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MODERNIZING THE NUCLEAR SECURITY ENTERPRISE

A Complete Scope of Work Is Needed to Develop Timely Cost and Schedule Information for the Uranium Program

Accessible Version

GAO-17-577

GAO Highlights

Highlights of GAO-17-577, a report to congressional committees

Why GAO Did This Study

Uranium is crucial to our nation's ability to maintain its nuclear weapons stockpile. NNSA processes uranium to meet this need. In 2004, NNSA began plans to build a new UPF that would consolidate capabilities currently housed in deteriorating buildings; by 2012, the project had a preliminary cost of $4.2 billion to $6.5 billion. To control rising costs, NNSA changed its approach in 2014 to reduce the scope of the new UPF and move uranium processing capabilities once intended for the UPF into existing buildings. The broader uranium program also includes the needed repairs and upgrades to these existing buildings.

The National Defense Authorization Act for Fiscal Year 2013 as amended includes a provision for GAO to periodically assess the UPF. This is the fifth report and (1) describes the status of NNSA's efforts to develop a revised scope of work, cost estimate, and schedule for the UPF project, and (2) examines the extent to which NNSA has developed a complete scope of work, life-cycle cost estimate, and integrated master schedule for the overall uranium program. GAO reviewed program documents on planning, strategy, cost, and implementation and interviewed program officials to examine the program's scope, cost and schedule.

What GAO Recommends

GAO recommends that NNSA set a time frame for completing the scope of work, life-cycle cost estimate, and integrated master schedule for the overall uranium program. NNSA generally agreed with the recommendation and has ongoing efforts to complete these actions.

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MODERNIZING THE NUCLEAR SECURITY ENTERPRISE

A Complete Scope of Work Is Needed to Develop Timely Cost and Schedule Information for the Uranium Program

What GAO Found

The National Nuclear Security Administration (NNSA) has made progress in developing a revised scope of work, cost estimate, and schedule for its project to construct a new Uranium Processing Facility (UPF), according to NNSA documents and program officials. As of May 2017, NNSA had developed and approved a revised formal scope of work, cost, and schedule baseline estimates for four of the seven subprojects into which the project is divided. NNSA expects to approve such baseline estimates for the other three—including the two largest subprojects—by the second quarter of fiscal year 2018. NNSA also plans to validate the estimates by then through an independent cost estimate.

NNSA, however, has not developed a complete scope of work, life-cycle cost estimate (i.e., a structured accounting of all cost elements for a program), or integrated master schedule (i.e., encompassing individual project schedules) for the overall uranium program, and it has no time frame for doing so. In particular, it has not developed a complete scope of work for repairs and upgrades to existing buildings in which NNSA intends to house some uranium processing capabilities and has not done so for other key program elements. For example:

- The scope of work for a portion of the upgrades and repairs will not be determined until after fiscal year 2018, when NNSA expects to conduct seismic and structural assessments to determine what work is needed to address safety issues in existing buildings.
- NNSA has developed an initial implementation plan that roughly estimates a cost of $400 million over the next 20 years for the repairs and upgrades, but a detailed scope of work to support this estimate is not expected to be fully developed except on an annual basis in the year(s) that immediately precedes the work.

Because NNSA has not developed a complete scope of work for the overall uranium program, it does not have the basis to develop a life-cycle cost estimate or an integrated master schedule. Successful program management depends in part on developing a complete scope of work, life-cycle cost estimate, and an integrated master schedule, as GAO has stated in its cost estimating and schedule guides. In previous work reviewing other NNSA programs, GAO has found that when NNSA did not have a life-cycle cost estimate based on a complete scope of work, the agency could not ensure its life-cycle cost estimate captured all relevant costs, which could result in cost overruns. The revised cost estimate that NNSA is developing for the new UPF will be an essential component of a life-cycle cost estimate for the overall program. However, for other program elements, NNSA has either rough or no estimates of the total costs and has not set a time frame for developing these costs. Federal internal control standards call for management to use quality information to achieve an entity's objectives, and among other characteristics, such information is provided on a timely basis. Without setting a time frame to complete the scope of work and prepare a life-cycle cost estimate and integrated master schedule for the program, NNSA does not have reasonable assurance that decision makers will have timely access to essential program management information—risking unforeseen cost escalation and delays.

Contents

Abbreviations

BOP	Business Operating Procedure
CD	Critical Decisions
DOE	Department of Energy
NNSA	National Nuclear Security Administration
TRL	Technology Readiness Levels
UPF	Uranium Processing Facility project

U.S. GOVERNMENT ACCOUNTABILITY OFFICE
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Congressional Committees

Uranium is crucial to our nation's ability to maintain its nuclear weapons stockpile and fuel the U.S. Navy's fleet of nuclear-powered aircraft carriers and submarines. To transform uranium ore into a form that can be used for these purposes, uranium goes through a number of steps that include mining, conversion, and enrichment. Conversion is the process of converting mined natural uranium to a gas that can be used for enrichment, and enrichment is the process of separating uranium-235—the form, or isotope, that undergoes fission to release enormous amounts of energy in nuclear reactors and weapons—from much of the uranium-238, the form more prevalent in natural uranium, to increase the concentration of uranium-235. The National Nuclear Security Administration (NNSA), an agency within the Department of Energy (DOE), is responsible for meeting national needs for enriched and depleted uranium (a byproduct of the enrichment process) in support of the nuclear weapons stockpile and the Navy, as part of NNSA's broader nuclear security missions.[1] Enriched uranium is processed, for example, into components that support the nation's nuclear weapons stockpile and re-processed when components eventually need to be replaced. However, some of NNSA's uranium processing facilities—located at the Y-12 National Security Complex in Oak Ridge, Tennessee, and built in the 1940s and 1950s—are outdated and deteriorating, according to NNSA and DOE officials and documents. In addition, DOE's Office of Inspector General reported in November 2016 on NNSA's aging uranium

[1]The enrichment process results in two principal products: (1) enriched uranium hexafluoride, which can be further processed for specific uses, such as nuclear weapons or fuel for power plants, and (2) leftover "tails" of uranium hexafluoride, which also are called depleted uranium because the material is depleted in uranium-235 (i.e., uranium-235 concentrations of less than 0.7 percent) compared with natural uranium. NNSA is not currently enriching uranium. For additional information on the steps of the nuclear fuel cycle, see GAO, *Department of Energy: Interagency Review Needed to Update U.S. Position on Enriched Uranium That Can Be Used for Tritium Production,* GAO-15-123 (Washington, D.C.: Oct. 14, 2014).

infrastructure, which the office found poses risks to NNSA's ability to meet its missions in the future.[2]

In 2004, NNSA initiated plans for the construction of a new Uranium Processing Facility (UPF), a more modern facility that would consolidate Y-12's uranium processing capabilities into a single facility. NNSA's efforts to modernize its uranium capabilities, however, have experienced scope of work changes, cost increases, and schedule delays. As we have previously found, NNSA has experienced ongoing problems in contract and project management, including its modernization of uranium processing capabilities, which have resulted in our designating these activities as at high risk of waste, fraud, and abuse.[3] In June 2012, the Deputy Secretary of Energy approved $4.2 billion to $6.5 billion in funding to build the UPF. One month later, the UPF contractor concluded that the UPF's processing equipment would not fit into the UPF facility as designed. Concerned about cost growth and budget constraints for construction of the facility, NNSA's Acting Administrator in 2014 directed that a peer review team be established to develop and recommend an alternative approach to meet specific NNSA objectives. In April 2014, the peer review team recommended that NNSA develop an integrated uranium program to include construction of a new, smaller UPF with fewer capabilities; infrastructure repairs and upgrades for existing Y-12 facilities; and further development of certain technologies that are

[2]Department of Energy, *Office of Inspector General, Management Challenges at the Department of Energy—Fiscal Year 2017,* OIG-SR-17-02 (Washington, D.C.: Nov. 16, 2016).

[3]GAO, *High-Risk Series: Progress on Many High-Risk Areas, While Substantial Efforts Needed on Others,* GAO-17-317 (Washington, D.C.: Feb. 15, 2017). We designated DOE's contract management—which includes both contract administration and project management—as a high-risk area in 1990 because DOE's record of inadequate management and oversight of contractors had left the department vulnerable to fraud, waste, abuse, and mismanagement. In January 2009, to recognize progress made by DOE's Office of Science, we narrowed the focus of its high-risk designation to two DOE program elements—the Office of Environmental Management (EM) and NNSA. In February 2013, we further narrowed the focus of the high-risk designation to EM and NNSA's major contracts and projects—those with an estimated cost of $750 million or more—to acknowledge progress made in managing projects with an estimated cost below that amount. In our 2017 report, we found that EM and NNSA have demonstrated limited progress in contract management, particularly in the area of financial management, and have struggled to stay within cost and schedule estimates for some major projects.

planned for eventual use within Y-12's new buildings and existing facilities.[4]

Since 2014, NNSA has planned for the modernization of its uranium processing capabilities under the auspices of a broader uranium program. However, DOE's and NNSA's requirements for program management are evolving and, as we have previously reported, are somewhat less well defined than those for project management.[5] (See the list of related GAO products at the end of this report.) For example, in 2014, we found that DOE's order on program and project management, which also applies to NNSA, requires life-cycle cost estimates for projects, but it does not explicitly require that life-cycle cost estimates be developed for programs that include both construction projects and other efforts and activities not related to construction.[6]

According to our review of NNSA documents and interviews with NNSA officials, NNSA's modernization of uranium processing capabilities may cost several billions of dollars and take at least 2 decades to execute. Successful program management depends, in part, on developing a complete scope of work, life-cycle cost estimate, and an integrated master schedule,[7] as we have stated in our cost estimating and schedule

[4]Oak Ridge National Laboratory, managed by UT-Battelle, LLC, for the U.S. Department of Energy, *Final Report of the Committee to Recommend Alternatives to the Uranium Processing Facility Plan in Meeting the Nation's Enriched Uranium Strategy* (Oak Ridge, Tennessee: Apr. 15, 2014).

[5]In 2004, NNSA established its policy for conducting program management activities, which defined "program" as a group of ongoing activities and related projects conducted with a defined set of resources and managed in a coordinated way to achieve mission objectives and obtain benefits not available from managing them individually. NNSA cancelled this policy in 2013 but did not establish a new policy that addressed key internal control standards or leading practices related to program management. NNSA's Office of Defense Programs has its own program management policy, which it last updated in 2005. See GAO, *Program Management: DOE Needs to Develop a Comprehensive Policy and Training Program*, GAO-17-51 (Washington, D.C.: Nov. 21, 2016).

[6]See GAO, *Plutonium Disposition Program: DOE Needs to Analyze the Root Causes of Cost Increases and Develop Better Cost Estimates*, GAO-14-231 (Washington, D.C.: Feb. 13, 2014) and Department of Energy, *Program and Project Management for the Acquisition of Capital Assets*, DOE Order 413.3B (Washington, D.C.: Nov. 29, 2010). A life-cycle cost estimate provides an exhaustive and structured accounting of all resources and associated cost elements required to develop, produce, deploy, and sustain a particular program.

[7]An integrated master schedule is a document that integrates the planned work, the resources necessary to accomplish that work, and the associated budget for a program, as called for in best practices.

guides, which identify best practices.[8] These best practices call for the life-cycle cost estimate and integrated master schedule to reflect all activities necessary to accomplish a program's objectives—that is, the estimate and schedule should be based on a complete scope of work.[9] In our previous work reviewing other NNSA programs, we have found, for example, that when NNSA did not have a life-cycle cost estimate based on a complete scope of work, NNSA could not ensure that its life-cycle cost estimate captured all relevant costs, which could result in cost overruns.[10]

Section 3123(f) of the National Defense Authorization Act for Fiscal Year 2013, as amended by section 3126 of the National Defense Authorization Act for Fiscal Year 2014 and section 3118 of the Carl Levin and Howard P. "Buck" McKeon National Defense Authorization Act for Fiscal Year 2015, includes a provision for us to periodically review the new UPF, including any issues that we determine appropriate with respect to the requirements, cost, schedule, or technology readiness levels of the project.[11] This is our fifth report in response to section 3123(f), as

[8]We discuss best practices concerning the development of scope of work, cost estimates, and schedules in two guides. In March 2009, we issued a cost estimating guide, a compilation of cost estimating best practices drawn from across industry and government: GAO, *GAO Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Capital Program Costs*, GAO-09-3SP (Washington, D.C.: March 2009). In December 2015, we issued a schedule guide that develops the scheduling concepts introduced in our cost estimating guide and presents them as 10 best practices associated with developing and maintaining a reliable, high-quality schedule. GAO, *Schedule Assessment Guide: Best Practices for Project Schedules*, GAO-16-89G (Washington, D.C.: December 2015).

[9]According to the GAO best practice for capturing all activities, the schedule should reflect all activities as defined in the program's work breakdown structure, which defines in detail the work necessary to accomplish a project's objectives. In this report, we refer to such a work breakdown structure as the complete scope of work.

[10]GAO-14-231.

[11]National Defense Authorization Act for Fiscal Year 2013, Pub. L. No. 112-239, § 3123(f), 126 Stat. 1632, 2178-79 (2013), as amended by the National Defense Authorization Act for Fiscal Year 2014, Pub. L. No. 113-66, § 3126, 127 Stat. 672, 1063-64 (2013) and the Carl Levin and Howard P. "Buck" McKeon National Defense Authorization Act for Fiscal Year 2015, Pub. L. No. 113-291, § 3118, 128 Stat. 3292, 3889 (2014). The provision specifies that we review the UPF at such times as the Comptroller General, in consultation with congressional defense committees, determines appropriate, taking into consideration the project's critical decision points.

amended.[12] This report (1) describes the status of NNSA's efforts to develop a revised scope of work, cost estimate, and schedule for the new UPF project, and (2) examines the extent to which NNSA has developed a complete scope of work, life-cycle cost estimate, and integrated master schedule for the overall uranium program.

To describe the status of NNSA's efforts to develop a revised scope of work, cost estimate, and schedule for the new UPF project, we reviewed NNSA program planning documents, and any updates, concerning cost estimates and budgets and interviewed agency officials. In addition, we reviewed NNSA business operating procedures for developing program requirements and the steps NNSA has taken to identify and update requirements for the construction of the new UPF. We interviewed program officials to understand how they defined and adjusted program requirements and to understand the potential effects of any adjustments on NNSA's infrastructure plans.

To examine the extent to which NNSA has developed a complete scope of work, life-cycle cost estimate, and integrated master schedule for the overall uranium program, we reviewed NNSA program planning documents concerning cost estimates, budgets, and implementation of program activities, such as efforts to repair and upgrade existing Y-12 facilities. We also interviewed NNSA's uranium program manager and other program and contractor officials to understand how they defined and adjusted program requirements and the potential effects of any adjustments on NNSA's infrastructure plans. In addition, we met with officials from the Defense Nuclear Facilities Safety Board and reviewed its recent letter regarding facility safety issues at Y-12.[13] We reviewed the best practices for cost and schedule estimating, identified the benefits of developing a life-cycle cost estimate and integrated master schedule, and

[12]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); *Nuclear Weapons: Technology Development Efforts for the Uranium Processing Facility.* GAO-14-295 (Washington, D.C.: Apr. 18, 2014); *Nuclear Weapons: Information on Safety Concerns with the Uranium Processing Facility*, GAO-14-79R (Washington, D.C.: Oct. 25, 2013); *Nuclear Weapons: Factors Leading to Cost Increases with the Uranium Processing Facility,* GAO-13-686R (Washington, D.C.: July 12, 2013). For a list of our other work in this area, see the Related GAO Products page at the end of this report.

[13]The Defense Nuclear Facilities Safety Board was established by statute in 1988 to provide independent analysis, advice, and recommendations to the Secretary of Energy to inform him in providing adequate protection of public health and safety at defense nuclear facilities.

obtained information from the uranium program manager on the use of these selected best practices in managing the overall uranium program. We analyzed the information from documents we reviewed and officials we interviewed to determine the extent to which NNSA had developed a life-cycle cost estimate and an integrated master schedule as called for in our cost-estimating and schedule guides. Our review of the overall uranium program did not address U.S. efforts to establish a domestic uranium enrichment capability that provides low-enriched uranium,[14] which is managed under a separate program. Appendix I presents a more detailed description of the scope and methodology of our review.

We conducted this performance audit from November 2015 to September 2017, in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

This section describes (1) Y-12's role in NNSA's Nuclear Security Enterprise; (2) NNSA policy for setting program requirements; (3) best practices for program cost and schedule estimating; and (4) best practices for technology readiness.

Y-12's Role in NNSA's Nuclear Security Enterprise

NNSA is responsible for managing national nuclear security missions: ensuring a safe, secure, and reliable nuclear deterrent; supplying nuclear fuel to the Navy; and supporting the nation's nuclear nonproliferation efforts.[15] NNSA directs these missions but relies on management and operating contractors to carry them out and manage the day-to-day operations at each of eight sites that comprise the agency's nuclear

[14] DOE needs low-enriched uranium in order to produce tritium, a radioactive isotope of hydrogen used to enhance the power of U.S. nuclear weapons.

[15] The primary focus of nuclear nonproliferation efforts is reducing the threat posed by the proliferation of nuclear materials both domestically and internationally. The objective of the program is to make surplus enriched uranium unusable for weapons and dispose of it in a safe, secure, and environmentally acceptable manner.

security enterprise. These sites include laboratories, production plants, and a test site.[16]

Of NNSA's eight sites, the Y-12 National Security Complex in Tennessee is the primary site with enriched uranium processing capabilities. Y-12's primary mission is processing and storing uranium, processing nuclear fuel for the U.S. Navy, and developing technologies associated with those activities, including technologies for producing uranium-related components for nuclear warheads and bombs.[17] Construction of the 811-acre Y-12 site began in 1943 as part of the World War II-era Manhattan Project. Y-12's enriched uranium processing and storage capability is primarily housed in the following buildings:[18]

- **Building 9212:** This building was constructed in 1945, at the end of World War II, and includes a number of support and storage facilities related to uranium purification and casting.[19] According to a 2016 report from the DOE Office of Inspector General,[20] all of the various support and storage facilities of Building 9212 contain radioactive and chemical materials in sufficient quantities that an unmitigated release would result in significant consequences. These facilities do not meet current safety requirements for such facilities in that they cannot withstand a seismic event, high wind event, or aircraft crash. The

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

[17]Nuclear weapon systems in the U.S. stockpile include the W76-0/1 and W88-0 submarine-launched ballistic missile warheads; W78-0 and W87-0 Intercontinental ballistic missile warheads; B61-3/4/7/10/11 and B83-1 bombs; and the W80 air-launched cruise missile warhead. Enriched uranium is needed to produce components in each of these weapon systems.

[18]For the purposes of this report, the term "building" can include a facility, group of buildings, complex, or structure located at Y-12.

[19]Uranium purification is the process of converting uranium that contains relatively high amounts of impurities, such as carbon, into a more purified form. Uranium casting is the process that heats and casts uranium metal into various shapes.

[20]Department of Energy, Office of Inspector General, Office of Audits and Inspections, *Audit Report: Enriched Uranium Operations at the Y-12 National Security Complex*, DOE-OIG-16-13 (Washington, D.C.: July 2016).

shutdown of Building 9212 operations that have the highest nuclear safety risk at Y-12 is a key NNSA uranium program goal. Because of these risks, according to NNSA officials, NNSA has substantially reduced the risks from high-hazard materials, such as enriched uranium in organic and aqueous solutions, with a focus on materials located in Building 9212. As such, according to these officials, the remaining material at risk in Building 9212 has been reduced to a level significantly below the facility's administrative limit, and NNSA is implementing a four-phase exit strategy to systematically phase out mission dependency on Building 9212. The exit strategy includes actions necessary to remove material hold-up, complete all process relocations, transition personnel to the UPF, and complete post-operations cleanout of the facility, among other things, according to NNSA officials.

- **Building 9215:** This building was constructed in the 1950s and consists of three main structures. Specific activities in Building 9215 include fabrication activities, such as metal forming and machining operations for highly enriched uranium,[21] low-enriched uranium,[22] and depleted uranium. NNSA and others, such as the Defense Nuclear Facilities Safety Board, have raised concerns about the future reliability of the building, particularly as the amount of deferred maintenance in Building 9215 has steadily increased over the past several years.[23] According to NNSA officials, NNSA's contractor has hosted a series of technical evaluations that identified and prioritized needed infrastructure investments over the next 15 years, including within Building 9215, that are intended to ensure facility reliability through the 2040s. NNSA is reviewing these initial proposed investments.
- **Building 9204-2E:** This building, constructed in the late 1960s, is a three-story, reinforced concrete frame structure. Operations in this building include the assembly and disassembly of enriched uranium

[21]Highly enriched uranium is uranium enriched in the isotope uranium-235 to 20 percent or greater.

[22]Low-enriched uranium contains less than 20 percent and greater than 0.7 percent of uranium-235 and is considered to not be usable for weapons.

[23]According to DOE documents, maintenance is defined as the act of keeping fixed assets in acceptable condition, and deferred maintenance is maintenance that was not performed when it should have been or was scheduled to be performed. Examples of deferred maintenance at Y-12 include fire suppression system repairs, identification of and remediation for potential asbestos, electrical safety switch replacement, water and steam leaks, and numerous repairs to walls, doors, and floors in both Buildings 9212 and 9215.

components with other materials. Also, according to NNSA officials, radiography capabilities have been successfully relocated out of Building 9212 and installed in Building 9204-2E. The design used for this facility predates modern nuclear safety codes.

- **Building 9720-82 (also called the Highly Enriched Uranium Materials Facility):** This building became operational in January 2010. Built to current safety standards, the facility provides long-term storage of enriched uranium materials and accepts the transfer of some legacy enriched uranium from older facilities. According to NNSA officials, as part of the uranium program NNSA transferred 12.3 metric tons of enriched uranium to this facility in fiscal year 2015, 9.8 metric tons in fiscal year 2016, and anticipates transferring 6 metric tons in fiscal year 2017.

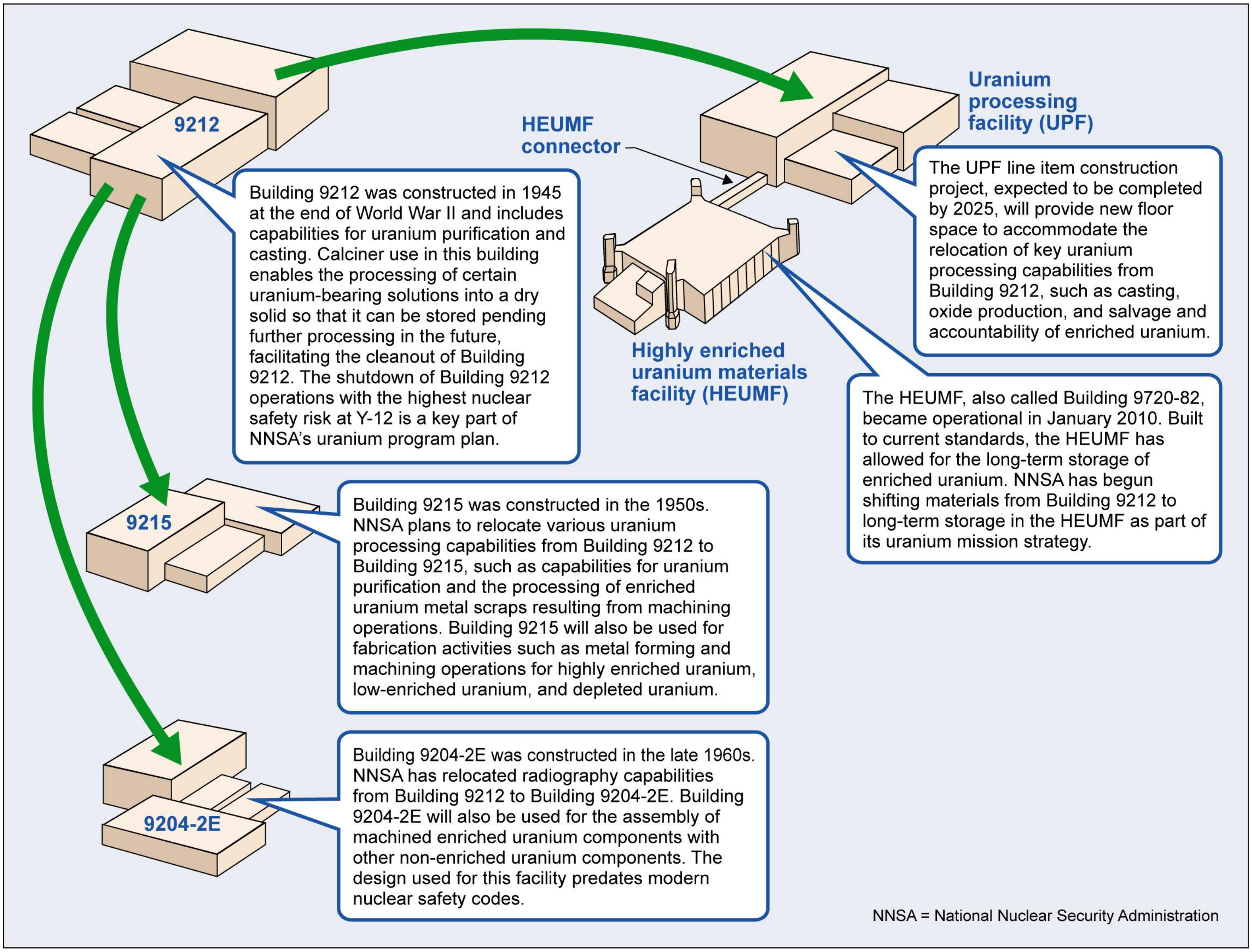
According to NNSA documents, Y-12's enriched uranium operations have key shortcomings including (1) an inefficient workflow, (2) continually rising operations and maintenance costs due to facility age, and (3) hazardous processes that could expose workers to radiological contamination. To address these shortcomings, NNSA developed plans to replace aging infrastructure at Y-12 and relocate key processing equipment without jeopardizing uranium production operations. The first solution, proposed in 2004, envisioned relocating Y-12's main uranium processing equipment into a new UPF.[24] NNSA planned to construct this single, consolidated facility that would be less than half the size of existing facilities; reduce costs by using modern processing equipment; and incorporate features to increase worker protection and environmental health and safety. In 2007, NNSA estimated the UPF would cost from $1.4 billion to $3.5 billion to design and construct. In June 2012, the Deputy Secretary of Energy approved an updated cost estimate range for the UPF of from $4.2 billion to $6.5 billion. However, by August 2012, the UPF contractor concluded that the uranium processing and other equipment would not fit into the UPF as designed.

In 2014, because of the high cost and schedule concerns of a solution focused solely on constructing new buildings, NNSA prepared a high-level strategic plan for its uranium program that is now focused on ceasing operations in building 9212 through a combination of new construction, infrastructure investments in existing facilities, upgrades to

[24]According to NNSA officials, the new UPF was intended only for replacing enriched uranium processing capabilities, the plant analytical laboratory, and space for technology development. It was not intended to replace depleted uranium facilities.

and relocation of select processing technologies, and improved inventory management. This strategy includes replacing certain 9212 capabilities, with continued operation of 9215 and 9204-2E, and removing a considerable amount of the scope of work that had been included in the original UPF plan (as the functions performed in Buildings 9215 and 9204-2E are no longer included within the UPF project). Figure 1 below depicts the planned transfer of uranium processing capabilities out of Building 9212 and into a new UPF and existing facilities by 2025 under the new approach.

Figure 1: NNSA's High-Level Strategic Plan for the Transfer of Highly Enriched Uranium Processing Capabilities among Facilities at Y-12 through 2025



Source: GAO analysis of National Nuclear Security Administration and Defense Nuclear Facilities Safety Board information. | GAO-17-577

Note: The size, shape, and configuration of the planned construction of the new UPF are not shown to scale. This illustration shows, as indicated by the arrows, NNSA's high-level strategic plan for transferring highly enriched uranium capabilities out of Building 9212 and into new and existing facilities by 2025.

Under the new approach, the UPF is to provide less floor space, compared to the original UPF design, for casting, oxide production,[25] and salvage and accountability of enriched uranium. NNSA has stated that this newly designed UPF is to be built by 2025 for no more than $6.5 billion through a series of seven subprojects. NNSA is required to manage construction of the new UPF in accordance with DOE Order 413.3B, which requires the project to go through five management reviews and approvals, called "critical decisions" (CD), as the project moves forward from planning and design to construction and operation. The CDs are as follows:

- CD 0: Approve mission need.
- CD 1: Approve alternative selection and preliminary cost estimate.
- CD 2: Approve the project's formal scope of work, cost estimate, and schedule baselines.
- CD 3: Approve start of construction.
- CD 4: Approve start of operations or project completion.

NNSA Policy for Setting Program Requirements

In March 2014, NNSA updated its Business Operating Procedure, clarifying its policy for developing and maintaining program requirements on construction programs and projects executed by the agency.[26] According to this procedure, this program requirements policy is applicable to most projects constructed for NNSA or managed by NNSA personnel and that have an estimated total project cost of $10 million or greater, or the cost threshold determined appropriate by the Deputy

[25]Uranium processing capabilities include the conversion of uranium scrap and other uranium-bearing solids to an oxide form suitable for storage or to produce high-quality uranium oxides for various NNSA customers, including highly enriched uranium fuel feedstock for research reactors or highly enriched uranium dioxide fuel feedstock for space reactors, among other uranium oxide products.

[26]National Nuclear Security Administration, *Program Requirements Document for Construction Projects*, Business Operating Procedure, BOP-06.02 (Washington, D.C.: Mar. 20, 2014). This policy pertains to all projects constructed for NNSA or managed by NNSA personnel on behalf of other government agencies with an estimated total project cost greater than or equal to $10 million, or the threshold as determined appropriate by the Deputy Secretary of Energy. This policy excludes General Plant Projects—miscellaneous minor new construction projects of a general nature for which the total estimated cost may not exceed the congressionally established limit—and Capital Equipment Projects.

Secretary of Energy. These projects include line item (capital asset) projects.[27]

According to NNSA's Business Operating Procedure policy, program officials should establish the mission- and program-level requirements that apply to the development and execution of the program or project. The policy also states that program officials should translate the "need" in the Mission Need Statement into initial top-level requirements addressing such concerns as performance, supportability, physical and functional integration, security, test and evaluation, implementation, and quality assurance. The policy states that experience has shown that a formal process resulting in an agreed-upon definition of requirements for new systems, new capabilities, and updates or enhancements to systems is a prerequisite to proceeding to system or capability design. Furthermore, according to the policy, failure to do this results in rework and unnecessary costs and delays in schedule. NNSA policy states that Program Requirements Documents shall contain both mission and program requirements and should include the "objective" value—the desired performance, scope of work, cost, or schedule that the completed asset should achieve, as well as the "threshold" value—representing the minimum acceptable performance, scope of work, cost, or schedule that an asset must achieve.[28]

NNSA's requirements policy also states that the development of mission requirements should include summary documentation on how the requirements were identified or derived and that the documentation should contain explanations of the processes, documentation, and direction or guidance that govern the derivation or development of the requirements. The policy also states that the basis for the requirements, where not obvious, should be traceable to decisions or source documentation and that details relating to the traceability of requirements may be included in an attachment to the program requirements document.

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[27]DOE defines a capital asset project as having defined start and end points with an acquisition cost that includes all costs incurred to construct the project for its intended purpose, bringing it to a form and location suitable for its intended use, excluding operating expenses that are part of routine operations and maintenance functions.

[28]According to NNSA's requirements policy, key performance parameters include the vital characteristic, function, requirement, or design basis that, if changed, would have a major impact on the facility or system performance, scope of work, schedule, cost and/or risk, or the ability of an interfacing project to meet its mission requirements.

NNSA's uranium modernization efforts under the broader program have focused on establishing NNSA program requirements, which NNSA considers in determining its infrastructure plans.[29] In July 2014, NNSA appointed a uranium program manager to integrate all of the uranium program's elements.[30] According to NNSA uranium program officials and documents, uranium program elements include

- construction of the new UPF;
- repairs and upgrades to existing facilities;
- uranium sustainment activities for achieving specific uranium production capabilities and inventory risk reduction (the strategic placement of high-risk materials in lower-risk conditions);
- depleted uranium management; and
- technology development, deployment, and process relocation.

Best Practices for Program Cost and Schedule Estimating

In March 2009, we published a cost estimating guide to provide a consistent methodology that is based on best practices and that can be used across the federal government for developing, managing, and evaluating capital program cost estimates.[31] The methodology outlined in the guide is a compilation of best practices that federal cost estimating organizations and industry use to develop and maintain reliable cost estimates throughout the life of a government acquisition program.

According to the cost estimating guide, developing accurate life-cycle cost estimates has become a high priority for agencies in properly managing their portfolios of capital assets that have an estimated life of 2 years or

[29]NNSA outlined uranium mission requirements to be aligned with four program goals: (1) drive down the risk to meeting mission requirements, (2) reduce the safety risk associated with meeting mission requirements, (3) install and operate replacement capabilities in a new facility (i.e., construction of a new UPF) by 2025, and (4) sustain capabilities in existing facilities.

[30]For purposes of this report, we define the uranium program elements as each of the distinct categories of program activities that NNSA expects will contribute to meeting overall uranium program goals.

[31]GAO-09-3SP.

more.[32] A life-cycle cost estimate provides an exhaustive and structured accounting of all resources and associated cost elements required to develop, produce, deploy, and sustain a particular program. According to the guide, a life-cycle cost estimate can be thought of as a “cradle to grave” approach to managing a program throughout its useful life. This entails identifying all cost elements that pertain to the program from initial concept all the way through operations, support, and disposal. A life-cycle cost estimate encompasses all past (or sunk), present, and future costs for every aspect of the program, regardless of funding source. According to the guide, a life-cycle cost estimate can enhance decision making, especially in early planning and concept formulation of acquisition, as well as support budget decisions, key decision points, milestone reviews, and investment decisions. The guide also states that a credible cost estimate reflects all costs associated with a system (program)—we interpret this to also mean that it must be based on a complete scope of work—and the estimate should be updated to reflect changes in requirements (which affect the scope of work). Because of the inherent uncertainty of every estimate due to the assumptions that must be made about future projections, once life-cycle costs are developed it is also important to continually keep them updated, according to the guide.

We also published a schedule guide in December 2015—as a companion to the cost estimating guide—that identifies best practices for scheduling the necessary work.[33] According to the schedule guide, a well-planned schedule is a fundamental management tool that can help government programs use funds effectively by specifying when work will be performed in the future and measuring program performance against an approved plan. Moreover, an integrated master schedule can show when major events are expected as well as the completion dates for all activities leading up to these events, which can help determine if the program’s parameters are realistic and achievable. An integrated master schedule may be made up of several or several hundred individual schedules that represent portions of effort within a program. These individual schedules are “projects” within the larger program. An integrated master schedule integrates the planned work, the resources necessary to accomplish that work, and the associated budget, and it should be the focal point for program management. Furthermore, according to the schedule guide, an

[32]Examples of capital assets include land, structures and buildings, laboratories, and equipment.

[33]GAO-16-89G.

integrated master schedule constitutes a program schedule that includes the entire required scope of work, including the effort necessary from all government, contractor, and other key parties for a program's successful execution from start to finish.[34] Conformance to this best practice—that the schedule should capture all activities or scope of work—logically leads to another key schedule best practice: the sequencing of all activities. This best practice states that activities must be listed in the order in which they are to be carried out and be joined with logic. Consequently, developing a complete scope of work or knowing all of the activities necessary to accomplish the project's objectives is critical to adhering to these best practices. In other words, a schedule is not complete and reliable if significant portions of the scope of work are not yet developed or are still uncertain, including over the longer term.

In prior reports from February 2014, November 2014, and August 2016, we included recommendations concerning NNSA's development of life-cycle cost estimates or an integrated master schedule for certain projects and programs, as called for in our cost estimating and schedule best practice guides. Specifically:

- In February 2014, we recommended that to develop reliable cost estimates for its plutonium disposition program, among other things, the Secretary of Energy should direct the NNSA office responsible for managing the program to, as appropriate, revise and update the program's life-cycle cost estimate following the 12 key steps described in our Cost Estimating Guide for developing high-quality cost estimates.[35]
- In our November 2014 report, we recommended that to enhance NNSA's ability to develop reliable cost estimates for its projects and for its programs that have project-like characteristics, the Secretary of Energy should revise DOE directives that apply to programs to require that DOE and NNSA and its contractors develop cost estimates in

[34]According to the schedule guide, the integrated master schedule must be a complete and dynamic network. That is, it should consist of logically related activities whose forecasted dates are automatically recalculated when activities change. If the schedule is not dynamic, planned activities will not react logically to changes, and the schedule will not be able to identify the consequences of changes or possible managerial action to respond to them. Furthermore, a comprehensive integrated master schedule should reflect all program activities and recognize that uncertainties and unknown factors in schedule estimates can stem from, among other things, data limitations.

[35]GAO-14-231.

accordance with the 12 cost estimating best practices, including developing life-cycle cost estimates for programs.[36]

- In August 2016, regarding the preparation of integrated master schedules, we recommended that to ensure that NNSA's future schedule estimates for the revised Chemistry and Metallurgy Research Replacement project—a key element of NNSA's plutonium program—provide the agency with reasonable assurance regarding meeting the project's completion dates, the Secretary should direct the Under Secretary for Nuclear Security, in his capacity as the NNSA Administrator, to develop future schedules for the revised project that are consistent with current DOE project management policy and scheduling best practices. Specifically, the Under Secretary should develop and maintain an integrated master schedule that includes all project activities under all subprojects prior to approving the project's first CD-2 decision.[37]

The agency generally agreed with these recommendations and has initiated various actions intended to implement them, including revising certain DOE orders, but it has not completed all actions needed to fully address the recommendations.

Best Practices for Technology Readiness

To ensure that new technologies are sufficiently mature in time to be used successfully, NNSA uses a systematic approach—Technology Readiness Levels (TRL)—for measuring the technologies' technical maturity.[38] TRLs were pioneered by the National Aeronautics and Space Administration

[36]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).

[37]GAO, *DOE Project Management: NNSA Needs to Clarify Requirements for Its Plutonium Analysis Project at Los Alamos,* GAO-16-585 (Washington, D.C.: Aug. 9, 2016).

[38]To assess the maturity of new technologies, DOE and NNSA adopted the use of TRLs. DOE took this action in response to our recommendation that DOE develop a consistent approach to assessing the extent to which new technologies have been demonstrated to work as intended in a project before starting construction; GAO, *Department of Energy: Major Construction Projects Need a Consistent Approach for Assessing Technology Readiness to Help Avoid Cost Increases and Delays*, GAO-07-336 (Washington, D.C.: Mar. 27, 2007). NNSA recommends that projects attain TRL 7 prior to approval of final design at Critical Decision 2 (CD 2) unless they are not major system projects and do not represent first-of-a-kind engineering endeavors. See the May 12, 2016, update to DOE Order 413.3B, *Program and Project Management for the Acquisition of Capital Assets*.

and have been used by the Department of Defense and other agencies in their research and development efforts for several years. As shown in table 1, TRLs start with TRL 1, which is the least mature, and go through TRL 9, the highest maturity level and at which the technology as a total system is fully developed, integrated, and functioning successfully in project operations.

Table 1: Definitions of Technology Readiness Levels (TRL)

TRL	Definition
TRL 1	Basic technology principles observed
TRL 2	Concept/applications formulated
TRL 3	Proof of concept
TRL 4	Validated in laboratory environment
TRL 5	Validated in relevant environment
TRL 6	Subsystem demonstrated in relevant environment
TRL 7	Subsystem demonstrated in an operational environment
TRL 8	Total system tested and demonstrated
TRL 9	Total system used successfully in project operations

Source: GAO analysis of Department of Defense, National Aeronautics and Space Administration, and Department of Energy data. | GAO-17-577

In November 2010, when NNSA's original approach was to consolidate Y-12's uranium processing capabilities into a single large facility, we reported that NNSA did not expect to have optimal assurance as defined by TRL best practices that 6 of the 10 new technologies being developed for construction of the new UPF would work as intended before project critical decisions are made.[39] Our November 2010 report also concluded that because all of the technologies being developed for construction of the new UPF would not achieve optimal levels of readiness prior to project critical decisions, NNSA might lack assurance that all technologies would work as intended. The report further stated that this could force the project to revert to existing or alternate technologies, which could result in design changes, higher costs, and schedule delays. In September 2011, DOE issued a technology readiness assessment guide for the agency, which states that new technologies should reach TRL 6 by CD 2, when the scope of work, cost estimate, and schedule baselines are to be approved. The guide also encouraged project managers to reach TRL 7

[39]GAO, *Nuclear Weapons: National Nuclear Security Administration's Plans for Its Uranium Processing Facility Should Better Reflect Funding Estimates and Technology Readiness*, GAO-11-103 (Washington, D.C.: Nov. 19, 2010).

prior to CD 3, or when the start of construction is approved.[40] In April 2014, we provided additional information on technology development efforts for the UPF and identified five additional technology risks since our November 2010 report.[41] In May 2016, DOE strengthened TRL requirements and updated DOE Order 413.3B, *Program and Project Management for the Acquisition of Capital Assets*, which states that project managers shall reach TRL 7 prior to CD 2 for major system projects or first-of-a-kind engineering endeavors. In August 2016, we provided an exposure draft to the public to obtain input and feedback on our technology readiness guide, which identifies best practices for evaluating the readiness of technology for use in acquisition programs and projects.[42]

NNSA Has Made Progress in Developing a Revised Scope of Work, Cost Estimate, and Schedule for the New UPF

NNSA documents we reviewed and program officials we interviewed indicate that NNSA has made progress in developing a revised scope of work, cost estimate, and schedule for the new UPF, potentially stabilizing escalating project costs and technical risks experienced under the previous strategy. According to NNSA's 2014 high-level strategic plan for the uranium program, NNSA changed its strategy for managing the overall uranium program, including the UPF, that year, which resulted in the need to develop a new scope of work. NNSA has reduced the scope of work for construction of the new UPF—the most expensive uranium program element—as a result of key adjustments NNSA had made to program requirements. For example, NNSA's October 2014 revision of

[40]U.S. Department of Energy, *Technology Readiness Assessment Guide*, DOE G 413.3-4A (Washington, D.C.: Sept. 15, 2011, updated Oct. 22, 2015).

[41]GAO, *Nuclear Weapons: Technology Development Efforts for the Uranium Processing Facility*, GAO-14-295 (Washington, D.C.: Apr. 18, 2014).

[42]GAO, *Technology Readiness Assessment Guide: Best Practices for Evaluating the Readiness of Technology for Use in Acquisition Programs and Projects (Exposure Draft)*, GAO-16-410G (Washington, D.C.: Aug. 11, 2016).

program requirements for construction of the new UPF resulted in the following changes: [43]

- NNSA modified the processing capability for casting uranium initially intended for construction of the new UPF, which then allowed the agency to scale back certain capabilities envisioned for the facility, potentially reducing project costs.
- NNSA significantly simplified processing capabilities and reduced critical technologies needed for construction, due to the reduction in the scope of work for the new UPF from the 10 technologies the agency planned to use prior to 2014 to 3, according to program officials.[44] NNSA officials told us that this change was needed to help control escalating costs and technical risks.
- NNSA integrated graded security and safety factors into the new UPF design, which resulted in cost savings and schedule improvement for the UPF project, according to agency officials.

According to NNSA's fiscal years 2017 and 2018 budget requests, NNSA expects to approve formal scope of work, cost, and schedule baseline estimates for construction of the new UPF as the designs for the Main Process and Salvage and Accountability Buildings subprojects—the two largest subprojects—reach at least 90 percent completion, which is

[43]NNSA's 6th revision to its uranium Program Requirements Document sought the input of key stakeholders and for the first time defined both (1) threshold requirements—the minimum acceptable performance, scope of work, cost, or schedule that the UPF must achieve, and (2) objective requirements—the desired performance, scope of work, cost, or schedule that the UPF should achieve. See National Nuclear Security Administration, Office of Acquisition and Project Management, *Program Requirements Document for Construction Projects*, Business Operating Procedure BOP-06.02 (Washington, D.C.: Feb. 15, 2008; updated Mar. 20, 2014).

[44]The 3 technologies needed for construction of the new UPF as of October 2014 included (1) bulk metal oxidation—a process that converts bulk uranium metal to oxide, (2) microwave casting—a process that uses microwave energy to heat and cast uranium metal into various shapes, and (3) UNH calcination—a process that converts impure solutions into a stable, storable condition. For the purposes of this report, we did not determine the extent to which the revision of program requirements for construction of the new UPF, or associated changes in processing capabilities and technologies for meeting these requirements, are effective and appropriate.

consistent with DOE's order on project management for construction of these types of facilities.[45]

According to NNSA's fiscal year 2017 and 2018 budget requests,[46] construction of the new UPF will occur in distinct phases, by key subproject. The seven key subprojects are as follows:

- **Main Process Building Subproject:** This subproject includes construction of the main nuclear facility that contains casting and special oxide production.[47] Support structures include a secure connecting portal to the Highly Enriched Uranium Materials Facility.
- **Salvage and Accountability Building Subproject:** This subproject includes work intended to construct a facility for handling chemicals and wastes associated with uranium processing, as well as decontamination capabilities, among other things.
- **Mechanical Electrical Building Subproject:** This subproject includes work intended to provide a building for mechanical, electrical, heating, ventilating, air conditioning, and utility equipment for the Main Process and Salvage and Accountability buildings.
- **Site Infrastructure and Services Subproject**: This subproject includes work intended for demolishment, excavation, and construction of a parking lot, security portal, and support building.
- **Process Support Facilities Subproject:** This subproject includes work intended to provide chilled water and chemical and gas supply storage for the UPF.
- **Substation Subproject:** This subproject includes work intended to provide power to the new UPF and additional capacity for the remainder of the Y-12 Plant.

[45]U.S. Department of Energy*, Program and Project Management for the Acquisition of Capital Assets*, DOE Order 413.3B (Washington, D.C.: Nov. 29, 2010; updated May 12, 2016).

[46]Department of Energy, *FY 2017 Congressional Budget Request, National Nuclear Security Administration* (Washington, D.C.: February 2016), and *FY 2018 Congressional Budget Request, National Nuclear Security Administration* (Washington, D.C.: May 2017).

[47]The main process building subproject of the UPF project is to also contain various other uranium processing, analysis, waste preparations, and process support space such as personnel-related rooms. This building is to be constructed to nuclear standards commensurate with high-hazard materials and security for the processes to be carried out within.

- **Site Readiness Subproject:** This subproject included work to relocate Bear Creek Road and construct a new bridge and haul road.

As of May 2017, NNSA had developed and approved a revised formal scope of work, cost, and schedule baseline estimates for four of the seven subprojects. NNSA expects to approve such baseline estimates for the all of the remaining subprojects—including the two largest subprojects—by the second quarter of fiscal year 2018. NNSA also plans to validate the estimates through an independent cost estimate at that time.[48] Concurrently with its approval and validation of the formal baseline estimates—which constitutes CD 2 in NNSA's project management process—NNSA intends to approve the start of construction, which constitutes CD 3 in that process. Table 2 shows estimated or approved time frames for CD 2, 3, and 4 milestones, as well as preliminary or (where available) formal cost baseline estimates for each subproject.

[48]According to GAO's cost estimating guide, independent cost estimates are conducted by an organization outside the acquisition chain, using the same detailed technical information as the program estimate; it is a comparison with the program estimate to determine whether it is accurate and realistic. Because the team performing the independent cost estimate is independent, it provides an unbiased test of whether the program office cost estimate is reasonable.

Table 2: Selected Critical Decision (CD) Milestones and Cost Estimates for New Uranium Processing Facility Subprojects

Dollars in millions

Subproject	CD 2/3[a]	CD 4	Preliminary or formal baseline cost estimate ($)
Main Process Building Subproject	Second quarter fiscal year 2018	Fourth quarter fiscal year 2025	Up to 4,828[b]
Salvage and Accountability Building Subproject	Second quarter fiscal year 2018	Fourth quarter fiscal year 2025	Up to 1,085[b]
Mechanical Electrical Building Subproject	Approved December 13, 2016	Second quarter fiscal year 2022	284
Site Infrastructure and Services Subproject	Approved March 12, 2015	Third quarter fiscal year 2018	78.5
Process Support Facilities Subproject	Second quarter fiscal year 2018	Fourth quarter fiscal year 2025	Up to 121[b]
Substation Subproject	Approved September 14, 2016	Third quarter fiscal year 2020	60
Site Readiness Subproject	Approved January 29, 2013	Approved February 27, 2015	43
Total			**6,499.5**

Legend:

CD 2: Approve the project's formal scope of work, cost estimate, and schedule baselines.

CD 3: Approve start of construction.

CD 4: Approve start of operations or project completion.

Source: NNSA Budget Justifications for Fiscal Years 2017 and 2018; updates provided by NNSA uranium program. | GAO-17-577

[a]NNSA combined critical decisions 2 and 3 for several of its subprojects.

[b]Preliminary cost estimate since a formal cost baseline has not yet been developed.

NNSA Has Not Developed a Complete Scope of Work, Life-Cycle Cost Estimate, and Integrated Master Schedule for Its Overall Uranium Program

NNSA has not developed a complete scope of work, life-cycle cost estimate, or integrated master schedule for its overall uranium program, and it has no time frame for doing so. In particular, it has not developed a complete scope of work for repairs and upgrades to existing facilities, nor has it done so for other key uranium program elements. Therefore, NNSA does not have the basis to develop a life-cycle cost estimate or an integrated master schedule for its overall uranium program.

Scope of Work for Repairs and Upgrades to Existing Facilities of the Overall Uranium Program Is Not Complete

NNSA has not developed a complete scope of work to repair and upgrade existing facilities for the overall uranium program, even though these activities could be among the most expensive and complicated non-construction portions of the uranium program. According to a July 2014 memorandum from the NNSA Administrator, the uranium program manager is expected to, among other things, identify the scope of work of new construction and infrastructure repairs and upgrades to existing facilities necessary to support the full uranium mission.[49] NNSA is still evaluating a November 2016 initial implementation plan, proposed by the Y-12 contractor, for the repairs and upgrades that broadly outlines the scope of work.

We found that some areas of the scope of work are more fully defined than others. For example, NNSA's implementation plan identifies the scope of work to conduct electrical power distribution repairs and upgrades in buildings 9215 and 9204-2E—which were constructed in the 1950s and 1960s, respectively—beginning in fiscal year 2017. However, NNSA does not have a complete scope of work to serve as the basis for its $400 million estimate. Officials we interviewed said that the agency intends to develop each year the complete and detailed scope of work to be done in the following year or two, including the work related to infrastructure investment.[50]

We also found that one significant area of the scope of work that has not been developed concerns repairs and upgrades to address certain safety issues confirmed by the Defense Nuclear Facilities Safety Board. For

[49]Department of Energy, Under Secretary for Nuclear Security and Administrator of National Nuclear Security Administration, *Roles and Responsibilities for the Uranium Program Manager*, Memorandum for Distribution (July 9, 2014).

[50]According to GAO's *Cost Estimating Guide* best practices, all programs have uncertainties, particularly in the early stages, and cost estimates tend to become more certain as actual costs begin to replace earlier estimates—when risks are either mitigated or realized. The guide also acknowledges that cost estimates are typically based on limited information and therefore need to be bound by the constraints that make estimating possible, such as assumptions that bind the estimate's scope of work, establishing baseline conditions the estimate will be built from. As such, every estimate is uncertain because of the assumptions that must be made about future projections.

example, according to the board's February 2015 letter to NNSA, earthquakes or structural performance problems in Buildings 9215 and 9204-2E could contribute to an increased risk for structural collapse and release of radiological material.[51] NNSA officials said they have not fully developed the long-term scope of work to address the safety issues that the board confirmed because much of this work depends on the results of upcoming seismic and structural assessments the agency expects to be conducted in or after fiscal year 2018. According to these officials, the need for these assessments was not apparent until after 2014, when NNSA decided to rely, in part, on aging existing facilities to meet uranium program requirements. NNSA then had to adjust plans in alignment with the new circumstances that required repairs and upgrades to these facilities. According to NNSA program officials, the planned infrastructure repairs and upgrades will address many, but not all, of the safety issues identified by the board. For example, NNSA program officials stated that they do not expect building 9215, which it expects to be in operation through the late 2030s, to meet all modern safety standards even with planned upgrades. NNSA officials also stated that planned upgrades have not been finalized and will focus on the upgrades that balance cost and risks.

Other aspects of the scope of work for repairs and upgrades have been developed but may not be stable because NNSA continues to review and adjust program requirements that affect the scope of work. For example, during our examination of how NNSA established uranium purification requirements, NNSA program officials told us that they identified a more accurate program requirement for purified uranium that increased the required annual processing throughput capability for purified uranium from 450 to 750 kilograms. As a result, in August 2016, NNSA program officials told us that NNSA will need to add to the capacity of the equipment to be installed in Building 9215 to convert uranium that contains relatively high amounts of impurities, such as carbon, into a more purified form—increasing the scope of work for this upgrade. The uranium program manager told us that, in an effort to make the requirement more accurate, NNSA changed its approach to determining the requirement so that it relied less on historical data and more on data

[51]The board's subsequent letter in May 2017 acknowledged that NNSA's actions to manage higher-risk uranium inventories do mitigate some of the risks associated with aging infrastructure, but the letter reaffirmed the structural engineering expert panel's September 2016 recommendation for reanalysis of Buildings 9215 and 9204-2E for structural safety.

on the purification levels of uranium inventories on hand, among other considerations. This program manager also told us that accurate and stable program requirements establish the basis for the infrastructure and equipment that will be needed to meet program goals, such as processing uranium for nuclear components necessary to meet nuclear weapons stockpile needs. The ongoing review of program requirements, with minor adjustments, is expected and necessary to ensure accuracy, according to NNSA officials.

Scope of Work for Other Uranium Program Elements Are Not Fully Developed

We also found that NNSA has not developed complete scopes of work for other uranium program elements, including uranium sustainment activities, depleted uranium management, and technology development, based on our review of documents and discussion with NNSA officials. NNSA officials we interviewed told us that NNSA is working to develop these scopes of work, but the agency has no time frames for completion.

Uranium Sustainment Activities for Achieving Inventory Risk Reduction

We determined that NNSA has not yet developed the complete scope of work for activities to reduce the risk associated with and sustain its uranium inventory, based on our review of program documents and interviews with NNSA program officials. These activities include efforts to remove higher-risk materials from higher-risk conditions and strategically place them in lower-risk conditions. For example, NNSA expects to reprocess the uranium contained in organic solutions, which is a relatively higher-risk form of uranium storage, for repackaging and eventual removal from deteriorating, higher-risk buildings, such as Building 9212. These reprocessed materials and other materials that are more easily repackaged, such as nuclear components from dismantled nuclear weapons, are expected to be relocated to lower-risk storage areas, such as the Highly Enriched Uranium Materials Facility, which became operational in 2010. NNSA program officials told us that they have developed a detailed scope of work for the removal of higher-risk materials from some Y-12 areas but have not developed the complete scope of work for their removal from other facilities or for transferring these materials to the storage facility or other interim locations.[52]

Depleted Uranium Management

NNSA officials we interviewed told us that the agency recognized in December 2015 that requirements for depleted uranium were incomplete, which could affect the scope of work for meeting these requirements. In December 2015, NNSA completed its initial analysis of depleted uranium needs, by weapon system, to determine potential gaps in material availability in the future. This initial analysis was an important first step in defining requirements for depleted uranium, but the program element is in an early stage of development, according to NNSA program officials. According to NNSA officials, NNSA is developing the scope of work necessary to sustain depleted uranium capabilities and infrastructure at Y-12, and it is evaluating strategies to procure or produce additional feedstock of high-purity depleted uranium to support production needs.

Technology Development

NNSA's broad strategy to replace Building 9212 capabilities by 2025—through plans for the construction of a new UPF under a reduced scope of work—currently involves plans to install new uranium processing capabilities in other existing Y-12 buildings, including Buildings 9215 and 9204-2E, and will rely on developing and installing new technologies. Two of the uranium processing technologies—calciner and electrorefining—are at later stages of development, and the scope of work needed to bring them to full maturity is relatively straightforward, according to NNSA program officials. One technology—chip processing—is less mature, but the remaining activities necessary to potentially develop it to full maturity have been determined, according to NNSA program officials. Also, according to these officials, for one technology that has been deferred, the remaining activities necessary to develop it to full maturity are less clear.

[52]The transfer of some of these materials will require changes to HEUMF's safety basis analysis. NNSA has begun this analysis, which is in the initial phase and expected to continue into fiscal year 2021, according to NNSA implementation plans. NNSA conducts safety basis analyses to identify potential accidents and hazards associated with a facility's operations and outlines controls to mitigate or prevent their impact on workers and the public.

- **Calciner technology** enables the processing of certain uranium-bearing solutions into a dry solid so that it can be stored pending further processing in the future. According to a NNSA uranium program official, NNSA had determined as of May 2015 that the calciner technology had reached TRL 6—the level required prior to CD 2 (when scope of work, cost, and schedule baselines are to be approved) under DOE's technology readiness guide.[53] After finishing calciner equipment installation in Building 9212 and project completion, expected in fiscal year 2022, NNSA plans to conduct a readiness review to demonstrate that the technology meets TRL 8 (meaning that it has been tested and demonstrated), according to a NNSA uranium program official.
- **Electrorefining technology** applies a voltage that drives a chemical reaction to remove impurities from uranium. According to NNSA documents, using this technology eliminates various hazards associated with current chemical purification processes, such as using hydrogen fluoride and certain solvents,[54] and allows a 4-to-1 reduction in square footage to operate compared with existing technologies. As of December 2015, NNSA had determined that the electrorefining technology had reached TRL 6, according to a key NNSA program official.[55] After finishing electrorefining equipment installation in Building 9215 and project completion, expected in fiscal year 2022, NNSA plans to conduct a readiness review to demonstrate that the technology meets TRL 8, according to a NNSA uranium program official.
- **Direct electrolytic reduction** technology could convert uranium oxide to uranium metal using an electrochemical process similar, but not identical, to electrorefining. It was assessed at TRL 4 as of

[53]DOE's technology readiness guide states that new technologies should reach TRL 6 by CD 2. However, DOE Order 413.3B, *Program and Project Management for the Acquisition of Capital Assets* (as updated in May 2016), states that project managers shall reach TRL 7 prior to CD 2 for major system projects or first-of-a-kind engineering endeavors. DOE officials we interviewed stated that developing the calciner technology is not a major system project because the estimated cost does not meet the threshold for a major project, nor is it a first-of-a kind engineering endeavor.

[54]Hydrogen fluoride is a colorless, fuming liquid or gas used in uranium processing that is corrosive to the respiratory tract and skin, and it is a serious systemic toxin.

[55]DOE officials we interviewed stated that developing electrorefining technology is not a major system project because the estimated cost does not meet the threshold for a major project, nor is it a first-of-a kind engineering endeavor. Accordingly, it is required to reach TRL 6 by CD 2 under DOE's technology readiness guide.

September 2014. According to NNSA program officials, NNSA may pursue direct electrolytic reduction technology as a follow-on to electrorefining, but NNSA has not determined whether there is a mission need for this technology. Currently, NNSA has deferred funding for it until fiscal year 2019.

- **Chip processing** technology converts enriched uranium metal scraps from machining operations into a form that can be re-used. This technology is already in use, but NNSA is investigating improved technology to potentially simplify the process and reduce the number of chip processing steps, according to NNSA program officials. As of July 2016, NNSA had determined that the new technology had reached TRL 5, and the agency plans to reach TRL 6 by June 2017.[56]

NNSA Has Not Developed Life-Cycle Costs or an Integrated Master Schedule for the Uranium Program

Because NNSA has not developed a complete scope of work for the overall uranium program, it does not have the basis to develop a life-cycle cost estimate or an integrated master schedule for the program. As noted previously, NNSA has made progress in developing a cost estimate for the new UPF, and this estimate will be an essential component of a life-cycle cost estimate for the overall program. For other program elements, discussed below, NNSA either has rough or no estimates of the total costs.[57] According to our analysis of information from NNSA documents and program officials, these program elements may cost nearly $1 billion over the next 2 decades.

- **Repairs and upgrades to existing facilities:** NNSA's contractor's implementation plan includes a rough-order-of-magnitude cost

[56]DOE officials we interviewed stated that developing chip processing technology is not a major system project because the estimated cost does not meet the threshold for a major project, nor is it a first-of-a kind engineering endeavor. Accordingly, it is required to reach TRL 6 by CD 2 under DOE's technology readiness guide.

[57]In contrast with NNSA's efforts to define longer-term scope of work and estimates, NNSA has a reliable process in place for developing near-term estimates, based on our assessment of its cost estimating processes for one piece of near-term scope of work to repair and upgrade existing Y-12 facilities.

estimate of $400 million over the next 20 years—roughly $20 million per year—for repairs and upgrades to existing facilities.[58]

- **Uranium sustainment activities for achieving inventory risk reduction:** Activities to reduce the risk associated with and sustain NNSA's uranium inventory are expected to cost roughly $25 million per year in fiscal years 2017 through 2025 for a total of around $225 million, according to NNSA program officials.
- **Depleted uranium management:** NNSA has not estimated costs for meeting depleted uranium needs for weapons systems. Current costs related to managing depleted uranium are broadly shared among various NNSA program areas. NNSA is exploring options and costs of increasing the supply of depleted uranium to meet NNSA needs.
- **Technology development:** Estimated costs for development of technology to be installed in existing Y-12 buildings are roughly $30 million per year in fiscal years 2017 through 2025, for a total of around $270 million, according to NNSA program officials.

Our cost estimating guide states that a credible cost estimate reflects all costs associated with a system (program)—i.e., it must be based on a complete scope of work—and that the estimate should be updated to reflect changes in requirements (which affect the scope of work).[59] Because NNSA has not developed the complete scope of work for each program element and the overall uranium program, NNSA does not have the basis for preparing a credible life-cycle cost estimate for the program. Having a life-cycle cost estimate can enhance decision making, especially in early planning and concept formulation of acquisition, as well as support budget decisions, key decision points, milestone reviews, and investment decisions, according to our cost estimating guide. For the uranium program, a life-cycle cost estimate could better inform decision making, including by Congress. Uranium program managers indicated that they plan to eventually develop a life-cycle cost estimate for the

[58]According to NNSA officials, the repairs and upgrades to existing facilities will be funded primarily through operating funds provided to NNSA's Associate Administrator for Infrastructure and Operations (NA-50). The NNSA's FY 2017 Congressional Budget Request for operations of all facilities at the Y-12 National Security Complex was $107 million. According to NNSA's contractor's implementation plan, annual maintenance costs above base operating costs could be about $5 million by fiscal year 2020 and increase to almost $10 million per year after 20 years. The planned $20 million annual funding for repairs and upgrades is in addition to these costs and is estimated for an initial period of at least 15 years, according to NNSA officials.

[59]GAO-09-3SP.

overall uranium program, but they have no time frame for doing so and said that it may take several years.

In addition, NNSA has not developed an integrated master schedule for its uranium program as called for in our schedule guide. An integrated master schedule for the uranium program would need to include individual schedules that represent portions of effort within the program—that is, program elements.[60] As noted earlier, NNSA has made progress in developing a schedule for the UPF project and expects to complete development of schedule baselines for all UPF subprojects in 2018; this schedule information will be an essential component of an integrated master schedule for the overall program. For other program elements, however, NNSA does not have a basis to develop a complete schedule because, as discussed above, NNSA has not developed a complete scope of work.

NNSA's program guidance recommends development of an integrated master schedule and states that having one supports effective management of program scope, risk, and day-to-day activities.[61] Specifically, the guidance states that during the initial phases of a program, an integrated master schedule provides an early understanding of the required scope of work, key events, accomplishment criteria, and the likely program structure by depicting the progression of work through the remaining phases. Furthermore, it communicates the expectations of the program team and provides traceability to the management and execution of the program. However, NNSA's guidance does not always explicitly require the development of such a schedule—the guidance allows for the tailoring of the agency's management approach based on the particular program being managed. Uranium program managers indicated that they plan to eventually develop an integrated master schedule for the uranium program but were uncertain when this schedule may be developed. In the meantime, NNSA plans to spend tens of millions of dollars annually on uranium program activities—including $20 million per year for repairs and upgrades to existing buildings—without providing decision makers with an understanding of the complete scope of work, key events, accomplishment criteria, and the likely program structure.

[60]GAO-16-89G.

[61]Department of Energy, National Nuclear Security Administration, *Office of Defense Programs DP Program Execution Instructions* (Washington, D.C.: Oct. 15, 2015).

Under federal standards for internal control,[62] management should use quality information to achieve the entity's objectives, and, among other characteristics, quality information is provided on a timely basis. Without NNSA setting a time frame for when it will (1) develop the complete scope of work for the overall uranium program, to the extent practicable, and (2) prepare a life-cycle cost estimate and integrated master schedule, NNSA does not have reasonable assurance that decision makers will have timely access to essential program management information—risking unforeseen cost escalation and delays in NNSA's efforts to meet the nation's uranium needs.

Conclusions

NNSA is making efforts to modernize uranium processing capabilities that are crucial to our nation's ability to maintain its nuclear weapons stockpile and fuel its nuclear-powered naval vessels. NNSA's modernization efforts will likely cost several billions of dollars and take at least 2 decades to execute. As part of these efforts, NNSA is planning to construct a new UPF, using a revised approach intended to help control escalating costs and schedule delays. NNSA has made progress in developing a scope of work, cost estimates, and schedules for the new UPF.

However, the success of the new UPF approach, which relies on support capabilities outside of the new UPF project, depends on the successful completion and integration of many other projects and activities that comprise the overall uranium program, including repairs and upgrades to existing Y-12 facilities needed for housing uranium processing capabilities.

NNSA has not developed a complete scope of work for its overall uranium program, nor has it set a time frame for doing so. In the interim, NNSA cannot adhere to best practices, such as developing a credible life-cycle cost estimate or an effective long-term, integrated master schedule for the program because of gaps in information about future activities and their associated costs. Without NNSA setting a time frame for when it will (1) develop a complete scope of work for the overall uranium program, to the extent practicable, and (2) prepare a life-cycle cost estimate and an integrated master schedule for the program, NNSA does not have

[62] GAO, *Standards for Internal Control in the Federal Government,* GAO-14-704G (Washington, D.C.: September 2014).

reasonable assurance that decision makers will have timely access to essential program management information for this costly and important long-term program.

Recommendation for Executive Action

We recommend that the NNSA Administrator set a time frame for when the agency will (1) develop the complete scope of work for the overall uranium program to the extent practicable and (2) prepare a life-cycle cost estimate and an integrated master schedule for the overall uranium program.

Agency Comments

We provided a draft of this report to DOE and NNSA for their review and 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 generally agreed with our recommendation. NNSA stated that the recommendation reflects the logical next steps in any program's maturity and is consistent with its existing planning goals. NNSA further stated that while it is too early to have developed full scope and cost estimates for the entire program at this point, it fully intends to implement the recommendation at the appropriate times in the uranium program's continuing development. In particular, NNSA stated that it is developing a complete scope of work, which is necessary for a fully informed program cost estimate, and anticipates this to be a multiyear effort. Regarding cost estimates, NNSA said that initial cost estimates it develops will continue to reflect strategies and emerging risks over the course of the Future Years Nuclear Security Plan—a 5-year plan typically used as part of the basis for NNSA congressional budget requests for each fiscal year. NNSA stated that once stable implementation plans are developed for its activities, it will consider whether there is value in further extending the time frame for estimates. NNSA further stated that it plans to complete an initial coordinated program schedule by December 31, 2018, and that the schedule would continue to be updated as plans and strategies evolve. NNSA also provided additional examples to illustrate the program's progress in improving safety, relocating processes, improving infrastructure, and construction of the UPF, among other things. We incorporated several of these examples in the report where appropriate.

We are sending copies of this report to the appropriate congressional committees, the Secretary of Energy, the Administrator of the National Nuclear Security Administration, 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 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
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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
Committee on Appropriations
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Ranking Member
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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 status of the National Nuclear Security Administration's (NNSA) efforts to develop a revised scope of work, cost estimate, and schedule for the new Uranium Processing Facility (UPF) project, we reviewed NNSA program planning documents, and any updates, concerning cost and budget and interviewed agency officials to determine the effect of uranium program strategy revisions on the UPF project's scope of work, cost, and schedule. To examine the scope of work for the UPF project, which directly impacts the project's cost and schedule, we reviewed NNSA business operating procedures for developing program requirements and the steps taken to identify and update requirements, which would apply to the construction of the new UPF. We interviewed program officials to understand how they defined and adjusted program requirements and to understand the potential effects of any adjustments on NNSA's infrastructure plans. For example, NNSA officials stated that they followed key portions of the applicable Business Operating Procedure (BOP)[1] regarding program requirements for construction projects. As such, we reviewed those portions of BOP-06.02 that the officials stated were applicable, including stipulations that requirements include the "threshold" value (the minimum acceptable performance, scope of work, cost, or schedule that construction of the new UPF must achieve), and "objective" value (the desired performance, scope of work, cost, or schedule that the new UPF should achieve). To review project requirements for the construction of the new UPF, we reviewed copies of the most recent requirements revision documents—NNSA's project and program requirements documents. Specifically, we reviewed the requirements to determine whether requirements for the construction of the new UPF specified both threshold and objective requirements.

To examine the extent to which NNSA has developed a complete scope of work, life-cycle cost estimate, and integrated master schedule for the overall uranium program, we reviewed NNSA program-planning documents concerning cost and budget and interviewed NNSA's program

[1]National Nuclear Security Administration, *Program Requirements Document for Construction Projects*, Business Operating Procedure, BOP-06.02 (Washington, D.C.: Mar. 20, 2014).

manager and other program and contractor officials. We examined information regarding the broader uranium program, including NNSA's efforts to repair and upgrade existing Y-12 facilities and other key uranium program elements. Specifically, to examine the scope of work for key elements of the overall uranium program—this scope of work directly impacts the program's cost and schedule—we reviewed NNSA planning, strategy, and implementation-related documents for the program. We reviewed NNSA business operating procedures for developing program requirements and the steps taken to identify and update requirements for unique processing capabilities to be housed in existing facilities external to the UPF. We interviewed program officials to understand how they defined and adjusted program requirements and to understand the potential effects of any adjustments on NNSA's infrastructure plans. In particular, we reviewed requirements external to the construction of the new UPF that were determined to be critical in meeting key program goals, according to NNSA officials, such as uranium purification requirements. We interviewed officials to determine the approach/process used for requirement-setting, the data used, and how NNSA analyzed the data. In addition, we reviewed detailed program planning documents, such as the Y-12 *Enriched Uranium Facility Extended Life Program Report and Highly Enriched Uranium Mission Strategy Implementation Plan* to learn about the infrastructure repairs and upgrades NNSA identified it needs to meet facility safety and other requirements. To obtain the views of independent subject matter experts on the structural, seismic, and safety condition of existing Y-12 facilities, we reviewed the Defense Nuclear Facilities Safety Board 2014 report that addressed the subject and that included conclusions and recommendations. In September 2016, we also spoke with board officials to determine if there were updates, additions, or changes to its letter; the officials said there were none and that the Y-12 facility structural concerns expressed in the 2014 letter remain.

To further examine the estimated cost and schedule for the overall uranium program from a broader perspective, we gathered and analyzed information regarding the extent to which NNSA has developed a life-cycle cost estimate and an integrated master schedule as called for in best practices. We reviewed best practices for cost and schedule as described in our *Cost Estimating Guide*[2] and *Schedule Guide*.[3] For the

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

cost estimating guide, GAO cost experts established a consistent methodology that is based on best practices that federal cost estimating organizations and industry use to develop and maintain reliable cost estimates. Developing a life-cycle cost estimate and an integrated master schedule for the overall program are critical to successfully managing a program. We identified the benefits of using these best practices and interviewed program officials to obtain information on the status of their adherence to these best practices in managing the overall uranium program.

[3]GAO, *Schedule Assessment Guide: Best Practices for Project Schedules*, GAO-16-89G (Washington D.C.: December 2015).

Appendix II: Comments from the National Nuclear Security Administration

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

National Nuclear Security Administration

August 11, 2017

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

Dear Mr. Trimble:

Thank you for the opportunity to review the Government Accountability Office (GAO) draft report "Modernizing the Nuclear Security Enterprise: A Complete Scope of Work Is Needed to Develop Timely Cost and Schedule Information for the Uranium Program" (GAO-17-577). The National Nuclear Security Administration (NNSA) appreciates the auditors' recognition of our progress in developing the scope of work, cost estimate, and schedule for the Uranium Processing Facility project as part of the overall uranium mission.

GAO's observations highlight the significant progress the uranium program has made in the short time since its establishment in 2014. The decision to construct a smaller Uranium Processing Facility (UPF) and utilize existing floor space to replace some Building 9212 capabilities required coordinated investment, planning, and action on the part of NNSA to implement. The resulting path forward is defined in the Uranium Mission Strategy, which combines risk reduction, capability sustainment, process relocations, infrastructure improvements, and construction of new floor space into an integrated portfolio of investments. NNSA is executing the near-term programmatic scope associated with this strategy, and continues to evaluate additional measures which could reduce risk within the program.

The auditors' recommendations reflect the logical next steps in any program's maturity, and they are consistent with our existing planning goals. While it is too early to have developed full scope and cost estimates for the entire program at this point, we fully intend to implement the recommendations at the appropriate times in the Uranium program's continuing development. Towards that goal, NNSA is developing the full scope of work for each element of the uranium mission. In addition, NNSA will develop a coordinated uranium program schedule by December 31, 2018, and will continue to develop and refine estimates to execute projects at the Y-12 National Security Complex. NNSA plans to establish project baselines for the UPF nuclear subprojects in fiscal year (FY) 2018, electro-refining in FY 2019, and calciner in FY 2020.

The enclosure to this letter provides more detail on actions NNSA has taken and plans to take address the recommendations in the report. Technical comments have also been provided for your consideration under separate cover to enhance the clarity and accuracy of the report.

If you have any questions, regarding this response, please contact Dean Childs, Director, Audits and Internal Affairs, at (301) 903-1341.

Sincerely,

Frank G. Klotz

Frank G. Klotz

Enclosure

Enclosure

NATIONAL NUCLEAR SECURITY ADMINSITRATION (NNSA)

Response to Report Recommendations

"Modernizing the Nuclear Security Enterprise: A Complete Scope of Work Is Needed to Develop Timely Cost and Schedule Information for the Uranium Program" (GAO-17-577)

The Government Accountability Office (GAO) recommends NNSA:

Recommendation 1: Establish a time frame for developing the complete scope of work for the overall uranium program to the extent practicable.

Management Response: NNSA firmly grasps the urgency and complexity of actions required to sustain essential uranium capabilities that support national security missions including enriched uranium purification, uranium casting, radiography, and assembly and disassembly of enriched uranium weapons components. To do so, NNSA has a robust program that will modernize and recapitalize substantial portions of the uranium capabilities and infrastructure at the Y-12 National Security Complex. In 2014, NNSA began developing a complete scope of work—independently reviewed in 2014 by the Uranium Processing Facility (UPF) Red Team—which directly addresses the impacts, risks and path forward resulting from the decision to construct a smaller UPF and replace other Building 9212 capabilities in existing facilities. This resulted in a mission approach that combines risk reduction, capability sustainment, process relocations, infrastructure improvements, and construction of new floor space into a broad portfolio of integrated uranium investments.

This approach is reflected in the program of record developed as part of the annual Planning, Programming, Budgeting and Evaluation process. NNSA keeps Congress fully informed on the strategy and progress of these activities through briefings to relevant committees in the Senate and House. NNSA recognizes that the full scope of work for these initiatives is not complete, and the program is updating and/or developing execution strategies, as appropriate, in each of these areas to support overall stewardship of the uranium mission. Once completed, these strategies will represent a documented scope of work for the overall uranium program. Given the complexities of these actions, this is anticipated to be a multiyear effort.

Recommendation 2: Establish a time frame for preparing a life-cycle cost estimate and an integrated master schedule for the overall uranium program.

Management Response: NNSA plans to develop a coordinated program schedule to capture the broad elements of the uranium program, which would include the key projects and interdependencies to phase out mission dependency on Building 9212 and complete the UPF project. The degree of detail in the schedule at any point in time will be commensurate with the information that is available. The estimated completion date for the initial coordinated program schedule is December 31, 2018. The schedule will then continue to be updated as plans and strategies evolve.

Regarding cost estimates, the program continues to develop and refine estimates to execute projects at Y-12 and implement broad elements of the overall uranium modernization strategy.

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Enclosure

NNSA plans to establish project baselines for the UPF nuclear subprojects in fiscal year (FY) 2018, electro-refining in FY 2019, and calciner in FY 2020. In addition, NNSA is still analyzing the full scope of work and associated costs of the Building 9212 exit strategy and the Extended Life Program for Buildings 9215 and 9204-2E. The program is assessing cost, priority and executability of these activities in support of preparing fully developed implementation plans for this work. As these elements are necessary for a fully informed program cost estimate, NNSA plans to focus its near-term activities on these efforts. Initial cost estimates will continue to reflect strategies and emerging risks over the course of the FYNSP. Once stable implementation plans are developed, NNSA will consider whether there is value in extending the timeframe for estimates further. This will be a multi-year effort.

2

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, Jonathan Gill (Assistant Director), Martin Campbell, Antoinette Capaccio, Jennifer Echard, Cynthia Norris, Christopher Pacheco, Sophia Payind, Timothy M. Persons, Karen Richey, Jeanette Soares, and Kiki Theodoropoulos made significant contributions to this report.

Appendix IV: Accessible Data

Data Tables

Accessible Data for Figure 1: NNSA's High-Level Strategic Plan for the Transfer of Highly Enriched Uranium Processing Capabilities among Facilities at Y-12 through 2025

9212

Building 9212 was constructed in 1945 at the end of World War II and includes capabilities for uranium purification and casting. Calciner use in this building enables the processing of certain uranium-bearing solutions into a dry solid so that it can be stored pending further processing in the future, facilitating the cleanout of Building 9212. The shutdown of Building 9212 operations with the highest nuclear safety risk at Y-12 is a key part of NNSA's uranium program plan.

9215

Building 9215 was constructed in the 1950s. NNSA plans to relocate various uranium processing capabilities from Building 9212 to Building 9215, such as capabilities for uranium purification and the processing of enriched uranium metal scraps resulting from machining operations. Building 9215 will also be used for fabrication activities such as metal forming and machining operations for highly enriched uranium, low-enriched uranium, and depleted uranium.

9204-2E

Building 9204-2E was constructed in the late 1960s. NNSA has relocated radiography capabilities from Building 9212 to Building 9204-2E. Building 9204-2E will also be used for the assembly of machined enriched uranium components with other non-enriched uranium components. The design used for this facility predates modern nuclear safety codes.

Uranium processing facility (UPF)

The UPF line item construction project, expected to be completed by 2025, will provide new floor space to accommodate the relocation of key uranium processing capabilities from Building 9212, such as casting, oxide production, and salvage and accountability of enriched uranium.

Highly enriched uranium materials facility (HEUMF)

The HEUMF, also called Building 9720-82, became operational in January 2010. Built to current standards, the HEUMF has allowed for the long-term storage of enriched uranium. NNSA has begun shifting materials from Building 9212 to long-term storage in the HEUMF as part of its uranium mission strategy.

HEUMF connector

NNSA= National Nuclear Security Administration

Source: GAO analysis of National Nuclear Security Administration and Defense Nuclear Facilities Safety Board information. GAO-17-577

Agency Comment Letter

Accessible Text for Comments from the National Nuclear Security Administration

Page 1

Department of Energy

Under Secretary for Nuclear Security

Administrator, National Nuclear Security Administration

Washington, DC 20585

August 11, 2017

Mr. David C. Trimble Director, National Resources and Environment

U.S. Government Accountability Office

Washington, DC 20548

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The auditors' recommendations reflect the logical next steps in any program's maturity, and they are consistent with our existing planning goals. While it is too early to have developed full scope and cost estimates for the entire program at this point, we fully intend to implement the recommendations at the appropriate times in the Uranium program's continuing development. Towards that goal, NNSA is developing the full scope of work for each element of the uranium mission. In addition, NNSA will develop a coordinated uranium program schedule by December 31, 2018, and will continue to develop and refine estimates to execute projects at the Y-12 National Security Complex. NNSA plans to establish project baselines for the UPF nuclear subprojects in fiscal year (FY) 2018, electro- refining in FY 2019, and calciner in FY 2020.

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Sincerely,

Frank G. Klotz

Enclosure

Page 3

NATIONAL NUCLEAR SECURITY ADMINISTRATION (NNSA)

Response to Report Recommendations

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This approach is reflected in the program of record developed as part of the annual Planning, Programming, Budgeting and Evaluation process. NNSA keeps Congress fully informed on the strategy and progress of these activities through briefings to relevant committees in the Senate and House. NNSA recognizes that the full scope of work for these initiatives is not complete, and the program is updating and/or developing execution strategies, as appropriate, in each of these areas to support overall stewardship of the uranium mission. Once completed, these strategies will represent a documented scope of work for the overall uranium program. Given the complexities of these actions, this is anticipated to be a multiyear effort.

Recommendation 2: Establish a time frame for preparing a life-cycle cost estimate and an integrated master schedule for the overall uranium program.

Management Response: NNSA plans to develop a coordinated program schedule to capture the broad elements of the uranium program, which would include the key projects and interdependencies to phase out mission dependency on Building 9212 and complete the UPF project. The degree of detail in the schedule at any point in time will be commensurate with the information that is available. The estimated completion date for the initial coordinated program schedule is December 31, 2018. The schedule will then continue to be updated as plans and strategies evolve.

Regarding cost estimates, the program continues to develop and refine estimates to execute projects at Y-12 and implement broad elements of the overall uranium modernization strategy.

Page 4

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