NATIONAL NUCLEAR SECURITY ADMINISTRATION

Actions Needed to Improve Integration of Production Modernization Programs and Projects

Report to Congressional Committees

July 2024
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Accessible Version

GAO Highlights

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July 2024

NATIONAL NUCLEAR SECURITY ADMINISTRATION

Actions Needed to Improve Integration of Production Modernization Programs and Projects

Why GAO Did This Study

NNSA plans to invest tens of billions of dollars in its decades-long effort to modernize the facilities and infrastructure needed to produce the strategic materials and components required for nuclear weapons. However, NNSA has a history of program management challenges, and recent GAO reports have identified challenges with NNSA's use of program schedules and cost estimates.

A committee report accompanying a bill for the National Defense Authorization Act for Fiscal Year 2024 includes a provision for GAO to review NNSA's requirements for the integrated planning of the Production Modernization effort. This GAO report (1) describes NNSA's Production Modernization programs and their associated major projects and how NNSA manages them, (2) examines the extent to which NNSA effectively uses schedules to ensure integration, and (3) examines the extent to which NNSA effectively uses cost estimates. Program schedules and cost estimates, among other tools and practices, are essential to help ensure integration. GAO reviewed NNSA's program management requirements for using these tools for eight Production Modernization programs, and interviewed NNSA officials. GAO also assessed agency requirements and practices against best practices GAO has published for using reliable schedules and cost estimates.

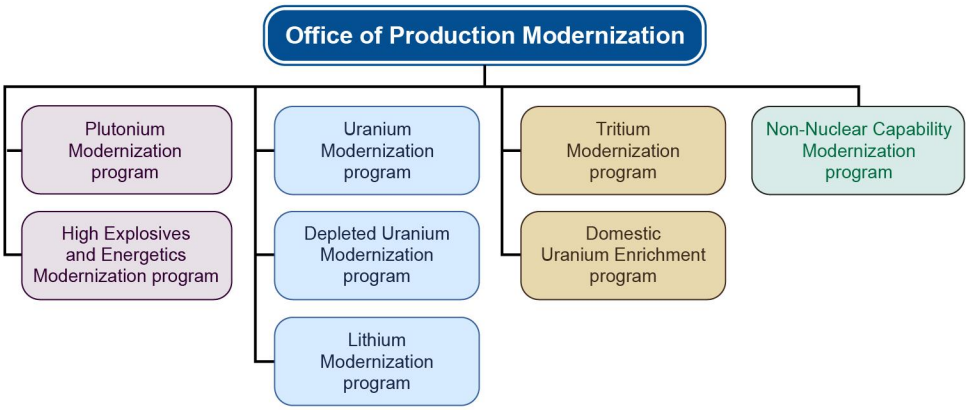
What GAO Recommends

GAO is making four recommendations, including that NNSA revise its requirements and practices to follow best practices. NNSA agreed with all four recommendations.

What GAO Found

The National Nuclear Security Administration's (NNSA) Production Modernization effort consists of eight programs and 16 related and ongoing major projects. These programs and projects are managed by separate offices and are subject to different management requirements. However, NNSA officials told GAO that each program and its associated projects must be integrated to achieve NNSA's modernization goals and that they use established teams and meetings for this purpose as well as schedule and cost information.

NNSA's Office of Production Modernization



Source: National Nuclear Security Administration (NNSA) documentation. | GAO-24-106342

Production Modernization program schedules are insufficient for ensuring the effective integration of programs and their associated major projects. Specifically, NNSA's schedule requirements do not incorporate the 10 best practices for developing reliable and integrated program schedules identified in the *Schedule Guide* GAO published and that define the characteristics of schedules that support program success. Further, the program schedules GAO reviewed are insufficient for ensuring effective integration because most are not resource-loaded integrated master schedules. Developing such schedules, according to the *Schedule Guide*, would allow NNSA to better integrate programs' operations with their major projects and other activities that, together, represent one of NNSA's most urgent, complex, and costly efforts.

Production Modernization program cost estimates are insufficient for ensuring the effective integration of programs and their associated major projects. Specifically, NNSA's cost estimate requirements do not fully incorporate all 12 steps for developing reliable cost estimates identified in the *Cost Guide* GAO published. Further, none of the Production Modernization programs have developed cost estimates that cover the full life cycle of program activities. The *Cost Guide* states that reliable life cycle cost estimates are a key tool for informing decision-making and ensuring that resources are available to support program execution. Developing such estimates would provide NNSA and congressional decision-makers with greater assurance that they have accurate cost information when making critical decisions on how to estimate program budgets and spend the tens of billions of dollars requested to achieve NNSA's modernization goals.

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Abbreviations

DOE	Department of Energy
FY	fiscal year
NNSA	National Nuclear Security Administration
WBS	work breakdown structure

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Congressional Committees

In a time of rising nuclear threats and an uncertain international security environment, ensuring an effective nuclear deterrent depends on having the infrastructure necessary to quickly produce the strategic materials and components required to build and maintain nuclear weapons. However, our nation currently relies on aging, often deteriorating infrastructure and facilities that date back many decades, including some that were constructed in the 1940s during the Manhattan Project. In response, the United States is in the midst of a long-term and costly effort to simultaneously modernize the nation's nuclear weapons stockpile and the supporting infrastructure on which weapons programs depend. The National Nuclear Security Administration (NNSA)—a separately organized agency within the Department of Energy (DOE)—is responsible for managing our nation's nuclear stockpile and production infrastructure modernization activities.

To meet its responsibilities, NNSA is undertaking a range of production modernization efforts organized into eight programs and their related projects and activities to modernize the facilities, infrastructure, and processes necessary to produce the materials and components required for nuclear weapons. These materials and components include uranium, plutonium pits, and high explosives. NNSA's fiscal year 2024 budget justification to Congress included approximately $29 billion in funding for the Production Modernization effort over the next 5 fiscal years—nearly double the amount NNSA received for this effort during the prior 5-year period. The 2022 Nuclear Posture Review described NNSA's Production Modernization effort as urgent and of critical importance.[1] Most urgently, NNSA's capability to produce new plutonium pits and other nuclear materials and components is essential to the successful and timely delivery of NNSA's W87-1 warhead—the first weapon that NNSA will produce using entirely new or remanufactured nuclear and nonnuclear components since the end of the Cold War.[2]

However, NNSA has a long history of program and project management challenges. Issues associated with NNSA program and project management have been on our High Risk List since the agency was established by statute in 1999.[3] Recently, we have found shortcomings with NNSA's management of the programs and

[1]U.S. Department of Defense, *Nuclear Posture Review* (Washington, D.C.: October 2022). This document establishes U.S. nuclear policy, strategy, capabilities, and force posture for the next 5 to 10 years.

[2]The W87-1 nuclear warhead will replace the W78 nuclear warhead, which was first introduced in 1979 and represents the oldest weapon in the U.S. nuclear stockpile that has not undergone a major life extension or replacement. The W87-1 will be carried on the Air Force's Sentinel intercontinental ballistic missile and is slated for deployment in the early 2030s. However, we reported in June 2023 that the Sentinel program is behind schedule and faces further schedule delays. GAO, *Weapons Systems Annual Assessment: Programs Are Not Consistently Implementing Practices That Can Help Accelerate Acquisitions,* GAO-23-106059 (Washington, D.C.: June 8, 2023). For more information on the W87-1 nuclear warhead, see GAO, *Nuclear Weapons: NNSA Should Further Develop Cost, Schedule, and Risk Information for the W87-1 Warhead Program*, GAO-20-703 (Washington, D.C.: Sept. 9, 2020).

[3]Pub. L. No. 106-65, div. C, tit. XXXII, § 3211, 113 Stat. 512, 957 (1999) (codified at 50 U.S.C. § 2401(a)). GAO, *High-Risk Series: Efforts Made to Achieve Progress Need to Be Maintained and Expanded to Fully Address All Areas*, GAO-23-106203 (Washington, D.C.: Apr. 20, 2023). In 1990, we began reporting on government operations we identified as vulnerable to waste, fraud, abuse, and mismanagement or in need of transformation. We have included DOE project and contract management on the High Risk List since its inception. After NNSA was established, we included both the DOE and NNSA in our assessment of the area. In 2009, we narrowed the area to focus on two offices of the department, NNSA and the Office of Environmental Management, and in 2013 further narrowed the area to focus on major projects and contracts of these offices valued at $750 million or more.

projects that compose its Production Modernization effort, including the use of critical program management tools, such as integrated master schedules and life cycle cost estimates. For example, in January 2023, we reported that the Plutonium Modernization program, NNSA's most expensive Production Modernization program, does not have a comprehensive integrated master schedule that reflects all of the activities necessary to achieve NNSA's objectives.[4] Reliable integrated master schedules can help NNSA to effectively integrate the full scope of its planned activities and measure program performance against an approved plan.

We have also previously reported that both the Plutonium Modernization and Lithium Modernization programs do not have reliable life cycle cost estimates.[5] Reliable life cycle cost estimates can assist NNSA and congressional decision-making about program budgets and investments. Further, in August 2023, we reported that several of NNSA's major capital asset projects associated with Production Modernization programs face schedule delays and cost overruns that will, in turn, affect overall program operations.[6] For example, we reported that as of March 2023, NNSA estimated that one project—the Uranium Processing Facility—will cost about $2.0 billion more than its original cost baseline of $6.5 billion and take more than 3 years longer to complete than planned.[7]

A committee report accompanying a bill for the National Defense Authorization Act for Fiscal Year 2024 includes a provision for GAO to undertake a comprehensive review of NNSA's requirements and guidance for the integrated planning of its modernization efforts and the extent to which NNSA's requirements reflect best practices.[8] In our report, we (1) describe the programs and projects that compose NNSA's Production Modernization effort and NNSA's management of the effort, (2) examine the extent to which NNSA effectively uses schedules to ensure the integration of the programs and their associated projects under its Production Modernization effort, and (3) examine the extent to which NNSA effectively uses cost estimates to manage its Production Modernization programs.[9]

To address our objectives, we reviewed NNSA policies and other documents, including agency reports and budget requests. We also interviewed NNSA officials to identify the full scope of eight Production Modernization programs and 16 associated major capital asset projects that compose NNSA's Production

[4]GAO, *Nuclear Weapons: NNSA Does Not Have a Comprehensive Schedule or Cost Estimate for Pit Production Capability*, GAO-23-104661 (Washington, D.C.: Jan. 12, 2023). In this report, we reiterated the importance of our recommendation from September 2020 that the NNSA Administrator direct the Plutonium Modernization program to develop an integrated master schedule that meets best practices. See GAO-20-703. As of March 2024, this recommendation remained open.

[5]GAO-23-104661; GAO, *Nuclear Weapons: Actions Needed to Improve Management of NNSA's Lithium Activities*, GAO-21-244 (Washington; D.C.: Aug. 12, 2021). In both reports, we recommended that the Plutonium Modernization and Lithium Modernization programs develop life cycle cost estimates that meet best practices. As of March 2024, both recommendations remained open.

[6]GAO, *National Nuclear Security Administration: Assessments of Major Projects*, GAO-22-104402 (Washington, D.C.: Aug. 17, 2023).

[7]As of March 2024, NNSA expected additional schedule delays and cost increases for this project, according to NNSA's fiscal year 2025 budget justification. Specifically, NNSA planned to complete construction on the project no earlier than fiscal year 2030 at a total cost of at least $9.3 billion.

[8]S. Rep. No. 118-58, at 386 (2023).

[9]According to NNSA documents, programs are characterized by a range of measures to help fulfill the agency's mission. By contrast, projects are characterized by efforts to produce a specific product, facility, or system, and have a distinct start and end date. Programs, which typically include projects, are designed to help achieve overarching agency goals. This report focuses on NNSA's Production Modernization effort at the program level.

Modernization effort as of January 2024.[10] Further, we focused on two key program management tools—specifically, resource-loaded integrated master schedules and life cycle cost estimates. These tools, among other tools and practices, are essential to help ensure effective integration. Thus, we determined that focusing on these two tools would provide insight into how the Production Modernization programs integrate their full scopes of planned activities.

In addition, we assessed NNSA's Office of Defense Programs' *Program Execution Instruction* to identify NNSA's program management requirements for developing Production Modernization program schedules and cost estimates.[11] We compared these requirements against the best practices for developing and maintaining reliable integrated master schedules identified in the *Schedule Assessment Guide (Schedule Guide)* we published and the process steps for developing and maintaining reliable cost estimates identified in the *Cost Estimating and Assessment Guide (Cost Guide)* we published.[12]

Further, we reviewed documentation on Production Modernization program schedules and cost estimates and interviewed cognizant program officials to identify the types of schedules and cost estimates each program uses. We did not assess the reliability of each program's schedule and cost estimate. Instead, we compared the information on the types of schedules and cost estimates each program uses with the concepts in the *Schedule Guide* for developing resource-loaded integrated master schedules and in the *Cost Guide* for developing life cycle cost estimates. For more information about our scope and methodology, see appendix I.

We conducted this performance audit from November 2022 to July 2024 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

Nuclear Materials and Components Required for Nuclear Weapons

NNSA is responsible for modernizing the facilities, infrastructure, and equipment needed to produce or process the nuclear materials and components that are essential to nuclear weapon performance. Table 1 describes the strategic materials and components generally required for nuclear weapons that are produced as part of NNSA's Production Modernization programs.

[10]For the purposes of this report, and consistent with our prior work, we define a major project as a capital asset project that has an estimated total project cost of $100 million or more. Each major project included in our scope is associated with a Production Modernization program, is planned for use in the production of nuclear materials or components required for nuclear weapons, and has an approved statement of mission need from NNSA.

[11]DOE, *Program Execution Instruction* (Nov. 15, 2013; updated Sept. 23, 2021).

[12]GAO, *Schedule Assessment Guide: Best Practices for Project Schedules*, GAO-16-89G (Washington, D.C.: Dec. 22, 2015) and *Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Program Costs*, GAO-20-195G (Washington, D.C.: Mar. 12, 2020). As noted above, this report assesses NNSA's requirements specifically for Production Modernization programs. We did not assess NNSA's requirements for associated major capital asset projects.

Table 1: Overview of Nuclear Materials and Components Generally Required for Nuclear Weapons

Material/component	Description
Plutonium	Plutonium is a radioactive element comprising the central cores of thermonuclear weapons, or plutonium pits. Plutonium is produced by irradiating uranium in special nuclear reactors.[a]
High explosives and energetics	U.S. nuclear weapons include approximately 100 different explosive components that provide an essential function in delivering energy quickly and precisely.[b]
Highly enriched uranium	Uranium is a naturally occurring radioactive element that can be enriched to different levels for specific uses, such as in nuclear weapons components or to fuel the reactors that power the U.S. Navy's aircraft carriers and submarines.[c]
Depleted uranium	Depleted uranium is uranium with a lower content of a specific isotope than natural uranium. It is a byproduct of enriching natural uranium and must be further processed into high-purity metal form for use in nuclear weapons.[d]
Lithium	The isotope lithium-6 is a key element used in components of nuclear weapons that is separated—or enriched—from natural lithium.[e]
Tritium	Tritium is a radioactive isotope of hydrogen used to enhance the power of nuclear weapons. It is the byproduct of irradiating lithium targets in a nuclear reactor and can be captured.[f]
Domestic low-enriched uranium	Low-enriched uranium is used as fuel for commercial nuclear reactors, which can be used to produce tritium as a byproduct during a reactor cycle.
Non-nuclear components	Non-nuclear components provide critical safety and surety functions and support the processes of arming, fuzing, and firing nuclear weapons. These components include strategic radiation-hardened microelectronics, which provide the electronic signals that initiate the nuclear explosive chain.[g]

Source: GAO analysis of National Nuclear Security Administration documentation. | GAO-24-106342

[a]Production of plutonium in the United States ceased in 1988; however, the National Nuclear Security Administration continues to produce plutonium components.

[b]The term explosives refers to a group of materials also sometimes referred to as energetics. These terms include the same categories of materials (high explosives, pyrotechnics, and propellants). In this report, we use the term explosives unless the National Nuclear Security Administration's documentation specifically refers to energetics.

[c]The United States ceased production of highly enriched uranium for use in nuclear weapons in 1964 and stopped all production in 1992. The National Nuclear Security Administration still produces fuel to power the U.S. Navy from the existing supply of highly enriched uranium.

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

[e]The isotope lithium-6 is suitable for use in nuclear weapons and is different from forms of lithium used more broadly in industry, such as lithium-ion batteries.

[f]The U.S. only produces tritium in the Watts Bar nuclear reactors at the Tennessee Valley Authority, which is an independent federal corporation that works with the Department of Energy through interagency agreements.

[g]Radiation hardening is the use of process technology, circuit design, or system techniques (such as shielding) to mitigate performance degradation in microelectronics caused by radiation.

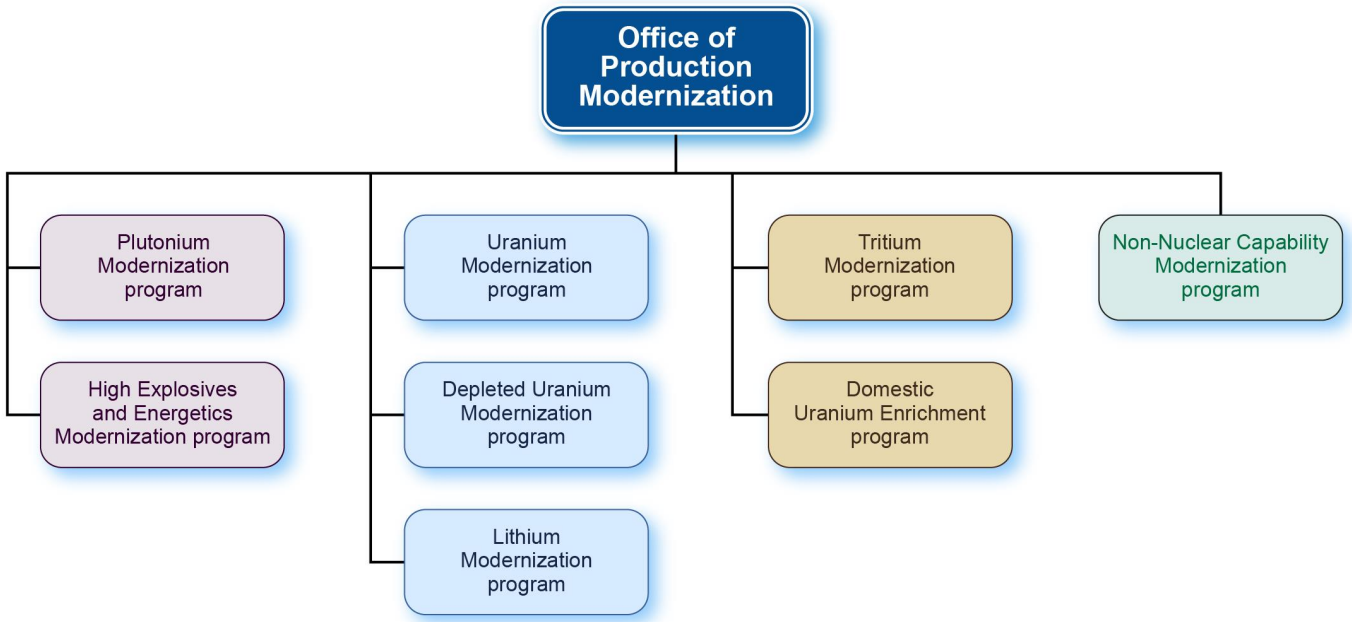
NNSA Management of Production Modernization

NNSA's Production Modernization effort is primarily managed by two offices—the Office of Production Modernization, within NNSA's Office of Defense Programs, and the Office of Infrastructure.[13] NNSA's Office of Production Modernization oversees eight Production Modernization programs that are responsible for

[13]NNSA's Office of Defense Programs consists of four offices apart from the Office of Production Modernization: the Office of Research, Development, Test, and Evaluation; the Office of Stockpile Management; the Office of Secure Transportation; and the Office of Systems Engineering and Integration.

producing or processing the nuclear materials and components described in table 1.[14] The organizational structure of NNSA's Office of Production Modernization at the time of our review is shown in figure 1.[15]

Figure 1: The National Nuclear Security Administration's (NNSA) Office of Production Modernization, as of September 1, 2023



Source: NNSA documentation. | GAO-24-106342

Note: NNSA's Office of Production Modernization is organized into four major areas which, in turn, consist of the eight individual Production Modernization programs. These areas include Primary Capability Modernization (Plutonium Modernization and High Explosives and Energetics Modernization programs); Secondary Capability Modernization (Uranium Modernization, Depleted Uranium Modernization, and Lithium Modernization programs); Tritium Modernization and Domestic Uranium Enrichment programs; and the Non-Nuclear Capability Modernization program. For the purposes of our report, we focus on the eight individual Production Modernization programs rather than the four areas since each program is responsible for producing nuclear materials or specific components for use in nuclear weapons. In September 2023, NNSA reorganized its Office of Defense Programs, including aspects of the Office of Production Modernization. NNSA officials said that the reorganization did not affect the organization of the eight individual Production Modernization programs.

NNSA manages its programs, including Production Modernization programs, under the agency's program management policy.[16] The Office of Defense Programs has issued further direction in its *Program Execution Instruction* document, which established four management categories, each with specific implementation

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[15]In September 2023, NNSA reorganized its Office of Defense Programs, including aspects of the Office of Production Modernization. NNSA officials said that the reorganization did not affect the organization of the eight individual Production Modernization programs included in our scope.

[16]National Nuclear Security Administration, *Program Management Policy,* NAP 413.2 (Feb. 4, 2019).

requirements that include differing degrees of rigor for managing a program.[17] Factors that influence which category a program is managed under include external commitments, the importance of meeting cost and schedule deadlines, the level of integration required with external stakeholders and partners, and the complexity and risk associated with the program. As a program's scope, cost, risk, and schedule evolve, program managers have the option to transition a program to a different category with a different level of rigor required in conducting program management activities. All programs managed under NNSA's *Program Execution Instruction*, regardless of category, are required to document the program scope, schedule, and cost estimate in their planning documents.

The second office involved in NNSA's Production Modernization effort is the Office of Infrastructure. This office is responsible for managing the design and construction of major capital asset projects that are critical to the success of NNSA's overall Production Modernization effort.[18] For example, the Office of Infrastructure is responsible for managing the construction of the High Explosives Science and Engineering Facility project at the Pantex Plant in Texas. This project plans to construct three new interconnected facilities to increase the amount of high explosives that can be used in the laboratory; reduce inefficiencies in moving high explosives between buildings; and increase the capability to develop diagnostic tools for the evaluation, manufacturing, and testing of materials. Once the Office of Infrastructure completes the construction of a Production Modernization major project, the Office of Production Modernization assumes responsibility for the facility and how it is used for program operations.

Major projects, such as the High Explosives Science and Engineering Facility, have an estimated project cost of $100 million or more and are subject to more rigorous management requirements than those required by the *Program Execution Instruction* for all Production Modernization programs. Specifically, major projects are managed in accordance with DOE's project management order for the acquisition of capital assets, which requires projects to undergo a rigorous management review and approval process as they move from planning and design to construction and operation.[19] For example, each major project is managed by a certified federal project director, a member of the Senior Executive Service who monitors cost and schedule using a certified earned value management system and defined critical decision points for risk review and acceptance.[20]

[17]The program management categories, from most to least rigorous, are Capital Acquisition Management, Enhanced Management A, Enhanced Management B, and Standard Management.

[18]DOE defines capital assets as land, structures, equipment, and intellectual property, which are used by the federal government and have an estimated useful life of 2 years or more. As described earlier, for the purposes of this report and in accordance with our prior work, we defined the projects that are critical to the Production Modernization programs as major capital asset projects. These major projects have an estimated total project cost of $100 million or more. DOE's order on project management for capital asset acquisitions applies to all projects estimated to cost $50 million or more and may be applied during the project development phase to nuclear projects or complex first-of-a-kind projects estimated to cost $10 million or more. In addition, the Order's Project Management Principles apply, using a tailored approach, to all capital asset projects estimated to cost $50 million and below, including minor construction projects that cost more than $30 million. DOE, *Program and Project Management for the Acquisition of Capital Assets*, DOE Order 413.3B (Washington, D.C.: Nov. 29, 2010) [Updated June 21, 2023].

[19]DOE Order 413.3B.

[20]An earned value management system measures the value of work accomplished in a given period and compares it with the planned value of work scheduled for that period and the actual cost of work accomplished. As a management concept, earned value management can improve project oversight. Using metrics derived from measures of the value of work to understand performance status and estimate costs and completion times, earned value management can alert managers to potential problems sooner than monitoring expenditures alone. See GAO-20-195G.

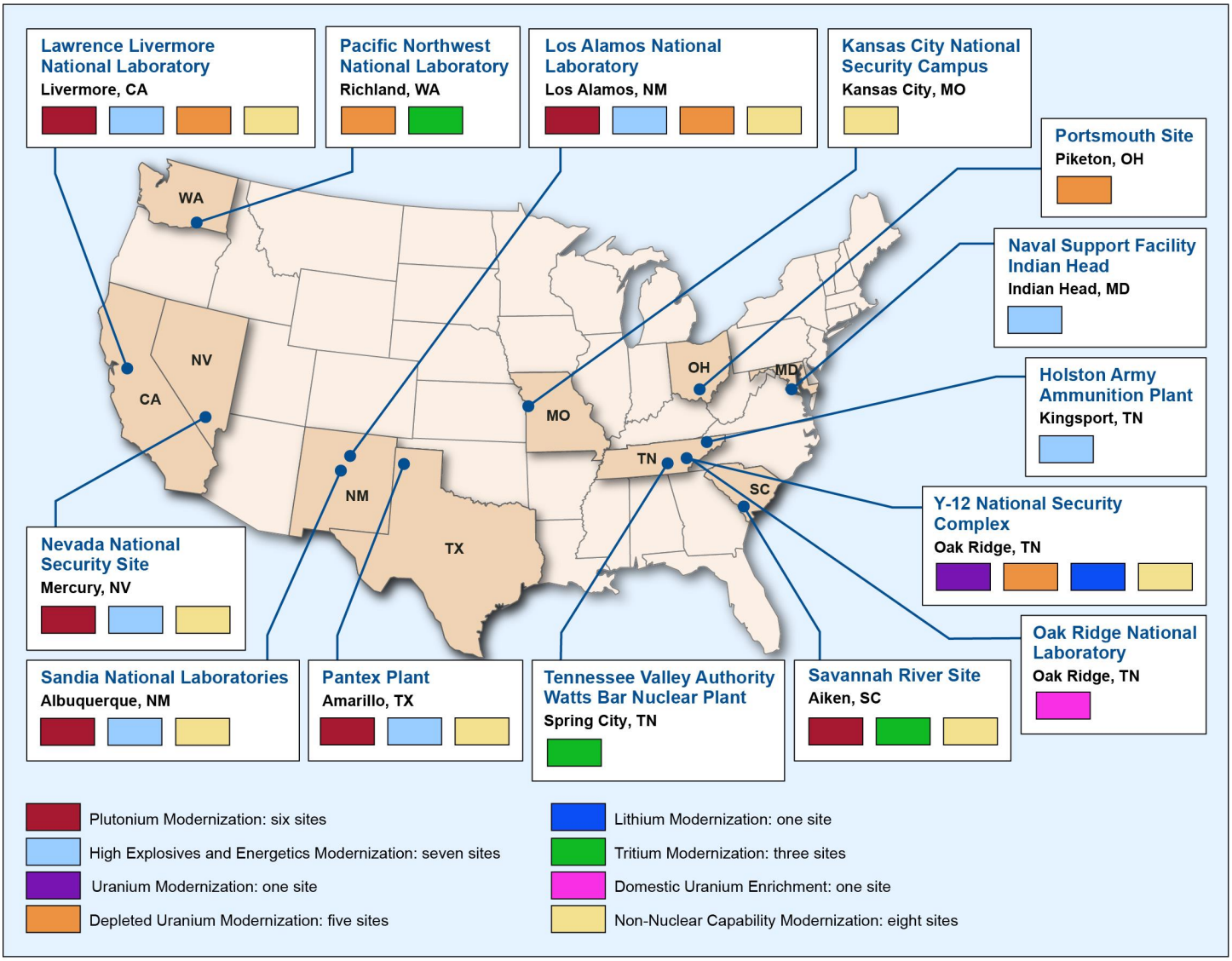
Sites Associated with the Production Modernization Effort

NNSA's Production Modernization effort comprises eight programs and 16 associated major projects that are located at multiple sites across the country managed by DOE, NNSA, and other federal entities. Several programs have ongoing operations and associated major projects underway at multiple sites. For example, the Plutonium Modernization program conducts operations at six sites—Lawrence Livermore National Laboratory (California), Los Alamos National Laboratory (New Mexico), Nevada National Security Site (Nevada), Sandia National Laboratories (New Mexico and other locations), Savannah River Site (South Carolina), and the Pantex Plant (Texas).[21]

In addition, certain NNSA sites house operations for multiple Production Modernization programs. For example, the Plutonium Modernization, High Explosives and Energetics Modernization, Depleted Uranium Modernization, and Non-Nuclear Capability Modernization programs conduct program operations at the Lawrence Livermore National Laboratory. Figure 2 provides more information on the sites associated with the Production Modernization effort.

[21]Sandia National Laboratories' primary site is in Albuquerque, New Mexico. Sandia has a second main facility in Livermore, California. Sandia personnel also work at sites located in Kauai, Hawaii; Tonopah, Nevada; and Washington, D.C.; among other locations.

Figure 2: Sites Associated with the National Nuclear Security Administration's Production Modernization Effort



Sources: GAO presentation of NNSA information; Map Resources (map). | GAO-24-106342

Accessible Text for Figure 2: Sites Associated with the National Nuclear Security Administration's Production Modernization Effort

Site name	Site location	Programs
Holston Army Ammunition Plant	Kingsport, TN	High Explosives and Energetics Modernization
Kansas City National Security Campus		Non-Nuclear Capability Modernization
Lawrence Livermore National Laboratory	Livermore, CA	• Depleted Uranium Modernization • High Explosives and Energetics Modernization • Non-Nuclear Capability Modernization • Plutonium Modernization
Los Alamos National Laboratory	Los Alamos, NM	• Depleted Uranium Modernization • High Explosives and Energetics Modernization • Plutonium Modernization • Non-Nuclear Capability Modernization
Naval Support Facility Indian Head	Indian Head, MD	High Explosives and Energetics Modernization
Nevada National Security Site	Mercury, NV	• High Explosives and Energetics Modernization • Non-Nuclear Capability Modernization • Plutonium Modernization
Oak Ridge National Laboratory	Oak Ridge, TN	Domestic Uranium Enrichment
Pacific Northwest National Laboratory	Richland, WA	• Depleted Uranium Modernization • Tritium Modernization
Pantex Plant	Amarillo, TX	• High Explosives and Energetics Modernization • Non-Nuclear Capability Modernization • Plutonium Modernization
Portsmouth Site	Piketon, OH	Depleted Uranium
Sandia National Laboratories	Albuquerque, NM	• High Explosives and Energetics Modernization • Non-Nuclear Capability Modernization • Plutonium Modernization
Savannah River Site	Aiken, SC	• Plutonium Modernization • Tritium Modernization • Non-Nuclear Capability Modernization
Y-12 National Security Complex	Oak Ridge, TN	• Depleted Uranium Modernization • Lithium Modernization • Non-Nuclear Capability Modernization • Uranium Modernization
Tennessee Valley Authority Watts Bar Nuclear Plant	Spring City, TN	Tritium Modernization

Site counts for each of the programs:

- Plutonium Modernization: six sites
- High Explosives and Energetics Modernization: seven sites

- Uranium Modernization: one site
- Depleted Uranium Modernization: five sites
- Lithium Modernization: one site
- Tritium Modernization: three sites
- Domestic Uranium Enrichment: one site
- Non-Nuclear Capability Modernization: eight sites

Sources: GAO presentation of NNSA information; Map Resources (map). | GAO-24-106342

Note: For the purposes of our report, the National Nuclear Security Administration's (NNSA) Production Modernization effort consists of eight individual programs responsible for producing nuclear materials or specific components for use in nuclear weapons: the Plutonium Modernization program, the High Explosives and Energetics Modernization program, the Uranium Modernization program, the Depleted Uranium Modernization program, the Lithium Modernization program, the Tritium Modernization program, the Domestic Uranium Enrichment program, and the Non-Nuclear Capability Modernization program. The Tennessee Valley Authority is an independent federal corporation that works with the Department of Energy through interagency agreements. We included sites that conduct the main activities for each program and excluded sites that play a secondary role to a program's mission (e.g., supplying materials or sharing expertise).

GAO Guides for Developing Program Schedules and Cost Estimates

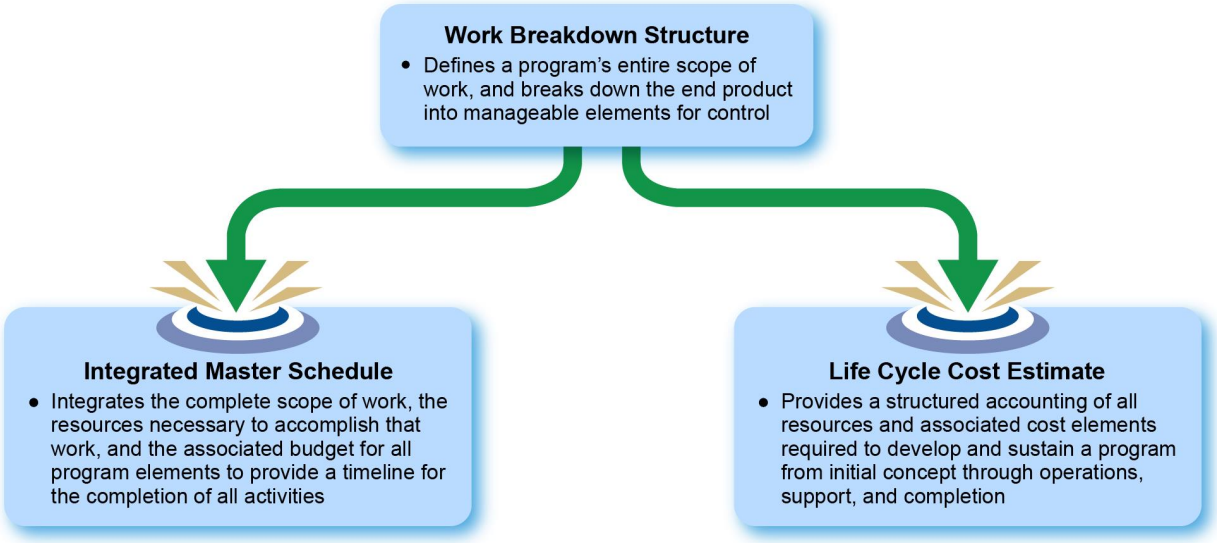
GAO's *Schedule Assessment Guide (Schedule Guide)* and *Cost Estimating and Assessment Guide (Cost Guide)* are designed to provide government-wide guidance on schedule development and cost estimating.[22] Our approach to developing these guides was to ascertain best practices from leading practitioners, and to develop standard criteria to determine the extent to which agency programs and projects meet industry scheduling standards. To do this, we consulted with a committee of specialists in the fields of scheduling and cost estimating from across government, private industry, and academia. Thus, both the *Schedule Guide* and *Cost Guide* represent a compilation of best practices that industry and the public sector use to develop and maintain reliable schedules and cost estimates throughout the life of a program.

While NNSA programs are not required to adhere to these best practices, NNSA's *Program Management Policy* states that programs must consider their use when developing program schedules and cost estimates.[23] Essential program and project management tools highlighted by the *Schedule Guide* and *Cost Guide* include the work breakdown structure, integrated master schedule, and life cycle cost estimate (see fig. 3).

[22]GAO-16-89G and GAO-20-195G.

[23]NAP 413.2.

Figure 3: Essential Tools for Managing Program Schedules and Cost Estimates



Sources: GAO, *Schedule Assessment Guide: Best Practices for Project Schedules*, GAO-16-89G (Washington, D.C.: December 2015) and GAO, *Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Program Costs*, GAO-20-195G (Washington, D.C.: March 2020). | GAO-24-106342

Accessible Text for Figure 3: Essential Tools for Managing Program Schedules and Cost Estimates

Work Breakdown Structure

- Defines a program's entire scope of work, and breaks down the end product into manageable elements for control

Life Cycle Cost Estimate

- Provides a structured accounting of all resources and associated cost elements required to develop and sustain a program from initial concept through operations, support, and completion

Integrated Master Schedule

- Integrates the complete scope of work, the resources necessary to accomplish that work, and the associated budget for all program elements to provide a timeline for the completion of all activities

Sources: GAO, Schedule Assessment Guide: Best Practices for Project Schedules, GAO-16-89G (Washington, D.C.: December 2015) and GAO, Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Program Costs, GAO-20-195G (Washington, D.C.: March 2020). | GAO-24-106342

The *Schedule Guide* outlines best practices for developing high-quality and reliable integrated master schedules. Such schedules identify the full scope of work for a given program or effort, including programmatic activities and associated projects. Integrated master schedules also clearly show how related portions of the program are integrated to ensure success. Further, the *Schedule Guide* states that a reliable integrated master schedule should be resource-loaded and assign specific resources—labor, materials, equipment, and other costs—to specific activities. A resource-loaded integrated master schedule is a fundamental management tool that should be the focal point of program management. Such schedules can help to identify and manage tradeoffs between cost, schedule, and scope. The schedule can also show when major events are expected to be completed, as well as the completion dates for all activities leading up to these events. This can help managers determine if a program's parameters are realistic and achievable.

The *Cost Guide* outlines best practices for developing high-quality, reliable cost estimates for use in effectively managing programs. The *Cost Guide* states that reliable cost estimates are critical for government programs as they facilitate effective resource allocation and increase the overall probability of the program's success. The *Cost Guide* also states that life cycle cost estimates provide a structured accounting of all resources and associated costs required to develop and sustain a particular program. According to the *Cost Guide*, developing an accurate life cycle cost estimate requires program officials to establish a full scope of work, including a complete work breakdown structure that captures all program activities.

NNSA's Production Modernization Effort Includes Multiple Programs and Major Projects That Must Be Integrated to Achieve NNSA's Goals

NNSA's Production Modernization effort includes eight programs and 16 related and ongoing major capital asset projects. While these programs and projects are managed by separate NNSA offices and subject to different management requirements, NNSA officials told us that each program and its associated projects must be integrated to achieve NNSA's modernization goals.

NNSA's Production Modernization Effort's Eight Programs Include 16 Related Major Capital Asset Projects

NNSA's Production Modernization effort consists of eight programs with wide-ranging scopes, milestones, and associated costs, as well as 16 related major capital asset projects in various stages of completion. The following section provides an overview of these eight programs and selected major projects associated with them. For more information on all 16 major projects associated with NNSA's Production Modernization effort, see appendix II.

Plutonium Modernization Program

- Budgeted program and project funding: fiscal years 2024–2028: $15.03 billion
- Number of associated major projects: 6

Source: GAO analysis of the National Nuclear Security Administration's (NNSA) fiscal year 2024 budget justification and other NNSA documentation. | GAO-24-106342

NNSA's **Plutonium Modernization program aims** to achieve the capability to produce 80 plutonium pits per year by 2030, consistent with military and legal requirements.[24] However, NNSA officials have estimated that this capability will not be achieved until 2032–2035 at the earliest. In January 2023, we reported that NNSA's efforts to reestablish the pit production capability is one of the most complex and potentially costly efforts presently undertaken by NNSA. Specifically, the program's scope of work includes a broad range of program activities, six major capital asset projects managed by NNSA's Office of Infrastructure, and other activities that must be effectively integrated across multiple NNSA offices and sites.[25] One major project—the Savannah River Plutonium Processing Facility—plans to modify a partially constructed 400,000 square foot nuclear facility in South Carolina, among other work scope, for use in producing 50 plutonium pits per year starting in 2035 at the latest. The preliminary cost estimate for this project is from $6.9 billion to $11.1 billion. However,

[24]*See* 50 U.S.C. § 2538a(a)(5).

[25]For more information, see GAO-23-104661.

NNSA's fiscal year 2024 budget justification states that the project's schedule may be delayed by up to 3 years and the cost may increase by 40 percent.

High Explosives and Energetics Modernization Program

- Budgeted program and project funding: fiscal years 2024–2028: $1.03 billion
- Number of associated major projects: 4

Source: GAO analysis of the National Nuclear Security Administration's (NNSA) fiscal year 2024 budget justification and other NNSA documentation. | GAO-24-106342

NNSA established the **High Explosives and Energetics Modernization program** in 2019 to manage all agency activities related to explosive materials under one program.[26] There are about 100 different nuclear weapons components that contain explosive materials, including the main charge, detonators, and arming, fuzing, and firing systems.[27] The program is responsible for the production and testing of these materials and components as well as the infrastructure and facilities across seven NNSA sites that support these activities.

The High Explosives and Energetics Modernization program also relies on four ongoing and planned major capital asset projects to meet program needs into the future. For example, as described above, the High Explosives Science and Engineering Facility project plans to construct three interconnected facilities at the Pantex Plant in Texas to increase NNSA's capability to evaluate, manufacture, and test explosive materials, among other things.[28] We reported in August 2023 that this project was currently under construction and slated for completion in November 2027 at a total estimated cost of $278 million, but noted that NNSA was in the process of assessing potential changes to these schedule and cost baselines.[29] In November 2023, NNSA officials told us that the estimated completion date for this project had been delayed to March 2028. Further, NNSA officials from the Office of Infrastructure who are responsible for this project told us that schedule changes may impact the start of operations in the new facilities, which could, in turn, affect the program's ability to meet its mission on time and on budget.

[26]In June 2019, we reported on NNSA's management of wide-ranging activities involving explosive materials and components prior to NNSA establishing the High Explosives and Energetics Modernization program. See GAO, *Nuclear Weapons: Additional Actions Could Help Improve Management of Activities Involving Explosive Materials*, GAO-19-449 (Washington, D.C.: June 17, 2019). In addition, we have an ongoing review specifically examining NNSA's High Explosives and Energetics Modernization program, which we plan to issue later in 2024.

[27]Arming, fuzing, and firing systems ensure that a nuclear weapon does not operate when not intended during any part of its manufacture and lifetime, and also that the weapon will operate correctly when a unique signal to do so is properly activated.

[28]The other three major projects associated with the program are the High Explosives Synthesis, Formulation, and Production Facility; the Energetic Materials Characterization Facility; and the Radiography and Assembly Capability Replacement project. See appendix II for more information on these major projects.

[29]GAO-23-104402. For the purposes of this report, we use the estimated date that construction on a major project will be completed as the project's planned completion date.

Uranium Modernization Program

- Budgeted program and project funding: fiscal years 2024–2028: $3.66 billion
- Number of associated major projects: 3

Source: GAO analysis of the National Nuclear Security Administration's (NNSA) fiscal year 2024 budget justification and other NNSA documentation. | GAO-24-106342

The **Uranium Modernization program** is responsible for managing NNSA's efforts to meet national needs for enriched uranium, including processing uranium-related components for nuclear warheads and bombs.[30] The vast majority of NNSA's uranium processing activities occur at the Y-12 National Security Complex in Oak Ridge, Tennessee, where several facilities are deteriorating to the point that they may pose risks both to safety and to NNSA's ability meet its uranium mission. To address these and other needs, NNSA is undertaking three major projects, including one to relocate key processing equipment and capabilities into a single new structure—the Uranium Processing Facility.[31] In August 2023, we reported that the Uranium Processing Facility project had experienced significant schedule delays and cost increases in recent years.[32]

Specifically, as of March 2023, NNSA expected to complete construction on the Uranium Processing Facility in February 2029 (more than 3 years later than originally planned) at a total cost of approximately $8.5 billion ($2.0 billion more than the original cost baseline).[33] Uranium Modernization program officials we interviewed told us that delays at the project level will affect the program. Specifically, they stated they would be required to update the program's schedule and cost estimate to reflect the need to operate for longer than planned in aging, deteriorating facilities that could affect NNSA's ability to meet a key mission—in this case, processing uranium for the nation's stockpile. The Uranium Processing Facility will be supported by the Highly Enriched Uranium Materials Facility, the construction of which was completed at the Y-12 National Security Complex in 2009 at a total cost of $527 million.

Depleted Uranium Modernization Program

- Budgeted program and project funding: fiscal years 2024–2028: $1.28 billion
- Number of associated major projects: 0

Source: GAO analysis of the National Nuclear Security Administration's (NNSA) fiscal year 2024 budget justification and other NNSA documentation. | GAO-24-106342

NNSA established the **Depleted Uranium Modernization program** in fiscal year 2021 to consolidate the management of its depleted uranium efforts under one program. The program is responsible for ensuring a

[30]We have previously reported on NNSA's Uranium Modernization program. See GAO, *Modernizing the Nuclear Security Enterprise: Uranium Processing Facility Is on Schedule and Budget, and NNSA Identified Additional Uranium Program Costs*, GAO-20-293 (Washington, D.C.: Mar. 11, 2020); and *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 (Washington, D.C.: Sept. 8, 2017).

[31]NNSA is undertaking two additional major projects associated with the Uranium Modernization program. First, the Electrorefining Project will design and install equipment to support a new process to produce high purity uranium. Second, the Direct Chip Melt Bottom Loading Furnace project will design, procure, test, and install new equipment to provide the capability to process uranium scrap metal. See appendix II for more information on these major projects.

[32]GAO-23-104402. The Uranium Processing Facility project consists of four "subprojects"—the Main Process Building, the Salvage and Accountability Building, the Process Support Facilities, and the Mechanical and Electrical Building. For the purposes of this report, we combine these subprojects into a single major capital asset project.

[33]As of March 2024, NNSA expected additional schedule delays and cost increases for this project, according to NNSA's fiscal year 2025 budget justification. Specifically, NNSA planned to complete construction on the project no earlier than fiscal year 2030 at a total cost of at least $9.3 billion.

sustainable supply of depleted uranium metal and the manufacturing capabilities to use this material to produce nuclear weapon components. To accomplish its mission, the program must restore and modernize aging equipment and restart processes for producing depleted uranium metal that lapsed in the early 2000s. In 2020, we reported that NNSA has a very limited stock of the specific material it needs to produce the high-purity metal form of depleted uranium required for nuclear weapons and that its current supply will be exhausted in the late 2020s.[34] Depleted Uranium program officials we interviewed during our audit told us that the program's top priority is to reestablish and sustain a reliable supply of depleted uranium metal from its limited stock by 2030.

At the time of our review, the Depleted Uranium Modernization program did not have any active major projects underway, but was in the early stages of planning for two key efforts aimed at ensuring a sustainable supply of depleted uranium metal. First, in January 2024, NNSA finalized its decision to use existing infrastructure at the DOE Office of Environmental Management's Portsmouth site in Ohio to address Depleted Uranium Modernization program needs.[35] Specifically, NNSA plans to use existing infrastructure to convert a depleted uranium product generated during the uranium enrichment process into the feedstock needed to produce the high-purity depleted uranium metal used as a material required for nuclear weapons.[36] In July 2022, we reported on NNSA's options for using the Portsmouth site to meet program needs and the challenges NNSA faces in meeting its 2030 deadline for producing new depleted uranium metal.[37] Second, NNSA officials told us they plan to undertake additional work to replace aging facilities at the Y-12 National Security Complex in Tennessee, but also stated that this effort is still in the early stages of planning.

Lithium Modernization Program

- Budgeted program and project funding: fiscal years 2024–2028: $1.31 billion
- Number of associated major projects: 1

Source: GAO analysis of the National Nuclear Security Administration's (NNSA) fiscal year 2024 budget justification and other NNSA documentation. | GAO-24-106342

NNSA established the **Lithium Modernization program** in 2019 to manage NNSA's efforts to ensure a sustained supply of lithium for use in the nuclear stockpile. Because the United States stopped enriching lithium in 1963, the Lithium Modernization program is responsible for recovering enriched lithium from retired, disassembled weapons and processing it for reuse in certain nuclear weapon components. However, we reported in 2021 and heard from program officials we interviewed that NNSA's ability to ensure a sustained

[34]GAO, *Nuclear Weapons, NNSA Plans to Modernize Critical Depleted Uranium Capabilities and Improve Program Management*, GAO-21-16 (Washington, D.C.: Oct. 15, 2020).

[35]According to NNSA documentation, this effort will not be categorized as a major capital asset project and therefore will not be subject to project requirements outlined in DOE Order 413.3B.

[36]Turning the products of enrichment into depleted uranium metal needed to produce weapons components involves processing the material through several forms. For more information on this process, see GAO-21-16.

[37]GAO, *Nuclear Waste Cleanup: DOE's Efforts to Management Depleted Uranium Would Benefit from Clearer Legal Authorities*, GAO-22-105471 (Washington, D.C.: July 27, 2022). According to NNSA officials, this project was paused in March 2021 because of an increase in the project cost estimate from $38 million to $58 million, which crossed the DOE threshold for managing a project under DOE Order 413.3B. In addition, we reported that NNSA officials told us they would need to produce feedstock by January 2026 to meet the 2030 deadline for producing high-purity depleted uranium metal. NNSA officials told us that meeting this deadline would be difficult because of the time required to implement DOE's program management processes.

supply of lithium is at risk due to the deteriorating and aging infrastructure and equipment used by the program at the Y-12 National Security Complex in Tennessee.[38]

To address this concern, NNSA is undertaking a major capital asset project, the Lithium Processing Facility, to construct a new facility to relocate existing lithium operations. According to its fiscal year 2024 budget justification, NNSA plans to begin construction on the project in fiscal year 2026, with a tentative construction completion date in fiscal year 2031.[39] However, we reported in August 2023 that the proposed facility size increased by approximately 85 percent, from about 135,000 square feet to about 250,000 square feet, which required NNSA to increase the project's cost estimate by about $145 million to account for this change.[40] NNSA officials from the Office of Infrastructure who are responsible for the project told us that any major construction delays would affect the Lithium Modernization program's ability to transition operations out of its current facilities to the new facility.

Tritium Modernization Program

- Budgeted program and project funding: fiscal years 2024–2028: $2.08 billion
- Number of associated major projects: 1

Source: GAO analysis of the National Nuclear Security Administration's (NNSA) fiscal year 2024 budget justification and other NNSA documentation. | GAO-24-106342

NNSA established what is now known as the **Tritium Modernization program** in 1996 to establish a long-term, reliable supply chain of tritium to meet national security needs. The program is responsible for two major activities—the recovery and recycling of existing tritium reserves and the production of new tritium. First, since tritium decays radioactively at a rate of 5.5 percent each year, the program must recover, recycle, and purify existing tritium from nuclear components with shorter operating lives so it can be returned to the nation's stockpile. Second, the program is responsible for producing new tritium for use in nuclear weapons by irradiating specially designed absorbers—called tritium-producing burnable absorber rods—at the Tennessee Valley Authority's Watts Bar nuclear reactors in Tennessee.[41]

To support this mission, the Tritium Modernization program is undertaking a major capital asset project—the Tritium Finishing Facility—to construct new buildings to relocate existing tritium program operations. Specifically, the facility will replace existing capabilities currently housed in a 1950s-era building that does not meet current codes and standards and presents a risk to the program's mission due to the age of the building and its systems. In August 2023, we reported that construction on the project was estimated to be completed by September 2031 at a total project cost of from $305 million to $640 million.[42] However, in November 2023, NNSA reported that this estimated completion date would be delayed until fiscal year 2034 because a portion of this project had been placed on hold. Specifically, NNSA did not request project funding in fiscal year 2024

[38]GAO-21-244.

[39]According to NNSA's fiscal year 2025 budget justification, as of March 2024, NNSA's planned construction completion date for this project had been delayed to fiscal year 2033.

[40]GAO-23-104402. Even with the $145 million increase, the project's cost estimate remained within the range NNSA previously approved—from $955 million to $1.6 billion.

[41]Tritium is produced in tritium-producing burnable absorber rods through a nuclear reaction with the lithium contained in the rods when irradiated in the Watts Bar nuclear reactors, which are owned and operated by the Tennessee Valley Authority. Subsequently, the rods are shipped to NNSA's Tritium Extraction Facility at the Savannah River Site in South Carolina.

[42]GAO-23-104402.

and does not plan to request additional funding until fiscal year 2027 at the earliest. According to NNSA's fiscal year 2024 budget justification, this decision was informed by delays and cost increases affecting other NNSA major projects and represents NNSA's strategy to focus resources on a reduced number of high-priority major projects.

Domestic Uranium Enrichment Program

- Budgeted program and project funding: fiscal years 2024–2028: $1.47 billion
- Number of associated major projects: 0

Source: GAO analysis of the National Nuclear Security Administration's (NNSA) fiscal year 2024 budget justification and other NNSA documentation. | GAO-24-106342

NNSA's **Domestic Uranium Enrichment program** is responsible for ensuring a reliable supply of domestic, low-enriched uranium for national security purposes.[43] Low-enriched uranium is used as fuel for commercial nuclear reactors, which can produce tritium as a byproduct during a reactor cycle. The program is responsible for making appropriate, existing sources of low-enriched uranium available to produce tritium through 2044. After this date, the program aims to have an operating uranium enrichment capability in place to ensure a reliable source of tritium. To achieve this goal, NNSA is in the process of analyzing options for developing a uranium enrichment capability. However, NNSA did not plan to pursue a major capital asset project for this purpose as of January 2024, according to NNSA officials. The officials also stated that NNSA was in the process of updating its acquisition strategy, including leveraging competitive commercial industry contracts to ensure a reliable supply of domestic, low-enriched uranium for national security purposes. NNSA officials also told us this capability must be in place by the early 2040s to ensure an uninterrupted supply of domestic, low-enriched uranium for national security purposes.[44]

Non-Nuclear Capability Modernization Program

- Budgeted program and project funding: fiscal years 2024–2028: $1.09 billion
- Number of associated major projects: 1

Source: GAO analysis of the National Nuclear Security Administration's (NNSA) fiscal year 2024 budget justification and other NNSA documentation. | GAO-24-106342

NNSA established the **Non-Nuclear Capability Modernization program** to ensure its ability to produce the non-nuclear technology, equipment, and infrastructure that enable critical functionality in nuclear weapons, including arming, fuzing, firing, and key safety features, among other vital functions. Unlike other Production Modernization programs focused on producing or processing a specific nuclear material or component, the Non-Nuclear Capability Modernization program is responsible for ensuring the availability of a wide range of components required to support the nuclear explosive package. Specifically, program officials told us they

[43]The use of uranium for the U.S. nuclear stockpile is affected by obligations to foreign partners that uranium and enrichment technology be used only for peaceful purposes. Material and technology not subject to such obligations are referred to as "unobligated," while material and technology with obligations attached are referred to as "obligated." DOE and NNSA require that enriched uranium used to fuel reactors that produce tritium for nuclear weapons and to power the nuclear Navy be unobligated. However, since the closure of the Paducah Gaseous Diffusion Plant in Kentucky in 2013, the United States has not had the capability to produce unobligated enriched uranium. We have previously reported on NNSA's management of domestic uranium. See GAO, *Uranium Management: Actions to Mitigate Risks to Domestic Supply Chain Could Be Better Planned and Coordinated*, GAO-21-28 (Washington, D.C.: Dec. 10, 2020).

[44]In addition, DOE's Office of Nuclear Energy is pursuing a separate effort that may also contribute to meeting NNSA's future needs for domestic, low-enriched uranium. In December 2020, we reported that these two ongoing efforts are not well coordinated, which raises questions about whether NNSA's process for analyzing options for developing a uranium enrichment capability is being managed from a strategic perspective. See GAO-21-28.

oversee contractors' execution of approximately 450 individual lines of effort to modernize the equipment, processes, and technologies needed to design, develop, and produce non-nuclear components. They stated these components vary in scope and complexity, including radiation-hardened microelectronics and neutron generators as well as structural elements, cables, connectors, and cushions.[45]

In addition, the program is undertaking one major project—the Power Sources Capability facility—to replace a more than 70-year-old building at Sandia National Laboratories in New Mexico. This facility is designed to encompass 135,000 square feet to include offices, specialized laboratory space, and support areas to enable NNSA to produce the technology and components that provide power to nuclear weapons. According to NNSA's fiscal year 2024 budget justification, NNSA plans to complete construction on this project in 2030 at a total project cost of $400 million.

NNSA Programs and Projects Are Subject to Different Management Requirements, but Management Efforts Must Be Integrated to Achieve NNSA Programs' Goals

NNSA's Production Modernization programs and major projects are managed by separate NNSA offices and subject to different management requirements.

Production Modernization programs. As of January 2024, all eight Production Modernization programs are being managed under the two *Program Execution Instruction* categories with the least rigorous program management requirements—Enhanced Management B and Standard Management.[46] Specifically, five Production Modernization programs are in the Enhanced Management B category, and three programs are in the Standard Management category. Table 2 provides information on each Production Modernization program's management category and NNSA's associated minimum requirements these programs must follow when developing program schedules and cost estimates, according to the *Program Execution Instruction*.

Table 2: Production Modernization Programs' Management Categories and the National Nuclear Security Administration's (NNSA) Associated Minimum Requirements

Program Execution Instruction category[a]	Production Modernization program	NNSA's minimum requirements for developing program schedules and cost estimates
Enhanced Management B	Plutonium Modernization[b]	Schedule: Programs must develop a logically sequenced integrated master schedule and an optional resource-loaded schedule. Cost estimate: Programs must develop detailed estimates at a level that enables programs to measure performance and track costs.

[45]In June 2020, we reported on NNSA's microelectronics activities. See GAO, *Nuclear Weapons: NNSA Needs to Incorporate Additional Management Controls Over Its Microelectronics Activities*, GAO-20-357 (Washington, D.C.: June 9, 2020). A neutron generator is an essential component of nuclear weapons that provides neutrons at specific times and rates to initiate weapon function.

[46]The *Program Execution Instruction* identifies four program management categories (in order of most to least rigorous): Capital Acquisition Management, Enhanced Management A, Enhanced Management B, and Standard Management. Production Modernization programs do not meet the *Program Execution Instruction's* criteria for inclusion in the Capital Acquisition Management or Enhanced Management A categories. The Capital Acquisition Management category applies to capital asset projects with a total project cost greater than $50 million and managed in accordance with DOE Order 413.3B—DOE's order on project management for capital asset acquisitions. The Enhanced Management A category applies to NNSA activities that require a selected acquisition report to Congress and follow the Joint Department of Defense-Department of Energy Nuclear Weapon Life-Cycle Process, commonly referred to as the Phase 6.X Process.

Program Execution Instruction category[a]	Production Modernization program	NNSA's minimum requirements for developing program schedules and cost estimates
Enhanced Management B	Uranium Modernization	Schedule: Programs must develop a logically sequenced integrated master schedule and an optional resource-loaded schedule. Cost estimate: Programs must develop detailed estimates at a level that enables programs to measure performance and track costs.
Enhanced Management B	Depleted Uranium Modernization	Schedule: Programs must develop a logically sequenced integrated master schedule and an optional resource-loaded schedule. Cost estimate: Programs must develop detailed estimates at a level that enables programs to measure performance and track costs.
Enhanced Management B	Lithium Modernization	Schedule: Programs must develop a logically sequenced integrated master schedule and an optional resource-loaded schedule. Cost estimate: Programs must develop detailed estimates at a level that enables programs to measure performance and track costs.
Enhanced Management B	Tritium Modernization	Schedule: Programs must develop a logically sequenced integrated master schedule and an optional resource-loaded schedule. Cost estimate: Programs must develop detailed estimates at a level that enables programs to measure performance and track costs.
Standard Management	High Explosives and Energetics Modernization	Schedule: Programs must develop a simple milestone-based schedule. Cost estimate: Programs must develop a cost management and tracking approach as specified in their program plan.
Standard Management	Domestic Uranium Enrichment	Schedule: Programs must develop a simple milestone-based schedule. Cost estimate: Programs must develop a cost management and tracking approach as specified in their program plan.
Standard Management	Non-Nuclear Capability Modernization	Schedule: Programs must develop a simple milestone-based schedule. Cost estimate: Programs must develop a cost management and tracking approach as specified in their program plan.

Source: GAO analysis of NNSA documentation and officials' statements. | GAO-24-106342

Note: An integrated master schedule integrates a program's complete scope of work and can show when major events are expected as well as what completion dates lead up to these events for all activities. A resource-loaded integrated master schedule assigns specific resources—labor, materials, equipment, and other costs—to specific program activities. Milestone-based schedules are less rigorous than integrated master schedules and include key milestone dates associated with a given program.

[a]The *Program Execution Instruction* includes two additional categories: Capital Acquisition Management and Enhanced Management A. Production Modernization programs do not meet the criteria for either of these categories. The Capital Acquisition Management category applies to capital asset projects with a total project cost greater than $50 million and managed in accordance with DOE Order 413.3B. The Enhanced Management A category applies to NNSA activities that require a selected acquisition report to Congress and follow the Joint Department of Defense–Department of Energy Nuclear Weapon Life-Cycle Process, commonly referred to as the Phase 6.X Process.

[b]The National Defense Authorization Act for Fiscal Year 2024, enacted in December 2023, requires the NNSA Administrator to ensure that the Plutonium Modernization program is managed in accordance with GAO's best practices for schedule development and cost estimating no later than July 14, 2025. Pub. L. No. 118-31, div. C, tit. XXXI, § 3117, 137 Stat. 136, 791 (2023) (codified at 50 U.S.C. § 2538a(h)). This legal requirement supersedes NNSA's program management requirements and requires NNSA to develop schedule and cost estimates for its Plutonium Modernization program that are more rigorous than the minimum requirements outlined in the *Program Execution Instruction*'s Enhanced Management B category.

As discussed above, programs under NNSA's Office of Defense Programs, including Production Modernization programs, are placed in *Program Execution Instruction* categories based on several factors, including program complexity and potential risks. For example, NNSA leadership determined that the Lithium Modernization program should follow the more rigorous management requirements outlined by the Enhanced Management B category to better manage program risks. As a result, the program is required to have, at minimum, a logically sequenced integrated master schedule and a detailed cost estimate that allows for measuring performance and accurately tracking costs, according to the *Program Execution Instruction*. In contrast, High Explosives and

Energetics Modernization program officials told us that NNSA leadership determined that the program did not require the more rigorous program management requirements outlined by the Enhanced Management B category. Therefore, the program is placed in the Standard Management category and is not required to develop an integrated master schedule, but instead must have, at minimum, a simple milestone-based schedule.

At the time of our review, NNSA officials we interviewed told us they were in the process of reorganizing the Office of Defense Programs—including its Office of Production Modernization—to implement a portfolio management framework.[47] The Project Management Institute, Inc., defines a portfolio as a collection of projects, programs, subsidiary portfolios, and operations managed as a group to achieve strategic objectives.[48] NNSA officials explained that such a framework would enhance agency leadership's ability to manage the numerous programs, projects, and activities that compose NNSA's Production Modernization effort in a more integrated way to achieve NNSA's mission. The officials also said that program management tools—such as integrated master schedules and cost estimates—would remain critically important for informing higher level decision-making at the portfolio level. At the time of our review, NNSA was only in the early planning stages of the portfolio management framework; thus, it was too early to gauge how such a framework would affect NNSA's management of its overall Production Modernization effort.

Major projects. NNSA's Production Modernization effort includes 16 ongoing major projects that are funded through the Production Modernization programs they support. The projects are managed, however, by NNSA's Office of Infrastructure, which is responsible for the design and construction of each project. Once the Office of Infrastructure completes the construction of a major project, the Office of Production Modernization assumes responsibility for the facility and its operations.

Major projects are required to follow DOE Order 413.3B, which outlines more rigorous management standards than those that apply to Production Modernization programs.[49] For example, for each capital asset project, NNSA must develop a resource-loaded integrated master schedule and a life cycle cost estimate—neither of which is required by the *Program Execution Instruction* for NNSA programs in the Enhanced Management B or Standard Management categories.

NNSA officials we interviewed told us that although each Production Modernization program and the associated major projects that support it are managed by separate NNSA offices and subject to different requirements, they are nonetheless contingent on one another and must be effectively integrated to achieve NNSA's overall modernization goals. More specifically, NNSA officials said that integration is necessary to ensure that projects are designed to meet the needs and requirements identified by specific programs and that

[47]We previously reported on NNSA's efforts to use portfolio management leading practices to manage nuclear weapons stockpile maintenance and modernization programs and projects. We recommended that the NNSA Administrator establish an enterprise-wide portfolio management framework. NNSA has taken steps to address this recommendation, which remained open as of March 2024. See GAO, *Nuclear Security Enterprise: NNSA Should Use Portfolio Management Leading Practices to Support Modernization Efforts*, GAO-21-398 (Washington, D.C.: June 9, 2021).

[48]Project Management Institute, Inc., *The Standard for Portfolio Management,* Fourth Edition (2017). The Project Management Institute is a not-for-profit association that, among other things, provides standards for managing various aspects of projects, programs, and portfolios.

[49]As described earlier, for the purposes of this report, and consistent with prior work, we define a major project as a capital asset project with an estimated total project cost of $100 million or more. DOE's order on project management for capital asset acquisitions applies to all projects estimated to cost $50 million or more. DOE Order 413.3B.

program officials are aware of project-level schedules, costs, and risks that may affect program operations and planning.

NNSA officials responsible for managing Production Modernization programs and associated major projects stated they use established teams and meetings for the purpose of coordinating efforts and integrating separately managed program and project activities. These include the following:

- **Federal Integrated Project Teams.** DOE Order 413.3B requires NNSA to form Federal Integrated Project Teams for all major capital asset projects. These teams comprise a cross-functional group of program and project officials, including contractor representatives, who are led by and responsible to a federal project director for the project's successful execution. These teams meet regularly to discuss project progress and consist of individuals representing a wide range of expertise with the specific knowledge, skills, and abilities to systematically oversee project execution, according to NNSA documentation.
- **Senior Management Teams.** Unlike Federal Integrated Project Teams, Senior Management Teams are not required by NNSA policy. However, NNSA officials told us that these teams are useful in convening a small group of senior-level program and project officials associated with a major project to discuss ongoing activities and quickly elevate any potential challenges. For instance, NNSA officials responsible for managing the Lithium Processing Facility project told us that certain Senior Management Team meetings focused on addressing challenges associated with an unexpected increase in the square footage needed for the Lithium Processing Facility. They stated that senior leadership used these meetings to assess the schedule and cost implications associated with constructing a larger facility.
- **Program-specific integration teams.** Certain Production Modernization programs have also elected to establish additional, program-specific teams for the purpose of ensuring effective integration across program and project activities. For example, in January 2023, we reported that the Plutonium Modernization program established a Matrixed Execution Team to help manage the wide range of program activities, projects, and other efforts needed to achieve its pit production capability.[50] This team is a cross-functional body of senior level NNSA executives that includes representatives from each NNSA office involved in pit production, as well as federal and contractor representatives from Los Alamos National Laboratory and the Savannah River Site. According to NNSA officials and its charter, the Matrixed Execution Team is responsible for synchronizing resources, schedules, and ongoing activities, as well as resolving conflicts that may arise among member offices.

  Likewise, NNSA officials cited the Tritium Modernization program's Tritium Enterprise Strategy Group. They explained this group helps to integrate the requirements, infrastructure, technology, and capabilities required to maintain NNSA's tritium capability and comprises officials from all NNSA sites associated with the Tritium Modernization program.

- **The Office of Production Modernization Risk Board.** NNSA's Office of Production Modernization also stood up a risk management board designed to identify and integrate risk information that can affect all aspects of NNSA's Production Modernization effort.

In addition, numerous NNSA officials told us they frequently communicate informally with their federal and contractor colleagues to ensure effective integration between major projects and the Production Modernization programs they support. For example, NNSA officials responsible for managing the Uranium Processing Facility

[50]GAO-23-104661.

project stated that they collaborate with contractor personnel daily to discuss and address any issues affecting project execution and stressed the importance of regularly communicating key information on project schedules and costs to the Uranium Modernization program. These officials told us that regular communication was especially critical when significant schedule delays and cost increases for the Uranium Processing Facility project necessitated changes to the Uranium Modernization program's integrated master schedule and cost estimate.

Production Modernization Program Schedules Are Insufficient for Ensuring Effective Integration

Production Modernization program schedules are insufficient for ensuring effective integration. Specifically, NNSA's requirements for developing Production Modernization program schedules do not incorporate most of the 10 best practices outlined in the *Schedule Guide*, which reflect the characteristics of schedules that contribute to program success. Further, the Production Modernization program schedules we reviewed varied by type, and only one program uses a resource-loaded integrated master schedule. According to the *Schedule Guide*, resource-loaded integrated master schedules should be the focal point of program management. Such schedules can identify the full scope of scheduled work for a given effort—including the resources necessary to complete this work—and clearly show how related portions of the program must be integrated.

NNSA Requirements Do Not Incorporate Best Practices for Developing Reliable Program Schedules

The *Schedule Guide* identifies 10 best practices that, when incorporated into an agency's procedures and guidance, are more likely to result in reliable, high-quality schedules that sufficiently integrate programmatic activities. However, our assessment of NNSA's *Program Execution Instruction* found that NNSA's requirements for developing Production Modernization program schedules did not incorporate most of these best practices. Specifically, NNSA's schedule requirements for Enhanced Management B programs partially met one, minimally met seven, and did not meet two best practices. NNSA's schedule requirements for Standard Management programs did not meet any of our best practices.[51] Table 3 shows the extent to which NNSA's schedule requirements for programs in the Enhanced Management B and Standard Management categories met each best practice. Appendix III provides the full results of our assessment.

Table 3: Our Assessment of the National Nuclear Security Administration's (NNSA) Program Management Requirements for Developing Production Modernization Program Schedules

Schedule Guide best practice	NNSA requirements for programs in the Program Execution Instruction's Enhanced Management B categorya	NNSA requirements for programs in the Program Execution Instruction's Standard Management categorya
Capturing all activities	partially met	not met

[51]We assessed the extent to which NNSA schedule requirements applicable to Production Modernization programs incorporate the 10 best practices outlined in the *Schedule Guide*. We did not assess individual Production Modernization program schedules. We rated the extent to which NNSA's schedule requirements incorporate our 10 best practices using the following scale: Fully met—NNSA provided evidence that satisfies the entire criterion; substantially met—NNSA provided evidence that satisfies a large portion of the criterion; partially met—NNSA provided evidence that satisfies about half of the criterion; minimally met—NNSA provided evidence that satisfies a small portion of the criterion; and not met—NNSA provided no evidence that satisfies any of the criterion.

Schedule Guide best practice	NNSA requirements for programs in the Program Execution Instruction's Enhanced Management B categorya	NNSA requirements for programs in the Program Execution Instruction's Standard Management categorya
Sequencing all activities	minimally met	not met
Assigning resources to all activities	minimally met	not met
Establishing the durations of all activities	not met	not met
Verifying that the schedule can be traced horizontally and vertically	minimally met	not met
Confirming that the critical path is valid	minimally met	not met
Ensuring reasonable total float	not met	not met
Conducting a schedule risk analysis	minimally met	not met
Updating the schedule using actual progress and logic	minimally met	not met
Maintaining a baseline schedule	minimally met	not met

Legend:

● = Fully met

◕ = Substantially met

◑ = Partially met

◔ = Minimally met

○ = Not met

Source: GAO analysis of National Nuclear Security Administration documentation and GAO, *Schedule Assessment Guide*: Best Practices for Project Schedules, GAO-16-89G (Washington, D.C.: Dec. 22, 2015). | GAO-24-106342

Note: This table presents our assessment of the extent to which NNSA schedule requirements for Production Modernization programs incorporate the best practices outlined in the *Schedule Guide*. This table does not present information on individual Production Modernization program schedules. We rated the extent to which NNSA's schedule requirements incorporate our 10 best practices using the following scale:

Fully met—NNSA provided evidence that satisfies the entire criterion; substantially met—NNSA provided evidence that satisfies a large portion of the criterion; partially met—NNSA provided evidence that satisfies about half of the criterion; minimally met—NNSA provided evidence that satisfies a small portion of the criterion; and not met—NNSA provided no evidence that satisfies any of the criterion.

[a]The *Program Execution Instruction* identifies four program management categories (in order of most to least rigorous): Capital Acquisition Management, Enhanced Management A, Enhanced Management B, and Standard Management. Production Modernization programs fall into the Enhanced Management B and Standard Management categories and do not meet the *Program Execution Instruction*'s criteria for inclusion in the Capital Acquisition Management or Enhanced Management A categories. The Capital Acquisition Management category applies to capital asset projects with a total project cost greater than $50 million and managed in accordance with DOE Order 413.3B. The Enhanced Management A category applies to NNSA activities that require a selected acquisition report to Congress and follow the Joint Department of Defense–Department of Energy Nuclear Weapon Life-Cycle Process, commonly referred to as the Phase 6.X Process.

As shown in table 3, there are clear shortcomings in NNSA's requirements for developing Production Modernization program schedules when compared with the *Schedule Guide*. NNSA officials told us that the *Program Execution Instruction*'s schedule requirements are designed to establish the minimum requirements for programs in each management category and to provide information and guidance on how to meet them. They explained that the *Program Execution Instruction* provides program officials with the option to exceed these minimum requirements and tailor their schedules to include additional rigor according to specific program needs. However, by not requiring program officials to follow best practices when developing schedules, NNSA risks developing and depending on program schedules that are not reliable. Incorporating best practices into NNSA's schedule requirements for Enhanced Management B and Standard Management programs will help to ensure the use of reliable, resource-loaded integrated master schedules that identify and sufficiently integrate each program's full scope of work, assign necessary resources to program activities, allow for measuring program performance, and more.

Production Modernization Schedules Vary by Type, and Only One Program Uses a Resource-Loaded Integrated Master Schedule

The eight Production Modernization program schedules we reviewed vary by type, and only one program—the Tritium Modernization program—uses a resource-loaded integrated master schedule. As described above, resource-loaded integrated master schedules should be the focal point of program management because they can help NNSA effectively integrate the full scope of planned program activities. Table 4 provides more information on the types of schedules used by the eight Production Modernization programs.

Table 4: Summary of the Types of Program Schedules Used by the National Nuclear Security Administration's (NNSA) Production Modernization Programs, as of January 2024

Production Modernization program	Schedule type	Resource loaded?	Additional information
Plutonium Modernization	Integrated master schedule	No	The schedule is incomplete—that is, it does not include the full scope of program operations, associated major projects, and other activities necessary to meet program goals.
High Explosives and Energetics Modernization	Milestone-based schedule	No	na
Uranium Modernization	Integrated master schedule	No	na
Depleted Uranium Modernization	Integrated master schedule	No	na
Lithium Modernization	Integrated master schedule	Partially	The schedule includes some information on resources associated with near-term activities.
Tritium Modernization	Integrated master schedule	Yes	The program uses a fully resource-loaded schedule that assigns specific resources—labor, materials, equipment, and other costs—to relevant program activities.
Domestic Uranium Enrichment	No program-level schedule	No	The program uses distinct, lower level schedules associated with different program elements.
Non-Nuclear Capability Modernization	No program-level schedule	No	The program uses an electronic database to oversee contractors' execution of hundreds of lines of effort.

Source: GAO analysis of NNSA documentation and NNSA officials' statements. | GAO-24-106342

Note: An integrated master schedule integrates a program's complete scope of work and can show when major events are expected as well as what the completion dates are for all activities leading up to these events. A resource-loaded integrated master schedule assigns specific resources—labor, materials, equipment, and other costs—to specific program activities. Milestone-based schedules are less rigorous than integrated master schedules and include key milestone dates associated with a given program. For the purposes of our report, we did not assess the reliability of each program's schedule. Instead, we reviewed relevant schedule documentation and interviewed NNSA officials to understand the types of schedules used by each Production Modernization program.

Of the eight Production Modernization programs, only the **Tritium Modernization program** uses a fully resource-loaded integrated master schedule, according to our review of program documentation and discussion with program officials. As described earlier, such schedules assign specific resources—labor, materials, equipment, and other costs—to relevant program activities and help to ensure the effective integration of a program's full scope of work.

One Production Modernization program schedule we reviewed was incomplete—that is, it did not include the full scope of program operations, associated major projects, and other activities necessary to meet program goals.

Our prior work recommended that NNSA develop an integrated master schedule for the **Plutonium Modernization program** that meets best practices, and a congressional committee also directed the program to develop an integrated master schedule.[52] However, in January 2023, we reported that the schedule NNSA developed in response to this direction was not comprehensive because it only captured the activities to manufacture a single plutonium pit by 2024, did not assign resources to these activities (i.e., was not resource-loaded), and minimally met best practices for assigning durations to all activities.[53]

For example, we reported that the integrated master schedule did not incorporate key construction milestones for major capital asset projects critical to the program's success, including the Los Alamos Plutonium Pit Production Project and the Savannah River Plutonium Processing Facility. In response to this report, in December 2023, the National Defense Authorization Act for Fiscal Year 2024 required the NNSA Administrator to ensure that the Plutonium Modernization program is managed in accordance with GAO best practices for schedule development no later than July 14, 2025.[54] As described previously, best practices state that programs should develop and maintain reliable, resource-loaded integrated master schedules.

Two other Production Modernization programs we reviewed do not use integrated master schedules or other program-level schedules but rely instead on schedules for lower level program components.

- The **Non-Nuclear Capability Modernization program** does not have a program-level schedule, but instead oversees contractors' execution of approximately 450 individual lines of effort using an electronic database, according to our review of program documentation and discussion with program officials. The officials stated that this database is an appropriate and useful tool given the program's wide-ranging efforts and added that the database serves as a milestone-based schedule—as required for Standard Management programs. The officials explained that contractors are responsible for and required to maintain rigorous schedules for each line of effort, among other project management requirements. In addition, they stated that each month, contractors are required to update schedule information for each line of effort in the database, which is then reviewed by program officials. Program officials told us they track program progress by monitoring this and other selected information, including upcoming project milestones and specific needs associated with each effort in the near and longer terms.
- **Domestic Uranium Enrichment program** officials told us they use distinct schedules to manage discrete components of the overall program. For example, they explained that they use one schedule to manage research and development efforts at the Oak Ridge National Laboratory in Tennessee. Program officials told us that using separate, lower level schedules is appropriate since current program efforts largely operate independently from one another and changes to one aspect of the program—such as a schedule delay—do not necessarily affect other aspects. The officials added that the program is still in its early stages and officials are evaluating options for how best to organize the program to meet its mission in

[52]GAO-20-703. In September 2020, we reported that NNSA did not have assurance that its Plutonium Modernization program would be able to produce enough plutonium pits in time to sustain production of warheads for a key weapons program. We recommended that the NNSA Administrator direct the Plutonium Modernization program to develop an integrated master schedule that meets our best practices. This recommendation remained open as of March 2024. In addition, a Senate committee report accompanying a bill for the National Defense Authorization Act for Fiscal Year 2022 directed NNSA to provide an integrated master schedule for producing 30 plutonium pits per year at Los Alamos no later than February 28, 2022. S. Rep. No. 117-39, at 367 (2021).

[53]GAO-23-104661.

[54]Pub. L. No. 118-31, div. C., tit. XXXI, § 3117, 137 Stat. 136, 791 (2023) (codified at 50 U.S.C. § 2538a(h)). The conference report accompanying the National Defense Authorization Act for Fiscal Year 2024 cites GAO's prior report on NNSA's Plutonium Modernization program, GAO-23-104661, in its discussion of section 3117. H.R. Rep. No. 118-301, at 1377-1378 (2023).

the future—ensuring a reliable supply of domestic enriched uranium. Program officials explained that they plan to transition from the Standard Management category to the Enhanced Management B category in the future, but stated that this transition would take several years. As part of this transition, the officials said they plan to develop a more rigorous integrated master schedule that captures the program's full scope of work.

One of the eight Production Modernization programs uses a simple milestone schedule.

The **High Explosives and Energetics Modernization program** schedule incorporates high-level milestones associated with planned program operations and major projects through fiscal year 2034. Program officials told us that ensuring that the program's entire scope of work was included in the milestone schedule was important for informing leadership decisions and tracking program deliverables.

The three remaining Production Modernization programs use integrated master schedules that include the full scope of program operations and associated major projects, but are not fully resource loaded, according to our review of program documentation and discussion with program officials. Specifically, the **Uranium Modernization, Depleted Uranium Modernization, and Lithium Modernization programs**—all three of which are in the Enhanced Management B category—use integrated master schedules as required by the *Program Execution Instruction*. Lithium Modernization program officials told us their schedule incorporates some information on resources associated with near-term activities. However, NNSA officials from the other two programs told us their schedules do not incorporate information on resources.

Existing Program Schedules Are Insufficient for Ensuring the Effective Integration of Production Modernization Programs and Their Associated Projects

As described above, fully resource-loaded integrated master schedules are a fundamental tool for ensuring effective program and project integration, according to schedule best practices. Specifically, best practices state that resource-loaded integrated master schedules should identify the full scope of scheduled work for a given effort—including the resources necessary to complete this work—and should clearly show how related portions of the program must be integrated. By not ensuring that its Production Modernization programs develop and maintain such schedules, NNSA risks continuing to rely on program schedules that are insufficient for ensuring the effective integration of the full scope of work for each of the eight programs and their associated major projects.

For instance, the Production Modernization program schedules we reviewed do not provide for a clear understanding of the timing of, and relationship between, major program and project events, which may result in unreliable completion dates and delays. In fact, our prior reports have routinely found long-standing challenges with schedule delays and cost increases specifically for Production Modernization programs and their associated major projects.[55] For instance:

[55]For examples, see GAO-23-104402, GAO-23-104661, GAO-21-244, and GAO-19-449.

- We reported in January 2023 that, without a reliable, resource-loaded integrated master schedule, the Plutonium Modernization program risks further delays to its mission—achieving the capability to produce 80 plutonium pits per year by 2030.[56]
- We reported in August 2023 that many of the NNSA major projects associated with Production Modernization programs face schedule delays and cost overruns.[57] Without reliable integrated master schedules, Production Modernization program officials are not able to effectively assess—at a specific level of confidence—how such problems or changes at the project level will affect their program's progress and timelines toward meeting future goals.

Senior NNSA officials we interviewed acknowledged that Production Modernization programs need to improve their program management activities, including their use of integrated master schedules. However, when we asked NNSA officials why seven of the eight Production Modernization programs had not developed fully resource-loaded integrated master schedules, they stated that (1) the *Program Execution Instruction* does not require such rigorous schedules and (2) current program schedules are sufficient for NNSA's purposes.

NNSA officials told us that most Production Modernization programs do not have resource-loaded integrated master schedules because the *Program Execution Instruction* does not require such schedules.[58] Specifically:

- Standard Management programs are required to develop a simple milestone-based schedule, and
- Enhanced Management B programs are required to develop an integrated master schedule, but incorporating resources into this schedule is optional.

Standard Management. As described above, our assessment of NNSA's requirements found that simple milestone-based schedules do not meet any of the best practices for developing reliable schedules outlined in the *Schedule Guide*. Specifically, milestone schedules lack key components necessary for effective management, such as the dynamic, logical sequencing and duration of detailed program activities and the specific resources necessary to complete them. The absence of such information in a program schedule can inhibit officials' ability to ensure all activities associated with the program are captured and integrated within the program's schedule.

In contrast, according to the *Schedule Guide*, an integrated master schedule would include these and other key components necessary for effective management. For example, a resource-loaded integrated master schedule would enable High Explosives and Energetics Modernization program officials to establish logical links among varied programmatic activities spanning seven different sites. In fact, in June 2024, NNSA officials told us the program was in the process of developing an integrated master schedule to replace the program's current milestone-based schedule. The officials stated that the first iteration of the program's revised schedule will not be resource-loaded and should be completed during the first quarter of fiscal year 2025.

A resource-loaded integrated master schedule would enable officials to better integrate key milestones associated with the program's four major projects being managed by the Office of Infrastructure. It would also

[56]GAO-23-104661. We reported that NNSA does not expect to be able to meet its 80 pit-per-year capability until 2032–2035 at the earliest.

[57]GAO-23-104402.

[58]As described above, in contrast with Production Modernization program requirements, NNSA is required to develop resource-loaded integrated master schedules for all major capital asset projects.

provide officials with a more strategic perspective for managing key program and project milestones, administering available resources, and mitigating potential risks to ensure the program's ability to achieve its mission. For example, NNSA's budget justifications for fiscal years 2024 and 2025 paused progress on two major projects associated with the High Explosives and Energetics Modernization program. Without a resource-loaded integrated master schedule, it is difficult for NNSA to determine the effect of these pauses on the overall program.

Enhanced Management B. Although programs in this category are required to develop integrated master schedules, not requiring these programs to incorporate the resources necessary to complete the full scope of work limits the schedules' effectiveness. Scheduling best practices state that an integrated master schedule should be resource loaded for several reasons. Specifically, the *Schedule Guide* states that including resources helps management compute total labor and equipment hours, calculate total project and per-period cost, resolve resource conflicts, and establish the reasonableness of the plan. For example, Tritium Modernization program officials told us their resource-loaded integrated master schedule allows them to track program funding needs and to take steps to ensure necessary funding is available to meet them.

In contrast, a schedule without resources implies an unlimited amount and availability of resources. It is impossible to tell if total available resources are adequate to complete work, and to determine if resources will be available at specific times when they are required. For instance, incorporating resources into the Uranium Modernization program's schedule would help officials to better identify and plan for the shifting resource needs associated with operating in deteriorating facilities for years longer than planned due to delays in completing the Uranium Processing Facility.

As discussed above, NNSA officials told us that the schedules they presently use are sufficient for ensuring the effective integration of all programmatic activities and major projects associated with each Production Modernization program. However, we found shortfalls in the use of certain program schedules. For example:

- Non-Nuclear Capability Modernization program officials told us that the electronic database they use as a milestone-based schedule is appropriate for monitoring contractors' execution of the hundreds of lines of effort overseen by the program. However, this database does not provide the same benefits or functionality as a reliable integrated master schedule. For example, unlike an electronic database, a reliable integrated master schedule could provide a strategic view of the program's hundreds of activities and milestones spanning eight sites, a roadmap for systematic project execution, and the ability to identify and resolve problems at all levels.

  Further, such a schedule would be particularly useful given that the program's scope includes one ongoing major project—the Power Sources Capability facility, described above—and plans for two additional major projects that are critical to NNSA's mission. For example, we reported in June 2020 that NNSA's plan to upgrade and sustain the infrastructure and processes for producing radiation-hardened microelectronics through 2040 represents a decades-long, significant undertaking that will cost about $1.0 billion.[59]

  While the construction of these facilities will be managed by NNSA's Office of Infrastructure, NNSA program and project officials emphasized the importance of integrating key construction milestones and

[59]GAO-20-357. In addition, according to its Fiscal Year 2024 Stockpile Stewardship and Management Plan, NNSA is analyzing options for a potential major project focused on consolidating existing facilities for producing neutron generators that are currently conducted in several buildings across multiple sites.

other project-level information into the program-level schedule to support program planning and execution. A reliable integrated master schedule would provide NNSA leadership and program officials with greater assurance the milestones and relevant information were being integrated effectively.

- A senior NNSA official told us at the time of our review that milestone schedules were sufficient for tracking key dates for certain programs that have smaller annual budgets, such as the High Explosives and Energetics Modernization program. However, all Production Modernization programs represent complex, high-priority, expensive, and high-risk efforts that are essential to maintaining an effective nuclear deterrent. For example, while funding levels for the High Explosives and Energetics Modernization program are less than other Production Modernization programs, the amount of funding is still substantial. Specifically, according to NNSA's budget justifications, from fiscal year 2019 through 2023, NNSA received a total of $526 million for this program and, as mentioned above, the agency plans to request more than $1.0 billion more from fiscal years 2024 through 2028.

  Further, NNSA officials acknowledged that ensuring a reliable supply of high explosives presents a major risk not only to the High Explosives and Energetics Modernization program, but to NNSA's overall Production Modernization effort. They stated that this risk must be carefully managed to ensure NNSA's ability to meet its mission. Although the program only had a simple milestone schedule at the time our review, NNSA officials told us in June 2024 that they were in the process of developing an integrated master schedule for this program, as described above. The officials anticipated completing the first iteration of this schedule during the first quarter of fiscal year 2025. Once completed, the program will no longer need to rely on a simple milestone schedule that, as detailed earlier, lacks key components required for effective program management.

NNSA officials we interviewed also consistently stated that NNSA's *Program Execution Instruction* is purposefully designed to outline the minimum requirements program officials must follow when developing program schedules. They reiterated that officials have the option to exceed these minimum requirements by tailoring their schedules according to program needs, including by developing resource-loaded integrated master schedules. Developing such schedules in accordance with the *Schedule Guide* would provide NNSA program officials with greater assurance that they were effectively integrating program operations, major projects, and other key activities. However, as described above, officials from only one program—the Tritium Modernization program—opted to develop such a schedule.[60] In fact, Tritium Modernization program officials stated that incorporating resources into their schedule had several benefits in informing their program planning efforts. According to these officials, the benefits included enabling program officials to assess the amount of funding required to ensure ongoing operations across several NNSA sites and to ensure the materials, workforce, and funding needed to complete upcoming work at these sites would be available.

Tritium Modernization program officials have taken steps to increase the rigor and usefulness of their program schedule by fully incorporating the resources required to support program activities. In contrast, NNSA officials told us that the Non-Nuclear Capability Modernization program may not benefit from having a resource-loaded integrated master schedule. Specifically, they emphasized the program's role in overseeing contractors' execution of hundreds of lines of effort, most of which are independent of one another—that is, delays and

[60]As described previously, the Lithium Modernization program's integrated master schedule is not fully resource-loaded, but does include some information on resources associated with near-term activities, according to NNSA officials we interviewed.

problems associated with one effort do not affect the timeline or success of another. The officials stated that given this structure, a resource-loaded integrated master schedule is not appropriate for this program.

However, as detailed above, we believe requiring the Non-Nuclear Capability Modernization program to develop a resource-loaded integrated master schedule could deliver key benefits, including providing a strategic perspective over the broad range of activities and milestones the program is responsible for monitoring. In this and other cases, however, if developing a resource-loaded integrated master schedule were required, program officials could have the option of documenting their rationale for not doing so and obtain senior leadership approval for their decision. Until a requirement to develop resource-loaded integrated master schedules is established, NNSA leadership will continue to rely on varied program schedules that—both individually and collectively—do not provide NNSA with reasonable assurance it is sufficiently integrating all aspects of its Production Modernization effort. Specifically, without resource-loaded integrated master schedules, Production Modernization program officials and NNSA leadership lack a fundamental tool to ensure integrated planning occurs when managing individual programs and NNSA's Production Modernization effort as a whole.

Finally, as noted above, in response to our prior work, the NNSA Administrator was statutorily required to ensure that, no later than July 14, 2025, the Plutonium Modernization program is managed in accordance with GAO's best practices for schedule development, which state that programs should develop and maintain resource-loaded integrated master schedules.[61] Given the urgency and importance of the Production Modernization effort as a whole, NNSA should ensure that the other Production Modernization programs also develop and maintain resource-loaded integrated master schedules in accordance with best practices, or document their rationale with senior leadership approval for not doing so. Resource-loaded integrated master schedules would provide senior NNSA leadership and congressional decision-makers with greater assurance that key milestone and schedule information they receive from programs are complete, accurate, and reliable. This, in turn, will help to inform critical decisions and better ensure that NNSA can meet necessary deadlines for producing the nuclear materials and components essential to the nation's weapons modernization programs.

Production Modernization Program Cost Estimates Are Insufficient for Ensuring Effective Integration

Production Modernization program cost estimates are insufficient for ensuring the effective integration of programs and their associated major projects. Specifically, NNSA's requirements for developing Production Modernization program cost estimates do not fully incorporate the steps outlined in best practices necessary to ensure the development of reliable cost estimates. Further, none of the Production Modernization programs use cost estimates that cover the full life cycle of planned program activities. According to the *Cost Guide*, life cycle cost estimates help program officials ensure that all costs are fully accounted for and that available resources are adequate to support program execution. Further, program-level life cycle cost estimates should be used as the basis for program budgeting.

[61]Pub. L. No. 118-31, div. C, tit. XXXI, § 3117, 137 Stat. 136, 791 (2023) (codified at 50 U.S.C. § 2538a(h)). The conference report accompanying the National Defense Authorization Act for Fiscal Year 2024 cites GAO's prior report on NNSA's Plutonium Modernization program, GAO-23-104661, in its discussion of section 3117. H.R. Rep. No. 118-301, at 1377-1378 (2023).

NNSA Requirements Do Not Fully Incorporate Necessary Steps for Developing Reliable Program Cost Estimates

The *Cost Guide* identifies 12 process steps that, when incorporated into an agency's procedures and guidance, are more likely to result in reliable and valid cost estimates. However, our assessment of NNSA's *Program Execution Instruction* found that NNSA's requirements for developing cost estimates for Production Modernization programs in both the Enhanced Management B and Standard Management categories do not fully incorporate the steps listed in the *Cost Guide*.[62] As shown in table 5, we found that NNSA's relevant cost estimating requirements for both categories met one, partially met three, and minimally met eight of the 12 steps needed to ensure a reliable cost estimating process.[63] Appendix IV provides the full results of our assessment.

Table 5: Assessment of the National Nuclear Security Administration's (NNSA) Program Management Requirements Applicable to Developing Production Modernization Program Cost Estimates

Cost Guide step	NNSA's requirements for programs in the Program Execution Instruction's Enhanced Management B and Standard Management categoriesa
Define the estimate's purpose	fully met
Develop the estimating plan	partially met
Define the program	partially met
Determine the estimating structure	partially met
Identify ground rules and assumptions	minimally met
Obtain the data	minimally met
Develop the point estimate	minimally met
Conduct a sensitivity analysis	minimally met
Conduct a risk and uncertainty analysis	minimally met
Document the estimate	minimally met
Present the estimate to management for approval	minimally met
Update the estimate to reflect actual costs and changes	minimally met

● = Fully met

◕ = Substantially met

[62]In contrast to its requirements for developing program schedules, we found that NNSA's requirements for developing cost estimates for programs in the Enhanced Management B and Standard Management categories are very similar and the *Program Execution Instruction* cites the same guidance documents for both categories. As a result, our assessment of NNSA's requirements is the same for both categories across all 12 process steps listed in the *Cost Guide*.

[63]Our assessment analyzed the extent to which the NNSA cost estimating requirements applicable to Production Modernization programs incorporate the 12 process steps outlined in the *Cost Guide*. This assessment did not analyze individual Production Modernization program cost estimates. A cost estimating process is considered reliable if the rating for each of the 12 steps is substantially or fully met. If any of the steps in the cost estimating process are not met, minimally met, or partially met, the cost estimating process does not fully reflect the process required to ensure a high-quality estimate and cannot be considered reliable. We rated the extent to which NNSA's cost estimating requirements incorporate our 12 process steps using the following scale:

Fully met—NNSA provided evidence that satisfies the entire criterion; substantially met—NNSA provided evidence that satisfies a large portion of the criterion; partially met—NNSA provided evidence that satisfies about half of the criterion; minimally met—NNSA provided evidence that satisfies a small portion of the criterion; and not met—NNSA provided no evidence that satisfies any of the criterion.

◑ = Partially met
◔ = Minimally met
○ = Not met

Source: GAO analysis of National Nuclear Security Administration documentation and GAO, *Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Program Costs*, GAO-20-195G (Washington, D.C.: Mar. 12, 2020). | GAO-24-106342

Note: This table presents our analysis of the extent to which the NNSA cost estimating requirements applicable to Production Modernization programs incorporate the process steps outlined in the *Cost Guide*. This table does not present information on individual Production Modernization program's cost estimates. A cost estimating process is considered reliable if the rating for each of the 12 steps is fully or substantially met. If any of the steps in the cost estimating process are partially met, minimally met, or not met, the cost estimating process does not fully reflect the process required to ensure a high-quality estimate and cannot be considered reliable. We rated the extent to which NNSA's cost estimating requirements incorporate our 12 process steps using the following scale:

Fully met—NNSA provided evidence that satisfies the entire criterion; substantially met—NNSA provided evidence that satisfies a large portion of the criterion; partially met—NNSA provided evidence that satisfies about half of the criterion; minimally met—NNSA provided evidence that satisfies a small portion of the criterion; and not met—NNSA provided no evidence that satisfies any of the criterion.

[a]The *Program Execution Instruction* identifies four program management categories (in order of most to least rigorous): Capital Acquisition Management, Enhanced Management A, Enhanced Management B, and Standard Management. Based on NNSA's criteria, Production Modernization programs fall into the Enhanced Management B and Standard Management categories. NNSA's requirements for developing cost estimates for programs in the Enhanced Management B and Standard Management categories are very similar, and the *Program Execution Instruction* cites the same guidance documents for both categories. As a result, our assessment of NNSA's requirements is the same for both categories across all 12 process steps listed in the *Cost Guide*. Further, Production Modernization programs do not meet the *Program Execution Instruction*'s criteria for inclusion in the Capital Acquisition Management or Enhanced Management A categories. The Capital Acquisition Management category applies to capital asset projects with a total project cost greater than $50 million and managed in accordance with DOE Order 413.3B. The Enhanced Management A category applies to NNSA activities that require a selected acquisition report to Congress and follow the Joint Department of Defense–Department of Energy Nuclear Weapon Life-Cycle Process, commonly referred to as the Phase 6.X Process.

Each of NNSA's Production Modernization programs, regardless of their management category, must follow *Program Execution Instruction* requirements when developing a cost estimate. However, as shown in table 5, our analysis found shortcomings with the requirements. The requirements do not mandate that program officials follow all 12 steps outlined in the *Cost Guide*. Instead, NNSA officials we interviewed noted that the *Program Execution Instruction* establishes minimum requirements for programs within each management category while providing program officials with the option to exceed these minimum requirements. Nevertheless, following the process steps listed in the *Cost Guide* ensures that cost estimates developed are reliable and accurate. Because NNSA's *Program Execution Instruction* does not fully incorporate these steps, NNSA is at greater risk that programs will develop and use cost estimates that are not reliable or accurate, which could result in relying on unreliable estimates and communicating lower quality information about planned costs to decision-makers.

Given the tens of billions of dollars NNSA plans to spend on its Production Modernization effort in the coming years, ensuring all programs have reliable cost estimates is critical for informing key decision-making. The 12-step cost estimating process outlined in the *Cost Guide* provides the foundational guidance for initiating, researching, assessing, analyzing, and presenting a cost estimate. Incorporating these steps into the NNSA requirements applicable to Production Modernization programs can assist programs to develop reliable cost estimates that can be replicated and updated to better manage their programs and inform decision-makers of the risks involved. This would also enable programs to better estimate and manage their costs to avoid missed deadlines and cost overruns. Finally, incorporating all 12 steps into NNSA's cost estimating process would provide NNSA leadership and Congress with better assurance they have the cost information they need to manage and execute NNSA's wide-ranging efforts to achieve its modernization goals.

NNSA Production Modernization Programs Do Not Use Cost Estimates That Cover Their Full Life Cycle

NNSA's Production Modernization programs have budget estimates that cover a portion of each program's scope, but none have cost estimates that cover the full life cycle of planned program activities. Specifically, all

Production Modernization programs prepare budget estimates that cover planned work scope for the next 5 fiscal years as part of NNSA's annual budget planning process. These estimates include the program's budget request for the upcoming fiscal year and estimated costs for the following 4 fiscal years, known as the Future Years Nuclear Security Program.[64] According to the *Cost Guide*, budget estimates typically capture program costs for only the upcoming few years—not for the entire program life cycle. Additionally, the *Cost Guide* states that budget estimates are used to ensure that the rate of program spending closely reflects available agency resources and funding.

In contrast to budget estimates, the *Cost Guide* defines a life cycle cost estimate as a structured accounting of all labor, material, and other efforts required to develop, produce, operate, maintain, and dispose of a program. While there are multiple types of cost estimates, the *Cost Guide* states that life cycle cost estimates, specifically, are a key management tool that should be used to inform program budget estimates. The *Cost Guide* states that such estimates are helpful in assessing the reasonableness of existing budgets and preventing overly optimistic budget estimates that could result in cost overruns. Additionally, the *Cost Guide* states that life cycle cost estimates help program officials ensure that all costs are fully accounted for and that available resources are adequate to support program execution.

None of the Production Modernization programs have developed a life cycle cost estimate to ensure the effective integration of each program and its associated major projects. However, officials from two programs told us they take additional steps beyond the Future Years Nuclear Security Program to estimate program costs. First, the Tritium Modernization program's budget estimate extends 10 years into the future, which helps to inform planning for maintenance and facility modifications. Nevertheless, the officials explained that this budget estimate is not a life cycle cost estimate since the Tritium Modernization program is ongoing and does not have a specified end date.

Second, Uranium Modernization program officials told us they developed a program life cycle cost estimate that covers planned operations through 2028. However, our review of the information NNSA provided indicates this estimate does not meet the *Cost Guide* criteria required to be considered a life cycle cost estimate. For example, among other things, the estimate did not incorporate the estimated costs associated with the Uranium Processing Facility project—a major component of the program.[65] Uranium Modernization program officials told us this was because the project's cost estimate is maintained separately by the Office of Infrastructure, which is responsible for managing the construction of the facility. While detailed project estimates are developed and maintained at the *project* level, the *Cost Guide* states that comprehensive life

[64]DOE and NNSA are required to report budget estimates for specific efforts beyond the 5 fiscal years included in the annual budget request. For instance, the Administrator of NNSA, in consultation with the Secretary of Defense and other appropriate officials, is required to update the Stockpile Stewardship and Management Plan annually. 50 U.S.C.§ 2523(a). The Stockpile Stewardship and Management Plan is NNSA's formal means for annually communicating to Congress the status of certain activities and any long-range plans and budget estimates for sustaining the stockpile and modernizing the nuclear security enterprise for up to the next 25 years.

Specifically, on a biennial basis, NNSA is to report on the status, plans, budgets, and schedules for warhead life extension programs and any other programs to modify, update, or replace warhead types. 50 U.S.C.§ 2523(b)(2), (d)(1)(C). Additionally, the President, in consultation with the Secretaries of Energy and Defense, is required to submit a detailed plan to the relevant congressional committees that addresses, among other things, the plan for the nuclear weapons stockpile and 10-year budget estimates for modernization. 10 U.S.C. § 492a(a)(1), (2)(F).

[65]In addition, we found that the amounts listed in the estimate are not linked to any data source, making it impossible to ascertain how these amounts were calculated and what activities are covered under each dollar amount. We also found that there is no alignment among the supporting documents, nor any indication of how these documents inform the cost estimate itself.

cycle cost estimates at the *program* level should incorporate all relevant life cycle costs, including those associated with essential projects—in this case, the Uranium Processing Facility.

NNSA officials we interviewed provided the following three reasons for why Production Modernization programs do not have life cycle cost estimates:

1. Similar to the use of resource-loaded integrated master schedules, the *Program Execution Instruction* does not require Production Modernization programs in the Enhanced Management B and Standard Management categories to develop life cycle cost estimates.[66] The *Program Execution Instruction* does allow program officials the option to exceed its *minimum* requirements and develop more rigorous cost estimates—in this case, a life cycle cost estimate—according to specific program needs. However, as noted above, none of the eight Production Modernization programs have opted to develop such an estimate.

2. Officials from two programs—the Tritium Modernization and High Explosives and Energetics Modernization programs—told us that program operations are ongoing and do not have specified end dates to use in estimating life cycle costs. However, senior NNSA officials responsible for developing and maintaining the *Program Execution Instruction* offered a countering view, stating that such programs can select a significant point in time—such as the completion of a major capital asset project—to use as an end date for such purposes. Additionally, according to the *Cost Guide*, life cycle cost estimates should include information on operational and maintenance costs. To do this, officials should make reasonable and clearly identified assumptions by, for example, selecting a specified amount of time after the completion of a facility, that can capture expected costs for operation and maintenance.

   For example, officials from the High Explosives and Energetics Modernization program could choose to capture 10 years of estimated costs associated with program operations and maintenance. To do so, program officials would select fiscal year 2045 as a specific end date for the purpose of developing a life cycle cost estimate. This estimate would extend 10 years past the completion of the Radiography and Assembly Capability Replacement project—which NNSA expects to be completed in fiscal year 2035.

3. For certain programs, NNSA is delaying the development of a life cycle cost estimate until the agency has approved the schedule and cost baselines for associated major projects. NNSA officials stated that this is because estimating program costs prior to the approval of cost estimates of major projects would result in inaccurate life cycle cost estimates. For example, we reported in January 2023 and August 2021 that the Plutonium Modernization and Lithium Modernization programs planned to develop program-level life cycle cost estimates once they had more reliable information on the cost of associated major projects, including the Savannah River Plutonium Processing Facility (Plutonium Modernization program) and the Lithium Processing Facility (Lithium Modernization program).[67] However, the Lithium Modernization program, for example, does not expect approval of cost estimates—the largest portion of the program's scope—until fiscal year 2026.

Regarding the third reason, delaying the development of program-level life cycle cost estimates for these programs means that NNSA officials will continue to manage them without complete cost information for the full scope of program activities that have been planned. In addition, these projects' approval dates may be

[66]As described above, in contrast with Production Modernization program requirements, NNSA is required to develop life cycle cost estimates for all major capital asset projects.

[67]GAO-23-104661 and GAO-21-244.

delayed, as has often occurred with NNSA's major capital asset projects. In the meantime, however, NNSA would continue to request billions of dollars in funding from Congress and manage these programs without a complete understanding of the full scope of their costs, at least through a specified end date that represents a significant point in time for the program. The *Cost Guide* states that programs should update cost estimates continually as the program passes new phases or milestones.

Furthermore, we previously found that another key impediment to NNSA's ability to develop such estimates for the Plutonium Modernization and Lithium Modernization programs was NNSA's incomplete understanding of the scope and costs of certain programmatic activities.[68] For example, in January 2023, we reported that the Plutonium Modernization program did not have an overall cost estimate nor had it compiled information on what was known about the costs for the activities needed to establish a pit production capability. At the time, we reported that NNSA could use existing information on major projects as well as current assumptions about program work scope in the future, even if preliminary or uncertain, to inform life cycle cost estimates. In fact, the *Cost Guide* states that for a life cycle cost estimate, one should use the best information available, clearly identify the confidence level in the estimate, and add detail as more is learned.

We previously recommended that the Plutonium Modernization and Lithium Modernization programs develop life cycle cost estimates.[69] Further, as noted above, in December 2023, the NNSA Administrator was statutorily required to ensure that, no later than July 14, 2025, the Plutonium Modernization program is managed in accordance with GAO's best practices for cost estimating, which state that a comprehensive cost estimate should include all life cycle costs.[70] Developing life cycle cost estimates would better inform NNSA's ability to quantify program costs to support programmatic, budgetary, and investment decisions—benefits that can also be realized for the other programs that compose NNSA's urgent Production Modernization effort. Specifically, NNSA should ensure that the other Production Modernization programs also develop and maintain life cycle cost estimates, or document their rationale with senior leadership approval for not doing so. Developing such estimates would allow program managers, NNSA leadership, and Congress to better assess resource needs, affordability of major investments, and potential trade-offs within and among Production Modernization programs when prioritizing where to allocate resources.

Conclusions

NNSA has an urgent mission to simultaneously modernize the nation's nuclear weapons stockpile and the supporting infrastructure on which weapons programs depend. To meet this mission, NNSA has undertaken a Production Modernization effort involving a broad range of programs, projects, and activities. NNSA officials told us that each Production Modernization program and its associated major projects must be integrated to achieve NNSA's modernization goals. The officials stated that they use established teams and meetings for this purpose as well as schedule and cost information. Program schedules and cost estimates, among other tools and practices, are essential for ensuring effective integration. However, we found that existing program

[68]GAO-23-104661 and GAO-21-244.

[69]GAO-23-104661 and GAO-21-244.

[70]Pub. L. No. 118-31, div. C, tit. XXXI, § 3117, 137 Stat. 136, 791 (2023) (codified at 50 U.S.C. § 2538a(h)).

schedules and cost estimates are insufficient for ensuring the effective integration of Production Modernization programs and their associated major projects.

NNSA's requirements for developing Production Modernization program schedules do not meet most of the best practices identified in the *Schedule Guide*. By fully incorporating best practices in its schedule requirements, NNSA can have greater assurance that program schedules are positioned to support program success. In the meantime, NNSA should take steps to improve its use of schedules as we determined NNSA's existing Production Modernization program schedules are insufficient for ensuring effective integration. Specifically, developing resource-loaded integrated master schedules for Production Modernization programs in accordance with the *Schedule Guide* would allow NNSA to better integrate programs' operations with their major projects and other activities that, together, represent one of the most urgent, complex, and costly efforts presently operated by NNSA. Such integrated schedules would demonstrate the credibility of programs' forecasted dates for decision-making.

Similar to its schedule requirements, NNSA's requirements for developing program cost estimates do not fully incorporate the process steps the *Cost Guide* identifies as necessary to ensure the development of reliable cost estimates. By following these steps, NNSA can have greater assurance that programs develop and use reliable cost estimates. In the meantime, NNSA should take steps to develop cost estimates that cover the full life cycle of program activities for its Production Modernization programs as we determined that none of the programs have developed such estimates. Developing life cycle cost estimates would provide NNSA and congressional decision-makers with greater assurance that they have accurate and timely cost information when making critical decisions on how to estimate program budgets and spend the tens of billions of dollars requested to achieve NNSA's modernization goals.

Recommendations for Executive Action

We are making the following four recommendations to NNSA:

The NNSA Administrator should ensure that the NNSA schedule requirements applicable to Production Modernization programs are revised to fully incorporate the 10 best practices for developing reliable program schedules from GAO's *Schedule Assessment Guide*. (Recommendation 1)

The NNSA Administrator should ensure that the other Production Modernization programs, as statutorily required for the Plutonium Modernization program, are managed in accordance with GAO's best practices for schedule development by developing and maintaining reliable, resource-loaded integrated master schedules, or otherwise documenting with senior leadership approval their rationale for not doing so. (Recommendation 2)

The NNSA Administrator should ensure that the NNSA cost estimating requirements applicable to Production Modernization programs are revised to fully incorporate the 12 steps for developing reliable program cost estimates from GAO's *Cost Estimating and Assessment Guide*. (Recommendation 3)

The NNSA Administrator should ensure that the other Production Modernization programs, as statutorily required for the Plutonium Modernization program, are managed in accordance with GAO's best practices for cost estimating by developing and maintaining reliable life cycle cost estimates, or otherwise documenting with senior leadership approval their rationale for not doing so. (Recommendation 4)

Agency Comments and Our Evaluation

We provided a draft of this report to NNSA for review and comment. In its comments, reproduced in appendix V, NNSA concurred with the report's four recommendations and described the agency's plans to implement them in fiscal year 2025. NNSA also provided technical comments that we incorporated into the report, as appropriate.

In addition, NNSA provided general comments outlining concerns about the report's use of best practices for scheduling and cost estimating to evaluate NNSA's integration of Production Modernization programs and their associated major projects. Specifically, NNSA stated that focusing our review only on best practices for schedule development and cost estimation resulted in incomplete and misleading conclusions that do not represent a holistic or balanced view of NNSA's integration efforts. NNSA also stated that incorporating best practices in the development of Production Modernization programs' schedules and cost estimates without also taking additional actions will not fundamentally change NNSA's ability to integrate the programs and projects urgently needed for national security. NNSA explained that it is important, in the agency's view, to acknowledge other actions NNSA has taken to improve the overall integration of its Production Modernization effort.

As NNSA acknowledged in its response, this report addresses a provision in a committee report accompanying a bill for the National Defense Authorization Act for Fiscal Year 2024 for GAO to review the extent to which NNSA's requirements for integrated planning of its modernization efforts reflect best practices. As we described above, we focused our review on best practices published in the *Schedule Guide* and *Cost Guide* and two fundamental program management tools associated with them—resource-loaded integrated master schedules and life cycle cost estimates. As we state in the report, these two tools, among other tools and practices, are essential in helping organizations to ensure effective integration—in this case, NNSA's integration of the eight Production Modernization programs and their associated major projects.

Specifically, resource-loaded integrated master schedules should be the focal point of program management, according to the *Schedule Guide*. Additionally, the *Cost Guide* states that a life cycle cost estimate is a key management tool for helping program officials ensure that all costs are fully accounted for and that available resources are adequate to support program execution. We acknowledge that NNSA can and should use other program management tools and practices to manage its programs and projects and to ensure effective integration occurs, both within its Production Modernization effort and beyond. These other tools and practices, however, are not the subject of this report.

As discussed in the report, we found that existing Production Modernization program schedules and cost estimates are insufficient for ensuring the effective integration of Production Modernization programs and their associated major projects. Further, we found that NNSA's requirements for developing Production Modernization program schedules and cost estimates set a low standard for managing such crucial, complex, and expensive efforts by not incorporating most best practices and related process steps, but do allow program officials to develop more rigorous schedules and cost estimates when they believe these are needed. In contrast, requiring program officials to develop more rigorous schedules and cost estimates—while still allowing the use of less rigorous tools when appropriate, with senior leadership approval—will provide NNSA with greater assurance that information on each program's schedule and cost is complete, accurate, and reliable. Therefore, we are encouraged that NNSA concurred with all four of our recommendations and that the agency plans to implement them in fiscal year 2025. We strongly believe that incorporating best practices in

program requirements and practice—including the development and use of resource-loaded integrated master schedules and life cycle cost estimates—will provide NNSA leadership and congressional decision-makers more reliable and actionable information to support effective integration, program management, and decision-making.

While our report focused on NNSA's use of program schedules and cost estimates, we agree that NNSA can and should take additional steps to integrate the management of Production Modernization programs and their associated projects. In its comments, NNSA included an enclosure describing actions the agency is taking that, according to NNSA, exemplify NNSA's efforts to ensure integration. For example, NNSA described the use of recurring reviews and integration meetings, including Senior Management Teams and Matrixed Execution Team meetings, to discuss and communicate project-level information and that information's potential effect at the program level. We agree that such efforts are important to ensure coordination and integration between Production Modernization programs and their associated major projects and our report includes these and other examples of established teams and meetings NNSA uses for this purpose.

NNSA also highlighted the Plutonium Modernization program's use of an integrated master schedule to help manage the program. As we detailed above and in prior reports, we found significant deficiencies with the Plutonium Modernization program's schedule as developed, including it was not comprehensive, did not assign resources to activities (i.e., was not resource-loaded), and minimally met best practices for assigning durations to all activities. We are aware of NNSA's ongoing efforts to improve the program's schedule, which we believe represents a positive step in helping NNSA leadership to make informed programmatic decisions in the coming years.

NNSA also provided examples of other ongoing integration activities, including efforts to integrate projects and activities that take place in individual facilities and efforts to improve the accuracy of NNSA's cost estimates for capital asset projects. We are encouraged by the efforts NNSA is taking to improve operations and integrate the wide-ranging efforts required to modernize its production infrastructure. However, as this report focused on the integration of NNSA's eight Production Modernization programs and their associated major projects, NNSA's use of facility utilization schedules and NNSA's efforts to improve project-level cost estimates, among some other examples, were not relevant to our scope.

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

If you or your staff have any questions about this report, please contact me at (202) 512-3841 or bawdena@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 VI.

Allison Bawden
Director, Natural Resources and Environment

List of Committees

The Honorable Jack Reed
Chairman
The Honorable Roger F. Wicker
Ranking Member
Committee on Armed Services
United States Senate

The Honorable Patty Murray
Chair
The Honorable John Kennedy
Ranking Member
Subcommittee on Energy and Water Development
Committee on Appropriations
United States Senate

The Honorable Mike Rogers
Chairman
The Honorable Adam Smith
Ranking Member
Committee on Armed Services
House of Representatives

The Honorable Chuck Fleischmann
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

Our objectives were to (1) describe the programs and projects that compose the National Nuclear Security Administration's (NNSA) Production Modernization effort and NNSA's management of the effort, (2) examine the extent to which NNSA effectively uses schedules to ensure the integration of the programs and their associated projects under its Production Modernization effort, and (3) examine the extent to which NNSA effectively uses cost estimates to manage its Production Modernization programs.[1]

Our scope included examining all programs and projects that compose NNSA's Production Modernization effort. This included examining the eight Production Modernization programs within NNSA's Office of Production Modernization that are each responsible for producing nuclear materials or specific components for use in nuclear weapons.[2] We examined the 16 ongoing major capital asset projects associated with and funded by Production Modernization programs, but managed by the

Office of Infrastructure.[3] Further, we focused on two key program management tools—specifically, resource-loaded integrated master schedules and life cycle cost estimates. These tools, among other tools and practices, are essential to help ensure effective integration. Thus, we determined that focusing on these two tools would provide insight into how the Production Modernization programs integrate their full scopes of planned activities.

For our first objective, we reviewed NNSA documentation and interviewed officials in NNSA's Office of Production Modernization to identify the full scope of programs, major capital asset projects, and activities composing NNSA's Production Modernization effort as well as its key goals, timelines, and associated costs as

[1]According to NNSA documents, programs are characterized by a range of measures to help fulfill the agency's mission. By contrast, projects are characterized by efforts to produce a specific product, facility, or system, and have a distinct start and end date. Programs, which typically include projects, are designed to help achieve overarching agency goals. This report focuses on NNSA's Production Modernization effort at the program level.

[2]NNSA's Office of Production Modernization is organized into four major areas which, in turn, consist of the eight individual Production Modernization programs. These areas include Primary Capability Modernization (Plutonium Modernization and High Explosives and Energetics Modernization programs); Secondary Capability Modernization (Uranium Modernization, Depleted Uranium Modernization, and Lithium Modernization programs); Tritium Modernization and Domestic Uranium Enrichment programs; and the Non-Nuclear Capability Modernization program. In September 2023, NNSA reorganized its Office of Defense Programs, including aspects of the Office of Production Modernization. NNSA officials said that the reorganization did not affect the organization of the eight individual Production Modernization programs included in our scope.

[3]The Department of Energy (DOE) defines capital assets as land, structures, equipment, and intellectual property, which are used by the federal government and have an estimated useful life of 2 years or more. For the purposes of this report, and consistent with prior work, we define the projects that are critical to the Production Modernization programs as major capital asset projects. These major projects have an estimated total project cost of $100 million or more. In contrast, the DOE order on project management for capital asset acquisitions defines a major system project to be any project with an estimated cost of over $750 million. DOE, *Program and Project Management for the Acquisition of Capital Assets*, DOE Order 413.3B (Washington, D.C.: Nov. 29, 2010) [Updated June 21, 2023].

However, DOE Order 413.3B applies to all projects estimated to cost $50 million or more and may be applied during the project development phase to nuclear projects or complex first-of-a-kind projects estimated to cost $10 million or more. In addition, the order's Project Management Principles apply, using a tailored approach, to all capital asset projects estimated to cost $50 million or less, including minor construction projects that cost more than $30 million. In addition, each major project included in the scope of our review is associated with a Production Modernization program, is planned for use in the production of nuclear materials or components required for nuclear weapons, and has an approved statement of mission need from NNSA.

of January 2024. In addition, we reviewed NNSA documentation, including agency budget requests and program strategies, and interviewed Office of Infrastructure officials to identify and discuss major capital asset projects that are critical to the success of NNSA's overall Production Modernization effort. Appendix II provides more information on these major projects. We also reviewed our prior work on NNSA's Production Modernization programs, projects, and related activities, which are listed on the Related GAO Products page at the end of this report.

In addition, we assessed NNSA's Office of Defense Programs' *Program Execution Instruction* to identify NNSA's program management category for each of the eight Production Modernization programs as of January 2024 as well as the associated requirements, by category, for developing program schedules and cost estimates.[4] We interviewed NNSA officials in the Office of Defense Programs' Office of Systems Engineering and Integration who are responsible for maintaining the *Program Execution Instruction* to better understand NNSA's requirements and how programs should use this document to develop program management tools. Further, we interviewed program management officials from each Production Modernization program and project management officials from the Office of Infrastructure associated with a non-generalizable sample of four major capital asset projects related to four Production Modernization programs. In choosing these four projects, we considered factors including project location, stage of completion, and estimated total project cost to allow us to more fully understand how NNSA's efforts at the individual project level integrate with program-level operations for relevant Production Modernization programs. Further, we interviewed these program- and project-level officials to understand the tools and processes NNSA uses to ensure the effective integration of all Production Modernization programs, associated major projects, and other activities needed to achieve NNSA's modernization goals.

For our second and third objectives, we analyzed NNSA documents and requirements associated with developing program schedules and cost estimates, including relevant reports and policies, and interviewed NNSA officials responsible for maintaining NNSA's requirements for developing these program management tools. We assessed NNSA's requirements for developing Production Modernization program schedules and cost estimates outlined in the *Program Execution Instruction* and associated guidance against the best practices identified in the *Schedule Assessment Guide (Schedule Guide)* and the process steps identified in the *Cost Estimating and Assessment Guide (Cost Guide)*.[5] The *Schedule Guide* identifies 10 best practices that, when incorporated into an agency's procedures and guidance, are more likely to result in reliable, high-quality integrated master schedules. The *Cost Guide* identifies 12 steps that, when incorporated into an agency's cost estimating procedures and guidance, are more likely to result in reliable and valid cost estimates. We then shared our preliminary findings for both analyses with NNSA. We updated our analyses on the basis of the agency responses provided to us.

[4]DOE, *Program Execution Instruction* (Nov. 15, 2013; updated Sept. 23, 2021). The NNSA Office of Defense Programs uses the *Program Execution Instruction* to place programs into different program management categories. The document then establishes different sets of requirements for each of those categories with various levels of rigor for program functional elements such as work breakdown structures, integrated master schedules, and cost estimates.

[5]GAO, *Schedule Assessment Guide: Best Practices for Project Schedules*, GAO-16-89G (Washington, D.C.: Dec. 22, 2015) and *Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Program Costs*, GAO-20-195G (Washington, D.C.: Mar. 12, 2020). Our approach to developing these guides was to ascertain best practices from leading practitioners and to develop standard criteria to determine the extent agency programs and projects meet industry scheduling standards. To do this, we consulted with a committee of specialists in the fields of scheduling and cost estimating from across government, private industry, and academia. Thus, both the *Schedule Guide* and *Cost Guide* represent a compilation of best practices that industry and the public sector use to develop and maintain reliable schedules and cost estimates throughout the life of a program.

In addition, we reviewed documentation on Production Modernization program schedules and cost estimates and interviewed cognizant program officials to identify the types of schedules and cost estimates each program uses. We did not assess the reliability of each program's schedule and cost estimate by evaluating each program management tool against the best practices in the *Schedule Guide* and against the process steps in the *Cost Guide*. Instead, we compared the information we collected on the types of schedules and cost estimates each program uses with concepts in the *Schedule Guide* and *Cost Guide* for using resource-loaded integrated master schedules and life cycle cost estimates. Specifically, according to the *Schedule Guide*, fully resource-loaded integrated master schedules are fundamental tools that should be the focal point of program management as they can help ensure effective program and project integration. Further, the *Cost Guide* states that life cycle cost estimates are essential in providing a structured accounting of all resources and associated costs required to develop and sustain a particular program. We also interviewed program officials as well as senior management officials in NNSA's Office of Production Modernization to learn their perspectives on the use of each program's schedules and cost estimates to ensure the effective integration of program operations, major projects, and other activities when managing both individual programs and NNSA's Production Modernization effort as a whole.

We conducted this performance audit from November 2022 to July 2024 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Appendix II: Major Capital Asset Projects Associated with Production Modernization Programs

The National Nuclear Security Administration's (NNSA) Production Modernization effort comprises eight programs and 16 related and ongoing major capital asset projects.[1] Table 6 provides more information on the 16 major projects associated with Production Modernization programs, including a description of each project and its planned construction completion date, as of January 2024.

Table 6: Major Capital Asset Projects Associated with the National Nuclear Security Administration's (NNSA) Production Modernization Programs, as of January 2024

Production Modernization program	Major project (location)	Project description	Planned construction completion date[a]
Plutonium Modernization	Los Alamos Plutonium Pit Production Project (Los Alamos National Laboratory, Los Alamos, NM)	This project provides the critical equipment, procurement, installation, and infrastructure upgrades necessary to enable the manufacturing of 30 pits per year at Los Alamos National Laboratory.	March 2032
Plutonium Modernization	Chemistry and Metallurgy Research Replacement Project PF-4 Equipment Installation, Phase 2 (Los Alamos National Laboratory, Los Alamos, NM)	This project consolidates and relocates existing capabilities; decontaminates and disposes of old equipment in existing laboratory space; replaces existing equipment; and installs glove boxes and equipment for plutonium analysis.	Fiscal Year (FY) 2029
Plutonium Modernization	Chemistry and Metallurgy Research Replacement Project Radiological Laboratory Utility Office Building to Hazard Category 3 (Los Alamos National Laboratory, Los Alamos, NM)	This subproject will maximize the use of the Radiological Laboratory Utility Office Building by reconfiguring existing laboratory space, equipping the remaining empty laboratories with plutonium analysis capabilities, and enabling the facility to be re-categorized to a higher Department of Energy nuclear hazard category.	NNSA did not provide a planned completion date
Plutonium Modernization	Transuranic Liquid Waste Treatment Facility Upgrade Project (Los Alamos National Laboratory, Los Alamos, NM)	This project will construct a new, more robust structure to replace an outdated facility for temporary storage and treatment of transuranic liquid waste.	August 2027

[1]For the purposes of this report and consistent with prior work, we define a major project as a capital asset project with an estimated total project cost of $100 million or more. Each major project included in the scope of our review is associated with a Production Modernization program, is planned for use in the production of nuclear materials or components required for nuclear weapons, and has an approved statement of mission need from NNSA.

Production Modernization program	Major project (location)	Project description	Planned construction completion date[a]
Plutonium Modernization	Technical Area-55 Reinvestment Project, Phase III (Los Alamos National Laboratory, Los Alamos, NM)	This project addresses a recognized safety vulnerability in Technical Area 55 by replacing, modifying, and upgrading the existing fire alarm system.	FY 2027
Plutonium Modernization	Savannah River Plutonium Processing Facility (Savannah River Site, Aiken, SC)	The project will (a) modify an existing, partially constructed 400,000 square foot nuclear facility originally planned to fabricate nuclear reactor fuel assemblies into the project's main process building; (b) re-purpose existing non-nuclear facilities; and (c) construct new non-nuclear and process support facilities.	FY 2032–FY 2035
High Explosives and Energetics Modernization	High Explosives Science and Engineering Facility (Pantex Plant, Amarillo, TX)	This project will construct three new interconnected facilities—a high explosives laboratory, a high explosives temporary staging area, and a technology development and deployment laboratory—that total approximately 70,000 square feet. The facility will increase the amount of high explosives that can be used in the laboratory, reduce inefficiencies in moving high explosives between buildings, and increase the capability to develop diagnostic tools for the evaluation, manufacturing, and testing of materials.	March 2028
High Explosives and Energetics Modernization	High Explosives Synthesis, Formation, and Production Facility[b] (Pantex Plant, Amarillo, TX)	This project will design and construct five new buildings that total nearly 100,000 square feet. These buildings will house the following three high explosives capabilities: (1) synthesis, which produces raw explosive molecules; (2) formulation, which mixes raw explosive molecules with binding ingredients to form an explosive mixture; and (3) blending, which will blend the formulated mixture. The completed project will allow for large-scale high explosives production, which is currently conducted by a single external vendor that primarily produces high explosives for the Department of Defense.	FY 2034
High Explosives and Energetics Modernization	Energetic Materials Characterization Facility[b] (Los Alamos National Laboratory, Los Alamos, NM)	This project will replace 18 aging or obsolete facilities housing high explosive characterization, analysis, and testing laboratories with a new, integrated campus.	FY 2034
High Explosives and Energetics Modernization	Radiography and Assembly Capability Replacement[c] (Los Alamos National Laboratory, Los Alamos, NM)	This project will provide modernized facilities for nuclear explosive package assembly and radiography capabilities to accommodate future workload and continue stockpile certification without the need for underground testing.	FY 2030–FY 2035
Uranium Modernization	Uranium Processing Facility (Y-12 National Security Complex, Oak Ridge, TN)	This project will construct and equip four new facilities to meet the nation's enriched uranium needs, including one facility to house processes for casting enriched uranium into various shapes and producing special uranium oxides.	February 2029[d]
Uranium Modernization	Electrorefining Project (Y-12 National Security Complex, Oak Ridge, TN)	This project will design and install equipment to support a new process for salvaging and purifying uranium metal that replaces current operations that use hazardous chemicals, and to produce uranium of high purity that can be further processed for a variety of purposes.	February 2025

Production Modernization program	Major project (location)	Project description	Planned construction completion date[a]
Uranium Modernization	Direct Chip Melt Bottom Loading Furnace (Y-12 National Security Complex, Oak Ridge, TN)	This project will design, procure, test, install, and implement a new process using four bottom load furnaces to process uranium scrap metal.	FY 2029–FY 2032
Lithium Modernization	Lithium Processing Facility (Y-12 National Security Complex, Oak Ridge, TN)	This project will construct a new facility to relocate existing lithium operations that are currently conducted in a building that is over 75 years old. The Lithium Processing Facility will be a non-nuclear facility that will include lithium purification and processing equipment, shipping and storage areas, administrative office space, and exterior storage for bulk chemicals.	FY 2031[e]
Tritium Modernization	Tritium Finishing Facility[b] (Savannah River Site, Aiken, SC)	This project comprises two subprojects. The site preparation subproject will demolish three existing warehouses, construct a new warehouse, and install new power supply lines. The process buildings subproject will construct two new buildings to relocate and replace existing tritium operations currently housed in a 1950s-era building. One building will contain equipment for processing tritium, and another building will contain equipment for needed non-nuclear processing steps, such as inspection and storage activities.	FY 2034
Non-Nuclear Capability Modernization	Power Sources Capability facility (Sandia National Laboratories, Albuquerque, NM)	This project will construct a new 135,000 square foot facility to include offices, specialized laboratory space, and support areas for NNSA's power source research, development, design, qualification, production, and surveillance activities.	FY 2030

Source: GAO analysis of NNSA documentation and NNSA officials' statements. | GAO-24-106342

Note: For the purposes of this report and consistent with prior work, we define a major project as a capital asset project with an estimated total project cost of $100 million or more. Each major project included in our scope is associated with a Production Modernization program, is planned for use in the production of nuclear materials or components required for nuclear weapons, and has an approved statement of mission need from NNSA.

[a]For the purposes of this report, we use the estimated date that construction will be complete as each project's planned construction completion date.

[b]According to NNSA's fiscal year 2024 budget justification, this project was placed on hold. This decision was informed by delays and cost increases affecting other NNSA major projects and represents NNSA's strategy to focus resources on a reduced number of high-priority major projects.

[c]According to NNSA officials, this project was placed on hold in September 2023.

[d]As of March 2024, NNSA's planned construction completion date for this project had been delayed to at least fiscal year 2030, according to NNSA's fiscal year 2025 budget justification.

[e]As of March 2024, NNSA's planned construction completion date for this project had been delayed to fiscal year 2033, according to NNSA's fiscal year 2025 budget justification.

Appendix III: Our Assessment of National Nuclear Security Administration (NNSA) Program Management Requirements for Developing Reliable Schedules

Our assessment of the NNSA Office of Defense Programs' *Program Execution Instruction* found that NNSA's requirements for developing Production Modernization program schedules do not incorporate most of the 10 best practices outlined in the *Schedule Assessment Guide* (*Schedule Guide*).[1] First, we found that NNSA's requirements for Standard Management programs did not meet any of our best practices since milestone-based schedules do not meet the characteristics of an integrated master schedule. Second, we found that NNSA's requirements for Enhanced Management B programs partially met one, minimally met seven, and did not meet two of our best practices. Table 7 includes the results of our assessment of how NNSA's requirements for Enhanced Management B programs align with our 10 best practices for developing reliable schedules.[2]

Table 7: Our Assessment of the National Nuclear Security Administration's (NNSA) Program Management Requirements for Developing Reliable Schedules

Schedule Guide best practice	Assessment of NNSA's requirements for programs in the Program Execution Instruction's Enhanced Management B categorya
Capturing all activities	Partially met According to the Schedule Guide, 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 program's objectives, including activities both the owner and contractor are to perform. NNSA's schedule requirements do state that a work breakdown structure and other key documents must be developed to integrate planning, scheduling, budgeting, and performance-based management measures. However, the level of detail in an integrated master schedule is determined by the level of risk associated with an NNSA program, as determined by the federal program manager. Further, there is no requirement for the schedule to include activities both NNSA and contractors are to perform.

[1]GAO, *Schedule Assessment Guide: Best Practices for Project Schedules*, GAO-16-89G (Washington, D.C.: Dec. 22, 2015). We assessed the extent to which NNSA schedule requirements applicable to Production Modernization programs incorporate the 10 best practices outlined in the *Schedule Guide*. We did not assess individual Production Modernization program schedules. We rated the extent to which NNSA's schedule requirements incorporate our 10 best practices using the following scale:

Fully met—NNSA provided evidence that satisfies the entire criterion; substantially met—NNSA provided evidence that satisfies a large portion of the criterion; partially met—NNSA provided evidence that satisfies about half of the criterion; minimally met—NNSA provided evidence that satisfies a small portion of the criterion; and not met—NNSA provided no evidence that satisfies any of the criterion.

[2]Since NNSA's requirements for Standard Management programs did not meet any of our best practices, we did not include our assessment of these requirements in table 7.

Schedule Guide best practice	Assessment of NNSA's requirements for programs in the Program Execution Instruction's Enhanced Management B categorya
Sequencing all activities	Minimally met According to the Schedule Guide, activities must be logically sequenced and linked—that is, listed in the order in which they are to be carried out and joined with logic. In particular, a predecessor activity must start or finish before its successor. While NNSA's schedule requirements state that a schedule should be logically sequenced, there is no specific guidance for the limited and justified use of unusual or complicated logic nor related requirements to include a critical path that determines the activities that drive the program's earliest completion date or the necessary total float that accurately reflects the schedule's flexibility.
Assigning resources to all activities	Minimally met According to the Schedule Guide, program schedules should reflect the resources (labor, materials, travel, facilities, and equipment, among other resources) needed to do the work, whether they will be available when needed, and any constraints on funding or time. NNSA documentation states that resource-loading program schedules are optional but not required, and there is no guidance in NNSA's requirements document that align with our best practices for assigning resources to all activities.
Establishing the durations of all activities	Not met According to the Schedule Guide, program schedules should realistically reflect how long each activity will take. Durations should be reasonably short and meaningful and should allow for discrete progress measurement. Schedules that contain planning and summary planning packages as activities will normally reflect longer durations until broken into work packages or specific activities. NNSA's schedule requirements do not include any information or guidance on this best practice.
Verifying that the schedule can be traced horizontally and vertically	Minimally met According to the Schedule Guide, program schedules should be horizontally traceable, meaning that it should link products and outcomes associated with other sequenced activities. Such links are commonly referred to as "hand-offs" and serve to verify that activities are arranged in the right order for achieving aggregated products or outcomes. The schedule should also be vertically traceable—that is, data are consistent between different levels of a schedule. When schedules are vertically traceable, lower level schedules are clearly consistent with upper level schedule milestones, allowing for total schedule integrity and enabling different teams to work to the same schedule expectations. NNSA's schedule requirements provide high-level information about creating a horizontally traceable schedule. However, there is no discussion about vertical traceability or about how to ensure that the integrated master schedule is vertically or horizontally traceable.
Confirming that the critical path is valid	Minimally met According to the Schedule Guide, program schedules should identify the critical path—the path of longest duration through the sequence of activities. Establishing a valid critical path is necessary for examining the effects of any activity's slipping along this path. The program's critical path determines the program's earliest completion date and focuses the team's energy and management's attention on the activities that will lead to the project's success. NNSA's schedule requirements state that programs should use a critical path-managed schedule. However, the requirements do not include any instructions to ensure that the critical path is valid.
Ensuring reasonable total float	Not met According to the Schedule Guide, a schedule should identify reasonable total float (or slack)—the amount of time a predecessor activity can be delayed before such delay affects the program's estimated completion date—so that the schedule's flexibility can be determined. NNSA's schedule requirements do not include any information or guidance on this best practice.

Schedule Guide best practice	Assessment of NNSA's requirements for programs in the Program Execution Instruction's Enhanced Management B categorya
Conducting a schedule risk analysis	Minimally met According to the Schedule Guide, a schedule risk analysis starts with a good critical path method schedule. Data about program schedule risks are incorporated into a statistical simulation to predict the level of confidence in meeting a program's completion date; to determine the contingency, or reserve of time, needed for a level of confidence; and to identify high-priority risks. Programs should include the results of the schedule risk analysis in constructing an executable baseline schedule. NNSA's schedule requirements do provide information on addressing risks and opportunities, but do not contain explicit instructions on how to conduct a schedule risk analysis that aligns with the Schedule Guide.
Updating the schedule using actual progress and logic	Minimally met According to the Schedule Guide, progress updates and logic provide a realistic forecast of start and completion dates for program activities. Maintaining the integrity of the schedule logic is necessary to reflect the true status of the program. To ensure that the schedule is properly updated, people responsible for updating it should be trained in critical path method scheduling. NNSA's schedule requirements provide some guidance about variance analysis but do not provide any detail about updating the schedule with logic and progress or developing a schedule narrative.
Maintaining a baseline schedule	Minimally met According to the Schedule Guide, a baseline schedule is the basis for managing the program scope, the time period for accomplishing it, and the required resources. The baseline schedule is designated the target schedule and is subject to a configuration management control process. Program performance is measured, monitored, and reported against the baseline schedule. The schedule should be continually monitored to reveal when forecasted completion dates differ from baseline dates and whether schedule variances affect downstream work. A corresponding basis document explains the overall approach to the program; defines custom fields in the schedule file; details ground rules and assumptions used in developing the schedule; and justifies constraints, lags, long activity durations, and any other unique features of the schedule. NNSA's schedule requirements state that a baseline schedule should be identified for program monitoring, reporting, and control. However, the requirements do not have explicit instructions on how to maintain a baseline schedule that align with the Schedule Guide. Further, the requirements do not specify that changes to the baseline schedule should be reviewed and approved according to the schedule change control process or prescribe what is included in a trend analysis.

Source: GAO analysis of NNSA documentation and GAO, *Schedule Assessment Guide: Best Practices for Project Schedules*, GAO-16-89G (Washington, D.C.: Dec. 22, 2015). | GAO-24-106342

Note: This table presents our assessment of the extent to which NNSA schedule requirements applicable to Production Modernization programs incorporate the 10 best practices outlined in the *Schedule Guide*. This table does not present information on individual Production Modernization program schedules. We rated the extent to which NNSA's schedule requirements incorporate our 10 best practices using the following scale:

Fully met—NNSA provided evidence that satisfies the entire criterion; substantially met—NNSA provided evidence that satisfies a large portion of the criterion; partially met—NNSA provided evidence that satisfies about half of the criterion; minimally met— NNSA provided evidence that satisfies a small portion of the criterion; and not met—NNSA provided no evidence that satisfies any of the criterion.

[a]The *Program Execution Instruction* identifies four program management categories (in order of most to least rigorous): Capital Acquisition Management, Enhanced Management A, Enhanced Management B, and Standard Management. Production Modernization programs fall into the Enhanced Management B and Standard Management categories. Since NNSA's requirements for Standard Management programs did not meet any of our best practices, we did not include our assessment of these requirements in the table. Further, Production Modernization programs do not meet the *Program Execution Instruction*'s criteria for inclusion in the Capital Acquisition Management or Enhanced Management A categories. The Capital Acquisition Management category applies to capital asset projects with a total project cost greater than $50 million and managed in accordance with DOE Order 413.3B. The Enhanced Management A category applies to NNSA activities that require a selected acquisition report to Congress and follow the Joint Department of Defense–Department of Energy Nuclear Weapon Life-Cycle Process, commonly referred to as the Phase 6.X Process.

Appendix IV: Our Assessment of National Nuclear Security Administration (NNSA) Program Management Requirements for Developing Reliable Cost Estimates

Our assessment of the NNSA *Program Execution Instruction* found that NNSA's requirements for developing cost estimates for Production Modernization programs in both the Enhanced Management B and Standard Management categories do not fully incorporate the steps listed in the *Cost Estimating and Assessment Guide (Cost Guide)*.[1] Specifically, we found that NNSA's relevant cost estimating requirements met one, partially met three, and minimally met eight of the 12 steps needed to ensure a reliable cost estimating process.[2] Table 8 includes the results of our assessment of how NNSA's requirements align with our 12 process steps.

Table 8: Our Assessment of the National Nuclear Security Administration's (NNSA) Program Management Requirements for Developing Reliable Cost Estimates

Step	Assessment of NNSA's requirements for programs in the Program Execution Instruction's Enhanced Management B and Standard Management categoriesa
Define the estimate's purpose	Met According to the Cost Guide, the purpose of a cost estimate is determined by its intended use, which determines its scope and detail. To determine an estimate's scope, cost analysts must identify the customer's needs. Without understanding the estimate's purpose and scope, the estimate may not reflect the context to meet the customer's needs. NNSA's documents include guidance for officials to define the estimate's purpose by identifying the customer's needs and determining an estimate's scope by its intended use and the availability of data.

[1]GAO, *Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Program Costs*, GAO-20-195G (Washington, D.C.: Mar. 12, 2020). In contrast to its requirements for developing program schedules, we found that NNSA's requirements for developing cost estimates for programs in the Enhanced Management B and Standard Management categories are very similar and the *Program Execution Instruction* cites the same guidance documents for both categories. As a result, our assessment of NNSA's requirements is the same for both categories across all 12 process steps listed in the *Cost Guide*.

[2]We assessed the extent to which NNSA cost estimating requirements applicable to Production Modernization programs incorporate the 12 process steps outlined in the *Cost Guide*. We did not assess individual Production Modernization program cost estimates. A cost estimating process is considered reliable if the rating for each of the 12 steps is substantially or fully met. If any of the steps in the cost estimating process are not met, minimally met, or partially met, the cost estimating process does not fully reflect the process required to ensure a high-quality estimate and cannot be considered reliable. We rated the extent to which NNSA's cost estimating requirements incorporate our 12 process steps using the following scale:

Fully met—NNSA provided evidence that satisfies the entire criterion; substantially met—NNSA provided evidence that satisfies a large portion of the criterion; partially met—NNSA provided evidence that satisfies about half of the criterion; minimally met—NNSA provided evidence that satisfies a small portion of the criterion; and not met—NNSA provided no evidence that satisfies any of the criterion.

Step	Assessment of NNSA's requirements for programs in the Program Execution Instruction's Enhanced Management B and Standard Management categoriesa
Develop the estimating plan	Partially met According to the Cost Guide, an analytic approach to cost estimates typically entails a written estimating plan detailing a schedule of specific tasks, responsible parties, and due dates. Not having a well-trained, centralized, and multidisciplinary cost estimating team that is allowed ample time to create estimates will hinder an agency's ability to develop and maintain reliable cost estimates. NNSA's cost estimating requirements direct officials to determine the cost estimate status. However, the requirements do not contain guidance to ensure that the cost estimating team's composition is commensurate with the assignment. According to the Cost Guide, the estimating team is ideally composed of people who have experience in estimating all cost elements of the program and should have the proper number and mix of resources, among other requirements. Additionally, the requirements do not specifically ensure that officials develop a written plan that describes the cost estimating approach.
Define the program	Partially met According to the Cost Guide, developing a credible estimate requires having an adequate understanding of the acquisition program—the acquisition strategy, technical definition, characteristics, system design features, and technologies. This technical baseline should document the underlying technical and program assumptions necessary to develop a cost estimate and update it with changes as they occur. NNSA's cost estimating requirements include steps to identify the program's purpose and the program's system and performance characteristics. However, the requirements do not mention identifying the program's acquisition strategy. An acquisition strategy is a key part of having an adequate understanding of the acquisition program when developing a reliable estimate.
Determine the estimating structure	Partially met According to the Cost Guide, a work breakdown structure (WBS) is the cornerstone of every program because it defines in detail the work necessary to accomplish a program's objectives. A WBS provides a consistent framework for planning and assigning responsibility for the work and is an essential element for identifying activities in a program's integrated master schedule. Establishing a product-oriented WBS is a best practice because it allows a program to track cost and schedules by defined deliverables, such as a hardware component. A WBS provides a basic framework for a variety of related activities including estimating costs, developing schedules, identifying resources, and determining where risks may occur. NNSA's cost estimating requirements state that NNSA programs, at a minimum, must have a WBS that enables milestone and cost tracking. NNSA's guidance for WBS structure suggests, but does not require, methods for understanding, preparing, working with, and presenting a WBS. The guidance also describes what should be included in a WBS dictionary and when the WBS should be updated. However, NNSA's documents do not require a specific level of detail and complexity for the WBS, but allow programs to make decisions based on their management category. Additionally, NNSA requirements do not explicitly have guidance for programs to ensure that the cost estimate WBS and schedule WBS match.

Step	Assessment of NNSA's requirements for programs in the Program Execution Instruction's Enhanced Management B and Standard Management categoriesa
Identify ground rules and assumptions	Minimally met According to the Cost Guide, cost estimates are typically based on limited information and therefore are dependent on ground rules and assumptions, which typically define the estimate's scope and establish baseline conditions on which the estimate is based. Assumptions represent a set of judgments about past, present, or future conditions postulated as true in the absence of positive proof. Assumptions are required only when no ground rules have been provided and are based on expert judgments rendered by experienced program and technical personnel. Unless assumptions are documented with their sources and supporting historical data, decision-makers will not understand the level of certainty around the assumption or the cost estimate. NNSA's cost estimating requirements provide instructions to identify and apply ground rules and assumptions. However, NNSA's cost estimating requirements do not provide clear instruction for programs to document the rationale and historical data that support the ground rules and assumptions, to include input from the technical community when developing ground rules and assumptions, or to document and trace risks associated with assumptions to specific WBS elements
Obtain the data	Minimally met According to the Cost Guide, the quality of the data affects the estimate's overall credibility. Depending on the data quality, an estimate can range anywhere from a rough guess to a highly defensible cost position. Analysts usually develop estimates for new programs by relying on data from programs that already exist and then making adjustments for any differences. The challenge of data collection is obtaining the most applicable historical data to ensure that the new estimate is as accurate as possible. NNSA's cost estimating requirements contain instructions to create a data collection plan. However, the requirements do not provide clear instructions on investigating data sources; analyzing data for cost drivers, trends, and outliers; interviewing data sources; and storing data for future estimates. Further, the requirements do not prescribe an examination of data sources and documentation of all pertinent information, including an assessment of data reliability and accuracy.
Develop the point estimate	Minimally met According to the Cost Guide, cost analysts must perform several activities to develop a point estimate. These include developing the cost model by estimating each WBS element using the best methodology from the data collected, including all estimating assumptions in the cost model, expressing costs in constant-year dollars, time-phasing the results by spreading costs in the years they are expected to occur, and totaling the WBS element estimates to develop the overall point estimate. Having developed the overall point estimate, cost analysts must then validate the estimate through a quality control process by looking for errors such as incorrect spreadsheet formulas, double counting, omitted costs, and mismatched costs between documents. NNSA's cost estimating requirements provide instructions to develop an initial estimate. However, the instructions do not include many of the process tasks described in our Cost Guide to develop a point estimate, such as to develop the cost model and estimate each WBS element using the best methodology from the data collection and include all estimating assumptions. Further, NNSA's instructions do not require independent cost estimates for NNSA's Production Modernization programs.

Step	Assessment of NNSA's requirements for programs in the Program Execution Instruction's Enhanced Management B and Standard Management categoriesa
Conduct a sensitivity analysis	Minimally met According to the Cost Guide, without a sensitivity analysis that reveals how the cost estimate is affected by a change in assumptions, cost analysts will not fully understand which variable most affects the cost estimate. A sensitivity analysis should be included in all cost estimates because it examines the effects of changing cost estimate inputs, or parameters, and underlying assumptions. Sensitivity analysis involves recalculating the cost estimate with different quantitative values for selected inputs to compare the results with the original estimate. NNSA's cost estimating requirements for sensitivity analyses include tasks such as identifying cost drivers, ground rules, and assumptions for sensitivity testing. However, it is not evident that there is sufficient guidance for NNSA's programs to conduct a sensitivity analysis that fully examines the effects of changing cost estimate inputs and underlying assumptions on the overall estimate.
Conduct a risk and uncertainty analysis	Minimally met According to the Cost Guide, a risk and uncertainty analysis quantifies cost, schedule, and technical risks to assess variability in the cost estimate. The cost estimator can create a range of potential costs by modeling effects such as changing technical parameters, schedule delays or accelerations, labor productivity, and changing missions. A range of costs is more useful to decision-makers than a point estimate because a range helps them better understand program risk. NNSA's cost estimating requirements have general guidance to conduct risk and uncertainty analysis, such as to evaluate the level of cost, schedule, and technical risk for the probability and consequences of defined uncertainties. However, NNSA's guidance does not incorporate many tasks listed in the Cost Guide, including modeling probability distributions based on data availability, reliability, and variability; accounting for correlation between cost elements; or allocating the risk-adjusted cost estimate to WBS elements, if necessary.
Document the estimate	Minimally met According to the Cost Guide, thorough documentation is essential for validating and supporting a cost estimate. A well-documented estimate can provide the necessary information to help answer questions from decision-makers and oversight groups. Such documentation should show all parameters, assumptions, descriptions, methods, and calculations used to develop a cost estimate. NNSA's cost estimating requirements ask officials to verify the estimate using a selected approach, document the summary and elements decided in each of the previous steps, document special calculations or analytical techniques applied, and ensure that results are auditable by an independent cost review team. However, NNSA's requirements do not ask officials to document all steps performed to develop the estimate so that a cost analyst unfamiliar with the program can recreate it quickly and produce the same result; discuss all ground rules and assumptions; and describe, in detail, the estimating methodology and rationale used to derive each WBS element's cost.
Present estimate to management for approval	Minimally met According to the Cost Guide, a cost estimate is not considered complete until management has approved it. Cost analysts should brief management with enough detail to easily defend the estimate and demonstrate its completeness and quality. NNSA's cost estimating requirements include tasks such as preparing a summary package or arranging for management to request a briefing that includes a program-project baseline cost estimate and resulting schedule. However, NNSA's requirements do not clearly state that management should be presented with sufficient information to understand how an estimate was developed. Such information should include details about the program's technical characteristics, assumptions, cost estimating methodologies, underlying data, sensitivity, and risk and uncertainty.

Step	Assessment of NNSA's requirements for programs in the Program Execution Instruction's Enhanced Management B and Standard Management categories[a]
Update estimate to reflect actual cost and changes	Minimally met According to the Cost Guide, programs should be updated with actual costs so that it is always relevant and current. Programs should be monitored continually for their cost effectiveness by comparing planned and actual performance against the approved baseline cost estimate. This process allows cost analysts to see how well they are estimating and how the program is changing over time. NNSA's cost estimating requirements state that cost estimates should be populated with actual data as becomes available. However, the requirements do not specifically mention keeping the estimate current as the program passes through new phases or milestones.

Source: GAO analysis of NNSA documentation and GAO, *Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Program Costs*, GAO-20-195G (Washington, D.C.: Mar. 12, 2020). | GAO-24-106342

Note: This table presents our analysis of the extent to which the NNSA cost estimating requirements applicable to Production Modernization programs incorporate the process steps outlined in the *Cost Guide*. This table does not present information on individual Production Modernization program cost estimates. A cost estimating process is considered reliable if the rating for each of the 12 steps is substantially or fully met. If any of the steps in the cost estimating process are not met, minimally met, or partially met, the cost estimating process does not fully reflect the process required to ensure a high-quality estimate and cannot be considered reliable. We rated the extent to which NNSA's cost estimating requirements incorporate our 12 process steps using the following scale:

Fully met—NNSA provided evidence that satisfies the entire criterion; substantially met—NNSA provided evidence that satisfies a large portion of the criterion; partially met—NNSA provided evidence that satisfies about half of the criterion; minimally met— NNSA provided evidence that satisfies a small portion of the criterion; and not met—NNSA provided no evidence that satisfies any of the criterion.

[a]The *Program Execution Instruction* identifies four program management categories (in order of most to least rigorous): Capital Acquisition Management, Enhanced Management A, Enhanced Management B, and Standard Management. Production Modernization programs fall into the Enhanced Management B and Standard Management categories. We found that NNSA's requirements for developing cost estimates for programs in the Enhanced Management B and Standard Management categories are very similar and the *Program Execution Instruction* cites the same guidance documents for both categories. As a result, our assessment of NNSA's requirements is the same for both categories across all 12 process steps listed in the *Cost Guide*. Further, Production Modernization programs do not meet the *Program Execution Instruction*'s criteria for inclusion in the Capital Acquisition Management or Enhanced Management A categories. The Capital Acquisition Management category applies to capital asset projects with a total project cost greater than $50 million and managed in accordance with DOE Order 413.3B. The Enhanced Management A category applies to NNSA activities that require a selected acquisition report to Congress and follow the Joint Department of Defense–Department of Energy Nuclear Weapon Life-Cycle Process, commonly referred to as the Phase 6.X Process.

Appendix V: Comments from the Department of Energy

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

June 14, 2024

Ms. Allison B. Bawden
Director, Natural Resources and Environment
U.S. Government Accountability Office
Washington, D.C. 20548

Dear Ms. Bawden:

Thank you for the opportunity to review the Government Accountability Office (GAO) draft report, *National Nuclear Security Administration: Actions Needed to Improve Integration of Production Modernization Programs and Projects* (GAO-24-106342). The National Nuclear Security Administration (NNSA) recognizes and appreciates GAO's knowledge of our weapons programs and the associated infrastructure projects. We accept the recommendations to employ government best practices and plan to implement the recommendations as detailed in Enclosure 1, *Management Decision*.

However, NNSA is concerned that the narrow view of evaluating program and project integration only by the inclusion of government-wide best practices leads to incomplete and misleading conclusions. As noted in the report, GAO has evaluated NNSA production modernization more than 10 times over the last 5 years. In every instance, NNSA has accepted all or most of the recommendations, and many have already been fully applied. As in this draft report, most of the recommendations involve the implementation of government-wide best practices in our policies and procedures. We strongly believe that the incorporation of government best practices *alone* will not fundamentally change our ability to integrate the program and project cost and schedule results required to meet the urgent national security requirements placed on our enterprise. We therefore feel it is important to acknowledge other actions and activities that NNSA has taken to improve integration, either generally or specifically. We believe these other actions and activities are having a significant and timely impact on program and project integration. We provide a few examples of activities that have improved program and project integration in Enclosure 2, *NNSA Practices to Improve Program and Project Integration*, to substantiate our perspective.

NNSA is particularly concerned that the "What GAO Found" section of this report is misleading. While GAO followed the statutory direction to review the extent to which NNSA's requirements and guidance reflect best practices, this approach does not represent a holistic or balanced view of our program and project integration. The most serious challenges in program and project integration require active management, partnership, decisive decision-making, and clear prioritization to advance the program goals in the most effective manner. This would not be reflected in a review focused on adherence to best practices, but NNSA's programs and projects are doing this every day. We encourage GAO to acknowledge this reality.

If you have any questions about this response, please contact Dean Childs, Director, Audits and Internal Affairs, at (202) 836-3327.

Sincerely,

Jill Hruby

Enclosure 1: Management Decision
Enclosure 2: NNSA Practices to Improve Program and Project Integration

Enclosure 1

NATIONAL NUCLEAR SECURITY ADMINISTRATION
Management Decision

"National Nuclear Security Administration: Actions Needed to Improve Integration of Production Modernization Programs and Projects" (GAO-24-106342)

The Government Accountability Office (GAO) recommends the Department of Energy's National Nuclear Security Administration (NNSA):

Recommendation 1: Ensure that the NNSA schedule requirements applicable to Production Modernization programs are revised to fully incorporate the 10 best practices for developing reliable program schedules from GAO's *Schedule Assessment Guide*.

Management Response: Concur. Although NNSA has not fully implemented GAO's non-mandatory *Schedule Assessment Guide*, NNSA already has internal controls in place to document program scope, schedule, and cost estimate in planning documents. By January 31, 2025, NNSA will incorporate, as appropriate, GAO's *Schedule Assessment Guide* 10 best practices into the Program Execution Instruction to bolster existing requirements to develop reliable program schedules.

Recommendation 2: Ensure that the other Production Modernization programs, as statutorily required for the Plutonium Modernization program, are managed in accordance with GAO's best practices for schedule development by developing and maintaining reliable, resource-loaded integrated master schedules, or otherwise documenting with senior leadership approval their rationale for not doing so.

Management Response: Concur. By September 30, 2025, NNSA will incorporate, as appropriate, GAO's best practices for schedule development into the Program Execution Instruction. Programs will be required to develop and maintain reliable, resource-loaded integrated master schedules, or otherwise document with senior leadership approval their rationale for not doing so.

Recommendation 3: Ensure that the NNSA cost estimating requirements applicable to Production Modernization programs are revised to fully incorporate the 12 steps for developing reliable program cost estimates from GAO's *Cost Estimating and Assessment Guide*.

Management Response: Concur. NNSA has not fully implemented GAO's non-mandatory *Cost Estimating and Assessment Guide*, although NNSA has internal controls in place to ensure NNSA develops reliable program cost estimates. NNSA will incorporate, as appropriate, GAO's 12 steps for developing reliable program cost estimates into the Program Execution Instruction to bolster existing requirements by January 31, 2025. NNSA will also continue to implement multiple initiatives, such as supply chain health monitoring and material and capacity modeling, to ensure project cost estimates account for a broad set of possible demand drivers and risks.

Enclosure 1

Recommendation 4: Ensure that the other Production Modernization programs, as statutorily required for the Plutonium Modernization program, are managed in accordance with GAO's best practices for cost estimating by developing and maintaining reliable life cycle cost estimates, or otherwise documenting with senior leadership approval their rationale for not doing so.

Management Response: Concur. By September 30, 2025, NNSA will incorporate, as appropriate, GAO's best practices for cost estimating into the Program Execution Instruction. Programs will be required to develop and maintain reliable life cycle cost estimates, or otherwise document with senior leadership approval their rationale for not doing so.

Enclosure 2

NATIONAL NUCLEAR SECURITY ADMINISTRATION
Practices to Improve Program and Project Integration

"National Nuclear Security Administration: Actions Needed to Improve Integration of Production Modernization Programs and Projects" (GAO-24-106342)

The most serious challenges faced by the National Nuclear Security Administration (NNSA) Production Modernization Programs and Projects require active management, partnership, creative problem-solving, and decisive action, in which NNSA's program managers and project directors are constantly engaged. Examples include:

- In the spring of 2022, NNSA recognized that there was a looming mismatch between the demand for glove boxes at NNSA and other Department of Energy facilities and the capacity of U.S. industry to manufacture glove boxes of the needed types. One element of the problem was that the industry could not supply both the Los Alamos National Laboratory (LANL) and the Savannah River Site (SRS) with the glove boxes they needed on the timetables they wanted. Integration was needed to prioritize and manage glove box orders from the two sites. NNSA established a glove box working group to deconflict and flatten the demand curve. NNSA worked closely with the industry, including the American Glovebox Association, and after a great deal of effort devised and executed creative actions that will increase the capacity of the U.S. glove box industry. These actions required front-loaded funding for the Savannah River Plutonium Processing Facility (SRPPF), which the NNSA Administrator requested through an unfunded requirements letter to Congress and which Congress provided in its fiscal year 2023 appropriation. Detailed cost and schedule estimates were neither needed nor helpful for addressing this challenge, which would have resulted in serious negative consequences for the nuclear deterrent if not addressed.

- NNSA is currently addressing significant challenges associated with the supply of high explosives for its warhead modernization programs. The challenges include the unforeseen inability of the single manufacturer to make material that meets specifications, such as the recent declaration by 3M that they would no longer make the binder that is an essential ingredient for these particular high explosives and the recent declaration by the Environmental Protection Agency that certain per- and polyfluoroalkyl substances (PFAS) materials cannot exceed four parts per trillion in municipal drinking water supplies, which led the high explosives manufacturer to stop using the alternative binder NNSA had secured. NNSA is taking numerous creative steps to address these challenges, including steps to partner across the enterprise and steps to ensure the needed integration of Production Modernization programs and projects with each other and with programs and projects outside of Production Modernization. It is not possible for cost or schedule estimates to ensure the kind of integration needed to address such challenges.

- NNSA has awarded the SRPPF construction project to an industrial construction manager, recognizing that management and operating (M&O) contractors are not experienced with large project execution. This type of contract award leverages the construction company's experience to deliver the engineering design across multiple disciplines while managing

Enclosure 2

scope creep, material procurement, and storage management at a site using industrial best practices.

- NNSA has initiated partnering sessions with NNSA locations that were selected because of their high visibility challenges. Partnering sessions include program, project, and M&O leadership. Partnering sessions identified a need to establish an Infrastructure Executive Board. The Integrated Executive Task Force (IETF) Charter for Pit Production is being drafted and the IETF will begin operation, with leaders from NNSA and LANL meeting regularly to actively manage risks, remove roadblocks, and provide solutions to challenges on a near real time basis to support meeting pit production goals.

- To capture the scope and integration of infrastructure needs, NNSA is completing an Enterprise Blueprint effort. The report will be formally published and rolled out this Fall. This effort provides an integrated look, defined by program need, of the infrastructure projects required in the complex for the next few decades. This was an effort at integration of all major line-item project needs compared to the requirements of the entire NNSA organization.

NNSA regularly uses program and project integrated schedules for decision making. Examples include:

- Building PF-4 at LANL has an integrated master schedule (IMS) that includes program tasks for building pits, program tasks for Major Items of Equipment removal and installation, project tasks associated with multiple subprojects of the Los Alamos Plutonium Pit Production Project (including the Chemistry and Metallurgy Research Replacement Facility and the TA-55 Reinvestment Project Phase III), and numerous program tasks outside of Production Modernization (e.g., surveillance, subcritical experiments). This IMS is used effectively every day to help LANL managers, federal program managers, and federal project directors manage the complex interplay among the associated programs and projects.

- The Plutonium Modernization program uses an IMS to help manage the program to achieve its objectives. This IMS includes much of the work at PF-4 in addition to work at Lawrence Livermore National Laboratory (LLNL), Kansas City National Security Campus (KCNSC), and SRS. The fact that the program is on track to diamond stamp its first war-reserve W87-1 pit this year testifies to the effectiveness of this integration.

- NNSA has implemented regular and rigorous project schedule reviews to track weekly schedule performance metrics, specifically targeting schedule finishes. Examples of project deliverables are three-week look-ahead schedules, quality control plans, and construction production reports. These project deliverables are discussed and reviewed with the program sponsor during monthly project reviews, Senior Management Team meetings, Matrixed Execution Team meetings and other integration meetings. This effort has resulted in the ability to provide real-time risk-informed decision-making of routine and emergent project issues.

Enclosure 2

NNSA regularly uses cost estimates to inform decisions related to program and project integration and is taking many steps to improve cost estimates. Examples of both include:

- The NNSA Weapons Activities Account Integrator uses cost estimates, with uncertainties, along with warhead delivery schedules to manage the Production Modernization portfolio (along with other weapons activities portfolios). Cost estimates and delivery requirements inform the time-phasing of the numerous infrastructure projects, all ultimately essential for warhead delivery, and fit the total funding profile into the boundaries prescribed by the Office of Management and Budget.

- NNSA has developed and improved the use of models to cross-check laboratory, plant, and site cost estimates and understand impact of excursions on the infrastructure portfolio.

- To improve cost estimating accuracy, NNSA has taken a two-pronged approach for capital projects. First, the projects asked U.S. Army Corps of Engineers for support in cost estimating to understand and take advantage of their best practices. Second, the projects target major drivers of cost increases to manage them early to hold to the original cost estimate.

- NNSA's Cost Estimating Analysis Group (CEAG) has led an effort to update the Capital Acquisition Estimating Framework to incorporate the latest developments in NNSA policy/guidance, recommendations for improvement from the SRPPF Bottom-Up Estimate Review conducted by CEAG, and lessons learned from prior major construction projects' cost guidance/requirements development.

- NNSA has developed two documents describing improvements to cost estimates: a Management Reserve and Contingency (MR&C) memorandum, which clarifies NNSA's expectations for risk management and development of MR&C estimates and will soon be issued, and a cost estimating guidance/requirements document for NNSA's major line-items, which will soon be issued by the Federal Project Director for each site.

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

June 14, 2024

Ms. Allison B. Bawden
Director, Natural Resources and Environment
U.S. Government Accountability Office
Washington, D.C. 20548

Dear Ms. Bawden:

Thank you for the opportunity to review the Government Accountability Office (GAO) draft report, National Nuclear Security Administration: Actions Needed to Improve Integration of Production Modernization Programs and Projects (GAO-24-106342). The National Nuclear Security Administration (NNSA) recognizes and appreciates GAO's knowledge of our weapons programs and the associated infrastructure projects. We accept the recommendations to employ government best practices and plan to implement the recommendations as detailed in Enclosure 1, Management Decision.

However, NNSA is concerned that the narrow view of evaluating program and project integration only by the inclusion of government-wide best practices leads to incomplete and misleading conclusions. As noted in the report, GAO has evaluated NNSA production modernization more than 10 times over the last 5 years. In every instance, NNSA has accepted all or most of the recommendations, and many have already been fully applied. As in this draft report, most of the recommendations involve the implementation of government-wide best practices in our policies and procedures. We strongly believe that the incorporation of government best practices alone will not fundamentally change our ability to integrate the program and project cost and schedule results required to meet the urgent national security requirements placed on our enterprise. We therefore feel it is important to acknowledge other actions and activities that NNSA has taken to improve integration, either generally or specifically. We believe these other actions and activities are having a significant and timely impact on program and project integration. We provide a few examples of activities that have improved program and project integration in Enclosure 2, NNSA Practices to Improve Program and Project Integration, to substantiate our perspective.

NNSA is particularly concerned that the "What GAO Found" section of this report is misleading. While GAO followed the statutory direction to review the extent to which NNSA's requirements and guidance reflect best practices, this approach does not represent a holistic or balanced view of our program and project integration. The most serious challenges in program and project integration require active management, partnership, decisive decision-making, and clear prioritization to advance the program goals in the most effective manner. This would not be reflected in a review focused on adherence to best practices, but NNSA's programs and projects are doing this every day. We encourage GAO to acknowledge this reality.

If you have any questions about this response, please contact Dean Childs, Director, Audits and Internal Affairs, at (202) 836-3327.

Sincerely,

Jill Hruby

Enclosure 1: Management Decision
Enclosure 2: NNSA Practices to Improve Program and Project Integration

NATIONAL NUCLEAR SECURITY ADMINISTRATION
Management Decision

"National Nuclear Security Administration: Actions Needed to Improve Integration of Production Modernization Programs and Projects" (GAO-24-106342)

The Government Accountability Office (GAO) recommends the Department of Energy's National Nuclear Security Administration (NNSA):

Recommendation 1: Ensure that the NNSA schedule requirements applicable to Production Modernization programs are revised to fully incorporate the 10 best practices for developing reliable program schedules from GAO's Schedule Assessment Guide.

Management Response: Concur. Although NNSA has not fully implemented GAO's non- mandatory Schedule Assessment Guide, NNSA already has internal controls in place to document program scope, schedule, and cost estimate in planning documents. By January 31, 2025, NNSA will incorporate, as appropriate, GAO's Schedule Assessment Guide 10 best practices into the Program Execution Instruction to bolster existing requirements to develop reliable program schedules.

Recommendation 2: Ensure that the other Production Modernization programs, as statutorily required for the Plutonium Modernization program, are managed in accordance with GAO's best practices for schedule development by developing and maintaining reliable, resource-loaded integrated master schedules, or otherwise documenting with senior leadership approval their rationale for not doing so.

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Appendix VI: GAO Contact and Staff Acknowledgments

GAO Contact

Allison Bawden at (202) 512-3841 or bawdena@gao.gov

Staff Acknowledgments

In addition to the contact named above, Brian M. Friedman (Assistant Director), Bryan Bourgault (Analyst in Charge), Karen Chen, Juan? Collymore, John Delicath, Emily Ellison, Cindy Gilbert, Jennifer Leotta, Dan C. Royer, and Jeanette Soares made key contributions to this report.

Related GAO Products

National Nuclear Security Administration: Update on Actions to Manage Production Challenges at the Kansas City Site. GAO-24-105858. Washington, D.C.: November 16, 2023.

National Nuclear Security Administration: Assessments of Major Projects. GAO-23-104402. Washington, D.C.: August 17, 2023.

Nuclear Weapons: NNSA Does Not Have a Comprehensive Schedule or Cost Estimate for Pit Production Capability. GAO-23-104661. Washington, D.C.: January 12, 2023.

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