United States Government Accountability Office

Report to Congressional Committees

July 2015

DOE PROJECT MANAGEMENT

NNSA Should Ensure Equal Consideration of Alternatives for Lithium Production

GAO-15-525

GAO Highlights

Highlights of GAO-15-525, a report to congressional committees

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Why GAO Did This Study

An isotope of lithium is a key component of nuclear weapons and is essential for their refurbishment. NNSA halted certain aspects of its lithium production operation—conducted at its Y-12 site—in May 2013 due to the condition of the site's 72-year old lithium production facility. Y-12 management concluded that usable lithium could run out without additional actions. In response, NNSA developed a strategy that proposed a new lithium production facility by 2025 and identified "bridging" actions needed to meet demand through 2025. In January 2015, NNSA submitted for approval a mission need statement for lithium production capabilities.

Senate Report 113-176 included a provision for GAO to review lithium production at NNSA's Y-12 site. This report (1) describes the challenges NNSA has identified with its lithium production strategy, and (2) determines the extent to which NNSA developed a mission need statement that is independent of a particular solution, as called for in DOE's directive on project management.

To do this work, GAO reviewed relevant agency directives, guidance, and other documents and interviewed agency officials.

What GAO Recommends

GAO recommends that NNSA objectively consider all alternatives, without preference for a particular solution, as it proceeds with its analysis of alternatives process. NNSA neither agreed nor disagreed with GAO's recommendation; however, it disagreed with the conclusions. GAO continues to believe its conclusions are fair and well supported.

View GAO-15-525. For more information, contact David C. Trimble at (202) 512-3841 or trimbled@gao.gov.

What GAO Found

The National Nuclear Security Administration's (NNSA) has identified various challenges in its lithium production strategy that may impact its ability to meet demand for lithium in the future, as well as actions that may mitigate these challenges. These challenges pertain to three key areas. First, NNSA may not have a sufficient supply of lithium material for defense program requirements. NNSA officials told GAO in April 2015 that, due to additional recent increases in demand, its supply of currently qualified lithium—lithium approved for use in weapon systems in refurbishment—will run out by 2018 without additional actions. Second, at NNSA's Y-12 National Security Complex in Oak Ridge, Tennessee, where lithium production operations are conducted, the existing lithium production facility and equipment are at risk of catastrophic failure. In March 2014, for example, a 300-pound slab of concrete fell from the ceiling into an active work area (this area is no longer in use). Third, fiscal constraints could cause delays in the construction of a new lithium production facility. NNSA, in its lithium production strategy, also identifies various actions that it could take to mitigate these challenges—including procuring lithium from outside sources and outsourcing certain aspects of the lithium production process. However, the mitigating actions are in early stages of development, and may bring additional challenges.

In developing and implementing its lithium production strategy, NNSA did not develop a mission need statement that is fully independent of a particular solution, contrary to the agency directive on Program and Project Management for the Acquisition of Capital Assets, which governs the design and construction of new facilities (DOE Order 413.3B). According to this directive, the mission need statement should be independent of a particular solution, and it should not be defined by the equipment, facility, technological solution, or physical end-item. This allows the program office responsible for the capital asset project to explore a variety of alternatives. In January 2015, NNSA program officials submitted a mission need statement for lithium production for approval to the Deputy Administrator for Defense Programs, NNSA. It was approved on June 10, 2015. The mission need statement included, among other things, a description of the capability gap, alternatives for addressing its mission need—such as building a new facility, leasing off-site facilities, or outsourcing lithium processing—and estimated cost and schedule ranges. However, the document expresses the capability gap in terms of a particular solution—specifically, a new facility. For example, it includes multiple references to an alternative facility to replace the existing facility, suggesting that NNSA gave preference to building a new facility. In addition, it did not include cost and schedule estimates for six of the seven alternatives presented in the mission need document. The mission need statement includes cost and schedule estimates only for the alternative of building a functioning facility at Y-12. NNSA officials told GAO that they plan to analyze other alternatives for meeting the mission need for lithium production. However, by seemingly giving preference to a particular solution in its mission need document, NNSA is not following DOE's project management order, which may preclude serious consideration of other potential viable alternatives. A mission need statement biased toward a particular solution may introduce bias into the rest of the analysis of alternatives process.

Contents

Abbreviations

CD	Critical Decision
COLEX	column exchange
CSA	canned subassemblies
DMM	Direct Materials Manufacturing
DOE	Department of Energy
DOE-IG	DOE's Office of the Inspector General
LPC	Lithium Production Capability
NNSA	National Nuclear Security Administration
QER	Qualification Evaluation Release

U.S. GOVERNMENT ACCOUNTABILITY OFFICE
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July 13, 2015

Congressional Committees

The National Nuclear Security Administration (NNSA), a separately organized agency within the Department of Energy (DOE), is responsible for the maintenance and refurbishment of nuclear weapons.[1] The isotope lithium-6 is a key component of nuclear weapons and is therefore essential for the refurbishment of the nuclear weapons stockpile.[2] Natural lithium consists approximately of 7.5 percent of the isotope lithium-6 and 92.5 percent of the isotope lithium-7. NNSA's Y-12 National Security Complex in Oak Ridge, Tennessee, separated lithium-6 from lithium-7 using a process that required large quantities of mercury,[3] and resulted in worker exposure to mercury and environmental contamination, from 1954 through 1963.

NNSA still has a large supply of lithium-6 in storage and in retired weapons awaiting disassembly.[4] NNSA relies on contractors to carry out its lithium production operations at its Y-12 site. Since 1963, Y-12's lithium production operations have relied on existing supplies of lithium-6. Specifically, to produce lithium for NNSA's defense programs, Y-12 recovers lithium-6 from disassembled weapons, cleans it, and prepares the cleaned lithium into forms suitable for refurbished weapons. Until May 2013, Y-12 relied on a cleaning process known as "wet chemistry." Wet chemistry involves purifying lithium from dismantled weapons and storing it as lithium chloride. To be usable in refurbished weapons, the lithium chloride must be converted first to lithium metal and then treated with

[1]Since the end of the cold war, instead of designing, testing, and producing new nuclear weapons, NNSA has sought to extend the time that existing nuclear weapons can safely and reliably remain in the weapons stockpile through refurbishment.

[2]Isotopes are varieties of a given chemical element with the same number of protons but different numbers of neutrons.

[3]A column exchange (COLEX) process separated the two lithium isotopes by using natural lithium dissolved in mercury and other chemicals. Lithium-6 is more attracted to the mercury than lithium-7, which is more attracted to the other chemicals, thus separating the two isotopes.

[4]A nuclear weapon that has been dismantled—reduced to its component parts—can then be further disassembled into additional components, such as lithium.

hydrogen gas to create lithium hydride or treated with deuterium gas to create lithium deuteride.[5] In May 2013, due to the deteriorating conditions of NNSA's 72-year old lithium production facility at the Y-12 site (building 9204-2), Y-12 suspended its wet chemistry and conversion operations. In doing so, Y-12 suspended its ability to convert the existing inventory of lithium chloride into lithium usable for refurbished weapons.

To meet lithium demand without its wet chemistry capabilities, Y-12 began in May 2013 to rely exclusively on a process known as Direct Materials Manufacturing (DMM)—which involves recycling lithium hydride and deuteride directly from disassembled weapons and manually sanding the outer layer of the lithium material to remove impurities.[6] At the same time, however, projected demand for lithium for use in refurbished weapons tripled. As a result, according to a 2013 assessment,[7] Y-12 concluded that it could run out of usable lithium by 2020 if it does not take additional actions.[8]

In light of the deteriorating condition of building 9204-2, in August 2013, NNSA's Y-12 contractor proposed a strategy for meeting lithium demand that included, among other things, increased use of DMM in existing Y-12 facilities for lithium production through 2025. The strategy, according to Y-12's proposal, called for the design and construction of a new lithium production facility that would provide lithium production capabilities beyond 2025. In a February 2014 memorandum from the Assistant Deputy Administrator of Stockpile Management to the NNSA Production Office Manager regarding "Lithium Production Capability and Supply," NNSA committed to working with Y-12 to implement the strategy. In January 2015, Y-12 finalized a "Lithium Materials Production Transition Implementation Plan" (Implementation Plan), which describes the major

[5]Hereafter, "lithium" refers to lithium-6 (for example, here we are referring to lithium-6 chloride, lithium-6 hydride, and lithium-6 deuteride).

[6]Y-12 began this process in 2012, when it was also using wet chemistry. DMM cleaning involves treating the outermost layer of lithium material, whereas the wet chemistry purification process dissolves all of the material, removing any impurities and creating chemically pure, homogenous lithium.

[7]Y -12 Lithium Materials Production Strategy for Defense Programs Requirements prepared by Babcock & Wilcox Technical Services, LLC.

[8]In April 2015, NNSA officials told us that, due to additional recent increases in demand, this date has moved to 2018.

elements of its lithium strategy—particularly the "bridging" actions required to meet lithium demand until a new lithium production facility is operational. This document also discusses challenges associated with implementing the strategy and actions that may mitigate these challenges. Together, these documents encompass NNSA's lithium production strategy—hereafter referred to as "the lithium production strategy" or "the strategy."

Also in January 2015, NNSA finalized its statement of mission need for providing new lithium production capabilities, the approval of which marks the end of the first phase—preconceptual design—of its capital asset acquisition process.[9] This statement was approved on June 10, 2015. The design and construction of new NNSA facilities is governed by DOE Order 413.3B, Program and Project Management (PM) for the Acquisition of Capital Assets. The capital asset acquisition process begins with identifying a mission need (independent of a particular solution), which provides the basis for objectively analyzing alternative solutions. Objectively analyzing alternatives helps ensure that the best alternative that satisfies the mission need is chosen. According to Order 413.3B, the mission need must be independent of a particular alternative, allowing the program office responsible for the capital asset project to explore a variety of alternatives. We previously found that DOE and NNSA officials had acknowledged that unreliable analysis of alternatives is a risk factor for major cost increases and schedule delays for NNSA projects.[10] Also, we have previously found that NNSA has selected preferred alternatives for many projects, and then spent billions of dollars designing and partially constructing several major capital asset projects, only to later reassess alternatives for each project.[11]

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

[10]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).

[11]GAO, *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); and *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).

Senate Report 113-176 included a provision that GAO review lithium production at NNSA's Y-12 site in Tennessee. In response, this report (1) describes the challenges, if any, NNSA has identified with its lithium production strategy and (2) determines the extent to which NNSA developed a mission need statement for lithium production that is independent of a particular solution. DOE's Office of the Inspector General is conducting a related audit, with a planned issue date later in 2015. That audit is to address, among other things, projected lithium supply and demand.

To describe any challenges NNSA has identified with its lithium production strategy, we reviewed NNSA and Y-12 documents related to lithium production and lithium requirements for fiscal years 2013 through 2015 and interviewed NNSA and Y-12 officials, as well as officials from Los Alamos and Lawrence Livermore National Laboratories, NNSA's design laboratories that must qualify, or approve, the lithium produced at Y-12. We also coordinated with DOE's Office of the Inspector General, which is conducting a related audit. To determine the extent to which NNSA developed a mission need statement for lithium production independent of a predetermined solution, in accordance with DOE direction and guidance, we reviewed DOE Order 413.3B ("Program and Project Management for the Acquisition of Capital Assets") and DOE G 413.3-17 ("Mission Need Statement Guide") to identify the direction and guidance. We also reviewed our related past work.[12] We interviewed NNSA and Y-12 officials regarding the mission need statement and overall strategy. Appendix I presents a more detailed description of our objectives, scope, and methodology.

We conducted this performance audit from October 2014 to July 2015 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.

[12] GAO-15-37 and GAO, *Project and Program Management: DOE Needs to Revise Requirements and Guidance for Cost Estimating and Related Reviews*, GAO-15-29 (Washington, D.C.: Nov 25, 2014).

Background

This section describes NNSA's nuclear security enterprise, lithium production, the process for qualifying lithium, DOE's capital asset acquisition process and mission need statement development, and NNSA's lithium production strategy.

NNSA's Nuclear Security Enterprise

NNSA is responsible for the management of the nation's nuclear weapons, nuclear nonproliferation, and naval reactor programs. NNSA relies on contractors to carry out these responsibilities and manage day-to-day operations at each of its eight sites. These sites include laboratories, production plants, and a test site. Together, these sites implement NNSA's Stockpile Stewardship program that, among other things, includes operations associated with maintenance, refurbishment, and dismantlement of the nuclear weapons stockpile. As discussed previously, lithium is a key component of nuclear weapons and is therefore essential for the refurbishment of the nuclear weapons stockpile. The following NNSA sites are involved in processes or decisions that impact the supply of lithium:

- The NNSA Production Office is responsible for overseeing contractor performance at the Pantex Plant and Y-12 National Security Complex, including the majority of the physical work on weapon refurbishment.
- The Pantex Plant located near Amarillo, Texas, dismantles retired nuclear weapons.
- The Y-12 Nuclear Security Complex disassembles canned subassemblies (CSA) from dismantled weapons; these CSAs contain lithium components that are the source material for lithium production for refurbished weapons.[13] NNSA's Y-12 site is also responsible for lithium production, which involves recovering lithium-6 from disassembled weapons, cleaning it, and preparing the cleaned lithium into forms suitable for refurbished weapons.
- NNSA's Los Alamos and Lawrence Livermore National Laboratories qualify, or approve, the lithium produced at Y-12 to ensure that it is suitable for use in refurbished weapons.

NNSA program offices are responsible for overseeing and supporting the activities performed by its contractors. NNSA's Office of Stockpile Management, within its Office of Defense Programs, oversees the

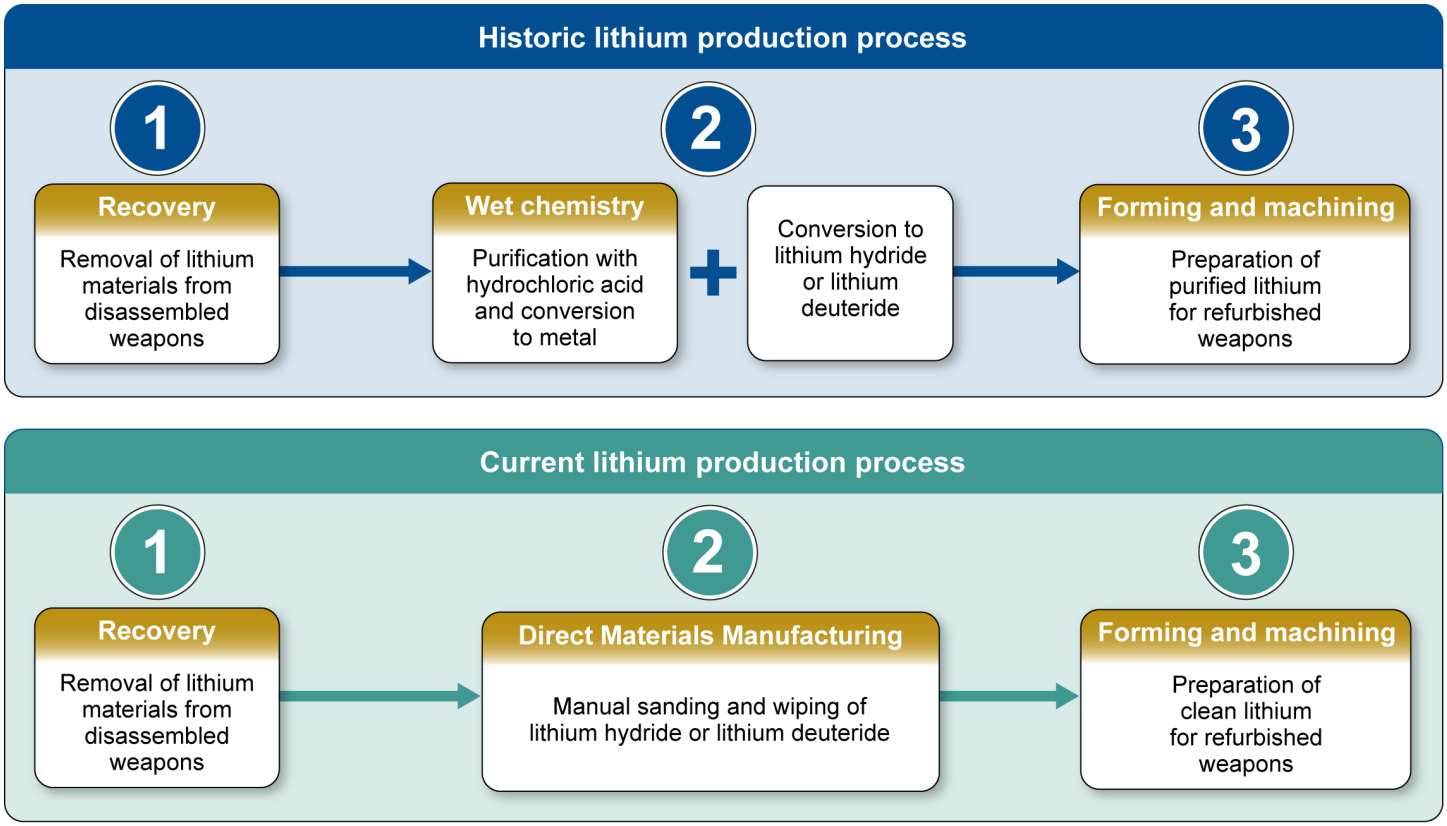
[13]Both the Pantex Plant and the Y-12 site are operated by Consolidated Nuclear Security, LLC.

maintenance, refurbishment, and dismantlement of nuclear weapons—to include overseeing Y-12's plans for meeting lithium demand.

Lithium Production

The lithium production process at NNSA's Y-12 National Security Complex involves multiple steps and requires specialized equipment and a controlled environment, according to NNSA's lithium production strategy. The lithium production process can be broken down into three stages: (1) lithium recovery from disassembled weapons, (2) lithium purification or cleaning, and (3) lithium forming and machining (see fig. 1).

Figure 1: Lithium Production (historic and current)



Source: GAO, based on National Nuclear Security Administration information. | GAO-15-525

Recovery. (Stage 1) The recovery of lithium source material from disassembled weapons is performed at Y-12 in building 9204-2E. Y-12

recovers lithium hydride and deuteride from CSAs it receives from the Pantex Plant.

Historic purification process. (Stage 2) The historic purification process relied on wet chemistry, conducted at Y-12 in building 9204-2. Using wet chemistry Y-12 purified the lithium hydride and deuteride (source material) recovered from dismantled weapons using hydrochloric acid. The resulting purified lithium chloride salt was then stored in 55-gallon drums at Y-12 until it was needed for use. The lithium chloride was subjected to electrolysis to produce lithium metal,[14] which was then placed in a reactor vessel with either hydrogen or deuterium gas for conversion to lithium hydride or deuteride. The bulk lithium hydride or deuteride resulting from this process was then ready for use as feedstock for the lithium forming and machining phase.

Current cleaning process. (Stage 2) The current cleaning process relies on DMM, which entails sanding and wiping the lithium hydride and deuteride (source material) removed directly from the disassembled weapons to remove impurities. This cleaned material becomes bulk material feedstock for the lithium forming and machining phase. The cleaning process is conducted in building 9202; the cleaned components are packaged and moved to building 9204-2 for forming and machining.

Lithium forming and machining. (Stage 3) Lithium forming and machining are conducted in building 9204-2 and involves preparing the purified or cleaned lithium feedstock for use in refurbished weapons. During this stage, the lithium hydride or deuteride (feedstock) is broken into pieces and fed into a crusher/grinder to pulverize it into a powder, which is then blended and loaded into molds for pressing. The resulting blanks are machined into high-precision components. Historically, the machine dust resulting from this process was purified using wet chemistry and reused. Now, Y-12 stores this dust for future use but cannot recycle it without wet chemistry capabilities.

[14]Electrolysis is a process by which electric current is passed through a substance to effect a chemical change. Electrolysis is used extensively in metallurgical processes, such as in extraction or purification of metals from ores or compounds and in deposition of metals from solution. Electrolysis of lithium chloride would produce metallic lithium and chlorine gas.

Qualification Process

Regardless of whether lithium undergoes DMM or wet chemistry, the resulting end product (i.e., lithium components suitable for refurbished weapons) must be qualified through a process approved by the design laboratories (Los Alamos and Lawrence Livermore National Laboratories).[15] Qualification entails testing for chemical and mechanical homogeneity, density, and tensile properties, among other things.[16] Although only the end product (lithium component) must be qualified, Y-12 prepares for qualification by evaluating the lithium material throughout the production process. Y-12 may evaluate the source material (i.e., lithium components from retired weapons), the processes used to produce lithium (i.e., cleaning, machining), and the feedstock for the forming and machining (i.e., the purified or cleaned lithium). Wet chemistry produced a homogeneous feedstock that only had to be evaluated once for use in a given weapon system in production, regardless of the source material. DMM feedstock, however, is not necessarily homogeneous and the source material, which may contain impurities, must be evaluated separately for each weapon system in production.

DOE's Capital Asset Acquisition Process and Mission Need Statement Development

DOE Order 413.3B governs NNSA's capital asset acquisition activities, including the Critical Decision (CD) process. The CD process breaks down capital acquisition into project phases that progress from a broad statement of mission need into well-defined requirements. Each critical decision point requires successful completion of the preceding phase and marks an authorization to increase the commitment of resources by DOE. Under Order 413.3B, the first two CDs—CD-0 (Approve Mission Need) and CD-1 (Approve Alternative Selection and Cost Range)—span the analysis of alternatives process; with the majority of the analysis of alternatives being conducted during CD-1 and ending with CD-1 approval.[17] CD-0 corresponds to the preconceptual design process.

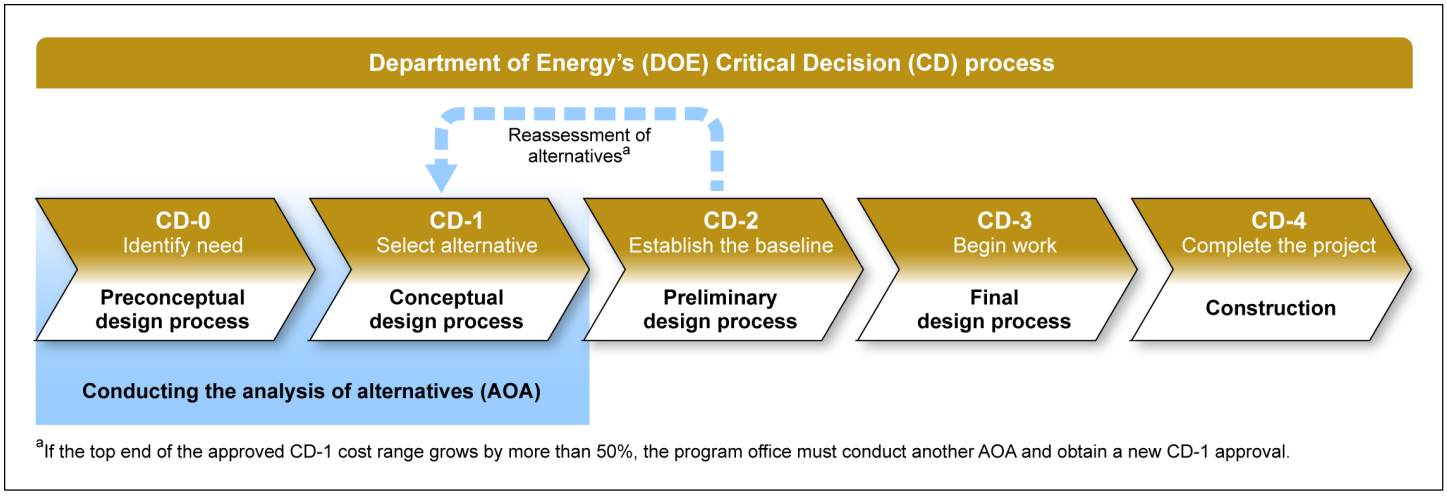
[15]Design agencies certify their review and acceptance of production agency processes through a Qualification Evaluation Release (QER), which authorizes use of a product or process. Los Alamos and Lawrence Livermore National Laboratories must review and accept Y-12's processes for their respective weapons systems.

[16]For example, qualification entails developing ASTM standards for each weapons system. ASTM International, formerly known as the American Society for Testing and Materials, specializes in the development and delivery of international voluntary consensus standards.

[17]GAO-15-37.

DOE's capital asset acquisition process, or its critical decision process, is depicted in figure 2.

Figure 2: DOE's Capital Asset Acquisition Process



Source: GAO analysis of DOE's Order 413.3B. | GAO-15-525

DOE's Order 413.3B and DOE's Mission Need Statement Guide (G 413.3-17) provide direction and guidance for preparing a mission need statement. A mission need statement identifies the capability gap between the current state of a program's mission and the mission plan. It is the first step in the identification and execution of a DOE capital asset project. DOE's Mission Need Statement Guide includes nonmandatory approaches for meeting requirements and is not intended to be a requirements document. The purpose of the guide is to provide suggested content, definitions, and examples for creating a mission need statement that fulfills DOE Order 413.3B. Suggested content, according to the guide, includes, among other things (1) a description of the capability gap, (2) alternatives, or approaches, for addressing the mission need, and (3) a section for estimated cost and schedule ranges to acquire various alternatives.

NNSA's Lithium Production Strategy

NNSA's lithium production strategy involves developing new lithium production capabilities in the long term and using existing capabilities until these long-term capabilities are available. As discussed previously, the lithium production strategy calls for the design and construction of a new lithium production facility that would provide lithium production capabilities

beyond 2025. To that end, NNSA began the process of identifying a mission need for lithium capabilities in June 2014—the first step in the identification and execution of a DOE project—and finalized its mission need statement in January 2015.

NNSA's lithium production strategy for meeting lithium demand through 2025 includes five key elements: (1) increasing DMM cleaning capabilities and qualifying additional weapon systems to serve as lithium source material; (2) converting its inventory of lithium chloride into a usable form; (3) procuring available enriched lithium from an outside source; (4) implementing new technologies for, among other things, purifying machine dust; and (5) sustaining the existing facility through investments in infrastructure and operations to support lithium operations until a new facility is available.[18] The strategy also discusses challenges associated with implementing the strategy and actions that may mitigate these challenges.

NNSA Has Identified Various Challenges in Its Lithium Production Strategy

NNSA has identified various challenges in its lithium production strategy that may impact its ability to meet demand for lithium through and beyond 2025. NNSA has also identified actions that may mitigate these challenges.

NNSA Has Identified Challenges in Three Key Areas

The challenges pertain to three key areas: (1) insufficient supply of qualified lithium material, (2) catastrophic failure of buildings or equipment, and (3) potential delays in the availability of the proposed new lithium production facility (Lithium Production Capability facility).

Insufficient Supply of Lithium Material

NNSA has identified challenges associated with its strategy for ensuring that it has a sufficient supply of lithium material for defense program requirements through and beyond 2025. NNSA's supply of currently qualified lithium—lithium approved for use in weapon systems in refurbishment—will run out by 2020, according to the lithium production

[18]Y-12's January 2015 "Lithium Materials Production Transition Implementation Plan" summarizes each of the elements of the lithium production strategy. It also presents challenges associated with the strategy and mitigating actions intended to address these challenges.

strategy. In April 2015, NNSA officials told us that due to additional recent increases in demand, with no additional action to increase supply, this date has moved to 2018. According to Y-12 officials, about 50 percent of lithium is lost as machine dust in the machining process. Y-12 currently stores this dust for future use but cannot recycle it without certain wet chemistry capabilities. As a result, reliance on DMM alone will require approximately twice the source lithium from dismantled weapons than when wet chemistry is in operation. According to NNSA's lithium production strategy, however, increasing the supply of qualified lithium material may be a challenge for the following three reasons.

- First, dismantlement and disassembly schedule changes could delay or reduce the availability of lithium source material. Because NNSA's weapons dismantlement and disassembly decisions drive the availability of source material for DMM, changes to the schedules could impact the available supply of lithium.[19] According to Y-12 documents, NNSA's decisions to hold certain weapons components for eventual, but not immediate, reuse and to hold some in its strategic reserve have decreased the amount of lithium material available.[20] We previously found that NNSA's retention of certain weapons components and uncertain policy decisions regarding when some will be released for disassembly pose challenges to Y-12's ability to plan for future work.[21] Y-12 officials told us that they estimate future supply and base their planning on NNSA's dismantlement and disassembly schedule. However, uncertainty in the dismantlement and disassembly schedule may make it difficult to determine whether a sufficient supply of lithium is available for production.

[19]The decision to retire and subsequently dismantle nuclear weapons is tied to a high-level policy-making process establishing the U.S. nuclear stockpile's size and composition. NNSA uses information from this process to develop a *Nuclear Weapons Production and Planning Directive*, which includes long-term schedules for weapons dismantlement at the Pantex plant and disassembly at Y-12, as well as plans for nuclear weapon life extension programs and other stockpile-related activities executed by the agency.

[20]Nuclear components from dismantled weapons may be retained for eventual reuse, disposed of, or retained as a "strategic reserve" to ensure an adequate supply of lithium material for the weapons program in the future.

[21]Nuclear weapons dismantlement is a multistage process that requires extensive planning, utilizes a mix of facilities, and relies on a number of supporting NNSA programs. See GAO, *Nuclear Weapons: Actions Needed by NNSA to Clarify Dismantlement Performance Goal,* GAO-14-449 (Washington, D.C.: Apr. 30, 2014).

- Second, it may be more difficult to qualify lithium source material under Y-12's current cleaning process (DMM)—which may reduce the supply of source material available. Because source material undergoing DMM is purified only through a surface cleaning (i.e., manual sanding and wiping), according to the lithium production strategy, ensuring that the end product can be chemically certified—part of the qualification—requires that the source material be selected from a supply of recycled lithium components known to possess sufficient chemical purity to meet specifications. In other words, not all potential sources of lithium will be of sufficient purity or quality, which may further reduce the available supply.
- Third, it is more time-consuming to qualify lithium under Y-12's current cleaning process (DMM). According to Y-12 officials, qualifying lithium produced through DMM is more rigorous and time-consuming because the lithium source material recovered from each dismantled weapon system must be qualified separately. In addition, the feedstock—cleaned lithium ready for machining—must also be qualified. In contrast, when source material is purified using wet chemistry, the resulting feedstock is homogeneous and therefore the source material and feedstock only have to be qualified once for use in a given weapon system.

According to NNSA officials, with no additional action to increase supply, Y-12 may run out of qualified lithium by 2018. According to the lithium production strategy, Y-12 has plans and schedules in place to qualify, by the end of fiscal year 2017, additional weapons systems as sources for material. This would extend the supply of qualified DMM source material into the early 2020s. Y-12 officials said that they are working with the design laboratories to streamline the qualification process—for example, to qualify multiple weapon systems as sources of DMM feedstock to multiple weapon systems in refurbishment.

Catastrophic Failure of Buildings or Equipment

NNSA has identified the catastrophic failure of buildings or equipment as a challenge that could impact its ability to meet lithium demand until a new facility is available. For example, building 9204-2 is a key facility for lithium production. However, according to the lithium production strategy, the building, together with much of the equipment inside, has deteriorated and is beyond its expected life span. Specifically, the building has experienced both internal and external deterioration of concrete in the roofs, walls, and ceilings from exposure to corrosive liquids and processing fumes (see fig. 3). In March 2014, for example, a 300-pound slab of concrete fell from the ceiling into an active work area—an area that has since been roped off and is no longer in use (see fig. 4). Moreover, according to the lithium production strategy, the building was

not built in accordance with current codes and standards, is costly to operate, and has multiple vulnerabilities that could threaten the entire production process. Y-12's operations health risk assessments rate the equipment for two parts of the lithium production process conducted in 9204-2 as among the highest health risks at Y-12, according to the mission need statement for lithium production.

Figure 3: Corroded Equipment in Building 9204-2

Source: National Nuclear Security Administration. | GAO-15-525

Figure 4: Building 9204-2 at Y-12 Where a 300-Pound Slab of Concrete from the Ceiling Collapsed in March 2014

Source: National Nuclear Security Administration. | GAO-15-525

Although certain parts of the DMM process are conducted in a different building (building 9202), moving material between buildings is inefficient and may not be sustainable if the use of DMM is to increase, according to the lithium production strategy. Specifically, DMM components are cleaned—manually sanded—in a closed container in building 9202. The cleaned components are packaged in sealed bags, placed in drums, and moved to building 9204-2 for crushing and grinding. As future demand increases and Y-12 meets this demand through increased use of DMM, according to the lithium production strategy, this process will strain the capacity of building 9202 and DMM cleaning capabilities will have to be installed in building 9204-2.

Potential Delays in the Availability of the Proposed Lithium Production Capability Facility

NNSA has also identified as a challenge, potential delays in the availability of the proposed Lithium Production Capability facility. According to the lithium production strategy, because building 9204-2 has been deteriorating rapidly in recent years and cannot be reasonably upgraded to ensure an enduring source of lithium components for the stockpile beyond 2025, the design and construction of a new lithium production facility that would provide lithium production capabilities beyond 2025 is called for. Key elements of the strategy—such as

qualifying additional weapon systems for use as source material for DMM in order to meet demand for lithium—are based on the assumption that the Lithium Production Capability facility will be designed and constructed from 2016 to 2023 and ready for use by 2025. However, the lithium production strategy notes that fiscal constraints could affect the availability of this facility in 2025. We have previously found that NNSA construction projects often experience schedule delays.[22]

NNSA Has Identified Mitigating Actions to Address Some Challenges

To address the challenges it has identified, NNSA has identified several mitigating actions, which are presented in its lithium production strategy. Many of the same five elements discussed previously that make up the strategy for meeting demand for lithium through 2025 are also cited as mitigating actions intended to address challenges. Specifically, the lithium production strategy cites varying combinations of the following mitigating actions:

- Accelerate the design and construction of the Lithium Production Capability facility.
- Procure lithium from outside sources.
- Pursue outsourcing of lithium materials production.
- Convert existing inventory of lithium chloride to a usable form of lithium.
- Identify and qualify additional weapon systems for use as lithium source material for DMM.
- Utilize leased or third party financed facilities for lithium production activities.
- Develop and deploy new purification and material production technologies and techniques, including machine dust recycling.
- Negotiate a dismantlement schedule that aligns the selected units for dismantlement and the dismantlement schedule with mission needs.
- Maintain spares and develop required specifications for backup of key process equipment.
- Maintain technical and operational skills and knowledge by establishing a prototype wet chemistry operation.

The mitigating actions identified in the lithium production strategy are in early stages of development, and may bring additional challenges. For example, the strategy offers as a mitigating action the conversion of Y-

[22]See GAO-15-126, GAO-15-37, GAO-14-231, and GAO-13-533.

12's existing inventory of lithium chloride to lithium metal. However, NNSA cannot convert this material to lithium metal without restarting certain steps in the wet chemistry process or outsourcing the conversion of lithium chloride to lithium metal to an external vendor. With either option, as stated in the lithium production strategy, after the stored lithium chloride is converted to lithium metal, Y-12 plans to convert the lithium metal to lithium hydride on-site. According to the strategy, this would require a significant investment in the existing facility (building 9204-2) to address deferred maintenance and refurbish key equipment.

NNSA's Mission Need Statement for a Lithium Production Capability Is Not Fully Independent of a Particular Solution

NNSA did not develop a mission need statement for lithium production that is fully independent of a particular solution, contrary to the direction of DOE Order 413.3B. In January 2015, NNSA program officials submitted a statement of mission need, or CD-0, for lithium production for approval to the Deputy Administrator for Defense Programs, NNSA. This statement was approved on June 10, 2015. As part of the preconceptual design (CD-0) approval process, the mission need—which DOE defines in Order 413.3B as a credible gap between current capabilities and those required to meet the goals articulated in the strategic plan—and functional requirements—the general parameters that the selected alternative must have to address the mission need—must be identified. The order directs that the mission need should be independent of a particular solution. According to the order and related guidance, this approach allows a program office the flexibility to explore a variety of solutions. NNSA's mission need statement for lithium production, however, expresses the gap in terms of a particular solution—specifically, a new facility.

The Lithium Production Capability mission need statement is a 24-page document that includes, among other things, a description of the capability gap, alternatives for addressing its mission need, and a section for estimated cost and schedule ranges. Specifically, the document describes the capability gap that exists due to the deteriorating condition of building 9204-2 and states that the mission need for lithium production is aligned with NNSA's strategic plans—citing passages from NNSA's strategic plan. For example, the document describes the primary capability gap as the loss of Y-12's wet chemistry process due to the degraded condition of building 9204-2. The mission need statement details this gap in terms of functional and operational gaps, including (1) the continued physical deterioration of the building where lithium operations are being conducted and the resulting shortage of components; (2) the continuous deterioration of mechanical and electrical systems in the existing facility (building 9204-2), with increasing

unsustainable energy costs and greenhouse gas emissions, which will affect controlled work environments, ongoing operations, and delivery of mission work; (3) the inability to introduce new technologies into the facility due to its degraded condition; and (4) the facility's noncompliance with current codes. NNSA's mission need statement also characterizes the capability gap in terms of demand for lithium but devotes most of the mission need statement to describing the current condition of its existing lithium production facility. According to the mission need statement, specific lithium requirements are contained in the Fiscal Year 2015 Production and Planning Directive and the classified annexes of the Stockpile Stewardship and Management Plans. This is the only characterization in the mission need statement of the capability gap in terms of demand for lithium. The remaining discussion describes the capability gap in terms of the degraded condition of building 9204-2. Order 413.3B and related guidance do not state that the capability gap should be defined in terms of program requirements.

NNSA's mission need statement lists seven alternatives for addressing its mission need:

- do nothing,
- refurbish/repurpose one or more of the existing Y-12 facilities,
- lease off-site suitable facilities,
- secure third-party financing to build one or more new facilities,
- outsource the lithium processing capability,
- consider new modular facilities to transfer missions from existing facility or facilities that are beyond repair, and
- build a complete and functioning facility at Y-12.

According to DOE Order 413.3B, the mission need should be independent of a particular solution, and should not be defined by the equipment, facility, technological solution, or physical end-item. In addition, the DOE order states that the mission need should be described in terms of the general parameters of the solution, how it fits within the mission of the program, and why it is critical to the overall accomplishment of the department's mission, including the benefits to be realized. However, some of language used and information included in NNSA's mission need statement suggests that NNSA may have given preference to a single alternative—building the Lithium Production Capability facility at Y-12—before identifying a mission need and conducting an analysis of alternatives. For example, the section describing the benefits from closing the capability gap includes phrases such as,

- an alternative facility that is code compliant, and
- replacing the existing facilities with an alternative facility will significantly improve NNSA's capability and efficiency in performing its Stockpile Stewardship and other national security missions at Y-12.

In addition, NNSA included in its mission need statement rough-order-of-magnitude estimates of the project cost and schedule ranges for only one alternative—build and equip a functioning facility at Y-12. According to its mission need statement, NNSA estimates that construction of the new facility will cost $302 million to $646 million (with $431 million "likely") and includes a schedule range estimate for project completion between fiscal year 2024 and fiscal year 2026.[23] Providing such estimates for only one alternative is contrary to DOE guidance that states that a mission need statement should provide a rough order of magnitude estimate of the project cost and schedule ranges to acquire various capability alternatives that address the stated mission need.[24]

NNSA officials said that they did not include cost and schedule estimates for other alternatives because there is no DOE requirement to do so. These officials acknowledged that DOE guidance states that a mission need statement is to provide cost estimates for various alternatives, but noted that this provision is not a requirement.[25] NNSA officials noted that they plan to analyze other alternatives for meeting the mission as part of CD-1. However, because NNSA's mission need statement did not include rough-order-of-magnitude estimates of the project cost and schedule ranges for other alternatives, it appears to be biased toward a particular solution and may introduce bias into the rest of the analysis of alternatives process. This, in turn, could undermine the purpose of the CD process: to help ensure that NNSA chooses the best alternative that satisfies the mission need on the basis of selection criteria, such as safety, cost, or schedule.

[23]DOE's fiscal year 2016 budget request for NNSA has placeholders totaling $125 million for fiscal years 2017-2020 for this facility.

[24]DOE's Mission Need Statement Guide (G 413.3-17).

[25]The provision to include cost and schedule estimates for all alternatives is in DOE's Mission Need Statement Guide (G 413.3-17), but not in DOE Order 413.3B, *Program and Project Management (PM) for the Acquisition of Capital Assets*. DOE states at the beginning of its Mission Need Statement Guide (G 413.3-17) that it includes nonmandatory approaches for meeting requirements and that the guide is not a requirements document.

Giving preference to a particular solution may exclude serious consideration of other potential viable alternatives. In our December 2014 report on the analysis of alternatives process applied by NNSA, we found that conducting such an analysis without a predetermined solution is a best practice.[26] In that report, DOE and NNSA officials acknowledged that unreliable analysis of alternatives is a risk factor for major cost increases and schedule delays for NNSA projects.[27] We recommended that DOE 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, but we noted in the report that DOE's unspecified, open-ended date for responding to this recommendation may have indicated a lack of urgency or concern about the need to implement these recommendations.

Conclusions

We are encouraged that NNSA officials plan to analyze alternatives for meeting the mission need for lithium production requirements as they proceed with the conceptual design phase of their capital asset acquisition process. However, by completing its preconceptual design (CD-0) phase with a mission need statement that is not fully independent of a particular solution, NNSA is not following DOE's project management order and may limit objective consideration of the other six alternatives identified for meeting mission requirements. Having prepared cost and schedule estimate ranges for only one of the seven alternatives—thus demonstrating preference for that alternative—may affect the rest of NNSA's analysis of alternatives process. This preference could potentially undermine NNSA's ability to choose the best alternative that satisfies the mission need.

Recommendation for Executive Action

To improve NNSA's ability to choose the best alternative that satisfies the mission need for lithium production, we recommend that the Secretary of Energy request that NNSA's Deputy Administrator for Defense Programs take steps to ensure that NNSA objectively consider all alternatives,

[26]GAO-15-37. We also found in that report that neither DOE's analysis-of-alternatives requirements nor its guidance conform to best practices and, therefore, DOE does not have assurance that applying these requirements and guidance may lead to reliable AOAs.

[27]GAO-15-37.

without preference for a particular solution, as it proceeds with the analysis of alternatives process. Such steps could include clarifying the statement of mission need for lithium production so that it is independent of a particular solution.

Agency Comments and Our Evaluation

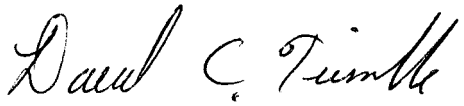
We provided a draft of this product to NNSA for comment. NNSA provided written comments, which are reproduced in full in appendix II, as well as technical comments, which we incorporated in our report as appropriate. In its comments, NNSA neither agreed nor disagreed with our recommendation. However, it stated that our conclusion that the agency has pre-selected an alternative for the Lithium Production Capability is not correct. It further stated that NNSA will conduct an Analysis of Alternatives, beginning in July 2015, and that it fully intends to evaluate multiple options, such as the use of an existing facility, the use of a new facility, or outsourcing.

We maintain that our conclusion is well supported. We did not conclude that NNSA would not conduct an analysis of alternatives, but that its mission need statement for lithium production was not fully independent of a particular solution, and that demonstrating preference for one alternative—a replacement facility for lithium production—may affect the rest of NNSA's analysis of alternatives process and could potentially undermine NNSA's ability to choose the best alternative that satisfies the mission need. Such a focus may introduce a bias into the analysis alternatives process. We stand by our recommendation that NNSA objectively consider all alternatives, without preference for a particular solution, as it proceeds with the analysis of alternatives process.

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

If you or your staff members have any questions about this report, please contact me at (202) 512-3841 or trimbled@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found

on the last page of this report. GAO staff who made key contributions to this report are listed in appendix III.



David C. Trimble
Director, Natural Resources and Environment

List of Committees

The Honorable John McCain
Chairman
The Honorable Jack Reed
Ranking Member
Committee on Armed Services
United States Senate

The Honorable Lamar Alexander
Chairman
The Honorable Dianne Feinstein
Ranking Member
Subcommittee on Energy and Water Development, and Related Agencies
Committee on Appropriations
United States Senate

The Honorable Mac Thornberry
Chairman
The Honorable Adam Smith
Ranking Member
Committee on Armed Services
House of Representatives

The Honorable Mike Simpson
Chairman
The Honorable Marcy Kaptur
Ranking Member
Subcommittee on Energy and Water Development and Related Agencies
Committee on Appropriations
House of Representatives

Appendix I: Objectives, Scope, and Methodology

To describe the challenges the National Nuclear Security Administration (NNSA) has identified with its lithium production strategy, we reviewed NNSA and Y-12 National Security Complex documents related to lithium production and lithium requirements. These documents included the Lithium Production Capability (LPC) CD-0 package—comprising LPC Mission Need Statement, Y-12 National Security Complex and the LPC Program Requirements Document; the Lithium Materials Production Transition Implementation Plan; the Y-12 Materials Production Strategy; and the Building 9204-2 Ops Plan for Sustainment Activities. We also conducted a site visit to Y-12 and interviewed NNSA and Y-12 officials, as well as officials from the weapons design laboratories—Los Alamos and Lawrence Livermore National Laboratories. We coordinated with the Department of Energy's (DOE) Office of the Inspector General (DOE-IG), which is/was conducting a related audit, to scope our work. Specifically, DOE-IG conducted an in-depth analysis of Y-12's forecasting of lithium supply and demand, coordination among NNSA program offices responsible for funding and implementation of lithium matters, facility conditions and maintenance and their impact on lithium production, and Y-12's lithium production strategy.

To determine the extent to which NNSA developed an independent mission need statement for lithium production independent of a particular solution, in accordance with DOE direction and guidance, we identified the requirements and guidance by reviewing DOE Order 413.3B ("Program and Project Management for the Acquisition of Capital Assets") and DOE G 413.3-17 ("Mission Need Statement Guide"). We also reviewed our previous report entitled DOE and NNSA Project Management: Analysis of Alternatives Could Be Improved by Incorporating Best Practices[1] to better understand the analysis of alternatives process. We then reviewed the Lithium Production Capability (LPC) CD-0 package; the Lithium Materials Production Transition Implementation Plan; the Y-12 Materials Production Strategy; and the Building 9204-2 Ops Plan for Sustainment Activities, and compared these documents with the direction and guidance. We also conducted a site visit to Y-12 and interviewed NNSA and Y-12 officials regarding the mission need statement and overall strategy.

[1]GAO-15-37.

We conducted this performance audit from October 2014 to July 2015 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 Department of Energy

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

July 1, 2015

Mr. David Trimble
Director, Natural 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 titled "DOE Project Management: NNSA Should Ensure Equal Consideration of Alternatives for Lithium Production" (GAO-15-525). The National Nuclear Security Administration (NNSA) appreciates GAO's efforts in helping to highlight the need for lithium materials sustainment.

We believe, however, the conclusion articulated in the draft report that the NNSA has pre-selected an alternative for the Lithium Production Capability is incorrect. Consistent with the Secretary's December 2014 *Improving the Department's Management of Projects* policy and June 2015 *Project Management Policies and Principles* memo, NNSA will conduct an Analysis of Alternatives (AoA) independent from the contractor organization prior to Critical Decision 1. NNSA fully intends to evaluate multiple options such as the use of an existing facility, the use of a new facility, or outsourcing. The AoA will begin on July 7, 2015.

We have also provided technical and general comments under separate cover for your consideration to enhance the clarity and 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

Appendix III: GAO Contact and Staff Acknowledgments

GAO Contact

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

Staff Acknowledgments

In addition to the individual named above, Diane LoFaro, Assistant Director; Alisa Beyninson; Kevin Bray; R. Scott Fletcher; Cynthia Norris; Steven Putansu; Dan Royer; and Kiki Theodoropoulos made key contributions to this report.