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September 2013

MODERNIZING THE NUCLEAR SECURITY ENTERPRISE

Observations on NNSA's Options for Meeting Its Plutonium Research Needs

GAO-13-533

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GAO Highlights

Highlights of GAO-13-533, a report to the Armed Services Committee, U.S. Senate

Why GAO Did This Study

Nuclear weapons are an essential part of the nation's defense strategy. NNSA manages the nation's nuclear weapons stockpile and carries out research to help extend the life of existing weapons. The core of a nuclear weapon requires plutonium—a man-made radioactive element—to create a nuclear explosion. NNSA's LANL in New Mexico houses key plutonium facilities needed for research for nuclear weapons life extension programs and other missions. In 2005, NNSA approved construction of CMRR to replace the aging facility being used. In February 2012, NNSA announced it had decided to defer CMRR nuclear facility construction for at least 5 years, creating a potential gap in plutonium research capabilities from 2019 to the late-2020s. NNSA requested LANL to study options to address this gap. The study was completed in April 2012.

The Senate Armed Services Committee Report accompanying the 2013 defense authorization directed GAO to review the study. GAO examined (1) the options identified in the study for meeting NNSA's plutonium research needs, including costs and health risks, if any and (2) the potential impacts of those options on NNSA's plutonium research for the nuclear weapons stockpile and other plutonium research missions.

What GAO Recommends

GAO is recommending that NNSA continue efforts to assess how plutonium research and capability needs and stockpile requirements have changed, if at all since 2008, and develop a plan for both near- and longer-term needs. NNSA agreed with the recommendation.

View GAO-13-533. For more information, contact David Trimble at (202) 512-3841 or trimbled@gao.gov

What GAO Found

The National Nuclear Security Administration's (NNSA) Los Alamos National Laboratory's (LANL) April 2012 study (1) identified general options for meeting the plutonium research needs of NNSA—a separately organized agency within the Department of Energy (DOE)—during the several-year gap created by the deferral of the Chemistry and Metallurgy Research Replacement (CMRR) nuclear facility and (2) included limited information on costs and health risks. The study noted that the level of plutonium research necessary to support the nuclear weapons life extension programs is affected by the planned schedule of the life extension programs, the number of pits that will be needed under the programs, and the number of pits that will need to be manufactured versus re-used, all of which have uncertainties. According to the April 2012 study, one option for meeting NNSA's plutonium research needs is to relocate analytical chemistry and materials characterization capabilities among facilities at LANL, which will require upgrades costing roughly $480 million to $820 million. A second option is to move capabilities to existing facilities at other sites. The study concluded that no single site could provide all the capabilities that might be needed, but that the facilities could be renovated to meet the needs. The study did not include costs for relocating capabilities to other sites. A third option is a combination of these two. The study also indicated some potential health risks to workers from increased plutonium handling if samples need to be transported to other sites. As of July 2013, NNSA officials stated that an option had not yet been selected for meeting plutonium research needs from 2019 through the late-2020s, and no decisions have been made on facilities to address longer-term plutonium research needs. To address its ongoing, longer-term plutonium research needs, NNSA stated it is now considering a modular facility.

The potential impacts of the options identified in LANL's study on NNSA's plutonium research for the nuclear weapons stockpile and other plutonium mission areas are uncertain. If NNSA uses space only at LANL, rather than relocating some capabilities to facilities at other sites, some LANL plutonium research missions could potentially be impacted because space may have to be reconfigured to accommodate nuclear weapons stockpile mission needs. NNSA has tasked LANL with assessing building space to see if it can be repurposed to better support plutonium research. In addition, the study noted that one potential impact of using facilities at other sites could be delays in completing needed analytical chemistry or materials characterization due to time needed to transport samples between sites. Using facilities at other sites will require time for NNSA to plan for and transport materials between LANL and other sites, which could increase the total time needed to complete the analyses for weapon pits. The study also noted that the shortage of trained staff in analytical chemistry could impact the ability to execute the options, which could affect NNSA's ability to meet proposed schedules for the refurbishment of nuclear weapons. The study reported that the analytical chemistry staff at LANL has been reduced by 60 percent in the span of a few years due to retirements and budget cuts. The contractor at LANL recommended that NNSA conduct a detailed risk analysis on staffing needs to better understand and plan for staffing limitations, according to the study.

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Abbreviations

ARIES	Advanced Recovery and Integrated Extraction System
CMR	Chemistry and Metallurgy Research
CMRR	Chemistry and Metallurgy Research Replacement
DOD	Department of Defense
DOE	Department of Energy
LANL	Los Alamos National Laboratory
M&O	management and operating
NNSA	National Nuclear Security Administration
PF-4	Plutonium Facility 4

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September 11, 2013

The Honorable Carl Levin
Chairman
The Honorable James M. Inhofe
Ranking Member
Committee on Armed Services
United States Senate

Nuclear weapons are an essential part of the national defense strategy. Plutonium—a man-made radioactive element produced by irradiating uranium in nuclear reactors—is vital to the nation's nuclear weapons. Plutonium is used in "pits"—the central core of a nuclear weapon that is compressed with high explosives to create a nuclear explosion. During the Cold War, the United States manufactured thousands of pits each year to maintain its stockpile of nuclear weapons. With the end of the Cold War in the early 1990s, the nation began to shift from designing, testing, and producing new nuclear weapons to a strategy of maintaining the existing nuclear weapons stockpile through surveillance and life extension programs.[1] Life extension programs are intended to lengthen the lives of existing nuclear weapons by 20 to 30 years by repairing or replacing nuclear weapons components as needed.

The National Nuclear Security Administration (NNSA), a separately organized agency within the Department of Energy (DOE), is responsible for the management of the nation's nuclear weapons.[2] This central mission is referred to as the Stockpile Stewardship Program. Specifically, under this program, NNSA annually assesses the stockpile and (1) determines which components, including the pit, will need refurbishment to extend each weapon's life; (2) designs and produces the necessary

[1]The number of nuclear weapons in the nation's stockpile has been decreasing since the end of the Cold War. The Department of Defense reported that in 1990, the nation had 21,392 nuclear weapons and by 2009 the number decreased to 5,113. In addition, under the Strategic Arms Reduction Treaty with Russia, the United States agreed to further future reductions in the stockpile.

[2]NNSA was created by the National Defense Authorization Act for Fiscal Year 2000, Pub. L. No. 106-65 (1999). It is a separate, semiautonomous agency within the Department of Energy, with responsibility for the nation's nuclear weapons, nonproliferation, and naval reactors programs.

components; (3) installs the components in the weapons; and (4) certifies that the changes do not adversely affect the safety and reliability of the weapons. NNSA uses science-based activities, such as computer simulations and laboratory analyses, to carry out this mission. The life extension programs require a coordinated effort among NNSA's three national weapons laboratories, four production facilities, and one support site—collectively known as the nation's Nuclear Security Enterprise. Each of these facilities is managed and operated by contractors, called management and operating (M&O) contractors. Of these facilities, the Los Alamos National Laboratory (LANL) in New Mexico houses most of the nation's capabilities for plutonium research in support of the nuclear weapons mission. In addition, LANL's scientists and technicians also perform research on plutonium to support other missions, such as conducting research on recycling plutonium for use as fuel in commercial nuclear reactors.

One of the key plutonium facilities at LANL is the Chemistry and Metallurgy Research facility (CMR). This facility has unique capabilities for performing analytical chemistry, material characterization, and research and development related to plutonium.[3] This includes activities that support the manufacturing, development, and surveillance of nuclear weapons pits; programs to extend the life of nuclear weapons in the stockpile; and nuclear weapon dismantlement efforts. Analytical chemistry in particular is needed to support the production of pits. The CMR was built in 1952 and is not sustainable in the long term because of its aging infrastructure and because it sits on a seismic fault line, raising concerns about the effect of earthquakes on the safety and security of plutonium used for research or stored at the facility.[4] To address these concerns, in 2005 NNSA approved construction of a new facility at LANL called the

[3]For the purposes of this report, we are using the term plutonium research to include research and development, analytical chemistry, materials characterization, and other support capabilities for plutonium manufacturing operations.

[4]LANL first assessed the currently known seismic risks in the late 1990s. At the time, DOE decided to continue operations at CMR using a safety analysis designed for nuclear facilities with limited operational lives. In order to keep operating under this safety analysis, LANL developed a strategy for minimizing risks at CMR, which included, among other things, closing several wings considered most at risk, improving safety controls, and reducing the amount of plutonium in the facility. DOE, then NNSA, has continued to operate CMR under this interim safety basis since 1998, but NNSA has committed to transferring all plutonium operations out of CMR by 2019 and then begin decommissioning activities.

Chemistry and Metallurgy Research Replacement (CMRR) nuclear facility.[5] The CMRR nuclear facility was to be built to current seismic standards and would modernize LANL's plutonium support capabilities, including research. NNSA plans to continue operations in the CMR until about 2019, when it expected to complete the transfer of operations from the CMR to existing facilities, including the planned CMRR. In March 2012, we reported that NNSA's selected design for the CMRR nuclear facility, which at 22,500 square feet of laboratory space, was too small to meet all stockpile and other plutonium-related research needs.[6]

However, it is now unclear when or if the CMRR nuclear facility will be built, which may lead to insufficient capabilities to meet LANL's plutonium research requirements. In February 2012, NNSA announced that it had decided to defer CMRR nuclear facility construction for at least 5 years. Since then, NNSA officials have announced that they are seeking alternatives to the CMRR nuclear facility that would provide the capabilities planned for the CMRR nuclear facility using existing infrastructure. NNSA officials have stated they are now reviewing concepts that could deliver incremental capability by the mid-2020s. One such concept is a modular facility that NNSA officials assert can be built in phases and will have the flexibility to support potential future changes in mission. The CMRR's estimated costs had increased 6-fold from an estimated high of $975 million in 2005 to an estimated high of $5.8 billion in 2010.[7] NNSA officials stated that their decision to defer construction of the CMRR nuclear facility was intended to free up funds for other higher priority projects, including a Uranium Processing Facility in Tennessee. According to NNSA officials, with the 5-year delay, the CMRR nuclear facility may not be completed until the late-2020s at the earliest,

[5]The CMRR included both a radiological laboratory, which could manage only small amounts of plutonium, and a nuclear facility, where the bulk of plutonium-related research was to be performed. This report focuses primarily on the nuclear facility.

[6]GAO, *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).

[7]Nominal dollars.

potentially creating a gap in the nation's plutonium research capabilities.[8] In particular, the delay in establishing new plutonium research capabilities could affect LANL's ability to manufacture pits for nuclear weapons. NNSA has estimated that it needs to be able to ramp up its capabilities to manufacture about 30 pits each year by 2021 to meet expected life extension program requirements.

In planning to avoid a potential insufficiency in plutonium research capabilities beginning in 2019 when the CMR is to cease operations, in February 2012, NNSA tasked the M&O contractor operating LANL with assessing the potential effects of deferring the construction of the CMRR nuclear facility. NNSA asked the M&O contractor to propose options for NNSA to maintain continuity in analytical chemistry and materials characterization capabilities using existing infrastructure. If the CMRR nuclear facility were to be built, it would not become operational until at least the late-2020s, assuming a 5-year delay. NNSA officials stated that if they built another facility as an alternative to the CMRR nuclear facility, it would likely take at least through the mid-2020s to plan and construct. On April 16, 2012, the contractor completed and issued LANL's study,[9] also called the 60-day study, which discusses potential capabilities at LANL and other sites that could be used to meet NNSA's plutonium research needs. In accordance with the tasking letter from NNSA, the April 2012 study did not discuss longer-term options, such as the construction of the CMRR nuclear facility or other alternatives.

In light of concerns about maintaining the nation's plutonium research capabilities for both its nuclear weapons stockpile and other plutonium research missions, the Senate Armed Services Committee Report, accompanying the National Defense Authorization Act for Fiscal Year

[8]We reported in March 2012 that the CMRR nuclear facility had initially been planned to be completed between 2013 and 2017, but that it was delayed until 2020 due to cost increases, reflecting a 3- to 7-year delay. See GAO-12-337. With the 5-year deferral, assuming no further delays, NNSA officials stated that the CMRR nuclear facility could be completed in approximately 2029, but some critics of NNSA we spoke to stated that, based on NNSA's prior project management experience, the CMRR nuclear facility likely could not have been built within NNSA's stated time frames and that further delays could be expected.

[9]Los Alamos National Laboratory, *Los Alamos Initial Response for Maintaining Capabilities with Deferral of the CMRR Nuclear Facility Project*, (Los Alamos, N.M.: Apr. 16, 2012).

2013, directed that we review LANL's April 2012 study.[10] This report examines: (1) the options for meeting NNSA's plutonium research needs identified in LANL's April 2012 study, including their costs and health risks, if any, and (2) the potential impacts of those options on NNSA's plutonium research for the nuclear weapons stockpile and other plutonium research missions.

To examine the options for meeting NNSA's plutonium research needs identified in LANL's April 2012 study, including costs and risks to health, we reviewed the April 2012 study as well as pertinent budget, planning, and analytical documents from NNSA and LANL. We interviewed NNSA officials and the M&O contractor to discuss the options and to better understand other facilities that could be used to meet plutonium research needs. We interviewed Department of Defense (DOD) officials to gain a better understanding of nuclear weapons stockpile requirements and DOD's input into the options identified in LANL's April 2012 study. We reviewed pertinent documents from the Defense Nuclear Facilities Safety Board, a statutorily-created body that reviews safety issues for certain NNSA and DOE facilities, and we interviewed board officials to discuss potential safety issues with LANL's plutonium facilities. To examine the potential impact of the options identified in LANL's April 2012 study on NNSA's plutonium research for the nuclear weapons stockpile and other mission areas, we reviewed pertinent documents from NNSA and LANL. We interviewed NNSA officials and the M&O contractor to discuss the impacts, if any, of using the facilities identified in LANL's April 2012 study. We also interviewed former DOE officials and former LANL contractor officials to understand the history of the CMRR and reviewed documents and interviewed representatives from the JASON Program Office to gather other perspectives on NNSA and its plutonium science mission.[11] Appendix I describes our objectives, scope, and methodology. We conducted this performance audit from October 2012 to September 2013 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain

[10]Senate Report 112-173 for the National Defense Authorization Act for Fiscal Year 2013 directed GAO to report by January 31, 2013. Sen. Rep. No. 112-173 at 282 (2012). The Senate Report directed us to review NNSA's proposed plutonium strategy, the options for which were initially outlined in the April 2012 study. On January 31, 2013, we reported our preliminary findings to the Senate Armed Services Committee.

[11]JASON is a scientific advisory group that provides consulting services to the U.S. government on matters of defense science and technology.

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 background section discusses activities related to managing the stockpile and conducting plutonium related research, plutonium related research at LANL, and development of the CMRR.

Activities Related to Managing the Stockpile and Conducting Plutonium-Related Research

Two key activities related to the management of the nuclear weapons stockpile are determining the size and composition of the stockpile and the schedule for life extension programs. The DOD and DOE each play an important role in nuclear weapons stockpile management, including participation in the Nuclear Weapons Council, which serves as the focal point for interagency activities to maintain the U.S. nuclear weapons stockpile. The council is a joint DOD and DOE organization responsible for facilitating cooperation and coordination, reaching consensus, and establishing priorities between the two departments as they manage the U.S. nuclear weapons stockpile. The Secretaries of Defense and Energy, with input from the Nuclear Weapons Council, recommend a multiyear plan to the President on the size and composition of the stockpile, which if approved by the President, becomes the Nuclear Weapons Stockpile Plan. Based on this plan, the Nuclear Weapons Council approves the schedule for nuclear weapons' life extension activities. Because of limited production capacity, NNSA has conducted these life extension programs consecutively, rather than concurrently. Although their durations have varied, life extension programs can take nearly a decade or more from the start of the planning phases until refurbished weapons are delivered to DOD for reintroduction into the stockpile.

Plutonium research facilities and capabilities are needed to fulfill NNSA's nuclear weapons stockpile plutonium research mission as well as its other plutonium research missions. Although the rate of deterioration for some components of nuclear weapons is relatively well-known, scientists are still learning about the effects of aging on pits, particularly on the plutonium housed inside. Scientists must perform research to determine if existing pits can be reused or if new pits need to be manufactured to

extend the life of nuclear weapons.[12] When manufacturing new pits, scientists perform about 20 different types of analyses to characterize and assess the chemical and material properties of plutonium. Analytical chemistry and materials characterization analyses are also used to assess plutonium's structural attributes, such as the metal's microscopic grain size and texture, to identify any potential defects.

Plutonium Related Research at LANL

While LANL houses most of the capabilities for plutonium research related to maintaining the nation's nuclear weapons stockpile, it also has a broader plutonium-related research mission. For example, LANL 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. As part of this capability, LANL has demonstrated the conversion of weapons-grade excess plutonium to mixed oxide fuel for electric power generation in commercial nuclear reactors.[13] This core plutonium research capability also contributes to LANL's role in understanding and minimizing the risks of proliferation and terrorism. Specifically, LANL conducts research to support safeguards in nuclear processing and storage facilities; arms control, denuclearization, and nuclear test treaty verification; and detection of nuclear materials in transit.

Currently, three main facilities at LANL are used for plutonium-related research:

[12]NNSA is studying the potential for reusing existing pits. Different studies have produced varying results on the life time of pits, and NNSA officials are not certain whether or for how long pits can be safely reused. NNSA and LANL officials told us, however, that although there are some generic analyses on pit reuse that can be done now, specific analyses must be tied to the weapon system being refurbished because each weapon has unique system requirements.

[13]The Advanced Recovery and Integrated Extraction System, or ARIES, demonstrated the technology for extracting plutonium from used pits and converting it into a plutonium oxide. The intent of making the plutonium oxide is to blend it with other materials to make a mixed oxide fuel that can be used as fuel for commercial nuclear power reactors. The technology was to be used at the planned Mixed Oxide Fuel Fabrication Facility, the future of which is uncertain because the President's fiscal year 2014 budget request proposes decreasing funding for the facility while NNSA assesses other plutonium disposition strategies. The mixed oxide fuel produced by ARIES was to have been eventually produced by the planned Plutonium Disposition and Conversion Facility, but NNSA terminated that facility because of budget conflicts.

- CMR—The CMR became operational in 1952 and has unique capabilities for performing analytical chemistry, materials characterization, and research and development related to plutonium. NNSA plans to transfer operations out of CMR in about 2019.

- Plutonium Facility 4 (PF-4)—PF-4 began operations in 1978 and is the nation's only fully operational plutonium facility supporting pit manufacturing and the research of plutonium, including chemical and metallurgical processes to purify and convert plutonium into other chemical compounds. Space in PF-4 is also used to support the manufacture of plutonium heat sources and electric generators in spacecraft as well as the research into improved methods for reprocessing of spent nuclear fuel. The facility is capable of handling and storing plutonium and other special nuclear materials, although much of its storage space is already filled.

- Radiological Laboratory Utility Office Building—The radiological laboratory, consisting of office-space, training areas, utilities, and laboratory space for research, was built to complement the proposed CMRR nuclear facility. According to NNSA officials, operations began in the radiological laboratory in 2013. The laboratory has the capacity to handle small plutonium samples for use in analytical chemistry research to support plutonium programs in PF-4.

History of the Proposed CMRR Nuclear Facility

DOE's and NNSA's plans for replacing the CMR have changed over the past several decades. In 1983, DOE first decided that the CMR was outdated and began making plans to replace it. Over the next nearly 2 decades, several large replacement projects were proposed, but none progressed beyond conceptual stages. In developing a major construction project, like the CMRR, DOE and NNSA follow specific DOE orders, regulations, and guidance, which, as a whole, are intended to ensure that broadly stated mission needs can be transformed into well-defined requirements, ultimately resulting in operationally effective, suitable, and affordable facilities.[14] NNSA has taken a number of steps to develop the CMRR nuclear facility or some facility to replace the CMR, but its plans have continued to change over time. Specifically:

[14]See DOE, *DOE Order 413.3B: Program and Project Management for the Acquisition of Capital Assets* (Washington, D.C.: Nov. 29, 2010).

- In 2002, NNSA developed an initial design for the CMRR nuclear facility with 40,500 square feet of laboratory space to meet mission needs and to ensure ample contingency for program changes.
- In 2004, NNSA evaluated three different possible laboratory space sizes for the CMRR nuclear facility—22,500, 31,500, and 40,500 square feet—and selected the smallest option, reporting that cost was the primary driver of the decision.[15]
- In 2006, an independent business case analysis validated the need for the CMRR nuclear facility, but it concluded that an additional 9,000 square feet of laboratory space could allow for contingency in the event of changing requirements.
- In 2008, as part of a complex-wide review, NNSA issued a study that revalidated the need for the CMRR nuclear facility based on program requirements, the capabilities within the facility, and its size of 22,500 square feet.
- In 2010, NNSA estimated that the CMRR nuclear facility would cost from $3.7 to $5.8 billion—a nearly 6-fold increase from the initial estimate—and that construction would be complete by 2020—a 3- to 7-year delay.
- In February 2012, NNSA announced that construction of the CMRR nuclear facility would be delayed for at least 5 years.
- In March 2012, we reported that the CMRR nuclear facility design may not meet all plutonium-related research needs and recommended that NNSA conduct a comprehensive assessment of needed plutonium-related research.[16,17]
- In March 2013, the NNSA Administrator directed the agency to conduct an analysis to compare the planned CMRR nuclear facility

[15]NNSA based its initial plans for the CMRR nuclear facility on the 22,500 square feet design and, in 2005, projected that the facility would cost from $745 million to $975 million and would be completed from 2013 to 2017.

[16] GAO-12-337.

[17]By October 2012, NNSA had spent about $450 million designing the CMRR nuclear facility and $360 million designing, constructing, and equipping the radiological laboratory.

with other options—including a modular facility concept that could be built in phases to meet additional capacity needs or new mission requirements—and to enlist the assistance of the Office of the Secretary of Defense's Cost Assessment and Program Evaluation office in carrying out this analysis. According to NNSA officials, the results are expected in October 2013.

LANL's Study Identified General Options for Meeting NNSA's Plutonium Research Needs and Included Limited Information on Their Costs and Risks

LANL's April 2012 study identified general options for meeting NNSA's plutonium research needs. The study included limited information on the potential costs and health risks associated with those options.

Options Identified for Meeting NNSA's Plutonium Research Needs

LANL's April 2012 study identified general options for meeting NNSA's plutonium research needs. Specifically, the April 2012 study outlined three options for analytical chemistry and materials characterization capabilities to support current and future pit production requirements and other plutonium research needs. These options include relocating analytical chemistry and materials characterization capabilities among facilities at LANL, moving some capabilities to facilities at other sites, or some combination of the two. Contractor representatives at LANL noted that the April 2012 study was intended primarily to identify options that needed to be addressed quickly to support decisions for the fiscal year 2014 budget cycle, and that additional information and analysis would be required to develop a plan to meet NNSA's ongoing—and much longer-term—plutonium research needs.

The April 2012 study stated that the level of plutonium research necessary to support nuclear weapons life extension programs would be affected by the planned schedule of the life extension programs, the number of pits that will be needed under the programs, and the number of pits that will need to be manufactured versus reused, all of which have uncertainties. The Nuclear Weapons Council is still evaluating specifications for nuclear weapons and their corresponding life extension program schedules, and it may take another year or two before final

decisions are made, according to NNSA officials. Since the schedule has not been finalized, the number of pits that will be needed is uncertain as well. The number of pits that need to be manufactured is an important consideration because the analytical chemistry capacity needed is largely proportional to the pit manufacturing capacity needed. Roughly speaking, the more pits that must be manufactured, the more analytical chemistry is required. On the other hand, according to the April 2012 study, reusing pits is less resource intensive because it requires less analytical chemistry. For planning purposes, NNSA is studying the possibility of manufacturing about 30 pits per year and the potential reuse of up to about 90 pits per year by 2021. According to NNSA officials, initial studies indicate it is likely that pits can be reused, but further detailed studies regarding pit specifications will need to be completed before NNSA can be certain which pits, if any, can be reused. According to the April 2012 study, several independent, but key factors must be considered when making decisions about options to meet future analytical chemistry requirements. For example, any option should have the ability to increase the capacity of analytical chemistry to support increased pit manufacturing rates, should it be required. Also, the disposal of byproduct radiological material needs to be taken under consideration.

One option for meeting NNSA's plutonium research needs identified in the April 2012 study was relocating analytical chemistry and materials characterization capabilities to other facilities at LANL. The study noted that LANL had demonstrated it could provide the analytical chemistry support for manufacturing 10 pits per year but that manufacturing the 30 pits per year that are estimated would be needed by 2021 would require more analytical chemistry capacity than LANL can currently provide. The April 2012 study noted that any option for increasing the analytical chemistry capability to support the manufacture of more than 10 pits per year should involve more effective use of the radiological laboratory at LANL. According to NNSA officials and representatives of the M&O contractor at LANL, the radiological laboratory was designed to handle about 6 grams of weapons-grade plutonium at a single time, which, without additional capabilities, is not sufficient to support the manufacture of 30 pits per year. The April 2012 study suggested that the radiological laboratory could be outfitted with additional equipment that would allow for additional capability and capacity. The study also suggested that the amount of plutonium that can be handled in the radiological laboratory could be increased to enhance the analytical chemistry capability at LANL. The study stated that the amount of plutonium could be increased to 26 grams using revised material limits for radiological facilities—the current limit for the radiological laboratory under DOE's hazard

categorization standard—or 1,750 grams by attempting to increase the hazard categorization level.[18] The 26-gram level still requires additional analytical chemistry and materials characterization capabilities in other facilities to support the manufacture of 30 pits per year. The 1,750-gram level was considered not practical, considering the regulatory and cost challenges. To more effectively use space for analysis, the study also suggested that space in PF-4 could be reconfigured to prepare radiological samples that would then be analyzed in the radiological laboratory. Since the April 2012 study, an NNSA official has stated that, with the upgrade of the radiological laboratory to handle 26 grams of plutonium, and with repurposing available space in PF-4, NNSA now believes that LANL can support the manufacture of 30 pits per year, but the official stated that many uncertainties related to these possible improvements still exist.

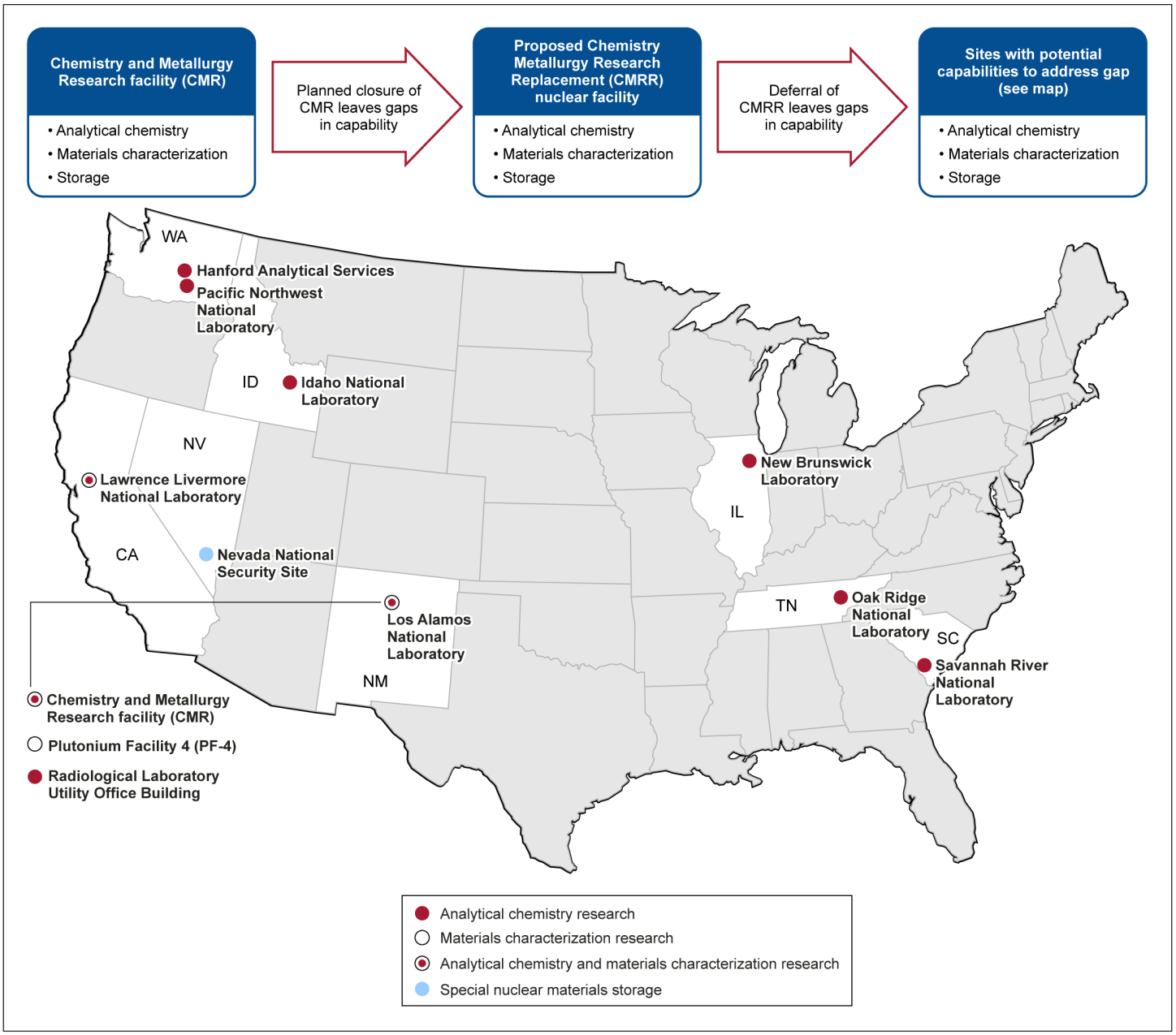
In addition to more effective use of the radiological laboratory and PF-4 at LANL, the April 2012 study stated that facilities at other sites were available to provide for basic analytical chemistry. The LANL M&O contractor sent a survey to seven sites to gather information about additional capabilities available. The study concluded that no site can provide all the capabilities needed, but sites indicated that they could take steps to obtain additional capabilities such as renovating an existing facility or upgrading equipment. The April 2012 study noted that finding facilities with the capability to perform materials characterization, however, is more difficult than for analytical chemistry because most materials characterization analyses require larger amounts of plutonium. While multiple sites in the nation's nuclear security enterprise have fairly broad analytical chemistry capabilities, materials characterization capabilities are mainly available at LANL and Lawrence Livermore National Laboratory in California. The April 2012 study also discussed moving some special nuclear material for staging at the Device Assembly Facility in Nevada to free up space in PF-4. Storage space in PF-4 for radioactive materials is already largely utilized and additional space is needed to store special nuclear material produced during plutonium-

[18]See *DOE Standard: Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*, DOE-STD-1027-92 (Washington, D.C.: September 1997) and *NNSA Supplemental Guidance: Guidance on Using Release Fraction and Modern Dosimetric Information Consistently with DOE STD 1027.92, Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports, Change Notice No. 1*, NA-1 SD G 1027 (Washington, D.C.: Nov. 28, 2011).

related research and pit manufacturing.[19] The study recommended that a base analytical capability could be established at the radiological laboratory and at PF-4 and as program requirements—including pit requirements—become more clear, additional options, such as using capabilities at other sites, could be explored. LANL officials told us that they are continuing to evaluate information about which facilities might be able to provide analytical chemistry and materials characterization. Figure 1 shows the facilities and sites that LANL considered in its April 2012 study.

[19]Special nuclear material comes from plutonium research and development programs and is not suitable for direct use in pit manufacturing.

Figure 1: Facilities and Sites Considered in LANL's April 2012 Study



Sources: Copyright © Corel Corp., all rights reserved (map); GAO analysis based on LANL data.

As of July 2013, NNSA officials told us that they had not selected any options for meeting the plutonium research needs from 2019 through the late-2020s, although they were exploring improved work processes in analytical chemistry that could potentially enable LANL to support the manufacture of 30 pits per year. In addition, NNSA officials said that they had not made any decisions on facilities to address longer-term research needs, such as the phased, modular facility NNSA officials are considering. NNSA officials said planning must begin soon on some longer-term plutonium research facility if it were to be constructed and operational by the late-2020s.

Costs of the Options Are Uncertain

The April 2012 study provided limited information on general options for meeting NNSA's plutonium research needs and, given the time frames in which it was produced, was not expected to provide a meaningful assessment of the costs associated with any of the options. Specifically, the study reported that the cost of moving capabilities among facilities at LANL ranged from $480 million to $820 million. The study characterized these cost estimates as high-level and a rough order of magnitude and noted that the estimates should be viewed as preliminary and preconceptual that would not be useful for program definition or scoping. The April 2012 study did not include any estimated costs for the option of relocating some plutonium research capabilities to facilities at other sites, such as any actions that would be potentially necessary to conduct the needed research at those facilities, including capital improvements to develop analytical chemistry or materials characterization capabilities, or any operational costs related to the start-up or transportation. The information in the April 2012 study was not sufficient for a meaningful assessment of the costs associated with any of the options for meeting NNSA's plutonium research needs identified in the study.

Some Potential Health Risks of the Options Have Been Identified

The April 2012 study also included some discussion of risks to workers. Although risks to workers and the public exist at PF-4 due to seismic hazards, some additional risks could be posed by the option to use facilities at other sites. Specifically, the study reported that using facilities at other sites for analytical chemistry research increases the handling and shipping of small samples of plutonium, thereby increasing the risk of contamination to workers. The study did not, however, quantify what the risk to workers might be. The April 2012 study also did not assess any risks to the public posed by transporting plutonium or other radiological materials. An NNSA official told us that transportation accidents or unintentional releases could pose risks to the public but that these risks

generally are low given DOE's history of successful shipments, existing transportation protocols, and the planned use of robust shipping containers.

The Potential Impacts of Options on NNSA's Plutonium Research Missions Are Uncertain

The potential impacts of the options on NNSA's plutonium research for the nuclear weapons stockpile and other plutonium mission areas are uncertain but could include reduced space to accommodate other plutonium research missions if NNSA relies only on facilities at LANL for nuclear weapons stockpile research, delays in completing needed analytical chemistry and materials characterization analyses if facilities at other sites were to be used, and challenges in meeting stockpile refurbishment schedules due to shortages in certain staff.

Relying on LANL to Accommodate Nuclear Weapons Stockpile Mission Could Potentially Reduce Space for Other Plutonium Research Missions

If NNSA uses space only at LANL, rather than moving some capabilities to facilities at other sites, some LANL plutonium research missions could potentially be impacted because space may have to be reconfigured to accommodate nuclear weapons stockpile mission needs. Currently, the bulk of the plutonium research activities for missions other than the nuclear weapons stockpile take place in PF-4. If NNSA decides to rely only on space at LANL, then PF-4 at LANL might have to absorb the additional plutonium research for the nuclear stockpile mission, which, in turn, could reduce the space available for other NNSA plutonium research missions. This impact, if it occurs, would not take place for several more years because, according to agency officials, NNSA plans to continue using the CMR until about 2019. The April 2012 study stated that the required number of activities in PF-4 would likely be too great to be supported in the facility but noted further that it was a rough guess given that no formal PF-4 space analysis has been performed. Following the study, NNSA tasked the M&O contractor for LANL with assessing the space inside PF-4 to see if it could be repurposed to better support plutonium research for the nuclear weapons program and other mission areas.

Moving Capabilities to Facilities at Other Sites Could Result in Delays

According to the April 2012 study, one potential impact of using facilities at other sites could be delays in completing needed analytical chemistry or materials characterization due to the time needed for transportation of samples between sites. Using facilities at other sites will require time for NNSA to plan for and then transport materials from LANL to facilities at other sites. This in turn could increase the total time needed to complete the analyses for weapon pits. Plans for transporting plutonium or other

radioactive materials from LANL to facilities at other sites could also spur public opposition that may cause schedule delays or create other impediments to efficiently conduct analytical chemistry or materials characterization at other facilities in the nuclear security enterprise.

Shortage of Trained Staff Could Impact Ability to Meet Nuclear Weapons Missions

The April 2012 study stated that the shortage of trained staff in analytical chemistry could impact the ability to execute the options, which in turn could affect NNSA's ability to meet proposed schedules for the refurbishment of nuclear weapons. Specifically, the study noted that the number of analytical chemistry researchers has decreased by 60 percent from 2005 to 2012 due to retirements and budget cuts. According to the April 2012 study, any of the options, including relocating capability and capacity to an augmented radiological laboratory, reconfiguring capabilities in PF-4, or transferring capabilities to facilities at other sites, will strain existing staff resources and will require hiring additional staff. Staff shortages could adversely impact the ability of NNSA and LANL to meet proposed schedules for its nuclear weapons work. LANL's M&O contractor representatives told us that it takes years of on-the-job training to develop core competencies for nuclear weapons work—about 10 years for scientists and about 3 to 4 years for technicians. NNSA and LANL officials told us that recruiting additional staff for plutonium-related research necessarily takes years of advance planning, but that the uncertainty of where the new capabilities will be located or what the level of capacity is needed has complicated planning efforts. The contractor at LANL recommended that NNSA conduct a detailed risk analysis on staffing needs to better understand and plan for staffing limitations, according to the April 2012 study.

Conclusions

NNSA's mission to ensure the safety and security of nuclear weapons is a critical, complex, and costly one. Key plutonium research facilities and capabilities are needed to assess the condition of existing nuclear weapons, implement life extension programs, and ensure that the nation's nuclear weapons remain safe and reliable. Although NNSA has taken nearly a decade and spent millions of dollars designing a replacement for LANL's aging CMR facility—an initiative that was approved in 2005 and revalidated in 2008—the construction of the CMRR nuclear facility has been delayed for at least 5 years. With the current CMR facility slated to transfer operations to some as yet undecided facility or facilities by 2019, this deferral may lead to insufficient plutonium research capabilities beginning in 2019. The timing of this potential gap in capabilities is critical given the number of pits NNSA is expecting to have to manufacture by

2021 to support the life extension programs of our nuclear stockpile. The options identified in LANL's April 2012 study were intended to help meet NNSA's plutonium research needs, but NNSA has not clarified how these needs may have changed, if at all, since NNSA's validation of its requirements for the CMRR nuclear facility in 2008—requirements we reported might not fully account for all of NNSA's plutonium research needs. NNSA has also not selected one of the study's options, or developed a plan for meeting these needs. Many aspects of the options identified in its April 2012 study, including which facilities will be used, what upgrades or changes to facilities will be needed, and the costs of carrying out the options are still uncertain as are the potential impacts of the various options being considered. NNSA is assessing possible concepts to meet NNSA's longer-term plutonium research needs, including one that would call for constructing a facility at LANL in phases, as additional capacity is needed. A change in approach from constructing the CMRR nuclear facility, however, raises a number of questions. These include whether NNSA will make costly investments in short-term facilities that may ultimately not address its longer-term plutonium research needs. It is imperative that NNSA make prudent investments that right-size the solution with the actual and anticipated needs or it may continue to spend significant sums of money with little to show for it.

Recommendation for Executive Action

To ensure that NNSA's investments in plutonium research facilities and capabilities result in an operationally effective and affordable solution, we recommend that the Secretary of Energy continue efforts to assess how plutonium research and other capability needs and stockpile requirements have changed, if at all, since the needs were revalidated in 2008, and develop a plan to appropriately meet the nation's near-term and longer-term plutonium needs.

Agency Comments and Our Evaluation

We provided DOE and NNSA with a draft of this report for review and comment. In its written response on behalf of DOE, NNSA stated that it agreed in principle with our recommendation. NNSA suggested changing the recommendation by broadening it to also reflect other plutonium activities or capabilities. We have modified the recommendation to incorporate NNSA's suggested changes. In addition, NNSA noted that it has begun an evaluation of options for the plutonium strategy to inform the fiscal year 2015 budget request. Staff from LANL and DOD's Cost Assessment and Program Evaluation office will be involved in this evaluation. NNSA added that it believes that the results of this effort will be responsive to our recommendation. Although we discussed this effort

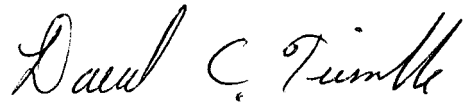
in our report, it is still underway and we have not evaluated whether it will fully respond to our recommendation.

NNSA also provided technical comments, which we incorporated into the report as appropriate. In particular, NNSA expressed concern that our use of the term plutonium research capabilities could be misleading to some readers. NNSA added that the principle role of the CMR, as well as its planned replacement, is to provide analytical chemistry and materials characterization capabilities to support plutonium manufacturing operations in other facilities at LANL. For consistency with our previous reports on this topic, we have continued to use the term plutonium research capabilities but have added language to the report to clarify our use of this term.

NNSA's written comments are reproduced in appendix II.

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

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



David C. Trimble
Director, Natural Resources and Environment

Appendix I: Objectives, Scope, and Methodology

To examine the Los Alamos National Laboratory's (LANL) April 2012 study for meeting the National Nuclear Security Administration's (NNSA) plutonium research needs, including costs and risks to health, if any, we reviewed LANL's April 2012 study and pertinent budget, planning, and analytical documents from NNSA and LANL. For example, we reviewed various technical documents on plans for research and production of pits. We interviewed senior NNSA officials at NNSA's Washington, D.C. headquarters and interviewed several LANL program managers at LANL to better understand NNSA's plutonium research needs and to the extent to which they analyzed cost estimates, and to determine what decisions still need to be made related to capacity requirements that may affect costs in the future. Separately, we interviewed Department of Defense (DOD) program officials to gain a better understanding of nuclear weapons stockpile requirements and DOD's input into the options and related costs. To examine the risks the options pose to public health and safety, we reviewed numerous pertinent documents from NNSA, LANL, and the Defense Nuclear Facilities Safety Board, focusing on issues related to seismic risks at LANL. In addition, we interviewed Defense Nuclear Facilities Safety Board officials to discuss the potential risks to public health and safety, if any, posed by the options.

To examine the potential impact of options in LANL's April 2012 study on NNSA's plutonium research for the nuclear weapons stockpile and other mission areas, we reviewed pertinent analytical documents from NNSA and LANL related to NNSA's options for maintaining its capabilities for plutonium-related analytical chemistry, materials characterization, and storage, following the deferral of Chemistry and Metallurgy Research Replacement (CMRR) nuclear facility. We also interviewed several NNSA and LANL program officials to better understand various facilities' capabilities that might be used as part of the options and to identify major impacts, if any, of using these facilities. We also interviewed former Department of Energy (DOE) officials and former contractor officials to understand the history of the CMRR and reviewed documents and interviewed representatives from the JASON Program Office to gather other perspectives on NNSA and its plutonium science mission. We also reviewed documents and interviewed representatives from several nongovernmental organizations, including the Los Alamos Study Group, the Union of Concerned Scientists, Nuclear Watch of New Mexico, and Project on Government Oversight, to identify challenges to using facilities across the nuclear security enterprise and to gain their perspective on NNSA's plan.

We conducted this performance audit from October 2012 to September 2013 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: Comments from the National Nuclear Security Administration

Department of Energy
National Nuclear Security Administration
Washington, DC 20585
August 23, 2013

Mr. David Trimble
Director
Natural Resources and Environment
Government Accountability Office
Washington, DC 20458

Dear Mr. Trimble:

Thank you for the opportunity to review the Government Accountability Office's (GAO) draft report titled "*MODERNIZING THE NUCLEAR SECURITY ENTERPRISE: Observations on NNSA's Options for Meeting Its Plutonium Needs, GAO-13-533.*" I understand the GAO began this review in response to a request made by the Committee on Armed Services, and was asked to examine: (1) the options identified in a 2012 Los Alamos National Laboratory study for meeting NNSA's plutonium needs, including costs and health risks, if any; and (2) the potential impacts of those options on NNSA's plutonium capabilities for the nuclear weapons stockpile and other plutonium research milestones. The report identified one recommendation for executive action.

NNSA agrees in principle with the recommendation. The enclosure to this letter provides detailed response to that recommendation, including the actions NNSA is taking to address the underlying findings, and suggested language change for the recommendation to reflect NNSA's current status and the breadth of analysis activities. In addition, we have provided technical and general comments to further enhance the clarity and factual accuracy of the report. If you have any questions regarding this response, please contact Dean Childs, Director, Office of Audit Coordination and Internal Affairs, at (301) 903-1341.

Sincerely,

Cynthia A. Lersten
Associate Administrator
For Management and Budget

Enclosure

Printed with soy ink on recycled paper

Enclosure

**National Nuclear Security Administrations Comments on
the Government Accountability Office (GAO) Draft Report titled
"MODERNIZING THE NUCLEAR SECURITY ENTERPRISE: Observations on NNSA's
Options for Meeting Its Plutonium Research Needs, GAO-13-533"**

The GAO recommended that the Secretary of Energy:

Recommendation: *Assess how plutonium research needs and stockpile requirements have changed, if at all, since the needs were revalidated in 2008, and develop a plan to appropriately meet the Nation's near-term and longer-term plutonium needs."*

Management Response: Concur in Principle

NNSA agrees that an assessment of both near and long-term plutonium needs is necessary. However, NNSA does not agree with the characterization/limitation of NNSA plutonium activities as solely "research," as they involve manufacturing, support and other capabilities. Classifying them as research activities limits the breadth of the analysis. In addition, in March 2013, the NNSA initiated a business case analysis with staff from Los Alamos National Laboratory (LANL) and the Department of Defense Cost Assessment and Program Evaluation (CAPE) office to evaluate options for the plutonium strategy to inform NNSA's Fiscal Year 2015 Budget Request. This effort is ongoing as of the date of this memorandum and NNSA believes the results of this effort will be responsive to the GAO recommendation.

To more accurately reflect the broader set of plutonium activities and acknowledge the current status of NNSA's assessment efforts, we propose the following revised language for the recommendation: "*...we recommend that the NNSA Administrator continue efforts to assess how plutonium capability needs and stockpile requirements have changed, if at all, since the needs were revalidated in 2008, and develop a plan to appropriately meet the nation's near-term and longer-term plutonium needs."*

Appendix III: GAO Contact and Staff Acknowledgments

GAO Contact

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

Staff Acknowledgments

In addition to the individual named above, Janet E. Frisch (Assistant Director); John Delicath; Mehrzad Nadji; Timothy Persons; Cheryl Peterson; Steven Putansu; Danny Royer; Robert Sánchez; Kiki Theodoropoulos; and Rajneesh Verma made key contributions to this report.