to which the Plutonium Modular

[12]For the purposes of this report, the revised CMRR project refers to the two new subprojects added in August 2014—Radiological Laboratory Utility Office Building Equipment Installation Phase 2 and Plutonium Facility 4 Equipment Installation. The scope of this report does not include the two subprojects that NNSA completed under the previously approved CMRR project that involved the design and construction of the radiological lab and the installation of the initial set of plutonium analysis equipment in the lab.

[13]S. Rep. No. 113-44, at 248 (2013). The National Defense Authorization Act for fiscal year 2014 defined the modular building strategy as an alternative strategy to the CMRR project that consists of repurposing existing facilities and constructing a series of modular structures, each of which is fully useable, to complement the function of the plutonium facility at Los Alamos National Laboratory, New Mexico, in accordance with all applicable safety and security standards within the Department of Energy. Because this definition of the modular building strategy includes work that NNSA is currently conducting under the revised CMRR project, we included both the revised CMRR project and the Plutonium Modular Approach in the scope of this review.

Approach is expected to meet plutonium analysis needs at Los Alamos, (3) how the revised CMRR project's cost and scope compare with those of the previously approved CMRR project, and (4) the extent to which the revised CMRR project's schedule and cost estimates reflect scheduling and cost-estimating best practices.

To assess the extent to which NNSA's revised CMRR project is expected to meet NNSA and DOE programs' plutonium analysis needs at Los Alamos, we reviewed documentation on the project's expected plutonium analysis equipment, the analysis capacity that the project is expected to provide, and NNSA and DOE programs' planned plutonium analysis needs at Los Alamos. We interviewed NNSA and DOE officials and representatives from NNSA's management and operating contractor at Los Alamos familiar with the project. To assess the extent to which the Plutonium Modular Approach is expected to meet plutonium analysis needs at Los Alamos, we examined documentation supporting NNSA's approval of the mission need and interviewed NNSA officials and contractor representatives familiar with the Plutonium Modular Approach. To assess how the cost and scope of NNSA's revised CMRR project compare with those of the previously approved CMRR project, which included constructing the CMRR nuclear facility, we reviewed documents that described the revised CMRR project's estimated cost and scope and noted instances where the documents highlighted differences between the revised project and the previously approved project. To assess the extent to which the schedule and cost estimates for NNSA's revised CMRR project reflect scheduling and cost-estimating best practices, we analyzed the agency's August 2015 schedule estimate and August 2014 cost estimate in light of best practices identified in our May 2012 schedule guide and our March 2009 cost guide, respectively—both of which are a compilation of best practices drawn from across industry and government.[14] We did not assess the schedule and cost estimates for the Plutonium Modular Approach because NNSA had not approved the estimates when we started our review. Appendix I presents a more detailed description of our objectives, scope, and methodology.

[14]GAO, *GAO Schedule Assessment Guide: Best Practices for Project Schedules,* GAO-12-120G (Washington, D.C.: May 2012) and *GAO Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Capital Program Costs*, GAO-09-3SP (Washington, D.C.: March 2009). We first published the criteria for assessing the reliability of schedules in our 2009 cost guide.

We conducted this performance audit from May 2015 to August 2016, 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 describes: (1) Los Alamos's role in NNSA's nuclear security enterprise; (2) DOE and NNSA programs' plutonium analysis needs at Los Alamos; (3) DOE and NNSA project management orders and policies; and (4) best practices for project cost and schedule estimating.

Los Alamos's Role in NNSA's Nuclear Security Enterprise

NNSA is responsible for managing the nation's nuclear security missions: ensuring a safe, secure, and reliable nuclear deterrent; achieving designated reductions in the nuclear weapons stockpile; and supporting the nation's nuclear nonproliferation efforts. NNSA directs these missions but relies on management and operating contractors to carry them out and manage day-to-day operations at each of its eight sites that comprise the agency's nuclear security enterprise. These sites include laboratories, production plants, and a test site.[15] Together, these sites implement NNSA's stockpile stewardship program. Specifically, under this program, NNSA annually assesses the nation's nuclear weapons stockpile and (1) determines which components, including the pit, will need refurbishment to extend each weapon's life; (2) designs and produces the necessary components; (3) installs components in the weapons; and (4) certifies that the changes do not adversely affect the safety and reliability of the weapons. The 2010 *Nuclear Posture Review*—which outlines U.S. nuclear policy, strategy, capabilities, and force posture—identified long-term stockpile modernization goals for NNSA that include sustaining a safe, secure, and effective nuclear arsenal through life

[15]NNSA oversees three national nuclear security laboratories—Lawrence Livermore National Laboratory in California, Los Alamos National Laboratory in New Mexico, and Sandia National Laboratories in New Mexico and California. It also oversees four nuclear weapons production plants—the Pantex Plant in Texas, the Y-12 National Security Complex in Tennessee, the National Security Campus at Kansas City in Missouri, and tritium operations at DOE's Savannah River Site in South Carolina. NNSA also oversees the Nevada National Security Site, formerly known as the Nevada Test Site.

extension programs and investing in a modern infrastructure.[16] NNSA has identified the revised CMRR project as critical to its infrastructure modernization efforts.

Of NNSA's eight sites, the Los Alamos National Laboratory in New Mexico houses most of the nation's capabilities for plutonium analysis in support of its nuclear weapons mission. Los Alamos also has a broader plutonium-related research and analysis mission. For example, Los Alamos conducts basic and applied research in the chemistry of plutonium and other radiological materials for the study of nuclear materials, including nuclear materials separation, processing, and recovery.

Currently there are three main facilities at Los Alamos that support plutonium analysis:

- **Chemistry and Metallurgy Research facility.** This facility became operational in 1952 and houses equipment for performing plutonium analysis. With this equipment, NNSA conducts analysis activities that support: the production, development, and testing of nuclear weapon pits, programs to extend the life of nuclear weapons in the stockpile, and efforts to dismantle surplus nuclear weapons. NNSA continues to operate some plutonium analysis equipment in the facility, but the agency has committed to ending plutonium operations in the facility by the end of 2019.
- **Plutonium Facility 4.** This facility began operations in 1978 and is the nation's only high-hazard, high-security, fully operational plutonium facility that produces pits. Plutonium Facility 4 is also used to support the production of plutonium-238 heat sources used for NASA spacecraft missions as well as the development of methods for fabricating advanced nuclear fuels.[17]

[16]Department of Defense, *Nuclear Posture Review Report* (Washington, D.C.: Apr. 6, 2010). Life extension programs entail refurbishing or replacing weapons' components to extend the lives of weapons by 20 years or more. Such programs may also enhance safety and security characteristics of weapons and consolidate the stockpile into fewer weapon types to minimize maintenance and testing costs while preserving needed military capabilities.

[17]Plutonium-238 is about 260 times more radioactive than plutonium-239, the plutonium isotope used in weapon pits.

- **Radiological Laboratory Utility Office Building (radiological lab).** NNSA began operations in the radiological lab in 2014. NNSA built the radiological lab—consisting of office space, training areas, utilities, and laboratory space for analysis—to complement the previously approved CMRR nuclear facility. The radiological lab has the capacity to handle small plutonium samples for use in analytical chemistry analysis to support plutonium program missions in Plutonium Facility 4.

DOE and NNSA Plutonium Analysis Needs at Los Alamos

Several DOE and NNSA program offices conduct plutonium analysis in the three main plutonium facilities at Los Alamos. The following are the primary users of plutonium analysis capabilities at Los Alamos.

NNSA Office of Defense Programs

This office is responsible for maintaining the reliability, security, and safety of the nuclear weapons stockpile by assessing the reliability of existing nuclear weapon pits and producing new pits to replace those destroyed in the testing process, among other activities. The majority of funding and scope associated with plutonium work at Los Alamos supports the Office of Defense Programs' missions.[18] Pit production relies on plutonium analysis to produce war reserve pits—pits that are certified for inclusion in the nuclear weapons stockpile—in support of life extension programs. Los Alamos has used its analytical chemistry equipment to support pit production more than to support all other program activities combined.[19] From 2007 to 2012, NNSA produced a limited number of war reserve pits at Los Alamos; according to NNSA, by 2011 the agency had demonstrated a production rate of up to 10 pits per year. In 2008, the Nuclear Weapons Council—a body that serves as the focal point of the Department of Defense and DOE interagency activities to maintain the nation's nuclear weapons stockpile—established the requirement for NNSA to develop pit production capabilities of 50 to 80 pits per year.[20]

[18]At the height of the Cold War, the Rocky Flats Plant in Colorado produced from 1,000 to 2,000 pits per year. Rocky Flats ceased operations in 1989, and in 1996, DOE tasked Los Alamos with producing all pits to be included in the nation's nuclear stockpile.

[19]The Los Alamos contractor estimated that pit production-related analyses constituted an average of 74 percent of all analytical chemistry analyses performed at Los Alamos for fiscal years 2007 to 2011.

[20]The weapons council reaffirmed the 50 to 80 pits-per-year requirement in 2012, and the Department of Defense revalidated it in 2014.

We found in March 2016 that modernizing NNSA's pit production capacity, including implementing the revised CMRR project, is fundamental to supporting a multi-billion-dollar life extension program.[21]

NNSA's *Fiscal Year 2016 Stockpile Stewardship and Management Plan* contains the agency's plan for meeting the weapons council's requirement and supporting life extension programs. According to the fiscal year 2016 plan, NNSA will develop the capability to produce at Los Alamos an increasing number of new pits over time.[22] These pits will be of a different type than the pits produced earlier, so Los Alamos has started a development process to establish a pit production capability for a new pit type. Beginning in fiscal year 2024, NNSA plans to be able to produce 10 war reserve pits per year, increasing to 30 war reserve pits per year in fiscal year 2026, and 50 to 80 war reserve pits per year by 2030 (see table 1).

Table 1: The National Nuclear Security Administration's Pit Development Timeline

	2016 - 2022	2023	2024	2026	2030
Pit Series	**Developmental pits[a]**	**War reserve pits[b]**	**War reserve pits**	**War reserve pits**	**War reserve pits**
Capacity of pits (per year)	4-5	1	10	30	50-80

Source: GAO analysis of NNSA information. | GAO-16-585

Note: A "pit" is the central core of a nuclear weapon that is commonly produced using plutonium.

[a]Developmental pits include development, process prove-in, and qualification pits.

[b]War reserve pits are certified for inclusion in the nuclear weapons stockpile.

[21]We found in March 2016 that budget estimates for an approximately $13 billion life extension program, Interoperable Warhead-1, are predicated on NNSA successfully modernizing its pit production capacity and that if there are delays in implementing the revised CMRR project or the Plutonium Modular Approach, this program will bear greater costs than currently estimated. See GAO, *Modernizing the Nuclear Security Enterprise: NNSA's Budget Estimates Increased but May Not Align with All Anticipated Costs,* GAO-16-290 (Washington, D.C.: Mar. 4, 2016).

[22]According to the *Fiscal Year 2016 Stockpile Stewardship and Management Plan*, NNSA developed multiple experimental pits for life extension programs in fiscal year 2013 in Plutonium Facility 4. However, Los Alamos paused pit production and other operations in the facility in 2013, in part, because of nuclear criticality safety concerns. According to NNSA, full operations are expected to resume in the facility in late 2016.

NNSA Office of Defense Nuclear Nonproliferation's Advanced Recovery and Integrated Extraction System (ARIES)

NNSA's ARIES supports the disposition of surplus weapons-grade plutonium by disassembling pits and converting the plutonium into a plutonium oxide. NNSA established ARIES in Plutonium Facility 4 as a technology development and demonstration project for pit disassembly and conversion and has used plutonium analysis equipment there to analyze plutonium samples from the oxide converted from existing pits. According to NNSA, ARIES currently conducts most of its plutonium analysis that supports disassembly and conversion at NNSA's Savannah River Site in South Carolina. However, ARIES will likely need more analysis equipment in Plutonium Facility 4 if its mission at Los Alamos is expanded, according to NNSA.[23]

DOE Office of Nuclear Energy's Office of Space and Defense Power Systems

This office provides plutonium-238 heat sources for electric generators used on NASA spacecraft and for national security applications. The plutonium-238 heat sources are also used to heat critical components on NASA spacecraft. The office relies on plutonium analysis equipment to support its work. The office recently stopped operating in the Chemistry and Metallurgy Research facility and installed its plutonium analysis equipment in Plutonium Facility 4. This DOE office shares the plutonium-238 analysis equipment with NNSA to support work examining existing pits.

DOE and NNSA Project Management Orders and Policies

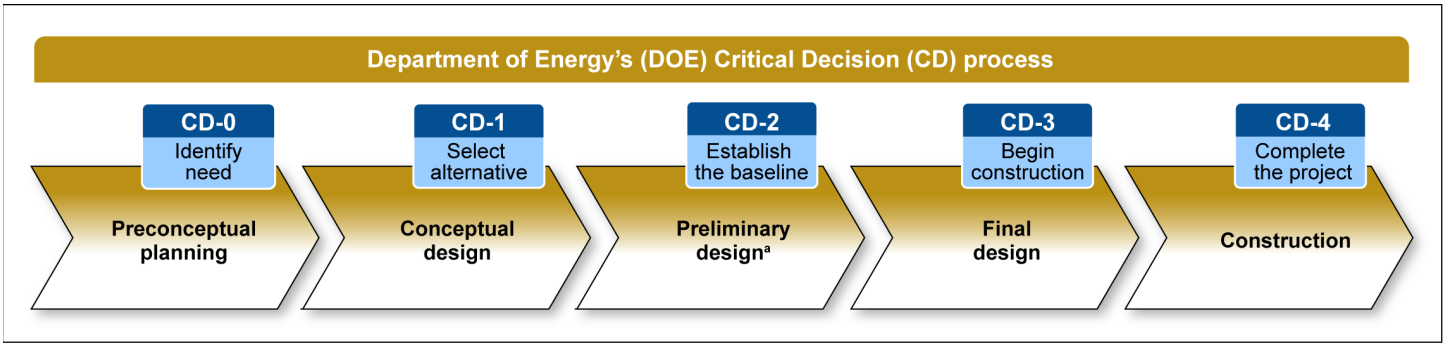
DOE Order 413.3B governs NNSA's capital asset acquisition activities. The order establishes the critical decision (CD) process.[24] This process breaks down capital asset acquisition into project phases that progress from a broad statement of mission need into requirements that guide project execution, through design and construction, and conclude with an operational facility. Each phase ends with a major approval milestone—or "critical decision"—and each critical decision requires the successful

[23]ARIES's mission is to convert about 2 metric tons of weapons-grade plutonium into plutonium oxide. This oxide was to be used as feedstock for NNSA's Mixed Oxide Fuel Fabrication Facility at Savannah River Site. NNSA proposed in its fiscal year 2017 congressional budget request to terminate this facility and pursue a new alternative to dilute and dispose of surplus weapons-grade plutonium in a geologic repository. According to NNSA, ARIES's mission could increase to converting additional weapons-grade plutonium under either scenario.

[24]DOE, *Program and Project Management for the Acquisition of Capital Assets,* Order 413.3B, Chg 2 (Washington, D.C.: May 12, 2016).

completion of the preceding phase. DOE's capital asset acquisition process, or critical decision process, is depicted in figure 1.

Figure 1: The Department of Energy's Capital Asset Acquisition Process



Source: GAO analysis of DOE Order 413.3B. | GAO-16-585

[a]For Hazard Category 1, 2, and 3 nuclear facilities, Order 413.3B states that design should be at least 90 percent complete prior to CD-2 approval.

DOE Order 413.3B provides direction for preparing a mission need statement at CD-0 (identify need). According to the order, a mission need statement identifies the capability gap between the current state of a program's mission and the mission plan and is part of the first phase of identifying and executing a capital asset project. The mission need, however, should not identify a particular solution such as equipment, facility, or technology.

In addition, Order 413.3B and NNSA's business operating procedure for creating program requirements documents for capital asset projects (NNSA's requirements policy) provide direction for preparing and updating a program requirements document. According to Order 413.3B, requirements identified in a program requirements document are statements that define the ultimate goals a project must satisfy. According to *A Guide to the Project Management Body of Knowledge*, defining requirements for a project is a key step in developing a project because the requirements dictate what is included—and what is not included—in a project's scope of work.[25] Order 413.3B states that NNSA must prepare a

[25]Project Management Institute, Inc. *A Guide to the Project Management Body of Knowledge (PMBOK® Guide),* Fifth Edition, 2013. *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 scope.

program requirements document for capital asset projects at CD-0. Order 413.3B directs project managers to implement NNSA's requirements policy when preparing the program requirements document at CD-0.[26] According to this policy, a project's requirements should include a specific type of requirement called a key performance parameter. Order 413.3B states that key performance parameters define how well a project will perform its functions, and appropriate parameters are those that express performance in terms of capacity, throughput (i.e., the amount of material or items passing through a system or process), or processing rate, among others. These parameters, among other things, identify vital characteristics, functions, or design bases that, if changed, would have a major impact on facility or system performance, scope, schedule, cost, or risk.

Under Order 413.3B, the first two decision points—CD-0 (identify need) and CD-1 (select alternative)—span the analysis of alternatives process.[27] The use of the analysis of alternatives process is a key first step to help ensure that the selected alternative best meets the agency's mission need. The majority of the analysis of alternatives process is conducted during the conceptual design phase and ends with CD-1 approval.

Best Practices for Project Cost and Schedule Estimating

To provide assistance in preparing high-quality cost and schedule estimates, we compiled best practices used throughout government and industry in two guides. In March 2009, we issued our *Cost Estimating and Assessment Guide* (cost guide).[28] Drawing from federal cost estimating

[26]NNSA Office of Acquisition and Project Management, *Business Operating Procedure: Program Requirements Documents for Construction Projects,* BOP-06.02 (Washington, D.C.: Mar. 20, 2014). Order 413.3B states that NNSA defines requirements for the project to meet in a program requirements document at CD-0, but offices within DOE define requirements in the conceptual design report at CD-1.

[27]In September 2009, we defined this process as an analytical study that is intended to compare the operational effectiveness, costs, and risks of a number of potential alternatives to address valid needs and shortfalls in operational capability. See GAO, *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).

[28]GAO-09-3SP.

organizations and industry, our cost guide provides best practices about the processes, procedures, and practices needed for ensuring development of high-quality—that is, reliable—cost estimates. A high-quality cost estimate helps ensure that management is given the information it needs to make informed decisions. The cost guide identifies the following four characteristics of a high-quality cost estimate: (1) comprehensive, (2) well documented, (3) accurate, and (4) credible.

We issued our *Schedule Assessment Guide* (schedule guide) in May 2012 as a companion to the cost guide.[29] A well-planned schedule is a fundamental management tool that can help government programs use public funds effectively by specifying when work will be performed in the future and measuring program performance against an approved plan. The schedule guide identifies 10 best practices for developing and maintaining a reliable, high-quality schedule. For example, the first best practice is for the schedule to capture all activities necessary to complete the project.

In May 2016, DOE published an update to Order 413.3B that institutionalizes recent policies that the Secretary of Energy had established in two memorandums, including one dated June 2015 that related to, among other things, cost and schedule estimating best practices. Specifically, the updated order incorporates policies first established in the June 2015 memorandum that state (1) cost estimates shall be developed, maintained, and documented in a manner consistent with methods and best practices identified in our cost guide, DOE guidance, and applicable acquisition regulations and Office of Management and Budget guidance; and (2) projects shall develop and maintain an integrated master schedule in a manner consistent with the methods and best practices identified in our schedule guide and in the National Defense Industrial Association's *Planning and Scheduling Excellence Guide*.[30]

[29]GAO-12-120G. In December 2015, we issued an updated version of the schedule guide but did not use it as a criterion for this engagement because it had not been finalized when we began our review of the revised CMRR project schedule estimate. See GAO, *Schedule Assessment Guide: Best Practices for Project Schedules,* GAO-16-89G (Washington, D.C.: December 2015).

[30]National Defense Industrial Association, *Planning & Scheduling Excellence Guide (PASEG)* (Arlington, VA: June 22, 2012).

NNSA Did Not Identify the Plutonium Analysis Capacity That Its Revised CMRR Project Should Provide, So the Project May Not Meet DOE and NNSA Needs

NNSA defined a set of requirements for the revised CMRR project, but these requirements did not include key performance parameters, such as the plutonium analysis capacity that the project should provide. NNSA has initiated actions that could increase the project's plutonium analysis capacity, but these actions create risk for meeting the project's estimated cost and schedule. Even with the new actions that NNSA has initiated, the agency is not designing the revised CMRR project to meet all DOE and NNSA plutonium analysis needs at Los Alamos.

NNSA's Requirements for the Revised CMRR Project Did Not Define the Plutonium Analysis Capacity the Project Should Provide

NNSA defined a set of requirements for the revised CMRR project, but these requirements did not include key performance parameters, as called for by NNSA's requirements policy.[31] Order 413.3B states that key performance parameters define how well a project will perform its functions, and appropriate parameters are those that express performance in terms of capacity or throughput, among others. According to NNSA documents, the revised CMRR project's primary function is to provide plutonium analysis capabilities in support of NNSA's stockpile stewardship program. The stockpile stewardship program includes producing new plutonium pits, but the revised CMRR project's requirements document did not define the annual rate of pit production that the project should support in a key performance parameter. NNSA's *Fiscal Year 2016 Stockpile Stewardship and Management Plan* stated that the agency will increase its capability to produce new pits over time to support life extension programs: 10 pits per year in 2024, 30 pits per year in 2026, and 50 to 80 pits per year by 2030. According to NNSA documents, the agency needs adequate quantities of plutonium analysis equipment, namely analytical chemistry equipment, and the space in which to house the equipment to support its planned pit production rates. The higher the pit production rate, the more analytical chemistry equipment will be needed. The project's requirements document included

[31]NNSA's program requirements document for CD-1 identified 21 mission and program requirements for the revised CMRR project to meet that cover a variety of topics, including engineering specifications, overall design principles, and safety management.

a list of plutonium analysis equipment that the project will provide and the capacity that each piece of equipment will provide—expressed as a number of plutonium samples processed per year. This information indicates the analysis capacity the project may provide but does not indicate the extent to which the project will support broader needs, including pit production.

NNSA officials and Los Alamos contractor representatives said that the program requirements document for the revised CMRR project does not contain a pit production-related performance parameter because NNSA tasked the revised project only with replacing plutonium analysis equipment that had been located in the Chemistry and Metallurgy Research facility. They explained that NNSA did not specifically task the revised project with supporting specific pit production levels.[32] Instead, contractor representatives told us that they created the list of analysis equipment to include in the revised project based on the capabilities that needed to be transferred from the Chemistry and Metallurgy Research facility and the amount of available space in the radiological lab and Plutonium Facility 4. NNSA officials told us they do not plan to identify key performance parameters for the revised CMRR project until CD-2 and that they do not plan to establish a key performance parameter that identifies pit production rates for the revised CMRR project to support in the near future. These officials agreed, however, that having sufficient plutonium analysis capacity is critical to supporting pit production.

Not identifying key performance parameters in the program requirements document for the revised CMRR project, including a parameter related to pit production, likely contributed to the project potentially providing insufficient plutonium analysis capacity to support planned pit production rates. In 2015, NNSA's contractor at Los Alamos conducted an analysis, calculating the pit production rate that the revised CMRR project's analysis equipment was expected to support, based on the amount of equipment, location, and the amount of plutonium allowed in the radiological lab and Plutonium Facility 4. The contractor's analysis

[32]The revised CMRR project's mission need statement, updated in June 2014 to support the revised CD-1 decision, states that the project's mission is to ensure continuity in enduring analytical chemistry and materials characterization capabilities for NNSA actinide-based missions in support of stockpile stewardship. Actinide elements include plutonium and uranium.

showed that the revised CMRR project, as approved at CD-1 in August 2014, may not provide sufficient analysis capacity to support a 10-pits-per-year production rate. Although NNSA previously demonstrated that it could produce up to 10 war reserve pits per year at Los Alamos, the pits were produced in Plutonium Facility 4 with support from the Chemistry and Metallurgy Research facility. However, according to contractor representatives, the radiological lab has stricter limits on the amount of plutonium allowed in it than the Chemistry and Metallurgy Research facility does, so supporting pit production in Plutonium Facility 4 with the radiological lab limits analysis capacity to support pit production.

Not identifying a key performance parameter related to pit production in the requirements document may have also contributed to different understandings of how the project will meet critical mission requirements. For example, NNSA and DOE management officials we interviewed have drawn their own, widely different conclusions about the extent to which the revised CMRR project will support pit production. One NNSA official involved in overseeing the project told us that the analysis equipment that will be installed under the revised CMRR project would provide the analysis capacity to support a production rate of 30 pits per year. A senior NNSA official said the project would provide the same capabilities as the previously approved CMRR project that included the nuclear facility but said that he was not aware of the revised CMRR project's expected analysis capacity. A senior DOE official said that, when he reviewed the CD-1 documentation and participated in meetings regarding the August 2014 CD-1 approval for the revised CMRR project, he was not aware that the project was needed to support pit production, and another DOE official responsible for reviewing the project said the revised project would support a production rate of about 10 pits per year.

We have previously found that poorly defined, incomplete, or missing requirements make it difficult to hold projects accountable, result in programs or projects that do not meet user needs, and can result in cost and schedule growth.[33] Notably, the memorandum approving CD-1 for the

[33]See, for example: GAO, *Defense Acquisition Process: Military Service Chiefs' Concerns Reflect Need to Better Define Requirements before Programs Start,* GAO-15-469 (Washington, D.C.: June 11, 2015); *Defense Acquisitions: Managing Risk to Achieve Better Outcomes,* GAO-10-374T (Washington, D.C.: Jan. 20, 2010); and *United States Coast Guard: Improvements Needed in Management and Oversight of Rescue System Acquisition,* GAO-06-623 (Washington, D.C.: May 31, 2006).

revised CMRR project states that one of the main reasons that the CMRR nuclear facility experienced significant cost and schedule growth was because of poorly defined requirements for the facility. By updating the program requirements document for the revised CMRR project to identify a key performance parameter that describes the plutonium analysis capacity that the revised CMRR project is required to provide to support specific pit production rates, NNSA could clarify the extent to which the project will support planned pit production, better enabling the agency to identify whether it will need to acquire additional plutonium analysis equipment or space by other methods.

NNSA Is Pursuing Actions to Increase Analysis Capacity

Even though NNSA did not identify pit production rates in a key performance parameter in the program requirements document for the revised CMRR project to support, the agency has taken steps since the August 2014 CD-1 approval that may increase the plutonium analysis capacity that the project will provide. For example, although the 2015 contractor analysis determined that the revised CMRR project as approved in August 2014 may not support a 10 pits-per-year production rate, the analysis also found that the project could support such a production rate at project completion in 2024 if the contractor successfully implements efforts to increase the efficiency of working in the radiological lab. These efforts involve potentially increasing the project's analysis capacity by reducing the amount of plutonium used in each analysis, in turn allowing scientists to conduct more analyses at a time. According to contractor representatives we interviewed, they have not determined if these efforts will be successful.

NNSA has initiated another action that could increase the plutonium analysis capacity that the revised CMRR project will provide, according to contractor documents. In November 2015, DOE approved a restructuring of the revised CMRR project by splitting the Plutonium Facility 4 Equipment Installation subproject, one of the two subprojects that comprised the revised CMRR project when it was approved in

August 2014,[34] and adding a new subproject that would upgrade the radiological lab from a radiological facility to a Hazard Category 3 nuclear facility.[35] Upgrading the radiological lab, according to NNSA and contractor documents, would involve (1) renovating the radiological lab to accommodate higher levels of plutonium, and (2) installing and operating a set of plutonium analysis equipment in the radiological lab that was otherwise slated to go into Plutonium Facility 4 as part of the revised CMRR project. In May 2015, NNSA and its contractor conducted a business case analysis of the upgrade that stated that the benefits of increasing work performed in the radiological lab instead of in Plutonium Facility 4 include increased operational efficiency and therefore increased analysis capacity. In addition, the business case analysis stated that the proposal offers the benefit of avoiding using the high-hazard, high-security space in Plutonium Facility 4 for analysis operations that do not need that level of safeguarding. According to the separate 2015 contractor analysis, conducting more plutonium analysis in the radiological lab instead of in Plutonium Facility 4—if combined with successful efforts to reduce the amount of plutonium used in each analysis—would likely increase the project's plutonium analysis capacity enough to support a 30-pits-per-year production rate. In a best case scenario, the analysis found the project might be able to support production at 80 pits per year.

[34]NNSA split the Plutonium Facility 4 Equipment Installation subproject into two phases: Plutonium Facility 4 Equipment Installation Phase 1, which is to end in 2019, and Plutonium Facility 4 Equipment Installation Phase 2, which is to end in 2024. Phases 1 and 2 involve the installation of plutonium analysis equipment in existing spaces in the facility. NNSA also created a new subproject: Recategorizing the Radiological Laboratory Utility Office Building to Hazard Category 3.

[35]DOE regulations identify three hazard categories for nuclear facilities. A Hazard Category 1 facility has the potential for significant off-site consequences; a Hazard Category 2 facility has the potential for significant on-site consequences beyond localized consequences; and a Hazard Category 3 facility has the potential only for local significant consequences. Facilities categorized as less than Hazard Category 3, including non-nuclear radiological facilities, have the potential only for consequences less than those that provide a basis for categorization as a Hazard Category 1, 2, or 3 nuclear facility. Unlike radiological facilities, Hazard Category 1, 2, and 3 facilities must meet the safety basis requirements at 10 CFR Part 830, Subpart B. The radiological lab at Los Alamos is a radiological facility; Plutonium Facility 4 is a Hazard Category 2 facility and the CMRR nuclear facility was anticipated to be a Hazard Category 2 nuclear facility.

NNSA's efforts to increase the plutonium analysis capacity of the revised CMRR project, however, may create risks for meeting the project's estimated cost and schedule. NNSA and DOE officials told us that the agency has not increased an existing facility's hazard category before and that NNSA is working to identify all of the steps that will be involved in upgrading the radiological lab to a Hazard Category 3 nuclear facility.[36] Also, the May 2015 business case analysis described some of the risks associated with the upgrade, some of which carry potentially significant cost and schedule effects if realized. For example, the business case analysis stated that it is possible that a forthcoming nuclear safety analysis could require modifying the building's ventilation system or increasing the safety rating of the gloveboxes used in the radiological lab for handling plutonium.[37] The business case analysis found that requiring such modifications could negatively affect the upgrade's schedule because, for example, the contractor has already started procuring gloveboxes for the radiological lab and changing their safety rating would require modifying the procurement or the gloveboxes themselves. Also, project costs could increase to the point where NNSA might decide it is not affordable to pursue the upgrade. If NNSA does not pursue the upgrade or the upgrade does not result in increasing the revised project's analysis capacity enough to support pit production rates of 50 to 80 pits per year by 2030 to support life extension programs, NNSA officials told us they do not currently have an alternate plan for acquiring and locating the remaining analysis equipment needed to support those production rates. Given the uncertainty surrounding the revised CMRR project's ability to support pit production rates of 50 to 80 pits per year, having a plan for providing sufficient analysis capacity may better enable NNSA to meet its pit production plans and support planned life extension programs critical to the agency's modernization efforts.

[36]NNSA's Los Alamos Field Office will ultimately decide the safety requirements necessary for the radiological lab building. We found in October 2008 that placing program offices in charge of approving and overseeing the creation of safety requirements for nuclear facilities that are being constructed by that same program office poses a potential conflict of interest. See GAO, *Nuclear Safety: Department of Energy Needs to Strengthen Its Independent Oversight of Nuclear Facilities and Operations*, GAO-09-61 (Washington, D.C.: Oct. 23, 2008).

[37]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.

NNSA Is Not Designing the Revised CMRR Project to Directly Meet Plutonium Analysis Needs of All DOE and NNSA Programs at Los Alamos

Even considering the actions that NNSA is pursuing to increase analysis capacity, the agency is designing the revised CMRR project to meet the Office of Defense Programs' plutonium analysis needs for its stockpile management mission and not the analysis needs of other NNSA and DOE programs that conduct plutonium analysis work at Los Alamos. This is counter to the revised CMRR project's requirements document for CD-1. More specifically, the first project requirement states that the revised CMRR project must provide infrastructure and equipment needed to support program offices with missions assigned to Los Alamos that involve plutonium analysis operations, including stockpile support and national security and science stewardship.[38] As stated, this requirement appears to include all DOE and NNSA program offices with plutonium analysis needs assigned to Los Alamos, including but not limited to the needs of the program sponsor—the Office of Defense Programs—and also other program offices, including the NNSA Office of Defense Nuclear Nonproliferation's ARIES and the DOE Office of Nuclear Energy's Office of Space and Defense Power Systems. The revised CMRR project's first requirement also directs readers to an appendix to the program requirements document that shows a list of programs—both within and outside of the Office of Defense Programs—that use plutonium analysis capabilities at Los Alamos mapped against specific types of plutonium analysis techniques. NNSA's requirements policy states that mission requirements should be a comprehensive set of what the project must provide to satisfy the mission need. In addition, *A Guide to the Project Management Body of Knowledge* states that mission requirements provide the basis for defining a project's scope.[39]

According to NNSA officials and contractor representatives, however, the revised CMRR project's scope does not include dedicated analysis equipment that specifically meets the needs of DOE and NNSA programs outside of the Office of Defense Programs. These officials and contractor representatives said that these programs' plutonium analysis needs are

[38]Specifically, the requirement states that the project is to provide infrastructure and equipment needed to support missions assigned to Los Alamos with plutonium analysis operations and supporting capabilities, including all plutonium mission-essential stockpile support, national security and science stewardship, and associated research and development space for these functions.

[39]Project Management Institute, Inc. *A Guide to the Project Management Body of Knowledge (PMBOK® Guide),* Fifth Edition, 2013.

not specifically included in the first project requirement for the revised CMRR project. They said that, as the project sponsor, it is Defense Programs' requirements that will dictate the specific analysis equipment to include in the project's scope of work. Officials we interviewed with ARIES and the Office of Space and Defense Power Systems said they are not customers of the revised CMRR project and that they did not provide input about their plutonium analysis requirements to inform the revised CMRR project's program requirements document. The Space and Defense Power Systems officials said that they have acquired dedicated plutonium analysis equipment to meet their plutonium analysis needs separately at Los Alamos, and the ARIES officials said they have moved most of their plutonium analysis work to another site but that they may seek to increase their analysis work at Los Alamos in the future if their mission changes.

Contractor representatives explained that they included programs outside of Defense Programs in the revised CMRR project's program requirements document to be comprehensive and show that the project may support customers beyond Defense Programs. They said that other programs may use the plutonium analysis equipment installed as part of the revised CMRR project, if and when the equipment is available. However, writing the first project requirement in a broad manner may provide the impression to senior managers and other stakeholders that the revised CMRR project will include the dedicated analysis equipment and space necessary to meet the plutonium analysis needs of programs other than Defense Programs. It also adds to the uncertainty surrounding the exact nature of the plutonium analysis capacity that the project will provide. By updating the program requirements document for the revised CMRR project to clarify whether the revised project will provide plutonium analysis equipment to meet the needs of DOE and NNSA programs other than those in the Office of Defense Programs, managers and stakeholders may have a clearer understanding of the extent to which the project will satisfy DOE and NNSA programs' needs.

NNSA Did Not Define Key Parameters or Program Requirements for the Plutonium Modular Approach, Therefore It Is Unclear If It Will Meet Analysis Needs

In November 2015, DOE approved the mission need (CD-0) for the Plutonium Modular Approach to examine building modular nuclear facilities to support plutonium work at Los Alamos. However, it is unclear whether the Plutonium Modular Approach will help meet DOE and NNSA programs' plutonium analysis needs at Los Alamos because NNSA did not identify key performance parameters, as with the revised CMRR project, or program-specific requirements in the mission need documentation. Further, the Plutonium Modular Approach's statement of mission need prematurely identified a specific solution, which is counter to Order 413.3B.

NNSA Did Not Specify Key Parameters, Including Plutonium Analysis Capacity

In its mission need documentation for the Plutonium Modular Approach, NNSA adopted a mission need statement and an initial set of requirements to meet the mission need. The mission need statement defined two missions: (1) provide high-hazard, high-security laboratory space to conduct operations to support enduring stockpile stewardship and management activities and (2) enable NNSA to continue working in Plutonium Facility 4 for longer than its planned life by moving some high-hazard operations out of the facility. The Plutonium Modular Approach requirements document stated that the project is to build no less than two modular nuclear facilities at Los Alamos adjacent to Plutonium Facility 4. The requirements document also included a list of potential program missions that the site might relocate from Plutonium Facility 4 into the new modular facilities and a statement that the space should be designed to accommodate any of the potential program missions listed. The program missions included pit production, pit disassembly conducted by ARIES, and plutonium-238 work conducted in part by the Office of Space and Defense Power Systems.

As with the revised CMRR project, NNSA did not identify any key performance parameters for the Plutonium Modular Approach to meet. NNSA's requirements policy directs NNSA to develop as many requirements as can be determined, including key performance parameters, in the program requirements document when it is first developed at CD-0. Also, NNSA did not identify any requirements that are specific to the needs of NNSA or DOE programs, including requirements related to providing additional plutonium analysis capacity that could support pit production. According to the best practices that we have identified for conducting analyses of alternatives, setting project requirements early in the analysis of alternatives process helps ensure

that the selected alternative best meets the agency's needs.[40] The program requirements document for the Plutonium Modular Approach states that NNSA plans to identify program-specific requirements at CD-2, which is after the agency has selected the project alternative. NNSA officials and contractor representatives told us that they did not identify program-specific requirements for the Plutonium Modular Approach to meet because they expect that these requirements will change between now and project completion. They said that although additional high-hazard, high-security laboratory space is needed, the exact use for that space has not been determined. In commenting on a draft of this report, contractor representatives stated that the justification for the Plutonium Modular Approach is "somewhat nebulous" because the mission need is based on the need to extend the life of Plutonium Facility 4 rather than on meeting specific program needs. Extending the life of Plutonium Facility 4 may be worthwhile, but by defining key performance parameters and program-specific requirements before conducting the analysis of alternatives, NNSA would have better information about program-specific requirements to inform its analysis and to provide a clearer basis for selecting a project alternative at CD-1.

Conducting the analysis of alternatives for the Plutonium Modular Approach without considering program-specific requirements may negatively affect programs that currently use space in Plutonium Facility 4. For example, NNSA reported in the mission need documentation that moving plutonium-238 activities out of Plutonium Facility 4 and into a new modular facility is a key example of how NNSA could extend the life of Plutonium Facility 4 by reducing nuclear safety risks in the facility. NNSA officials and contractor representatives told us that plutonium-238 activities is a top candidate to move into a modular facility if the goal is to extend the life of Plutonium Facility 4. However, NNSA did not consult the Office of Space and Defense Power Systems, which conducts most of the plutonium-238 activities in Plutonium Facility 4, when developing the mission need and requirements for the

[40]GAO, *Amphibious Combat Vehicle: Some Acquisition Activities Demonstrate Best Practices; Attainment of Amphibious Capability to be Determined,* GAO-16-22 (Washington, D.C.: Oct. 28, 2015). The best practices identified in this report are an update of and supersede the initial set of best practices we identified in a December 2014 report. 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).

Plutonium Modular Approach, according to officials with this office. These officials told us that they were not involved in discussions regarding the mission need for the project and that they had not heard about NNSA's potential plan to move plutonium-238 equipment out of Plutonium Facility 4. They said that NNSA's projected 2027 operational date for new modular facilities could directly impede the office's ability to meet NASA's future needs. They also said that if NNSA determines it needs to move the plutonium-238 equipment out of Plutonium Facility 4 to reduce risks, the Office of Space and Defense Power Systems may seek options for housing their equipment at another site rather than move into a new modular facility at Los Alamos.

Mission Need Prematurely Identified a Specific Solution

NNSA's mission need statement for the Plutonium Modular Approach may not provide NNSA with the flexibility to explore a variety of alternatives without limiting potential solutions because it prematurely identified a specific solution for the project, contrary to DOE Order 413.3B. According to the order, at CD-0 NNSA must develop statements of mission need that do not identify a particular solution such as equipment, facility, or technology. However, NNSA's mission need statement identifies a specific type of facility—high-hazard, high-security laboratory space. Also, in the program requirements document supporting CD-0, NNSA lists the Plutonium Modular Approach's first mission requirement as delivering no less than two new nuclear facilities with full operating capability no later than 2027. The mission need statement document states that a few options appear to be available to meet the mission need that would involve upgrading existing facilities instead of building new modular facilities, and NNSA officials told us that they will consider a range of options as part of the analysis of alternatives to support CD-1. However, by narrowly defining the mission need and the first requirement in terms of building two modular nuclear facilities at Los Alamos by 2027, there is effectively no project alternative other than the modular approach that NNSA could select to satisfy this requirement and the mission need as currently documented.

According to an NNSA official who helped develop the CD-0 project documentation, NNSA included language about building two new nuclear facilities in the project documentation to acknowledge congressional direction contained in the national defense authorization acts for fiscal

years 2014 and 2015 about building new modular facilities.[41] This official characterized the mission need statement as balancing compliance with congressional direction with compliance with Order 413.3B. The fiscal year 2014 statutory language limited the funds that NNSA could spend on pursuing an alternative other than the modular facilities, and the fiscal year 2015 statutory language expressed the sense of Congress that the best choice was to build two modular structures by 2027. The language neither required NNSA to move forward with a specific strategy nor relieved NNSA of its responsibility to analyze other alternatives.[42]

Identifying a specific solution in the mission need statement may create a potential bias against other potentially viable alternatives, limiting NNSA's ability to explore a variety of solutions. In our December 2014 report on NNSA's analysis of alternatives process, we found that conducting such an analysis without a predetermined solution is a best practice.[43] In that report, DOE and NNSA officials acknowledged that an unreliable analysis of alternatives is a risk factor for major cost increases and schedule delays for NNSA projects.[44] We recommended that NNSA incorporate best practices into its analysis of alternatives requirements to minimize the risk of developing unreliable analyses of alternatives and incurring major cost increases and schedule delays on projects. DOE agreed with our recommendation and in May 2016, the agency included language in an update to Order 413.3B directing that analyses of alternatives be conducted consistent with our published best practices. By rephrasing the Plutonium Modular Approach mission need statement and requirements so they are independent of a particular solution before conducting the

[41]The project's first requirement states, "based on the fiscal year 2014 National Defense Authorization Act, public law 113-66, and the fiscal year 2015 National Defense Authorization Act, the Plutonium Modular Approach is required to deliver no less than two modules that maintain the nuclear weapons stockpile over a 30-year period, provide a responsive infrastructure, and allow NNSA to meet plutonium pit production requirements at Los Alamos. Full operating capability will be realized no later than 2027."

[42]The national defense authorization act for 2015 refers to NNSA's "planned analysis of alternatives to support the plutonium strategy of the National Nuclear Security Administration." Carl Levin and Howard P. "Buck" McKeon National Defense Authorization Act for Fiscal Year 2015, Pub. L. No. 113-291, § 3132(a), 128 Stat. 3292, 3895.

[43]GAO-15-37. This best practice is also included in our October 2015 update to the analysis of alternatives best practices. See GAO-16-22.

[44]GAO-15-37.

analysis of alternatives, NNSA may be better positioned to objectively consider other alternatives before it makes its selection of an alternative at CD-1.

NNSA's Revised CMRR Project Has a Lower Estimated Total Cost than the Previously Approved CMRR Project, but Agency Estimates of Cost Savings May Be Overstated

The total estimated cost for the revised CMRR project is lower than the total estimated cost for the previously approved CMRR project that included constructing the CMRR nuclear facility, but estimates of cost savings may be too high because the revised project includes less scope and is likely to provide less plutonium analysis capacity. In internal documents used to present information to senior decision makers as they considered approving CD-1 for the revised CMRR project, DOE and NNSA stated that cancelling the nuclear facility portion of the previously approved CMRR project and approving the revised CMRR project would save billions of dollars. For example, in an August 2014 slide presentation to DOE's acquisition advisory board, NNSA reported that the total cost of its previously approved CMRR project—consisting of designing and constructing both the radiological lab and the nuclear facility, and installing equipment in both—would have reached up to approximately $7 billion. The presentation showed that since the total estimated cost of the revised CMRR project is up to approximately $3 billion—including sunk costs spent on designing, constructing, and installing equipment in the radiological lab and partially designing the nuclear facility—the agency will reduce costs by approximately $4 billion as a result of cancelling the CMRR nuclear facility. In a memorandum to the Deputy Secretary of Energy dated a day after the presentation and recommending approval of the revised CMRR project,[45] DOE's Office of Management stated that approving the revised CMRR project would reduce the total cost by more than $2 billion.[46] In that memorandum and in NNSA's budget requests for fiscal years 2016 and 2017, the agency stated that the revised CMRR project eliminated the need to construct the CMRR nuclear facility, thereby serving as its replacement.

[45]The Deputy Secretary of Energy is the acquisition executive charged with approving CD-1 for the revised CMRR project.

[46]NNSA and DOE compared the total estimated cost of the revised CMRR project with two different total estimated costs for the previously approved CMRR project, resulting in different estimated cost savings amounts. NNSA's presentation to the advisory board listed the total cost of the previously approved project at approximately $7 billion, and DOE's memorandum to the Deputy Secretary listed that cost as approximately $5 billion.

NNSA's cost savings calculations—whether $2 billion or $4 billion—may be overstated, however, because the revised CMRR project will likely provide less plutonium analysis capacity and less work scope than the previously approved CMRR project, which included the nuclear facility, and the calculations did not include costs associated with the Plutonium Modular Approach. More specifically:

- **The revised CMRR project will likely provide less analysis capacity than the previously approved CMRR project.** Before NNSA deferred construction of the CMRR nuclear facility, NNSA's contractor at Los Alamos estimated that the nuclear facility could support production of 40 pits per year in Plutonium Facility 4, and found that supporting 80 pits per year would require additional equipment and staff. NNSA reported that it expected the nuclear facility to support the production of up to 80 pits per year. In contrast, as discussed earlier, the 2015 contractor analysis determined that the revised project, as approved at CD-1 in August 2014, may not support the production of 10 pits per year and that the agency needs to successfully implement efforts to increase the project's analysis capacity to support production rates of 10 pits per year and 30 pits per year. In a best case scenario, the project might be able to support an 80-pits-per-year rate, according to the contractor's analysis. NNSA's statement that the revised CMRR project replaces the CMRR nuclear facility is based on the revised project providing the same analysis "capabilities" as the planned nuclear facility but not the same analysis capacity. NNSA uses the term capability to refer to specific types of analysis techniques, such as radiochemistry. For example, according to NNSA's contractor at Los Alamos, the revised project will install a set of plutonium analysis capabilities that is roughly comparable to the set of capabilities that was planned for the nuclear facility. However, contractor representatives added that, although the set of analysis capabilities is comparable, the analysis capacity is likely to be less because it is less efficient to conduct plutonium analysis in Plutonium

Facility 4 and the radiological lab than it would have been in the CMRR nuclear facility.[47]

- **The revised CMRR project includes less work scope than the previously approved CMRR project.** The CMRR nuclear facility was to include, among other things: a 31,100 square foot nuclear material storage vault; a 12,800 square foot tunnel system for secure transfer of materials between Plutonium Facility 4, the nuclear facility, and the radiological lab; and 7,200 square feet for staging waste drums before they were to be shipped for disposal.[48] The revised CMRR project does not include the storage vault, tunnel, or a new waste staging area. In its CD-1 documentation for the revised CMRR project, NNSA stated that it eliminated these scope elements because they were not needed at the time. However, NNSA also stated that it will eventually need a tunnel connecting Plutonium Facility 4 to the radiological lab and the future modular nuclear facilities and a waste staging area and that although the need for a new storage vault has been delayed, it has not necessarily been eliminated. As a result, removing these scope elements from the revised CMRR project may result in a reduction of the CMRR project's total cost, but it may not represent a net cost savings to the agency or the taxpayer, because some scope elements that were removed will need to be constructed eventually.[49]

[47]According to NNSA documents, the previously approved CMRR nuclear facility's ventilation system would have allowed for working at stations with open fronts, allowing for easier and more efficient work with small plutonium samples. In contrast, Plutonium Facility 4's ventilation system cannot support open front work stations, and samples must be managed in closed gloveboxes with thick gloves that make it difficult to work with small samples. Although the radiological lab supports working in open front stations, the relatively small total amount of plutonium allowed in the building limits the analysis capacity.

[48]In addition to the storage vault, tunnel, and waste staging area, the nuclear facility was to have included space for handling large vessels. According to NNSA documentation, capability to handle large vessels is not planned to be provided by the revised CMRR project—or any other project at Los Alamos—because programs no longer need this capability.

[49]Los Alamos contractor representatives said that the elimination of the storage vault will be partially mitigated by using existing storage at NNSA's Pantex Plant near Amarillo, Texas, as a long-term vault for storing material used and generated at Los Alamos. They said that using the Pantex storage vault will increase the need to transport materials between the sites but that it should not increase the number of shipments between the two sites because ongoing shipments should have sufficient space to accommodate moving additional material to and from storage. They said they had not calculated whether the increased transportation need would result in additional costs.

- **NNSA's calculations did not include costs associated with the modular facilities**. NNSA stated in the revised CMRR project's CD-1 documentation that the overall strategy for maintaining plutonium operations at Los Alamos without the CMRR nuclear facility consists of both the revised CMRR project and the Plutonium Modular Approach. The documentation mentioned that building new modular nuclear facilities will accommodate activities that are not included in the revised CMRR project or that are needed to facilitate the project. Therefore, without including some costs associated with the Plutonium Modular Approach, any cost savings calculations from cancelling the CMRR nuclear facility are likely to be overstated.

According to NNSA officials and contractor representatives, NNSA's cancellation of the previously approved CMRR project's nuclear facility may yield benefits in terms of an improved funding profile. These officials and representatives explained that one benefit of pursuing the revised CMRR project and the Plutonium Modular Approach lies in improving the agency's ability to fund the two projects. They said that although the total cost to build a set of modular nuclear facilities is not necessarily less than building one large nuclear facility, acquiring smaller nuclear facilities over time may be more affordable because NNSA can spread out the facilities' effect on the budget over a greater period of time. However, we found in our March 2016 report on NNSA's modernization plans and the budget estimates to implement these plans that the total costs of NNSA's plutonium infrastructure strategy at Los Alamos included in the plans were uncertain and may be underestimated because NNSA had not determined the number of modular facilities that may be required.[50] Therefore, the actual amount of any cost savings that NNSA may realize has yet to be determined.

[50]GAO-16-290.

NNSA's Schedule and Cost Estimates for the Revised CMRR Project Partially Met Best Practices

NNSA's estimated schedule and costs for completing the revised CMRR project partially met best practices. Importantly, the schedule estimate did not include all work activities required for the project's successful execution. The cost estimate exhibited two of the four characteristics of reliable cost estimates; as a result, NNSA cannot have confidence that it can meet its schedule and cost goals, including supporting the agency's commitment to end plutonium operations in the Chemistry and Metallurgy Research facility by the end of 2019.

NNSA's Schedule Did Not Include Most Activities Needed to Complete the Project

NNSA did not maintain a schedule for the revised CMRR project that included all activities needed to complete the project and did not sufficiently analyze risks to determine whether the project's estimated completion dates are reasonable. In August 2014, in support of the CD-1 decision, NNSA estimated that it would complete the revised CMRR project's first subproject—installing plutonium analysis equipment in the radiological lab—in December 2019 and that it would complete the second subproject—installing plutonium analysis equipment in Plutonium Facility 4—in February 2024. NNSA's contractor at Los Alamos updated the schedule subsequent to CD-1 approval. We reviewed an updated project schedule from August 2015 and assessed the extent to which it reflected best practices for creating a high-quality, reliable schedule.[51] We found that NNSA had not maintained an integrated master schedule that contained all work activities needed to complete the project consistent with best practices or conducted a schedule risk analysis to determine the likelihood of meeting completion dates. Also, the agency may not meet the December 2019 completion date for the first subproject to install analysis equipment in the radiological lab, which supports NNSA's commitment to end plutonium operations in the Chemistry and Metallurgy Research facility.

NNSA Had Not Maintained an Integrated Master Schedule

We found that NNSA's August 2015 updated schedule for the revised CMRR project substantially or fully met several scheduling best practices, but the schedule was limited to short-term work that ends in 2017. The

[51]NNSA provided us with updated schedules dated August 23, 2015, for both of the two revised CMRR subprojects. We assessed and scored each subproject's schedule separately and then averaged the results to create a single assessment for the entire project's schedule. Appendix II provides both the individual and combined assessment scores.

project schedule estimate fully met the best practice of establishing durations for those activities that the contractor included in the schedule. This best practice allows managers to more easily track progress and ensures that the schedule realistically reflects how long each activity will take. The schedule also substantially met the best practice of being horizontally and vertically traceable, meaning that related activities were correctly linked to intended outcomes, so that changing the amount of time planned for an activity would appropriately affect forecasted dates and that varying levels of activities were properly aligned. In addition, the updated schedule also substantially met the best practices for assigning resources to activities and sequencing activities. These best practices help ensure that resources, such as labor and equipment, are available when needed and that activities are listed in the order in which they are to be carried out.

However, we found that NNSA had not maintained a schedule for the revised CMRR project that contained all the activities within the project's scope of work, as called for by best practices. NNSA's August 2015 updated schedule that we reviewed did not contain most of the planned work necessary to complete the project. According to best practices, a project team should develop and maintain an integrated master schedule that includes the entire scope of work required for a project's successful execution. An integrated master schedule should include near-term and long-term activities throughout the life of the project, and a project team may account for uncertainty in future years by using a lesser level of detail to describe future activities. Among other things, an integrated master schedule provides managers with a plan for carrying out the project and a mechanism for measuring progress and identifying potential problems in meeting schedule milestones. An integrated master schedule is also important for meeting other best practices, such as assigning resources to activities and validating the critical path.[52]

An NNSA official and contractor representatives we interviewed who are members of the CMRR project team told us that they developed an integrated master schedule to support the project's CD-1 decision, but they did not maintain the integrated master schedule after CD-1. Rather,

[52]A project's critical path is generally defined as the longest continuous sequence of activities in a schedule. If any activities on the project's critical path are delayed, the entire project will be delayed by an equal amount of time.

the August 2015 updated project schedule we reviewed was limited to work activities scheduled to occur in the short-term, including design and site preparation activities that support progress toward CD-2 and long-lead procurement of analysis equipment. According to schedule documentation, these activities represent about 7 percent of the total remaining project, by cost. Specifically, these activities were scheduled to end in 2017 at an estimated cost of approximately $134 million. In contrast, the project's entire scope of work is not scheduled to end until 2024 at an approximate cost of up to $2 billion.

An NNSA project team member said the team did not maintain the integrated master schedule after CD-1 because, in general, they do not update a CD-1 schedule until they develop the project's schedule baseline before CD-2. NNSA directed contractor team members to create the project's updated schedule based on a plan—finalized in September 2014—to implement the project through CD-2. Project team members said that the updated schedule was sufficient for managing the project until CD-2. Project team members also said limiting the updated schedule to short-term work allows them to focus attention on near-term, critical activities as they manage and execute the project. At the time of the revised CMRR project's CD-1 approval in August 2014, Order 413.3B directed agencies to develop project schedules before multiple critical decisions, but the order did not specify when, and if, projects should create and maintain an integrated master schedule. By maintaining a schedule that is limited to short-term work ending in 2017, however, NNSA and its contractor have limited insight into how current performance affects completion dates beyond 2017, including completing the first subproject to install analysis equipment in the radiological lab in December 2019—in support of ending operations in the Chemistry and Metallurgy Research facility—and completing the rest of the revised CMRR project by 2024.

Subsequent to approving CD-1 in August 2014, DOE updated its direction to project managers for developing and maintaining integrated master schedules. In June 2015, the Secretary of Energy issued a department-wide memorandum directing NNSA to, among other things, develop, maintain, and document an integrated master schedule consistent with the methods and best practices identified by our schedule guide. In May 2016, DOE incorporated these policies into an update to

Order 413.3B.[53] Project team members said that they are creating a new project schedule to support the revised CMRR project's first CD-2 decision scheduled to occur by the end of September 2016, but according to an NNSA project team member, this schedule will be limited to activities estimated to end in 2019, primarily involving the installation of equipment in the radiological lab and, to a lesser extent, in Plutonium Facility 4.[54] As a result, this new schedule may not meet the criteria for an integrated master schedule and may not conform to the May 2016 update to Order 413.3B. NNSA plans to approve additional schedule baselines at a second CD-2 decision in mid-2017 for the remaining portions of the project, including activities needed to support upgrading the radiological lab to a Hazard Category 3 nuclear facility and installing most of the analysis equipment planned for Plutonium Facility 4. An NNSA project team member said that the remaining portions will be added to the overall project schedule estimate once their schedule baselines are approved at the second CD-2 decision. By using this approach, however, NNSA will not develop an integrated master schedule that includes all activities until the second CD-2 decision in mid-2017. Without developing and maintaining an integrated master schedule that includes all project activities under all subprojects prior to approving the first CD-2 decision for the revised CMRR project, NNSA does not have reasonable assurance that it has a mechanism for measuring progress and identifying potential problems in meeting schedule milestones for the revised CMRR project. Appendix II contains additional information about the details supporting our assessment of the August 2015 updated project schedule.

NNSA Did Not Conduct a Schedule Risk Analysis

We found that NNSA developed the revised CMRR project schedule without sufficiently analyzing risks to determine whether the project's estimated completion dates are reasonable, contrary to best practices.

[53]In addition, the June 2015 memorandum and the updated Order 413.3B direct DOE to develop integrated master schedules in a manner that is also consistent with the National Defense Industrial Association's planning and scheduling guide. DOE updated Order 413.3B on May 12, 2016, to institutionalize policies found in the June 2015 memorandum and in a December 2014 memorandum.

[54]In November 2015, DOE approved a new structure for the revised CMRR project, so that it consists of four subprojects instead of two. NNSA plans to approve CD-2 for the first two subprojects by the end of September 2016 and to approve CD-2 for the second two subprojects in 2017. DOE Order 413.3B allows a project team to split—or phase—a project into smaller, related components, each with its own CD-2 baseline.

Project teams should conduct a schedule risk analysis to examine risks and opportunities for the project, according to scheduling best practices. This analysis determines the level of confidence that the agency can have in whether it will meet its estimated completion dates, typically expressed as a percentage. For example, an agency may learn from a schedule risk analysis that it can have 70 percent confidence that it will finish the project by the estimated completion date. For the revised CMRR project, NNSA reported that it created an "aggressive" schedule to finish its first subproject by the end of 2019 to support ending plutonium operations in the Chemistry and Metallurgy Research facility. However, because NNSA did not conduct a schedule risk analysis, the agency does not have information about the level of confidence associated with meeting the first subproject's estimated completion date, and therefore cannot determine if that date is reasonable.

Instead of a schedule risk analysis, the CMRR project team completed a different kind of analysis called a risk assessment to support the August 2014 CD-1 approval decision, but this assessment minimally met best practices for a schedule risk analysis. The risk assessment provided information about, among other things, the potential effects of selected technical and programmatic risks on the schedule but was less comprehensive than a schedule risk analysis. The project team told us that they did not conduct a schedule risk analysis because they did not have sufficient detail about activities in the schedule, including those that would occur beyond CD-2. However, according to best practices, a schedule risk analysis can be performed on a summary version of the schedule if some activities are not well defined.

We previously found weaknesses in the schedule risk analysis that NNSA conducted on the previously approved CMRR project's schedule. In March 2012, immediately after NNSA deferred construction of the CMRR nuclear facility, we found that NNSA's schedule risk analysis did not include all risks identified by the project team, and we recommended that the agency conduct a new schedule risk analysis when it resumed the CMRR project and before establishing the schedule baseline at CD-2.[55] NNSA disagreed with our recommendation, stating that it would not be prudent to update the project's schedule at that time because the agency

[55]GAO-12-337.

had just deferred the project. However, NNSA did not conduct a schedule risk analysis when it later resumed the project in 2014. Project team members told us that they plan to complete separate schedule risk analyses before each CD-2 decision for the revised CMRR project. According to the Secretary of Energy's June 2015 memorandum on project management and the May 2016 update to Order 413.3B, NNSA is to develop project schedules consistent with the methods and best practices found in our schedule guide; these best practices include conducting a schedule risk analysis on a complete project schedule. Since NNSA will not create an integrated master schedule that includes all project activities until mid-2017, the schedule risk analysis that the agency will conduct on the portion of the project that NNSA is to approve at the first CD-2 decision by the end of September 2016 will be limited and may not account for all project risks. As a result, the schedule risk analysis may provide NNSA with information about the confidence level associated with meeting the first subproject's December 2019 completion date, but may not provide information on the likelihood of meeting the project's overall 2024 completion date. Without conducting a comprehensive schedule risk analysis that applies to the integrated master schedule to identify the likelihood that the revised CMRR project can meet all of its estimated completion dates, NNSA does not have reasonable assurance that it can meet the project's overall 2024 completion date.

NNSA May Not Meet Its Estimate to Complete the CMRR Subproject That Supports Ending Operations in the Chemistry and Metallurgy Research Facility

According to NNSA documentation, the agency may not meet its December 23, 2019, estimate for completing the first subproject of the revised CMRR project because the schedule for the first subproject does not include any schedule contingency to account for risks to the "aggressive" schedule that may be realized. NNSA's risk assessment identified four risks to the subproject that could require from 19 to 20 months, or more, of schedule contingency if the risks are realized.[56] Therefore, if NNSA needs to add more than 8 days to the schedule as

[56]The four project risks are: (1) the project will not design a glovebox fire suppression system that meets requirements and that is accepted by the Los Alamos fire marshal within the cost and schedule baseline; (2) Los Alamos's requirements may change, and inconsistent interpretation of requirements may result in additional scope; (3) glovebox vendors may not be able to meet the compressed fabrication schedule; and (4) an update to requirements could affect the project team's ability to duplicate glovebox design used under a previous project, requiring a redesign. The project team identified a separate list of potential risks and schedule impacts for the second subproject.

contingency to mitigate risks, the subproject's completion date extends into 2020; if NNSA needs the entire schedule contingency, the completion date extends into 2021. Project team officials told us that they set the completion date for the first subproject so that it would finish before the end of 2019 to support NNSA's commitment to end plutonium operations in the Chemistry and Metallurgy Research facility in 2019. According to NNSA documents, the project team streamlined some activities, including glovebox design work, to support the 2019 completion date. Unless its "aggressive" schedule stays precisely on track, the agency is likely to need at least some of its schedule contingency, extending the first subproject's completion date to beyond 2019.

NNSA officials told us that the agency remains committed to ending plutonium operations in the Chemistry and Metallurgy Research facility by the end of 2019. In commenting on a draft of this report, NNSA stated that the Office of Defense Programs may choose to accept risk or a gap in plutonium analysis capabilities to support this commitment if the first CMRR subproject is not completed by the end of 2019. One official also said NNSA is evaluating options to account for any gaps in capabilities and has worked with contractor representatives to prioritize establishing the most important capabilities first so that any gaps would involve less critical capabilities.

NNSA's Cost Estimate Exhibited Two of Four Characteristics of Reliable Estimates

NNSA's cost estimate for the revised CMRR project exhibited two of the four characteristics of a high-quality, reliable estimate. We reviewed and assessed NNSA's August 2014 CD-1 cost estimate covering the entire revised CMRR project—a cost range from $1.5 billion to $2.0 billion—against the four characteristics of reliable cost estimating: (1) comprehensive, (2) well documented, (3) accurate, and (4) credible.[57] We found that NNSA's cost estimate was substantially comprehensive and well documented. For example, the estimate recorded all ground rules and assumptions and fully defined the project's scope, including

[57]According to NNSA's acquisition strategy for the revised CMRR project, the revised project's total cost estimate range was from $1.5 billion to $2.0 billion, including contractor and federal costs. We reviewed a version of the cost estimate that NNSA's contractor created in June 2014 to support the August 2014 CD-1 decision, which did not appear to include federal project management costs. The contractor's cost estimate range was from $1.4 billion to $2.0 billion.

technical characteristics and performance, design, and quality assurance requirements, which are important for comprehensiveness. The estimate also sufficiently described the methods used to calculate the cost of each component of the estimate, which helps make an estimate well documented. Figure 2 shows our assessment of NNSA's cost estimate and appendix III contains additional information about the details supporting our assessment.

Figure 2: Assessment of the August 2014 Cost Estimate for the National Nuclear Security Administration's Revised Chemistry and Metallurgy Research Replacement Project

Characteristic of reliable cost estimates	Assessment				
	Not met	Minimally met	Partially met	Substantially met	Fully Met
Comprehensive				●	
Well documented				●	
Accurate			●		
Credible			●		

Source: GAO analysis of National Nuclear Security Administration data. | GAO-16-585

Notes: The ratings we used in this analysis are as follows: "Not met" means NNSA provided no evidence that satisfies any of a characteristic. "Minimally met" means NNSA provided evidence that satisfies a small portion of a characteristic. "Partially met" means NNSA provided evidence that satisfies about half of a characteristic. "Substantially met" means NNSA provided evidence that satisfies a large portion of a characteristic. "Fully Met" means NNSA provided complete evidence that satisfies an entire characteristic.

Cost Estimate Was Partially Accurate

We found that NNSA's cost estimate was partially accurate, in part, because the project team did not determine the project's most likely costs when calculating management reserve and the total cost range for the project. Specifically, the project team generally used appropriate estimating techniques to develop the point estimate. The team, however, then increased the point estimate by as much as 50 percent to include funds for management reserve.[58] According to our cost guide, management reserve is typically the amount of funds the contractor may

[58]The project team increased the point estimate for one subproject by 30 percent and for another subproject by 50 percent.

need to spend to account for uncertainty.[59] According to best practices, managers should use analyses, such as a risk analysis, to calculate a project's most likely costs, and the estimate should not be overly conservative or optimistic. Contractor project team members told us that they set the amount of management reserve funding based on their subject matter experts' assessments about the uncertainty related to the project and not on a formal risk analysis.

Similarly, contractor project team members told us that they created the top end of the total cost range by applying the highest amount possible under DOE guidance rather than using a risk analysis to calculate the most likely costs. DOE guidance suggests that NNSA could have added from 20 percent to 100 percent to the point estimate to create the top end of the range, depending on the level of information available about the project's scope of work.[60] Project team members said they determined that the highest amount possible was appropriate based on their subject matter experts' opinion that the project carried high levels of uncertainty. However, adding the highest amount possible above the point estimate may increase the high end of the cost range more than necessary. Because NNSA calculated management reserve and the total cost range based on assumptions rather than analyses, the high end of the cost range may overestimate the funds that will be needed and may not provide management with reliable information to inform its decisions.

Cost Estimate Was Partially Credible

We found that NNSA's cost estimate was partially credible, in part, because NNSA did not follow the best practice to conduct a sensitivity analysis. A sensitivity analysis quantifies the extent to which the cost

[59]GAO-09-3SP. According to DOE guidance, management reserve generally refers to funds that are used to cover risks for which the contractor is responsible, while DOE contingency refers to funds that are used to cover risks for which the agency is responsible. According to CD-1 documentation for the CMRR project, the management reserve is assumed to cover both contractor and agency risks.

[60]In calculating the amount of costs to add to the point estimate to create the top end of the cost range, NNSA followed DOE guidance for calculating a CD-1 cost range. Since the project team determined that the amount of definition for the first subproject was about 1 to 15 percent, the team applied a value of 50 percent to the point estimate to calculate the high end of the range. Since the project team determined that the amount of definition for the second subproject was about 0 to 2 percent, the team applied a value of 100 percent to the point estimate to calculate the high end of the range. These values represent the highest amount allowed for the amount of project definition.

estimate could vary because of changes in key assumptions and ground rules. Performing such an analysis increases the chance that decisions that influence the design of the project will be made with a focus on the elements that have the greatest effect on cost. The CMRR project team created a document that it labeled a sensitivity analysis to support its cost estimate, but this analysis did not follow most of the steps for conducting a sensitivity analysis as called for by best practices. The project team members said that they plan to conduct a sensitivity analysis to support the baseline cost estimate at CD-2. This would be in keeping with the Secretary's June 2015 memorandum and the May 2016 update to Order 413.3B, which direct project managers to develop cost estimates in accordance with best practices found in our cost guide, including sensitivity analysis.

The cost estimate also was partially credible because NNSA did not conduct an independent cost estimate of the revised CMRR project. According to best practices, an independent cost estimate is generated by an entity that has no stake in approval of the project and provides an unbiased test of whether a project estimate is reasonable. Prior to CD-1, DOE conducted an independent cost review of the project estimate, which addresses a cost estimate's high-value, high-risk, and high-interest aspects without evaluating the remainder of the estimate, as permitted under Order 413.3B. The independent cost review identified a number of problems with NNSA's cost estimate, such as estimation errors, and according to DOE officials, NNSA incorporated some of the independent cost review team's comments and recommendations prior to CD-1. Nevertheless, an independent cost estimate is a more thorough analysis than an independent cost review. We have previously recommended that DOE require independent cost estimates for all major projects at CD-1 to improve the credibility of cost estimates at this stage, but DOE has made independent cost estimates optional at CD-1.[61] Project officials told us

[61]In our 2010 report on DOE cost estimating, we recommended that DOE require independent cost estimates for all major projects at CD-1, CD-2, and CD-3. DOE partially agreed with our recommendation, stating that it would require independent cost estimates for major projects at CD-1 and CD-2. See GAO, *Department of Energy: Actions Needed to Develop High-Quality Cost Estimates for Construction and Environmental Cleanup Projects*, GAO-10-199 (Washington, D.C.: Jan. 14, 2010). However, subsequently DOE did not require independent cost estimates at CD-1, but instead provided that the DOE office charged with conducting the independent review at CD-1 could choose to perform an independent cost estimate or an independent cost review, as it deems appropriate.

NNSA is preparing to have an independent cost estimate conducted to support the CD-2 cost estimate, which is required by Order 413.3B.

Conclusions

NNSA has committed to improving its performance in managing major construction projects and has recently taken important steps toward achieving that end. However, NNSA's planning for the revised CMRR project at the Los Alamos National Laboratory indicates that the agency still has work to do. Specifically, NNSA did not identify a type of requirement called a key performance parameter in the revised CMRR project's requirements document, contrary to NNSA's requirements policy. These performance parameters are important because they define how well a project will perform its functions, expressed in terms such as capacity or throughput. One of the revised CMRR project's primary functions is to provide plutonium analysis to support producing new plutonium pits for life extension programs that are critical to NNSA's nuclear modernization efforts. NNSA needs a sufficient amount of plutonium analysis capacity to support the agency's pit production plans, but it is currently unclear how well the project will support NNSA's plan to develop the capability to produce 50 to 80 pits per year by 2030. By updating the program requirements document for the revised CMRR project to identify a key performance parameter that describes a pit production rate, NNSA could clarify the extent to which the project will support pit production plans, better enabling the agency to identify whether it will need to acquire additional plutonium analysis equipment or space by other methods. Also, NNSA officials told us that if the revised CMRR project does not provide sufficient plutonium analysis capacity to support a 50 to 80 pits-per-year rate by 2030, they do not have an alternate plan for obtaining that capacity. Given the uncertainty associated with the revised CMRR project supporting a 50 to 80 pits-per-year rate, having a plan for providing sufficient analysis capacity if the revised CMRR project will not support this rate may better enable NNSA to meet its pit production plans and support planned life extension programs critical to the agency's modernization efforts.

In addition, NNSA's broadly stated first requirement for the revised CMRR project suggests that the project must meet plutonium analysis needs of all DOE and NNSA program offices with plutonium analysis operations at Los Alamos. However, the revised CMRR project's scope is focused on exclusively meeting the needs of the Office of Defense Programs. Other DOE and NNSA offices may use the plutonium analysis equipment installed for the CMRR project, if and when it is available, but NNSA is not including plutonium analysis equipment in the scope of the project

specifically to meet their needs. NNSA's requirements policy states that the project's requirements should be a comprehensive set of what the project must provide to satisfy the mission need. By updating the program requirements document for the revised CMRR project to clarify whether the CMRR project will provide plutonium analysis equipment to meet the needs of DOE and NNSA programs other than those in the Office of Defense Programs, managers and stakeholders may have a clearer understanding of the extent to which the project will satisfy DOE and NNSA programs' needs.

We commend the Secretary of Energy for issuing the May 2016 update to Order 413.3B—and the June 2015 department-wide memorandum that preceded it—directing project teams to develop and maintain integrated master schedules consistent with the best practices in our schedule guide. Such a step is likely to improve schedule outcomes for the agency. However, NNSA did not maintain the integrated master schedule it created at CD-1 for the revised CMRR project, and the schedule that the agency plans to create to support the first CD-2 decision by the end of September 2016 may not meet the criteria for an integrated master schedule and, therefore, may not conform to the May 2016 update to Order 413.3B. Without developing and maintaining an integrated master schedule that includes all project activities under all subprojects prior to approving the first CD-2 decision for the revised CMRR project, consistent with current DOE project management policy and scheduling best practices, NNSA does not have reasonable assurance that it has a mechanism for measuring progress and identifying potential problems in meeting schedule milestones for the revised CMRR project. Also, waiting until the second CD-2 decision in mid-2017 to create the integrated master schedule means NNSA will not conduct a schedule risk analysis for the entire project until then. Conducting a schedule risk analysis to support the first CD-2 decision by the end of September 2016 may provide NNSA with information about the level of confidence that the agency can have in its ability to complete the first subproject by the end of 2019. However, without conducting a comprehensive schedule risk analysis that applies to the integrated master schedule to identify the likelihood that the project can meet all of its estimated completion dates, NNSA does not have reasonable assurance that it can meet the project's overall 2024 completion date.

Regarding the Plutonium Modular Approach, NNSA has approved the mission need for another potentially multi-billion dollar project at Los Alamos. NNSA, however, prematurely identified a specific solution when it approved the mission need—contrary to Order 413.3B and best

practices—by stating that the Plutonium Modular Approach would construct high-hazard, high-security laboratory space. NNSA also specifically set the project's first requirement as building no less than two modular nuclear facilities at Los Alamos with full operating capability by 2027. By defining the mission need and requirements in terms of this specific type of laboratory space and nuclear facility, NNSA has effectively predetermined that it is the only alternative that can meet the mission need and satisfy requirements. By rephrasing the mission need statement and requirements so they are independent of a particular solution before conducting the analysis of alternatives, NNSA may be better positioned to objectively consider other alternatives before making its selection of a project alternative at CD-1.

Also, when approving the mission need for the Plutonium Modular Approach, NNSA did not identify key performance parameters or program-specific requirements in the program requirements document. NNSA's requirements policy directs NNSA to develop requirements that include key performance parameters in the program requirements document when it is first developed, and according to the best practices that we have identified for conducting analyses of alternatives, setting requirements early in the analysis of alternatives process helps ensure that the selected alternative best meets the agency's needs. By defining key performance parameters or program-specific requirements before conducting the analysis of alternatives, NNSA would have better information about programs' specific needs to inform its analysis and to provide a clearer basis for selecting a project alternative at CD-1.

Recommendations for Executive Action

We are making seven recommendations to the Secretary of Energy.

To ensure that NNSA will acquire sufficient plutonium analysis equipment and space to meet its needs, including pit production to support critical life extension programs, we recommend that the Secretary direct that the Under Secretary for Nuclear Security, in his capacity as the NNSA Administrator:

- update the program requirements document for the revised CMRR project to identify a key performance parameter that describes the plutonium analysis capacity the CMRR project is required to provide to support specific pit production rates and
- specify plans for how the agency will obtain additional plutonium analysis capacity if the revised CMRR project will not provide

sufficient plutonium analysis capacity to support NNSA's pit production plans.

To ensure that NNSA will provide clear information to stakeholders about the program needs that the revised CMRR project will satisfy, we recommend that the Secretary direct the Under Secretary for Nuclear Security, in his capacity as the NNSA Administrator, to update the program requirements document for the revised CMRR project to clarify whether the project will provide plutonium analysis equipment to meet the needs of DOE and NNSA programs other than those in the Office of Defense Programs.

To ensure that NNSA's future schedule estimates for the revised CMRR project provide the agency with reasonable assurance regarding meeting the project's completion dates, we recommend that the Secretary direct the Under Secretary for Nuclear Security, in his capacity as the NNSA Administrator, to develop future schedules for the revised CMRR project that are consistent with current DOE project management policy and scheduling best practices. Specifically:

- develop and maintain an integrated master schedule that includes all project activities under all subprojects prior to approving the project's first CD-2 decision and
- conduct a comprehensive schedule risk analysis that applies to the integrated master schedule to identify the likelihood the project can meet its completion dates.

To ensure that NNSA is better positioned to objectively consider alternatives before making its selection of an alternative for the Plutonium Modular Approach, we recommend that the Secretary direct the Under Secretary for Nuclear Security, in his capacity as the NNSA Administrator, before completing the analysis of alternatives, to rephrase the statement of mission need and requirements for the Plutonium Modular Approach so that they are independent of a particular solution.

Finally, to ensure that NNSA has information about program-specific needs to inform its analysis of alternatives for the Plutonium Modular Approach and to provide a clearer basis for selecting a project alternative, we recommend that the Secretary direct the Under Secretary for Nuclear Security, in his capacity as the NNSA Administrator, before completing the analysis of alternatives, to identify key performance parameters and program-specific requirements for the Plutonium Modular Approach.

Agency Comments and Our Evaluation

We provided a draft of this report to DOE and NNSA for their review and comment. In its written comments, reproduced in appendix IV, NNSA generally neither agreed nor disagreed with our recommendations, although it outlined actions taken and planned to address each of our recommendations. NNSA also provided technical comments, which we incorporated in the report as appropriate.

Concerning our findings, in its comments, NNSA stated that the report substantially misinterprets the relationship between the CMRR project and plutonium pit production. NNSA also stated that the report incorrectly implies that the driver for the CMRR project and the project's ultimate success depend on meeting plutonium pit production needs when the goal of the project is to replace specific plutonium analysis capabilities. We state in this report that the revised CMRR project's purpose is to provide plutonium analysis capabilities to facilitate replacing the aging Chemistry and Metallurgy Research facility. However, we also state that, according to NNSA documents, one of the primary functions of these analysis capabilities is to support NNSA's efforts to produce new plutonium pits for life extension programs that are critical to nuclear modernization efforts. As such, the revised CMRR project plays a key role in supporting NNSA's pit production plans. We agree that the success of the CMRR project should not be measured in terms of actual pits produced, but rather in terms of the plutonium analysis capacity the project provides in support of production efforts and other stockpile stewardship needs. As a result, we continue to believe that it is important for the agency to be clear about how well the CMRR project will support NNSA's pit production plans. In addition, NNSA stated that the report does not reflect the depth and breadth of steps NNSA has taken in the last 2 years to improve project management in accordance with the Secretary of Energy's new policies. As we state in the report, we are pleased with the steps that NNSA has recently taken to improve project management, including the Secretary's new policies, and we are hopeful that they will lead to improved outcomes.

Concerning our recommendations, in its written comments NNSA outlined planned actions that are responsive to two of our seven recommendations. Specifically, the first of these two recommended that NNSA specify plans for how the agency will obtain additional plutonium analysis capacity if the revised CMRR project will not provide sufficient capacity to support pit production plans. In its written comments, NNSA stated that it will update its plutonium strategy to include estimates of the requirements and additional means, if needed, to achieve the required capacity. NNSA stated that this action will be completed by

September 30, 2017. The second of these two recommended that NNSA update the CMRR program requirements document to clarify whether the project will provide plutonium analysis equipment to meet the needs of DOE and NNSA programs other than those in the Office of Defense Programs. NNSA stated that it will update this document to clarify that the project will not install any unique analysis equipment required solely for non-defense-related programs. NNSA estimated the completion date for this activity to be December 31, 2017, or the next planned revision of the program requirements document.

Regarding our other five recommendations, NNSA outlined actions planned or taken that we do not believe are sufficiently responsive. Specifically, regarding our recommendation that NNSA identify a key performance parameter for the CMRR project that describes the plutonium analysis capacity needed to support specific pit production rates, NNSA stated that it is important to understand how the revised CMRR project will support the agency's overall plutonium strategy, including pit production and other NNSA programs. However, NNSA did not agree that it would be appropriate to establish a key performance parameter for the revised CMRR project related to supporting a specific pit production rate. The agency stated that incorporating such a key performance parameter would require the project to rely on factors beyond its control to demonstrate that it had met such a performance parameter before the project was completed. Instead, NNSA stated that it will perform an analysis to estimate a pit production capacity range that the project will support and include a reference to this analysis in its next revision to the program requirements document. Although conducting this analysis and including a reference to it in the program requirements document may be helpful, it may not be sufficient to describe how well the CMRR project will perform one of its primary functions—conducting plutonium analysis that is essential to supporting NNSA's pit production activities. As a result, we continue to believe that it is important for NNSA to define this information in a key performance parameter.

Regarding our recommendation that NNSA develop and maintain an integrated master schedule that includes all project activities contained within the revised CMRR project, NNSA stated that it does not intend to create one integrated master schedule. Instead, NNSA reiterated its plan—described earlier in this report—to create a separate schedule for each subproject as it reaches CD-2 rather than create an integrated master schedule that includes all project efforts. NNSA stated that, because the subprojects are minimally interdependent, there is little value to be gained by developing an integrated master schedule for the entire

project. NNSA also stated that the subproject schedules will reflect best practices defined in our schedule guide, including representing effort beyond the near-term that is less well defined as planning packages. We are pleased that DOE plans to incorporate the scheduling best practices into the subproject schedules. However, NNSA's proposed action does not meet the criteria for an integrated master schedule because it will not result in a schedule that includes all activities needed to complete the project when NNSA approves the first schedule baseline by the end of September 2016. At that time, the project schedule will reflect work activities only through 2019. Given that the entire CMRR project schedule is anticipated to extend into the mid-2020s, we continue to believe that it is necessary for NNSA to follow the best practice of creating an integrated master schedule that reflects the entire project because it provides the transparency needed to properly manage this complex project.

Similarly, regarding our recommendation that NNSA conduct a comprehensive schedule risk analysis for the revised CMRR project, NNSA stated that, rather than conduct a risk analysis that applies to an integrated master schedule, it would conduct separate schedule risk analyses for each of the subproject schedules in accordance with our schedule guide. We are pleased that NNSA will follow best practices when conducting these analyses. Conducting individual schedule risk analyses on each subproject schedule could provide information regarding the level of confidence associated with meeting the subprojects' estimated completion dates. However, a comprehensive risk analysis performed on an integrated master schedule—a best practice—is important to identify threats and opportunities that may affect multiple subprojects and the entire CMRR project.

Regarding our recommendation that NNSA rephrase the statement of mission need and requirements for the Plutonium Modular Approach to be independent of a particular solution, NNSA stated that it concurs with the recommendation. However, NNSA stated that it believes the conclusions articulated in our report that the agency has preselected an alternative for the Plutonium Modular Approach are incorrect and that it initiated the analysis of alternatives process in May 2016, which was always intended to be independent of a particular solution. We are encouraged by NNSA's statement that it intends to conduct the analysis of alternatives independent of a particular solution. However, we do not believe that NNSA's actions are responsive to this recommendation because these actions do not include rephrasing the mission need statement and requirements. Since the mission need statement provides the foundation on which the analysis of alternatives process is based, we

believe that continuing to define the mission need in terms of a specific solution—constructing high-hazard, high-security laboratory space—creates a potential bias against other potentially viable alternatives.

Regarding our recommendation that NNSA identify key performance parameters and program-specific requirements before conducting the analysis of alternatives for the Plutonium Modular Approach, NNSA stated in its written comments that it plans to develop initial key performance parameters, consistent with applicable DOE policy, after it completes the analysis of alternatives. The applicable policy, however, is NNSA's. Under NNSA policy, NNSA is directed to define these parameters prior to approving the mission need at CD-0 rather than after the agency completes the analysis of alternatives, as NNSA is proposing to do. Therefore, we continue to believe that NNSA should identify these parameters before completing the analysis of alternatives that they have already begun.

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, this 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 significant contributions to the report are listed in appendix V.

David C. Trimble
Director, Natural Resources and Environment

Appendix I: Objectives, Scope, and Methodology

In this report, we assessed: (1) the extent to which the National Nuclear Security Administration's (NNSA) revised Chemistry and Metallurgy Research Replacement (CMRR) project is expected to meet NNSA and other Department of Energy (DOE) programs' plutonium analysis needs at Los Alamos National Laboratory; (2) the extent to which the Plutonium Modular Approach is expected to meet plutonium analysis needs at Los Alamos; (3) how the revised CMRR project's scope and cost compare with those of the previously approved CMRR project; and (4) the extent to which the revised CMRR project's schedule and cost estimates reflect scheduling and cost estimating best practices.

To assess the extent to which NNSA's revised CMRR project is expected to meet NNSA and DOE programs' plutonium analysis needs, we first identified the plutonium analysis equipment, space for that equipment, and the analysis capacity that the project is expected to provide. This information was contained in a set of documents that NNSA and its management and operating contractor at Los Alamos developed to support the revised project's most recent critical decision (CD) milestone in August 2014, CD-1, including the mission need statement and program requirements document. We also reviewed documents that NNSA and its management and operating contractor at Los Alamos created after the revised CMRR project's CD-1 approval, including analyses that estimated the project's plutonium analysis capacity. We reviewed the revised CMRR project's mission need statement and program requirements document in light of DOE's project management directive Order 413.3B and accompanying DOE guidance and NNSA's business operating procedure for program requirements documents, as appropriate. We interviewed officials from the CMRR project sponsor, NNSA's Office of Defense Programs' Office of Major Modernization Programs, and other project stakeholders, including NNSA's Office of Acquisition and Project Management, DOE's Office of Project Management Oversight and Assessments, and DOE's Office of Enterprise Assessments, about the revised CMRR project. We also interviewed Los Alamos contractor representatives involved with the revised CMRR project during a visit to the Los Alamos site in August 2015 and later by telephone. We then reviewed documentation of NNSA and DOE programs' planned plutonium analysis needs at Los Alamos, as summarized in planning documents created by the Los Alamos contractor and as contained in the CD-1 documentation. We discussed the information in these documents with officials from NNSA's Offices of Defense Programs and other relevant program offices, including the NNSA Office of Defense Nuclear Nonproliferation's Advanced Recovery and Integrated Extraction System (ARIES) and the DOE Office of Nuclear Energy's Office of Space and

Defense Power Systems. We selected these program offices because after the Office of Defense Programs, they conduct the most plutonium analysis at Los Alamos.

To determine the extent to which NNSA's Plutonium Modular Approach is expected to meet plutonium analysis needs, we reviewed documentation supporting DOE's November 2015 approval of the mission need (CD-0), including the mission need statement and program requirements document. We reviewed the mission need statement in light of DOE Order 413.3B and accompanying DOE guidance. We interviewed NNSA officials with the Office of Defense Programs' Office of Major Modernization Programs—the Plutonium Modular Approach sponsor—and other stakeholders, including NNSA's Office of Acquisition and Project Management and DOE's Office of Project Management Oversight and Assessments. We also interviewed Los Alamos contractor representatives during our August 2015 site visit and officials with the Office of Space and Defense Power Systems and ARIES to discuss their involvement with the project.

To assess how the cost and scope of NNSA's revised CMRR project compare with those of the previously approved CMRR project, which included the construction of a nuclear facility, we reviewed the revised project's CD-1 documentation and noted instances where the revised CMRR project CD-1 documentation discussed the difference between the cost estimates for the previously approved project and the revised project, including in the CD-1 approval memo signed by the Deputy Secretary of Energy and in a slide presentation that NNSA provided to a DOE acquisition advisory board. Regarding the projects' scopes of work, we also reviewed the revised project's CD-1 documentation and noted instances where it discussed the scope that NNSA planned to include in the previously approved project but that the agency eliminated from the revised project. We also reviewed an analysis conducted by the Department of Defense's Office of Cost Assessment and Program Evaluation that included a comparison of the scope of the CMRR nuclear facility with the scope of the two subprojects that make up the revised CMRR project and the Plutonium Modular Approach, and we interviewed officials from this office about their analysis.

To assess the extent to which the revised CMRR project schedule and cost estimates reflect scheduling and cost-estimating best practices, we compared the schedule and cost estimates with best practices. Specifically, for our assessment of the revised CMRR project schedule estimate, we used the criteria in the May 2012 *GAO Schedule*

Assessment Guide (schedule guide).[1] The schedule guide identifies 10 best practices associated with effective scheduling: (1) capturing all activities, (2) sequencing all activities, (3) assigning resources to all activities, (4) establishing the duration of all activities, (5) verifying that the schedule can be traced horizontally and vertically, (6) confirming that the critical path is valid, (7) ensuring total reasonable float, (8) conducting a schedule risk analysis, (9) updating the schedule using actual progress and logic, and (10) maintaining a baseline schedule. We assessed an August 2015 version of the revised CMRR project schedule that NNSA's contractor at Los Alamos had updated since the project's August 2014 CD-1 approval. We did not assess the August 2014 project schedule estimate that NNSA developed to support CD-1 approval, because the agency did not provide us with an electronic copy of the CD-1 schedule, which was necessary to conduct our analysis. NNSA provided the August 2015 project schedule to us in two parts, one for each of the two subprojects that make up the revised CMRR project. We assessed each subproject's schedule estimate against the criteria in our schedule guide and then combined the scores to create the overall schedule assessment. For our assessment of the revised CMRR project cost estimate, we used the criteria in the *GAO Cost Estimating and Assessment Guide* (cost guide).[2] The cost guide identifies best practices for the development of reliable cost estimates and summarizes these best practices into four characteristics of high-quality cost estimating—comprehensive, well documented, accurate, and credible. We reviewed the revised CMRR project cost estimate that NNSA prepared to support the CD-1 approval in August 2014 and assessed the extent to which it exhibited the characteristics of high-quality cost estimating and the associated best practices. We also reviewed the project's CD-1 documentation that supported the cost estimate. For the schedule and cost assessments, we interviewed members of the CMRR project team, which consisted of

[1]GAO, *GAO Schedule Assessment Guide: Best Practices for Project Schedules,* GAO-12-120G (Washington, D.C.: May 2012). In December 2015, we issued an updated version of the schedule guide but did not use it as criteria for this engagement because it had not been finalized when we began our review of the revised CMRR project schedule estimate. See GAO, *Schedule Assessment Guide: Best Practices for Project Schedules,* GAO-16-89G (Washington, D.C.: December 2015). We first published criteria for assessing the reliability of schedules in our 2009 cost guide.

[2]GAO, *GAO Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Capital Program Costs*, GAO-09-3SP (Washington, D.C.: March 2009).

NNSA officials and Los Alamos contractor representatives who helped develop and maintain the estimates, to determine the policies and procedures the project team had followed to develop the estimates. We also interviewed officials with DOE's Office of Project Management Oversight and Assessments to understand the department's schedule and cost estimating policies and guidance, and we reviewed those policies and guidance. After conducting our initial assessments of the schedule and cost estimates, we shared our draft analyses with NNSA officials and contractor representatives and obtained comments and additional information, which we then incorporated as appropriate. We did not assess the schedule or cost estimates for the Plutonium Modular Approach because NNSA had not approved the estimates when we started our review.

We conducted this performance audit from May 2015 to August 2016 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.

Appendix II: Assessment of NNSA's Schedule Estimate for the Revised Chemistry and Metallurgy Research Replacement Project

When the National Nuclear Security Administration (NNSA) approved critical decision (CD) 1 (select alternative) for the revised Chemistry and Metallurgy Research Replacement (CMRR) project at Los Alamos National Laboratory in New Mexico in August 2014, the project's future work was organized under two subprojects. The first subproject, Radiological Laboratory Utility Office Building Equipment Installation Phase 2, involved installing plutonium analysis equipment in the radiological laboratory. The second subproject, Plutonium Facility 4 Equipment Installation, involved installing new plutonium analysis equipment in Plutonium Facility 4, the only high-hazard, high-security, fully operational plutonium facility in the country for producing plutonium pits,[1] after removing contaminated equipment in space no longer in use. For our assessment of the revised CMRR project schedule, we used the criteria in the *GAO Schedule Assessment Guide* (schedule guide), which identifies 10 best practices associated with effective scheduling.[2] We assessed an August 2015 version of the revised CMRR project schedule that NNSA's contractor at Los Alamos had updated since the project's approval in August 2014. We did not assess the project schedule estimate that NNSA developed to support the August 2014 CD-1 approval because the agency did not provide us with an electronic copy of that schedule. NNSA provided the August 2015 project schedule to us in two parts, one for each of the subprojects. We assessed each subproject's schedule estimate against the criteria in our schedule guide and then combined the scores to create the overall schedule assessment. Table 2 presents our assessment, including a narrative summary of the subprojects' schedule estimates and overall scores in terms of the 10 best practices.

[1]A "pit" is the central core of a nuclear weapon that is commonly produced using plutonium, a man-made radioactive element produced by irradiating uranium in nuclear reactors.

[2]GAO, *GAO Schedule Assessment Guide: Best Practices for Project Schedules,* GAO-12-120G (Washington, D.C.: May 2012).

Table 2: GAO's Assessment of the National Nuclear Security Administration's (NNSA) August 2015 Schedule Estimate for the Revised Chemistry and Metallurgy Research Replacement (CMRR) Project

		Detailed assessment by best practice	
Best practice	**Overall assessment**	**Radiological Laboratory Utility Office Building Equipment Installation Phase 2 subproject**	**Plutonium Facility 4 Equipment Installation subproject**
Capturing all activities	Partially met	*Partially met.* The schedule includes an extensive, well-developed work breakdown structure that is mapped to a detailed dictionary, ensuring that all necessary work is captured in the schedule. However, the schedule contains government and contractor work only through development of the critical decision (CD)-2/3A package. Work activities beyond 2017 are not included, although the subproject completion date is in 2019; thus, it is unclear how dates beyond 2017 are planned to or agreed upon by management.	*Partially met.* The schedule includes an extensive, well-developed work breakdown structure that is mapped to a detailed dictionary, ensuring that all necessary work is captured in the schedule. However, the schedule contains government and contractor work only through development of the CD-2/3A package. Work activities beyond 2017 are not included, although the subproject completion date is in 2024; thus, it is unclear how dates beyond 2017 are planned to or agreed upon by management.
Sequencing all activities	Substantially met	*Substantially met.* The logic and sequencing of activities are substantially complete for remaining activities, but the use of date constraints should be re-evaluated and necessary constraints should be documented and justified.	*Substantially met.* The logic and sequencing of activities are substantially complete for remaining activities, but the use of date constraints should be re-evaluated and necessary constraints should be documented and justified.
Assigning resources to all activities	Substantially met	*Partially met.* Costs are included in the schedule and some effort was made to assign resources to activities. However, we found that the majority of activities (89 percent) had no costs or resources assigned. In addition, we could not find evidence that the schedule is used to resolve resource conflicts.	*Substantially met.* Costs are included in the schedule and the majority of activities have assigned resources. However, we could find no evidence that the schedule is used to resolve resource conflicts.
Establishing the duration of all activities	Fully met	*Fully met.* Some activities have long durations, but the level of detail is appropriate given the agency's use of a planning approach that allows for the use of high-level planning packages for long-term activities that are better defined as the project progresses.	*Fully met.* Some activities have long durations, but the level of detail is appropriate given the agency's use of a planning approach that allows for the use of high-level planning packages for long-term activities that are better defined as the project progresses.
Verifying that the schedule is traceable horizontally and vertically	Substantially met	*Substantially met.* Vertical traceability is established by a well-developed work breakdown structure and traceability to dates reported in management documents; horizontal traceability can be affirmed through a substantially complete network of logic.	*Substantially met.* Vertical traceability is established by a well-developed work breakdown structure and general traceability to dates reported in management documents; horizontal traceability can be affirmed through a substantially complete network of logic.

		Detailed assessment by best practice	
Best practice	**Overall assessment**	**Radiological Laboratory Utility Office Building Equipment Installation Phase 2 subproject**	**Plutonium Facility 4 Equipment Installation subproject**
Confirming that the critical path is valid	Partially met	*Partially met.* The validity of the critical path is questionable because of date constraints and discontinuity between critical activities through 2017. A critical path should exist for the entire project because detailed activities, as well as long-term planning packages, must be logically linked within the schedule to create a complete picture of the project from start to finish. In addition, level-of-effort activities—scheduled activities that represent effort that cannot be associated with a defined deliverable—appear as critical. A critical path cannot include level-of-effort activities because, by their very nature, they do not represent discrete effort.	*Partially met.* Long-duration activities obscure the critical path in some places. Among other things, long-duration activities on the critical path should be reevaluated to determine if they can be broken down into more manageable pieces.
Ensuring reasonable total float	Partially met	*Partially met.* Our analysis concluded that the schedule exhibits an unreasonable amount of flexibility, with more than half of all planned activities able to slip more than 100 working days before affecting key milestone dates.	*Partially met.* Our analysis concluded that the schedule exhibits an unreasonable amount of flexibility, with an average total float value of 131 working days, with half of all remaining activities able to slip 84 working days before affecting key milestone dates.
Conducting a schedule risk analysis	Minimally met	*Minimally met.* A schedule risk analysis was not performed for the CD-1 schedule estimate.	*Minimally met.* A schedule risk analysis was not performed for the CD-1 schedule estimate.
Updating the schedule with actual progress and logic	Substantially met	*Substantially met.* There are no date anomalies in the schedule—such as planned dates in the past or actual dates in the future—and updates are governed by a documented process.	*Substantially met.* There are no date anomalies in the schedule—such as planned dates in the past or actual dates in the future—and updates are governed by a documented process.
Maintaining a baseline schedule	Partially met	*Partially met.* Project officials stated that there is no established baseline because the project has not yet reached CD-2. However, while not formally baselined, the project is measured against a target schedule.	*Partially met.* Project officials stated that there is no established baseline because the project has not yet reached CD-2. However, while not formally baselined, the project is measured against a target schedule.

Source: GAO analysis of NNSA data. | GAO-16-585

Notes: The ratings we used in this analysis are as follows: "Not met" means NNSA provided no evidence that satisfies any of a best practice. "Minimally met" means NNSA provided evidence that satisfies a small portion of a best practice. "Partially met" means NNSA provided evidence that satisfies about half of a best practice. "Substantially met" means NNSA provided evidence that satisfies a large portion of a best practice. "Fully met" means NNSA provided complete evidence that satisfies an entire best practice.

Appendix III: Assessment of NNSA's Cost Estimate for the Revised Chemistry and Metallurgy Research Replacement Project

The *GAO Cost Estimating and Assessment Guide* (cost guide) identifies best practices for the development of reliable cost estimates.[1] The cost guide identifies the following four characteristics of a high-quality, reliable cost estimate: comprehensive, well documented, accurate, and credible. Using the criteria in our cost guide, we assessed the extent to which the National Nuclear Security Administration's (NNSA) August 2014 cost estimate for both subprojects of the revised Chemistry and Metallurgy Research Replacement (CMRR) project exhibited the characteristics of high-quality cost estimating and the related best practices. NNSA created the cost estimate in June 2014 to support the revised CMRR project's August 2014 critical decision (CD) 1 (select alternative). Table 3 shows scores for both the characteristics and the best practices, including a narrative summary of our findings for each best practice.

Table 3: GAO's Assessment of the National Nuclear Security Administration's (NNSA) August 2014 Cost Estimate for the Revised Chemistry and Metallurgy Research Replacement (CMRR) Project

Characteristic	Overall assessment	Related best practice	Detailed assessment by best practice
Comprehensive	Substantially met	Estimate includes all life cycle costs.	*Partially met.* The detailed cost estimate covers the period until construction is complete but does not appear to include federal project management costs, operating costs, or decommissioning costs. The project team reports some of these costs, such as life-cycle costs and federal project costs, at a high-level, but the documentation does not provide sufficient information to determine whether these high-level estimates are reasonable.
		Cost estimate completely defines the program, reflects the current schedule, and is technically reasonable.	*Fully met.* Pre-conceptual and conceptual design documents serve as the technical baseline for the project and appear to have informed the cost estimate.
		Estimate work breakdown structure is product-oriented, traceable to the statement of work/objective, and at an appropriate level of detail to ensure that cost elements are neither omitted nor double-counted.	*Partially met.* Some cost elements do not have unique names, and some cost elements of non-zero duration have costs of zero.

[1]GAO, *GAO Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Capital Program Costs*, GAO-09-3SP (Washington, D.C.: March 2009).

Characteristic	Overall assessment	Related best practice	Detailed assessment by best practice
		Estimate documents all cost-influencing ground rules and assumptions.	*Fully met.* The estimate relies on referenced sources for labor rates and non-manual services and draws on historical and referenced data for sub-contractor pricing as well as escalation rates provided by the Los Alamos National Laboratory's Chief Financial Officer. In addition, each subproject has its own set of assumptions and was independently estimated.
Well documented	Substantially met	Documentation captures the source data used, the reliability of the data, and how the data were normalized.	*Partially met.* The estimate relies on historical data that were not provided for review. As a result, it is not possible to determine the exact sources of the data or whether the data were properly normalized.
		Documentation describes in sufficient detail the calculations performed and the estimating methodology used to derive each element's cost.	*Fully met.* The project team developed the cost estimate using the build-up method, whereby the cost of equipment is added to the sum of labor hours multiplied by the hourly rates for labor. The project team reported that the estimate was based on pre-conceptual layout, including necessary equipment and utilities, and cost examples from prior, related work. Because of the similarities between this project and prior work, the project team's use of the build-up method appears to be appropriate.
		Documentation describes step-by-step how the estimate was developed so that an analyst unfamiliar with the program could understand what was done and replicate it.	*Partially met.* It is not clear if the current estimate can be used to support future estimates because supporting data were not included with the cost estimate.
		Documentation discusses the technical baseline description and data in the baseline are consistent with the estimate.	*Partially met.* The CD-1 documentation explains the history of the development of the cost estimate for the project, but the cost estimate does not appear to depend on the technical baseline.
		Documentation provides evidence that the cost estimate was reviewed and accepted by management.	*Substantially met.* The documentation does not include a briefing provided to management with a clear explanation of the project's cost estimate. However, the project team did provide evidence of management approvals of CD-1 documents that include a high-level summary of the project's cost estimate.
Accurate	Partially met	Estimate results are not overly conservative or optimistic and are based on an assessment of most likely costs.	*Partially met.* The project team applied percentages to the point estimate to generate the project's cost range. The percentages the project team used represent the high end of the cost range allowed under Department of Energy (DOE) guidance. Given the nature of the project, assigning the high end of the cost range appears overly conservative.

Characteristic	Overall assessment	Related best practice	Detailed assessment by best practice
		Estimate has been properly adjusted for inflation.	*Fully met.* The cost estimate is based on guidance and escalation rates provided by the Los Alamos National Laboratory's Chief Financial Officer.
		Estimate contains few, if any, minor mistakes.	*Fully met.* Spot checks of the cost estimate did not reveal any arithmetic errors.
		Estimate is regularly updated to reflect significant changes in the program so as to always reflect current status.	*Minimally met.* The project team is receiving and reviewing earned value management system data, but these data are not reliable because DOE withdrew certification for the Los Alamos National Laboratory's earned value management system in November 2014. As a result, the estimate cannot be updated with reliable actual cost data.
		Variances between planned and actual costs are documented, explained, and reviewed.	*Minimally met.* The project team uses a tracking system to track and report the project's progress, including cost and schedule variances as well as estimated and budgeted costs at completion. However, these data are not reliable because DOE withdrew certification for the Los Alamos National Laboratory's earned value management system in November 2014. As a result, the estimate cannot be updated with reliable actual cost data.
		Estimate is based on a historical record of cost estimating and actual experiences from other comparable programs.	*Partially met.* Construction data are based, in part, on guidance from the Los Alamos National Laboratory as well as sub-contractor pricing information. However, the cost estimate does not show how the sub-contractor arrived at the estimated cost for some items or whether these costs were validated. In addition, according to the cost estimate, earned value management oversight is one of the roles of management, but the cost estimate does not discuss the earned value management in any detail.
		Estimating technique for each cost element was used appropriately.	*Partially met*. This is a construction estimate and the build-up method appears to be appropriate for a construction project. However, this is a Class 5 estimate, according to DOE guidance, with considerable uncertainty (-50% to +100%). For this reason, it may be premature to use the build-up method.
Credible	Partially met	Estimate includes a sensitivity analysis that identifies a range of possible costs based on varying major assumptions, parameters, and data inputs.	*Not met.* The documentation does not include a sensitivity analysis. Instead, there is a risk assessment report that includes the identification of risks and associated potential costs. However, the risk assessment report does not include a range of possible costs based on varying major assumptions, parameters, and data inputs.

Characteristic	Overall assessment	Related best practice	Detailed assessment by best practice
		Estimate includes a risk and uncertainty analysis that quantifies imperfectly understood risks and identifies the effects of changing key cost driver assumptions and factors.	*Fully met.* The project team created a risk assessment report that includes best case, most likely, and worst case estimates for selected cost drivers and top risks. The project team also created risk mitigation strategies for specific risks.
		Major cost elements were cross checked to see whether results were similar.	*Not met.* There is no evidence that major cost elements were cross checked to see if results are similar.
		An independent cost estimate was conducted by a group outside the acquiring organization to determine whether other estimating methods produce similar results.	*Partially met.* An independent cost estimate was not conducted. Instead, DOE conducted an independent cost review—a less rigorous type of assessment—that included recommendations for improving the cost estimate. The documentation showed where the review group's cost estimate differed from the project's cost estimate.

Source: GAO analysis of NNSA data. | GAO-16-585

Notes: The ratings we used in this analysis are as follows: "Not met" means NNSA provided no evidence that satisfies any of a characteristic. "Minimally met" means NNSA provided evidence that satisfies a small portion of a characteristic. "Partially met" means NNSA provided evidence that satisfies about half of a characteristic. "Substantially met" means NNSA provided evidence that satisfies a large portion of a characteristic. "Fully met" means NNSA provided complete evidence that satisfies an entire characteristic.

Appendix IV: Comments from the National Nuclear Security Administration

Department of Energy
Under Secretary for Nuclear Security
Administrator, National Nuclear Security Administration
Washington, DC 20585

July 8, 2016

Mr. David C. Trimble
Director, National Resources
and Environment
U.S. Government Accountability Office
Washington, DC 20548

Dear Mr. Trimble:

Thank you for the opportunity to review the Government Accountability Office (GAO) draft report "DOE Project Management: NNSA Needs to Clarify Requirements for Its Plutonium Analysis Project at Los Alamos" (GAO-16-585). We appreciate GAO's recognition of the positive actions the National Nuclear Security Administration (NNSA) has taken to maintain plutonium analytical capabilities at Los Alamos. The report, however, substantially misinterprets the relationship between the Chemistry and Metallurgy Research Replacement (CMRR) project and plutonium pit production. Moreover, it does not reflect the depth and breadth of steps NNSA has taken in the last two years to improve project management in accordance with the Secretary of Energy's new policies.

The CMRR project provides analytical chemistry (AC) and materials characterization (MC) capabilities to support Defense Programs' expected plutonium program needs for at least the next decade. The report incorrectly infers the driver for the CMRR project and the project's ultimate success are dependent upon meeting plutonium pit production needs. The goal of the project is to replace specific capabilities of the Chemistry and Metallurgy Research building (CMR), and it is not driven by specific pit production requirements. Similarly, while equipment provided under CMRR may be made available to other users when needed, it is not the intent of the project to define needs for and specifically provide AC and MC equipment to support missions outside of Defense Programs' needs.

The report also highlights several program and project management areas including establishing key performance parameters, analysis of alternatives, and integrated schedules. Many new requirements and practices have been introduced in the past year, and since the inception of CMRR, to help ensure that NNSA accomplishes its mission objectives in the most efficient manner. An updated version of Department of Energy Order 413.3B was, for example, just issued in May 2016, which addresses many of the topics covered in the draft report, including the need to develop and maintain an Integrated Master Schedule that is consistent with the GAO's December 2015 Schedule Assessment Guide and to conduct an analysis of alternatives that is consistent with GAO-15-37. As is the

case with any improvement program, implementation of these new requirements will not occur instantly and there will be cases were it does not make economic sense to redo already completed work to bring it into 100 percent compliance with the new approaches. Understanding these key points provides greater insight into our response to GAO's recommendations.

The report provides seven recommendations with the objectives of: a) helping to ensure adequate analytical capabilities are maintained to meet mission needs; b) providing clear information to stakeholders regarding program needs the CMRR project will satisfy; c) ensuring schedule estimates for the revised CMRR project are reasonable; d) ensuring objective consideration of alternatives for the Plutonium Modular Approach (PMA); and e) providing adequate information to support the analysis of alternatives for PMA. The enclosure to this letter outlines the actions taken and/or planned to address each recommendation. Where deemed appropriate, we have identified alternate actions to address recommendations. In all cases, we believe the proposed actions to be responsive to the objectives noted above, and the underlying intent of the original recommendations. We consider recommendations six and seven closed based on the actions reported.

Technical comments have been provided separately for your consideration to enhance the clarity and factual accuracy of the report. If you have any questions, regarding this response, please contact Dean Childs, Director, Audit Coordination and Internal Affairs, at (301) 903-1341.

Sincerely,

Frank G. Klotz

Enclosure

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NATIONAL NUCLEAR SECURITY ADMINSITRATION (NNSA)

Response to Report Recommendations
DOE PROJECT MANAGEMENT: NNSA Needs to Clarify Requirements for Its Plutonium Analysis Project at Los Alamos" (GAO-16-585)

The Government Accountability Office (GAO) recommends NNSA:

Recommendation 1: Update the program requirements document (PRD) for the revised CMRR project to identify a key performance parameter (KPP) that describes the plutonium analysis capacity the CMRR project is required to provide to support specific pit production rates.

Management Response: NNSA agrees it is important to understand how the Chemistry and Metallurgy Research Replacement (CMRR) project will support NNSA's overall Plutonium Strategy, including pit fabrication and other NNSA programs. NNSA does not agree that establishing a Key Performance Parameter (KPP) for the revised CMRR related to analysis to support a specific pit production rate is appropriate. Specifically, the purpose of the CMRR project is to maintain analysis capabilities and support the overall Plutonium Strategy. The CMRR project is designed to provide the analytical chemistry and materials characterization capabilities to support all plutonium mission work at Los Alamos, including planned pit production requirements consistent with recent National Defense Authorization Act (NDAA) language. Incorporating a KPP associated with pit production for the CMRR project would require the project to rely on factors beyond its control to ensure it can meet KPPs before achieving Critical Decision (CD)-4, despite the project executing planned scope. The Department is developing additional guidance to clarify the relationship between CD-4 and transition to operations.

To provide greater insight into the project's anticipated impact on the plutonium strategy, NNSA will perform an analysis to estimate the expected analytical throughput and relate that value to a notional pit-fabrication capacity range. Reference to this analysis will be included in the next revision to the CMRR PRD. The estimated completion date for this activity is September 30, 2017.

Recommendation 2: Specify plans for how the agency will obtain additional plutonium analysis capacity if the revised CMRR project will not provide sufficient plutonium analysis capacity to support NNSA's pit production plans.

Management Response: The CMRR project is designed to provide the analytical chemistry and materials characterization capabilities to support all plutonium mission work at Los Alamos, including planned pit production requirements consistent with recent National Defense Authorization Act (NDAA) language. NNSA will update its Plutonium Strategy to include estimates of the

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requirements and additional means, if needed, to achieve the required capacity. This action will be completed by September 30, 2017, concurrent with the analysis referred to in the response to Recommendation 1.

Recommendation 3: Update the requirements document for the revised CMRR project to clarify whether the project will provide plutonium analysis equipment to meet the needs of DOE and NNSA programs other than those in the Office of Defense Programs.

Management Response: NNSA will update the PRD to clarify that the CMRR project will not install any unique analysis equipment required solely for non-defense-related programs. The estimated completion date for this activity is by December 31, 2017, or the next planned revision of the PRD.

Recommendation 4: Develop future schedules for the revised CMRR project that are consistent with current DOE project management policy and scheduling best practices. Specifically, develop and maintain an integrated master schedule that includes all project activities under all subprojects prior to approving the project's first CD-2 decision.

Management Response: NNSA has identified the key milestone dates for the future subprojects including critical decisions and completion. Each subproject has been scoped as a standalone effort with minimum interdependencies between individual subprojects. Because of this lack of interdependency, schedule perturbations on an early subproject will normally not impact follow-on subprojects, and there is little value to be gained from delaying work while an overall program level integrated master schedule is developed as suggested in the GAO's December 2015 *Schedule Assessment Guide*. Integrated master schedules will, however, be created and maintained for each subproject prior to reaching Critical Decision 2.

These integrated master schedules will be developed using the rolling wave approach specified in the GAO's *Schedule Assessment Guide* with the degree of detail at any point in time being commensurate with the information that is available. Effort beyond the near term that is less well defined will be represented as planning packages, also as specified in the GAO's *Schedule Assessment Guide*. The estimated completion date for these activities is at the baselining of each CMRR subproject (CD-2/3), which will occur by the end of September 30, 2016, for REI-2 and PEI-1.

Recommendation 5: Develop future schedules for the revised CMRR project that are consistent with current DOE project management policy and scheduling best practices. Specifically, conduct a comprehensive schedule risk analysis that

applies to the integrated master schedule to identify the likelihood the project can meet is completion dates.

Management Response: Schedule risk analyses will be conducted when constructing future baseline schedules for the revised CMRR subprojects in keeping with Chapter 8 of the GAO *Schedule Assessment Guide*. These schedule risk analyses will account for both risk and uncertainty. They will be used to determine both the subprojects' and the overall project's completion dates. The estimated completion date for these analyses is September 30, 2016, concurrent with the subproject baselining schedule described in the response to Recommendation 4.

Recommendation 6: Before completing the analysis of alternatives, rephrase the statement of mission need and requirements for the Plutonium Modular Approach so that they are independent of a particular solution.

Management Response: Consistent with the Secretary's December 2014 *Improving the Department's Management of Projects* policy and June 2015 *Project Management Policies and Principles* memo, we concur with GAO's recommendation to ensure objective consideration of all alternatives, without preference for a particular solution, as we proceed with our analysis of alternatives process. However, we believe the conclusions articulated in the report that NNSA has pre-selected an alternative for the Plutonium Modular Approach are incorrect. In May 2016, NNSA initiated the PMA analysis of alternatives (AoA), which was always intended to be independent of a particular solution. NNSA considers this recommendation closed.

Recommendation 7: Before completing the analysis of alternatives, identify key performance parameters and program-specific requirements for the Plutonium Modular Approach.

Management Response: The AoA process establishes and validates requirements as an inherent part of the process. NNSA will develop initial KPPs consistent with applicable DOE policy, after the AoA has been completed. As this is an established process, NNSA considers this recommendation closed.

Appendix V: GAO Contact and Staff Acknowledgments

GAO Contact

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Staff Acknowledgments

In addition to the individual named above, Dan Feehan (Assistant Director), Andrew Berglund, Antoinette Capaccio, John Delicath, Jennifer Echard, Emile Ettedgui, Keith Hornbacher, Jason Lee, Leslie Kaas Pollock, Sara Sullivan, and Kiki Theodoropoulos made significant contributions to this report.