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NUCLEAR WEAPONS

NNSA Does Not Have a Comprehensive Schedule or Cost Estimate for Pit Production Capability

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Abbreviations

CMR	Chemistry and Metallurgy Research Facility
CMRR	Chemistry and Metallurgy Research Replacement Project
CD	Critical Decision
DOD	Department of Defense
DOE	Department of Energy
EMC2	Enhanced Minor Construction–Commercial
FIPT	Federal Integrated Project Team
FPU	first production unit
FTEs	full time equivalents
IMS	integrated master schedule
Kansas City	Kansas City National Security Campus
Livermore	Lawrence Livermore National Laboratory
Los Alamos	Los Alamos National Laboratory
LAP4	Los Alamos Plutonium Pit Production Project
MET	Matrixed Execution Team
MLLW	Mixed Low Level Waste
MFFF	Mixed Oxide Fuel Fabrication Facility
NAPA	National Academy of Public Administration
NAS	National Academies of Sciences, Engineering, and Medicine
NASA	National Aeronautics and Space Administration
NNSA	National Nuclear Security Administration
Nevada	Nevada National Security Site
Pantex	Pantex Plant
PIDAS	Perimeter Intrusion Detection and Assessment System
Pu-238	plutonium 238
PF-4	Plutonium Facility 4
PEI1	PF-4 Equipment Installation Phase 1
PEI2	PF-4 Equipment Installation Phase 2
PRT	Product Realization Team
RLUOB	Radiological Laboratory Utility Office Building
REI2	RLUOB Equipment Installation Phase 2
RC3	Re-categorizing RLUOB to Hazard Category 3
Safety Board	Defense Nuclear Facilities Safety Board
SRPPF	Savannah River Plutonium Processing Facility
Savannah River	Savannah River Site
TA-55	Technical Area 55
TRU	transuranic
TLW	Transuranic Liquid Waste
TRP III	Technical Area 55 Reinvestment Project, Phase III
WIPP	Waste Isolation Pilot Plant

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Congressional Committees

The National Nuclear Security Administration (NNSA) is re-establishing production capabilities for plutonium pits, the central cores of thermonuclear weapons. Plutonium is a dangerous material to work with and must be handled carefully. Due to safety requirements, and the need for pits to meet exacting design and performance standards consistent with nuclear weapons' designs, the production of pits is difficult and time consuming.

Large-scale production of pits in the U.S. ceased in 1989. As a result, most pits in the U.S. stockpile today are more than 30 years old. According to a May 2020 NNSA report to Congress, reestablishing a pit production capability is considered critical to maintaining the nation's nuclear weapons stockpile to meet modern standards for safety and reliability. It is one of many efforts currently ongoing to modernize the U.S. weapons stockpile and ensure that nuclear weapons production infrastructure is responsive to national security needs. During the Cold War, the United States could produce over a thousand pits per year. Since then, NNSA has produced a small number of war reserve pits (pits certified to be used in nuclear weapons) and has produced no war reserve pits since 2012.

Military and legal requirements direct the Department of Energy (DOE) to have capacity to produce no fewer than 80 pits per year by 2030.[1] To attain this pit production capability,[2] the Administrator of the NNSA, a separately organized agency within DOE, proposed a two-site plan in a May 2018 report to Congress. Under this plan, by 2030 NNSA would annually produce 30 pits at Los Alamos National Laboratory (Los Alamos) in New Mexico and 50 pits at Savannah River Site (Savannah River) in

[1]*See* 50 U.S.C. § 2538a.

[2]For the purposes of this report, the phrase "pit production capability" refers to the capability to produce 80 plutonium pits per year, unless otherwise noted.

South Carolina. Prior to 2018, work had already begun at Los Alamos to reestablish its capacity to produce pits.[3]

Despite NNSA's plans and prior efforts, an independent study produced in 2019 by the Institute for Defense Analyses concluded that no available production option considered by NNSA could be expected to provide capacity to produce 80 pits per year by 2030.[4] Similarly, In September 2020, we found that NNSA had not yet taken important project and program management steps for the manufacture of new pits.[5] This included not having developed an integrated master schedule (IMS).[6]

As a result, we found that NNSA had limited assurance that it would be able to produce sufficient numbers of pits in time, particularly to meet the preliminary schedule for its W87-1 modification program.[7] We also found that NNSA had a provisional alternative plan should its pit manufacturing schedule not be met. NNSA officials stated that, in October 2021, following congressional direction, they had established an IMS for pit

[3]Prior to 1989, pit production took place at DOE's plant at Rocky Flats in Colorado, which was shut down in 1989. In 1996, DOE issued a Record of Decision that provided for a limited production capacity at Los Alamos. Los Alamos produced its first war reserve pit in 2007 and was capable of manufacturing up to 10 war reserve pits per year. Los Alamos ceased pit production operations in 2012 after producing the quantity of pits needed at the time.

[4]Institute for Defense Analyses, *Independent Assessment of the Plutonium Strategy of the National Nuclear Security Administration* (Alexandria, VA: Mar. 2019). Section 3120 of the John S. McCain National Defense Authorization Act for Fiscal Year 2019 mandated that "the Secretary of Defense, in consultation with the Administrator for Nuclear Security, shall seek to enter into a contract with a federally funded research and development center to conduct an assessment of the plutonium strategy" of the NNSA. The Institute for Defense Analyses was the center selected to produce the assessment of NNSA's plutonium strategy.

[5]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).

[6]An IMS integrates a complete scope of work as defined in a program's work breakdown structure, the resources necessary to accomplish that work, and the associated budget for a program. The schedule can also show when major events are expected, as well as the completion dates for all activities leading up to these events, which can help managers determine if the program's parameters are realistic and achievable.

[7]The W87-1 Modification Program is intended to create a warhead designed for delivery by the next generation intercontinental ballistic missile, known as the Ground Based Strategic Deterrent, for the U.S. nuclear strategic deterrent. First Production Unit (FPU) of the W87-1 warhead is planned for 2030. The warhead's design calls for a newly manufactured pit.

production and that the IMS represented the entire 80-pit-per-year mission, including program activities, capital asset projects, and supporting facilities at each site.

Acknowledging some of the outside reviews' conclusions, the then-Acting NNSA Administrator testified in June 2021 that meeting required pit production levels of 80 per year would take 2 to 5 years longer than NNSA originally planned (2032-2035). However, the legislative requirement to have capacity to manufacture not less than 80 pits during 2030 is still in place. According to a March 2021 independent project review of the planned Savannah River Plutonium Processing Facility (SRPPF), additional, post-construction milestones to start facility operations and delivery of 50 pits would extend the time to meet the 80-pit requirement to 2036.[8] In March 2022, the commander of U.S. Strategic Command testified that NNSA would not meet the 80-pit-per-year manufacturing capability in 2030, and that no amount of funding would allow NNSA to recover enough time to do so.

Legislative reports accompanying recent national defense authorization and appropriations bills include provisions for GAO to review different aspects of NNSA's plutonium pit production activities, including plans, schedule, and cost.[9] This report examines (1) the scope of NNSA's efforts to achieve the required production capability of 80 pits per year and NNSA's management of that scope of work; and (2) the extent to which NNSA has met GAO best practices for the integrated master schedule and a life cycle cost estimate for achieving the capability to manufacture 80 pits per year.

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[8]National Nuclear Security Administration, *Critical Decision (CD)-1 Independent Project Review (IPR): Savannah River Plutonium Processing Facility (SRPPF)*, (Aiken, S.C.: Mar. 15, 2021).

[9]H.R. Rep. No. 116-83, at 120 (2019), accompanying H.R. 2960, a bill for the Energy and Water Development and Related Agencies Appropriations Act, 2020 includes a provision for GAO to monitor NNSA efforts on cost, scope, and schedule; S. Rep. No. 116-236, at 417 (2020), accompanying S. 4049, a bill for the National Defense Authorization Act for Fiscal Year 2021 includes a provision for GAO to periodically review NNSA's plutonium modernization plans; H.R. Rep. No. 116-449, at 140 (2020), accompanying H.R. 7613, a bill for the Energy and Water Development and Related Agencies Appropriations Act, 2021 includes a provision for GAO to review NNSA's plan for an integrated master schedule; S. Rep. No. 117-39, at 367 (2021) accompanying S. 2792, a bill for the National Defense Authorization Act for Fiscal Year 2022 includes a provision for NNSA to provide an integrated master schedule for activities at Los Alamos and for GAO to review this schedule according to GAO best practices.

To address our objectives, we reviewed relevant agency documents including NNSA reports, memoranda, and program and project management documents; NNSA's schedule for plutonium pit production; and budget estimate documents for the Plutonium Modernization program. We interviewed NNSA officials and contractor representatives and reviewed presentations by key NNSA officials from NNSA headquarters in Washington, D.C., Los Alamos in New Mexico, Savannah River in South Carolina, and other supporting offices. For our full scope and methodology, see appendix. I.

We conducted this performance audit from December 2020 to January 2023 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 Stockpile Modernization

The United States is in the midst of a long-term effort to modernize its nuclear security enterprise. The primary goal of this effort is to ensure the country's nuclear stockpile—composed of thermonuclear warheads and bombs—is safe, secure, and reliable as the nation's nuclear deterrent. To support this mission, NNSA is responsible for overseeing research, development, testing, and acquisition programs that produce, maintain, and sustain the stockpile.

NNSA undertakes nuclear stockpile modernization programs in coordination with the Department of Defense (DOD). The programs refurbish or replace nuclear weapons and their components to enhance their safety and security characteristics. They also seek to consolidate the stockpile into fewer weapon types to minimize maintenance and testing costs while preserving needed military capabilities.[10]

[10]We reported on recent DOD and NNSA efforts to modernize nuclear weapons. GAO, *Nuclear Triad: DOD and DOE Face Challenges Mitigating Risks to U.S. Deterrence Efforts*, GAO-21-210 (Washington, D.C.: May 6, 2021).

As part of these efforts, NNSA is responsible for manufacturing plutonium pits, a key component of nuclear warheads. Pits are essential to the thermonuclear weapons in the U.S. stockpile and serve as the first stage in physically triggering the nuclear explosion. Pits are typically composed of plutonium and other materials surrounded by high explosives.

According to NNSA, rebuilding a pit production capability is critical for meeting military requirements and maintaining the U.S. nuclear arsenal. In recent years, NNSA managed pit production activities under its Pit Manufacturing and Certification Campaign before the agency established the Plutonium Sustainment program in fiscal year 2010. This program evolved into the Plutonium Modernization program for fiscal year 2021.

In April 2017, we found that the next decade would be particularly challenging for DOE's nuclear modernization efforts because the agency needed to ensure sufficient production capacity while simultaneously conducting major construction projects and investing in operating programs to modernize its plutonium capabilities.[11] In March 2020, we testified that NNSA faced challenges as it balanced ongoing and planned nuclear stockpile modernization programs with related capital asset projects at various production sites.[12] We stated that NNSA made some progress in implementing our recommendations to improve the management of these programs and projects. However, we also found that any delays or technical challenges that affected NNSA's plans for its production facilities, including those for pits, could result in delays and challenges to stockpile modernization programs.

Plutonium

Plutonium is a radioactive element that the United States produced for use in nuclear weapons. By irradiating uranium in special nuclear reactors—primarily at the Hanford site near Richland, Washington, and at Savannah River—DOE produced plutonium and, in particular, the plutonium-239 isotope used in nuclear weapons. DOE ceased plutonium production in the 1980s because of environmental and regulatory concerns at its main plant, as well as having a large existing quantity. It

[11]GAO, *National Nuclear Security Administration: Action Needed to Address Affordability of Nuclear Modernization Programs*, GAO-17-341 (Washington, D.C.: Apr. 26, 2017).

[12]GAO, *Nuclear Weapons: NNSA's Modernization Efforts Would Benefit from a Portfolio Management Approach*, GAO-20-443T (Washington, D.C.: Mar. 3, 2020).

had over 50 metric tons of plutonium that was declared surplus to national defense needs.[13]

Plutonium and related transuranic waste generated from plutonium operations is dangerous and hazardous to human health. The material requires stringent safety and security measures and well-trained technicians to work with it.[14] As plutonium decays, it releases radioactive particles and produces other potentially radioactive elements, like americium, that increase the radiation risk for workers. In addition, it is carcinogenic and can cause cancer in human beings if inhaled or ingested. Plutonium is also pyrophoric and, under certain conditions, can ignite spontaneously when exposed to air.[15]

Because of these hazards, plutonium operations are generally conducted in sealed gloveboxes containing an inert, oxygen-free atmosphere. See figure 1 for an example of a glovebox. Plutonium facilities, to include gloveboxes, also utilize infrastructure and administrative measures to control the amount and configuration of the plutonium being processed or stored to avoid nuclear criticality. Nuclear criticality occurs when a mass of fissionable material sustains a nuclear chain reaction, thereby producing a large and sometimes lethal dose of ionizing radiation.

[13]The United States has over 50 metric tons of surplus plutonium and has committed to disposing of 34 metric tons. GAO, *Surplus Plutonium Disposition: NNSA's Long-Term Plutonium Oxide Production Plans are Uncertain*, GAO-20-166 (Washington, D.C.: Oct. 23, 2019).

[14]Transuranic waste includes discarded rags, tools, equipment, soils or other materials that have been contaminated by man-made radioactive elements, like plutonium. The Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico, is designed to safely dispose of transuranic waste generated as a result of DOE's nuclear weapons research, production, and cleanup activities at sites across the country as well as waste that will be generated from NNSA's pit manufacturing activities. Additionally, DOE Order 474.2 on material control and accountability requires plutonium to be accounted and controlled at the gram or tenth of a gram level. NNSA seeks to recover and recycle all scrap plutonium from the manufacturing process.

[15]Pyrophoric chemicals are liquids and solids that will ignite spontaneously in the presence of oxygen. There were two plutonium-related fires at the Rocky Flats Plant—which produced plutonium pits through 1989—in 1957 and 1969.

Figure 1: Glovebox at Los Alamos National Laboratory

Source: Los Alamos National Laboratory. | GAO-23-104661

U.S. nuclear energy and nuclear weapons research efforts have suffered a number of fatal accidents since the 1940s. Concerns over criticality and other safety issues also contributed to a two-and-a-half-year shutdown of production processes in Los Alamos's plutonium facility—Plutonium Facility 4 (PF-4)—from 2013 to 2016 and contributed to NNSA replacing the management and operating contractor there in 2018.[16]

In addition to safety concerns, missions involving plutonium and plutonium pits also require extensive security to prevent theft, unauthorized use, diversion, and sabotage. Plutonium and certain other special nuclear materials, such as highly enriched uranium, present the highest level of consequence for misuse and loss.[17]

Because of this, DOE and NNSA sites using these materials employ "defense-in-depth" security measures. For example, NNSA sites use

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[16] GAO-20-166; GAO, *National Nuclear Security Administration Contracting: Review of the NNSA Report on the Los Alamos National Laboratory Contract Competition*, GAO-20-292R (Washington, D.C.: Jan. 30, 2020).

[17] GAO, *Nuclear Security: DOE Could Improve Aspects of Nuclear Security Reporting*, GAO-17-239 (Washington, D.C.: Apr. 11, 2017).

physical security features and systems, such as integrated cameras, alarms, and motion sensors; fences and anti-vehicle barriers; and numerous access control points, including turnstiles, badge readers, and vehicle inspection stations. Sites generally have a heavily armed protective force that is often equipped with such items as automatic weapons, night vision equipment, body armor, and chemical protective gear. To protect special nuclear material, NNSA received funding of $763 million in fiscal year 2021 for Defense Nuclear Security operations and maintenance across the NNSA nuclear security enterprise.

The Pit Production Process

The pit production process involves a number of steps. The following describes the pit production process that NNSA is establishing at Los Alamos. The intent is for a similar production process to be established at Savannah River, although with higher production rate capacity. Differences from legacy production processes are noted.

1. **Arrival and disassembly**. Pits from retired nuclear weapons are securely transported from NNSA's Pantex Plant (Pantex) in Texas to PF-4 at Los Alamos where they are disassembled to provide feedstock for new pit manufacturing. Pantex is authorized to store 20,000 surplus pits.[18]
2. **Metal preparation.** Impurities are removed from the feedstock, which purifies the plutonium, and transuranic waste is discarded during metal preparation.
3. **Melting and casting.** After impurities are removed, the plutonium moves on to foundry processes where the purified plutonium feedstock is melted and poured into a cast for machining.[19]
4. **Machining.** The cast plutonium is machined into the correct pit shape, using lathe and mill metal cutting techniques, often with computer-assisted technology.
5. **Assembly.** The plutonium and non-nuclear parts are assembled and welded together to seal the pit against the environment.

[18]During the Cold War, newly produced plutonium was securely transported from Hanford and Savannah River to Rocky Flats for pit production.

[19]Pits at Rocky Flats were made using two processes, one of which was casting. In addition, Rocky Flats produced some pits using a wrought process that shaped the pits with rollers, hammers, and other tools. NNSA does not plan to re-establish the wrought pit production process at Los Alamos or Savannah River.

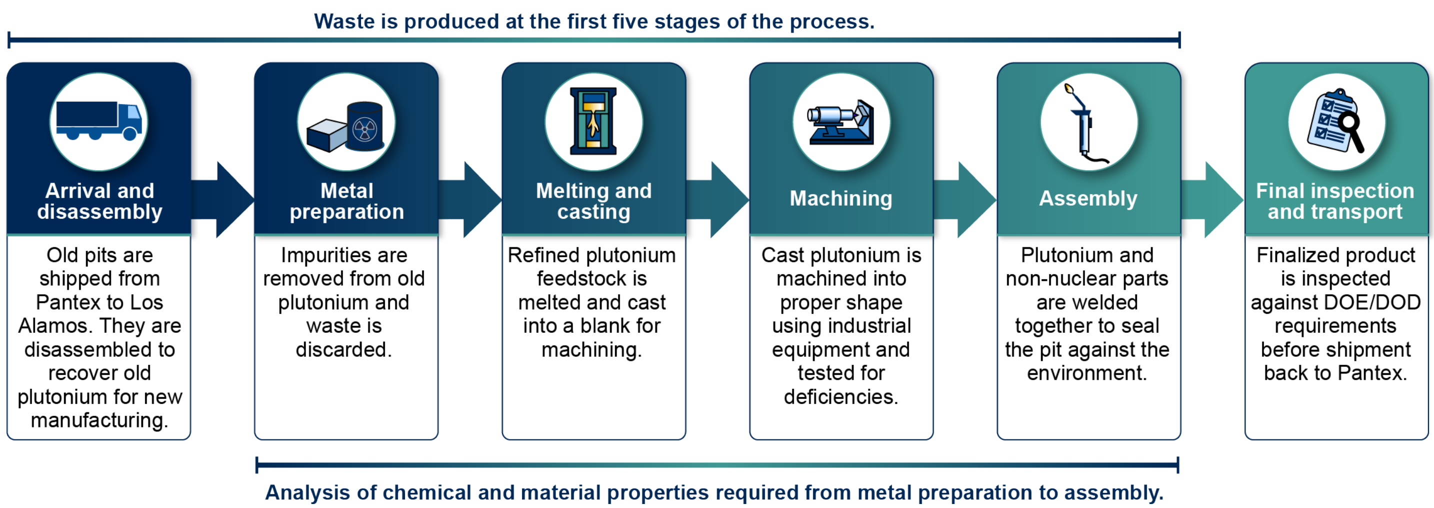
6. **Final inspection and transport.** The assembled pit receives a final inspection to determine if the pit meets both NNSA's design specifications and DOD requirements. It is then certified for use in a nuclear weapon and securely transported back to Pantex for nuclear weapon assembly.

During steps two through five, the plutonium and pit are continually inspected through plutonium analysis—analytical chemistry and materials characterization—to ensure both the chemical and physical properties of the plutonium and of the pit meet war reserve specifications.[20] Transuranic and other waste is produced in the first five stages of the process (prior to final inspection), which must be appropriately packaged for shipment and long-term disposal at the Waste Isolation Pilot Plant (WIPP).

Because of these many steps and the exacting standards that war reserve pits must meet, it typically takes three months for plutonium to move through all stages of the process from disassembly to final inspection. However, multiple pits can be staggered in different stages of production at a single site. To achieve an 80-pit-per-year capacity, NNSA plans to install similar equipment at Los Alamos and Savannah River. The difference in planned capacity between the two sites is mainly due to more equipment at some stages of the production process at Savannah River. The current pit production process is shown in figure 2, and photos of the process are shown in figure 3.

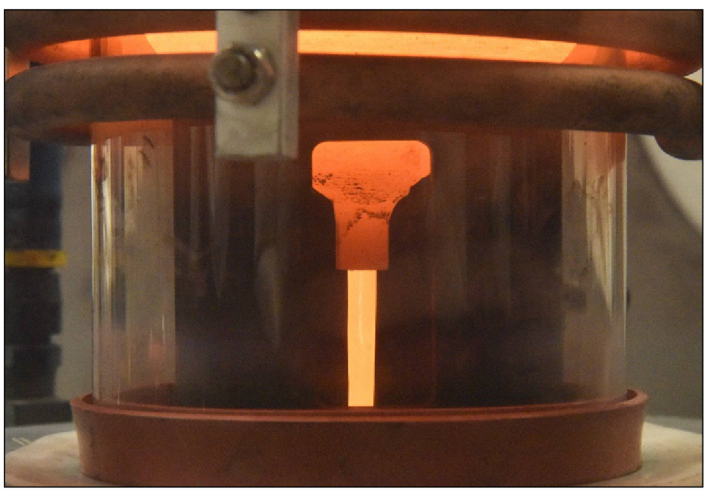
[20]For the purposes of this report, we refer to analytical chemistry and materials characterization, also known as AC/MC, as "plutonium analysis."

Figure 2: Plutonium Pit Production Flow Chart



Source: GAO adaptation of National Nuclear Security Administration graphic. | GAO-23-104661

Figure 3: Plutonium Pit Production Process Photos



Plutonium casting

Inspecting and weighing plutonium metal sample

Source: Los Alamos National Laboratory. | GAO-23-104661

History of Plutonium Pit Production in the U.S.

Historically, the Rocky Flats Plant outside of Denver, Colorado, manufactured plutonium pits on a large scale during the Cold War. Rocky Flats was capable of producing over 1,000 war reserve pits per year, as well as other non-nuclear pit components. In 1989, pit production ceased at Rocky Flats due to environmental and regulatory concerns.[21] DOE decided in 1996 to re-establish a limited production capacity in one of its existing plutonium research facilities—PF-4—at Los Alamos.[22]

Los Alamos produced its first war reserve pits in 2007 and was capable of manufacturing up to 10 war reserve pits per year through 2012, after which it ceased pit production operations because it completed production of the pits needed at the time. During this time, NNSA transferred most non-plutonium pit component production to its Kansas City Plant, now called the Kansas City National Security Campus, in Missouri.

Over the past two decades, NNSA and DOE developed several proposals—none of which came to fruition—to establish more robust pit production and related activities than have existed since the closure of Rocky Flats. These included a 2002 proposal for the Modern Pit Facility, a 2005 proposal to build a large plutonium analysis facility, a 2005 proposal for a Consolidated Nuclear Production Center, and a 2014 proposal for modular plutonium facilities.[23](See appendix II for a description of these proposed facilities.)

While NNSA did not ultimately pursue the above proposals, NNSA has invested over $5 billion over the past two decades to modernize and sustain plutonium operations, primarily in PF-4 and Technical Area 55, the portion of Los Alamos where plutonium facilities and operations are located. These investments were driven by wide-ranging operational and safety deficiencies in PF-4 including operational limitations in analytical chemistry, transuranic waste processing and storage, physical floor

[21]The Rocky Flats Plant was closed in 1989 as the result of a raid by the Federal Bureau of Investigation investigating safety and environmental violations. At the time, Rocky Flats was manufacturing pits for the W88 warhead to be carried by Trident II submarine-launched ballistic missiles. DOE considered restarting operations at Rocky Flats to finish W88 pit production, but ultimately chose not to. In 2007, DOE transferred administration of a large portion of the remediated Rocky Flats site to the Department of the Interior as a national wildlife refuge.

[22]Los Alamos produced the first plutonium pits in 1945, during the Manhattan Project. Since the end of World War II, it has done limited pit production for research purposes and, from 2007 to 2011, to replace the pits in 31 W88 warheads to be carried on submarine-launched missiles.

[23]The Consolidated Nuclear Production Center was a Secretary of Energy Advisory Board proposal. DOE discontinued this board shortly after it made its proposal for the consolidated production facility. DOE re-established it in October 2021.

space, and outmoded safety systems as recognized by NNSA and the Defense Nuclear Facilities Safety Board (Safety Board).[24] In particular, floor space is a major limiting factor due to the large number of plutonium activities that occur at PF-4 in addition to pit production.[25] These activities include plutonium science, pit surveillance, and heat source production for space missions supported by the National Aeronautics and Space Administration (NASA).[26] See appendix III for further descriptions of these other plutonium missions at Los Alamos.

The over $5 billion invested in plutonium modernization includes approximately $1.9 billion in capital acquisition projects at Los Alamos that have upgraded safety systems and security infrastructure, as well as completed portions of the Chemistry and Metallurgy Research Replacement project to modernize Los Alamos's plutonium analysis capabilities.[27]

In addition to the capital acquisition projects, NNSA's various pit production activities received $3.6 billion in funding in fiscal years 2005 through 2020 (an average of $226 million a year), according to DOE

[24]Established by statute in 1988, the Defense Nuclear Facilities Safety Board is an independent establishment in the executive branch that has broad oversight responsibilities regarding the Department of Energy's defense nuclear facilities. The Safety Board has provided independent analysis, advice, and recommendations to the Secretary of Energy regarding the adequacy of public health and safety protections at these facilities. GAO, *Nuclear Safety: DOE and the Safety Board Should Collaborate to Develop a Written Agreement to Enhance Oversight*, GAO-21-141 (Washington, D.C.: Oct. 29, 2020).

[25]PF-4 is the nation's only plutonium facility that is currently capable of conducting a full range of operations. A Lawrence Livermore National Laboratory (Livermore) facility known as Superblock used to be able to conduct many of these operations. Because of physical security concerns, however, Superblock is now only authorized to conduct small-scale plutonium operations. GAO, *Nuclear Security: Better Oversight Needed to Ensure That Security Improvements at Lawrence Livermore National Laboratory Are Fully Implemented and Sustained*, GAO-09-321 (Washington, D.C.: Mar. 16, 2009).

[26]NASA space missions utilize plutonium isotope Pu-238, which is far more radioactive and dangerous to work with than the Pu-239 used in plutonium pit production. A full list of plutonium activity at PF-4 is included in appendix III of this report.

[27]NNSA revised the Chemistry and Metallurgy Research Replacement project several times since its approval in 2005. Originally, the project included an office building and a large nuclear facility connected to PF-4 through an underground tunnel before NNSA revised the project into a now-constructed combination of a radiological laboratory and office building with four subprojects, two of which achieved completion in 2021.

budget justifications.[28] The pit production activities supported preventive maintenance and upgrades of key equipment for metal preparation and welding; provided the capability to manufacture parts and components for plutonium science and the stockpile; and continued the development of technology and manufacturing processes for different types of plutonium pits, among numerous other activities over the years. For additional details on these completed capital asset projects and programs, see appendix II.

In 2014, the joint DOD-DOE Nuclear Weapons Council affirmed to Congress that it needed NNSA to produce 50 to 80 pits per year.[29] The 2015 National Defense Authorization Act established a legal mandate to demonstrate a capability to produce no fewer than 80 war reserve pits annually in 2027.[30] This provision has since been amended to require NNSA to produce no fewer than 80 war reserve pits in 2030.[31] NNSA intends to meet this requirement by having capacity to produce 30 pits per year by 2026 at Los Alamos and having capacity to produce 50 pits per year at Savannah River by 2030. As discussed above, NNSA officials and independent researchers cast doubt on NNSA's ability to achieve these milestones.

Plutonium Modernization Program and Project Management

NNSA is organized into program offices, functional and mission-enabling offices, and field offices that are generally co-located at the sites that

[28]Funding totals were reported in DOE budget justifications dated from fiscal year 2007 through fiscal year 2021. Funds include those for the Pit Manufacturing and Certification Campaign in fiscal years 2005 through 2008, the Plutonium Capability Program in fiscal year 2009, and the Plutonium Sustainment program in fiscal years 2010 through 2020. The name was changed to Plutonium Modernization for fiscal year 2021.

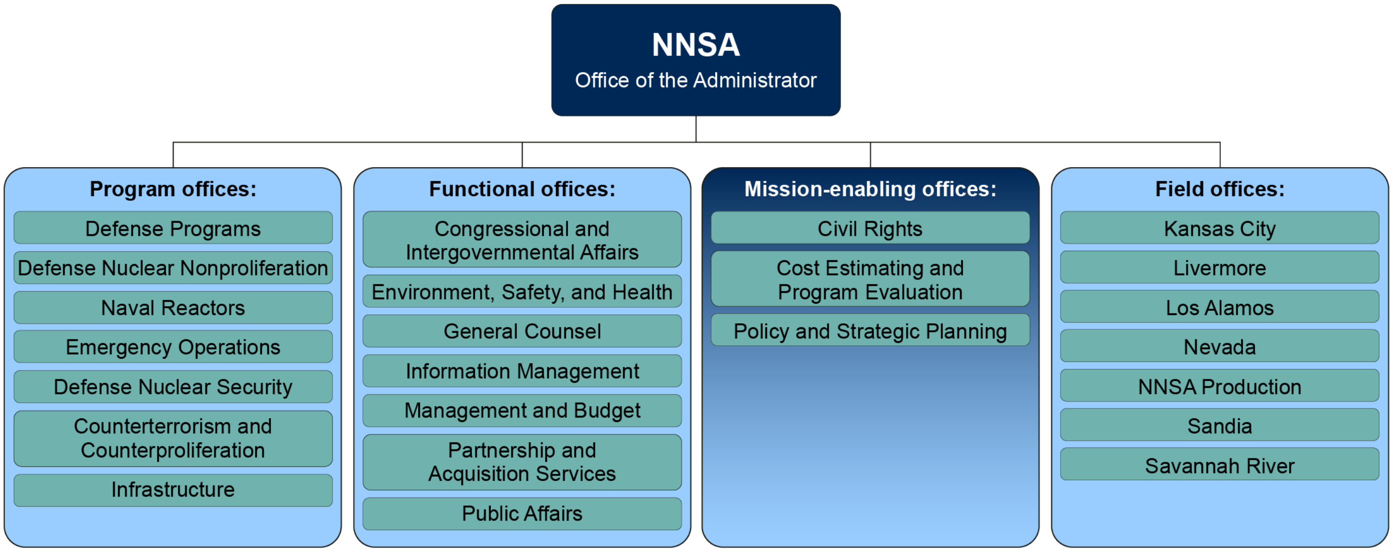
[29]The Nuclear Weapons Council is a joint DOD-DOE body that serves as the focal point for interagency activities to maintain and modernize the U.S. nuclear weapons stockpile.

[30]Carl Levin and Howard P. "Buck" McKeon National Defense Authorization Act for Fiscal Year 2015, Pub. L. No. 113-291, § 3112(b)(1), 128 STAT. 3292, 3886 (codified as amended at 50 U.S.C. § 2538a).

[31]This provision also includes interim production requirements of no fewer than 10 war reserve pits during 2024, no fewer than 20 war reserve pits during 2025, and no fewer than 30 war reserve pits during 2026.

comprise the nuclear security enterprise (see fig. 4).[32] Most of NNSA's weapons mission is executed at eight of these sites.[33] The majority of these eight sites are involved in the effort to establish a pit production capability.

Figure 4: NNSA's Organizational Structure as of July 2022



Source: GAO analysis of NNSA information. | GAO-23-104661

Many NNSA missions require the involvement of multiple program, field, and functional offices. Two NNSA offices—the Office of Defense Programs and the Office of Infrastructure—have primary responsibility for NNSA's pit production capability. Several other offices also support the pit

[32]Program offices are responsible for mission-related activities and integrating these activities across the multiple sites performing the work. Functional offices provide budget, legal, information technology, and other support to program and field offices. Mission-enabling offices are situated within the Office of the Administrator. These offices directly support the NNSA Administrator and provide mission-enabling support to the rest of the offices responsible for the agency's mission. Field offices, co-located at the sites, oversee the day-to-day activities of the contractors as well as mission support functions, such as safety.

[33]These sites include: Los Alamos in New Mexico, Savannah River in South Carolina, Livermore in California, Kansas City National Security Campus (Kansas City) in Missouri, Nevada National Security Site (Nevada) in Nevada, Y-12 National Security Complex in Tennessee, Sandia National Laboratories in New Mexico and other locations, and the Pantex Plant (Pantex) in Texas.

production effort, each applying its own management framework to the programs and projects for which it is responsible.

Office of Defense Programs

The Office of Defense Programs established the Plutonium Modernization program in fiscal year 2020. According to NNSA, the program's goal is to provide a pit production capability at reliable capacities to "ensure that the United States' nuclear deterrent is modern, robust, flexible, resilient, ready and appropriately tailored."[34] The program manages and provides funding to NNSA sites to support producing 80 pits a year.

NNSA manages programs, including the Plutonium Modernization program, under the agency's program management policy,[35] which provides specific requirements for conducting program management. NNSA's Office of Defense Programs has issued further direction, the *Program Execution Instruction*, to implement DOE and NNSA policies for managing its programs. As a program within the Office of Defense Programs, the Plutonium Modernization program is subject to this instruction.

The *Program Execution Instruction* establishes four program management categories and implementation requirements for each category.[36] Factors that impact which category a program or activity is managed under include external commitments, increased emphasis on meeting cost and schedule deadlines, frequency of interface with external stakeholders and partners, and the complexity and risk associated with the program.

[34]The Plutonium Program Office (NA-191) is a sub office within NNSA's Office of Defense Programs' Production Modernization Office (NA-19).

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

[36]The program management categories, from most rigorous to least, are Capital Acquisition Management, Enhanced Management A, Enhanced Management B, and Standard Management. The Plutonium Modernization program is currently managed as an Enhanced Management B program.

Office of Acquisition and Project Management and Office of Infrastructure

Until its reorganization in July 2022, NNSA's Office of Acquisition and Project Management was responsible for managing construction projects at Los Alamos and Savannah River that are considered capital asset acquisitions, under the direction of a federal project director. The Office of Acquisition and Project Management was responsible for managing the project execution, developing and administering the acquisition strategy, and completing procurements to meet the mission requirements established by the Office of Defense Programs. This was done primarily through Acquisition and Project Management Offices at the relevant sites, which were responsible for all functions necessary to deliver the project in accordance with an approved performance management baseline. These offices included certified federal project directors, responsible for large capital asset projects and who are members of the Senior Executive Service. NNSA reorganized the Office of Acquisition and Project Management in July 2022, and mostly separated its functions into two newly-established offices. NNSA moved its project management function into the Office of Infrastructure, which has these and additional responsibilities.[37]

For capital asset projects with a total project cost greater than $50 million, such as the SRPPF, NNSA is required to manage the construction in accordance with DOE Order 413.3B.[38] This order requires capital asset projects to go through five management reviews and approvals, called Critical Decisions (CD), as the projects move from planning and design to construction and operation (see figure 5).

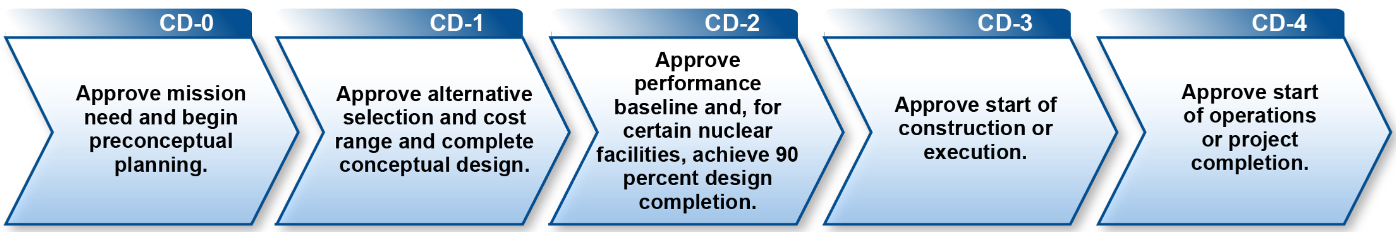
In November 2015, NNSA approved its statement of mission need for providing new plutonium production capabilities, the approval of which marks the end of the first phase—pre-conceptual planning (CD-0)—of its capital asset acquisition process. DOE's Order 413.3B also requires capital asset acquisition projects to follow certain best practices for cost

[37]The Office of Infrastructure also manages other aspects of NNSA's infrastructure beyond capital asset acquisitions, including recapitalization and maintenance projects. During the July 2022 reorganization, NNSA established the Office of Partnership and Acquisition Services to focus on acquisition management, including for the contracts to manage and operate its sites.

[38]Department of Energy, *Program and Project Management for the Acquisition of Capital Assets,* DOE Order 413.3B (Washington, D.C.: Jan 12, 2021).

and schedule estimating and monitoring that are included in our *Schedule Assessment* and *Cost Estimating and Assessment* guides.[39]

Figure 5: Summary of the Department of Energy's (DOE) Critical Decision (CD) Phases and Milestones



Source: GAO analysis of DOE Order 413.3B. | GAO-23-104661

Other Supporting NNSA and DOE Offices

Additionally, NNSA's Offices of Defense Nuclear Security, Secure Transportation, and others support various parts of the plutonium modernization mission. This includes managing security at sites and transporting nuclear material and components between sites. DOE's Office of Environmental Management also plays a key role in waste disposal. Finally, NNSA's Office of Cost Estimating and Program Evaluation provides independent assessment to the NNSA Administrator of project cost estimates, among other things.

GAO Best Practices for Estimating Schedules and Costs of Programs

GAO has published schedule development and cost estimating best practices in our *Schedule Assessment Guide* and *Cost Estimating and Assessment Guide* applicable across the government.[40] While NNSA programs are not required to adhere to these best practices, NNSA's *Program Management Policy* states that programs must consider the use

[39]GAO, *Schedule Assessment Guide: Best Practices for Project Schedules*, GAO-16-89G (Washington, D.C.: Dec. 22, 2015) and GAO, *Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Program Costs*, GAO-20-195G (Washington, D.C.: Mar. 12, 2020).

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

of GAO best practices as they develop their program schedules and cost estimates.[41]

The schedule and cost estimating guides and our previous reporting highlight the importance of outlining the scope, schedule, and cost of all programs.[42] We have reported that even at an early stage in the program, having preliminary cost estimates and a schedule are important. Our cost estimating guide notes that risk-adjusted estimates are especially important early in a program, when less is known about requirements and the opportunity for change (and cost growth) is greater. As more knowledge is gained, programs can retire some risk and reduce the potential for unexpected cost and schedule growth. Program and project management tools highlighted by the guides include:

- **Work breakdown structure.** This is a hierarchical structure that captures the complete scope of work and divides a program's end product into smaller elements suitable for management control.
- **Integrated master schedule (IMS).** This integrates a complete scope of work reflected in the work breakdown structure, the resources necessary to accomplish that work, and the associated budget for a program, which may include capital asset projects. The schedule can also show when major events are expected, as well as the completion dates for all activities leading up to these events. This can help managers determine if the program's parameters are realistic and achievable.
- **Life cycle cost estimate**. This is an exhaustive and structured accounting of all resources and associated cost elements required to develop and sustain a particular program. It requires a work breakdown structure that captures a complete scope of work. A life cycle cost estimate can be thought of as a "cradle to grave" approach to managing a program throughout its useful life. This entails identifying all cost elements that pertain to the program, from initial

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

[42]For examples of previous reports, see GAO, *Actions Needed to Improve Management of NNSA's Lithium Activities*, GAO-21-244 (Washington, D.C.: Aug. 12, 2021); 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 *Project and Program Management: DOE Needs to Revise Requirements and Guidance for Cost Estimating and Related Reviews*, GAO-15-29 (Washington, D.C.: Nov. 25, 2014).

concept all the way through operations, support, and the end of the program. A life cycle cost estimate encompasses all past (or sunk), present, and future costs for every aspect of the program, regardless of funding source.

GAO's *Schedule Assessment Guide* compiles best practices corresponding to the characteristics of high-quality and reliable schedules. A high-quality, reliable schedule has four characteristics: it is comprehensive, well-constructed, credible, and controlled.[43] If any of the four characteristics are assessed as being not met, minimally met, or partially met, then the schedule estimate does not fully reflect the characteristics of a high-quality schedule and cannot be considered reliable.

According to the *Schedule Assessment Guide*, a reliable schedule is a fundamental management tool that can help government programs use public funds effectively by specifying when work will be performed in the future and measuring program performance against an approved plan. Moreover, a reliable schedule can show when major events are expected as well as the completion dates for all activities leading up to them, which can help determine if the program's parameters are realistic and achievable. Additionally, a reliable schedule can facilitate an analysis of how change affects the program.

Similarly, GAO's *Cost Estimating and Assessment Guide* compiles a number of best practices to form the basis of effective program cost estimating. A reliable cost estimate is one that is comprehensive, well-documented, accurate, and credible.[44]

According to the *Cost Estimating and Assessment Guide*, a reliable cost estimate is critical for government programs. Having a realistic estimate of projected costs makes for effective resource allocation and increases the probability of a program's success. According to the guide, to build an accurate life cycle cost estimate, program officials need to establish a full scope of work, represented by a complete work breakdown structure, and an integrated schedule of all program activities.

[43]GAO-16-89G.

[44]GAO-20-195G.

NNSA's Plutonium Pit Production Scope of Work Includes Dozens of Programs, Projects, and Other Activities Managed by Multiple NNSA Offices at Multiple Sites

NNSA's plans to establish an 80-plutonium-pit-per-year production capability rely on the successful completion of a broad scope of work that includes a combination of program and project activities. Plans to produce 30 pits per year at Los Alamos rely on a broad range of program activities, five large capital asset projects, and a variety of other projects. Plans to produce 50 pits per year at Savannah River rely primarily on one large capital asset project—SRPPF—and some program activities, such as the hiring of personnel. Thus, the efforts at Los Alamos and Savannah River represent different approaches in infrastructure planning and development for establishing similar pit production objectives. Several other NNSA and DOE sites also play important supporting roles. Multiple NNSA offices manage these activities under different management requirements and coordinate with each other through inter-office teams.

Establishing the Los Alamos Pit Production Capability Relies on Multiple Program and Project Activities

NNSA's plans for producing 30 pits per year at Los Alamos involve multiple program and project activities that can broadly be grouped into (1) the Plutonium Modernization program, (2) large capital asset projects, (3) existing infrastructure facility maintenance and recapitalization projects, (4) new supporting office building projects, and (5) program activities managed by offices other than Plutonium Modernization.

Los Alamos's Plutonium Modernization Program Activities

NNSA plans to conduct a significant amount of work at Los Alamos through program activities that are managed by the Plutonium Modernization program in the Office of Defense Programs. The Plutonium Modernization program's role is to both manage some of the pit modernization work directly, and also to integrate all plutonium pit production activities at Los Alamos and across the enterprise.[45]

The scope of work at Los Alamos that is directly managed by the Plutonium Modernization program involves a range of activities necessary to achieve the capability to reliably produce 10 pits per year and to provide ongoing operational capabilities for Los Alamos's overall pit production mission. Specifically:

- **Designing and developing.** This includes the design of a new pit production line contained in gloveboxes, which will require the reconfiguration of PF-4.
- **Procuring and installing equipment.** This includes program activities to cover the equipment installations in PF-4 needed to reliably produce 10 pits per year, such as gloveboxes and equipment for melting, casting, and machining processes. Equipment needed for the capability to produce from 10 to 30 pits per year is not a program activity, but rather a part of a separate capital asset acquisition project.
- **Hiring and training staff.** This includes efforts related to hiring, retaining, and developing over 1,600 new full-time equivalents (FTEs) that Los Alamos has determined it needs to support the buildup of activities at its pit production facilities.[46]
- **Qualifying pit manufacturing processes.** This includes various activities to ensure the pit production manufacturing processes are of sufficient quality to consistently produce war reserve pits and includes production of five development pits. For example, as part of plutonium analysis, Los Alamos tests plutonium samples for various properties, such as tensile strength and surface chemistry. NNSA and its contractors then use these findings to qualify manufacturing processes and to troubleshoot production problems.
- **Certifying the quality of manufactured pits.** This includes various activities to help design and certify pits. Production laboratories use thermal and mechanical testing capabilities to evaluate newly manufactured pits. Further, pits are certified using additional analysis

[45]The Plutonium Modernization program is managed by NNSA's Plutonium Program Office within the Office of Defense Programs.

[46]FTEs reflect the total number of regular hours (i.e., not including overtime or holiday hours) worked by employees divided by the number of compensable hours applicable to each fiscal year.

and testing to ensure that the product meets war reserve specifications.

Large Capital Asset Projects at Los Alamos

In a second group of efforts, NNSA plans to construct five large capital asset projects—which are construction projects with estimated costs over $100 million. Each is to be managed by the Office of Infrastructure. Most are located in Technical Area 55, shown in figure 6 below.

Figure 6:Technical Area 55 at Los Alamos National Laboratory
This photo shows various buildings at Los Alamos National Laboratory in Technical Area 55, which encompasses plutonium activities.

Source: Los Alamos National Laboratory. | GAO-23-104661

These five large capital asset projects support the pit production capability by

- reconfiguring space in PF-4 and installing new equipment needed for certain pit manufacturing and support activities;
- expanding the Radiological Laboratory Utility Office Building's (RLUOB) capability to conduct plutonium analysis;
- building the necessary auxiliary infrastructure for staff accessibility to Technical Area 55;

- processing newly created transuranic waste; and
- improving worker conditions and environmental safety.

The largest project is the Los Alamos Plutonium Pit Production Project (LAP4). The remaining four capital asset projects at Los Alamos are necessary for plutonium pit production operations, but will also provide capabilities for Los Alamos's other plutonium missions. The details of the five ongoing projects are discussed in table 1.[47]

[47]In this report, we discuss the two Chemistry and Metallurgy Research Replacement subprojects separately in order to differentiate them from other completed Chemistry and Metallurgy Research Replacement subprojects. In addition, NNSA's Director of its Acquisition and Project Management Office noted that these subprojects are distinct, severable, deliverable efforts with their own funding streams and federal project directors. See appendix III for a full description of the Chemistry and Metallurgy Research Replacement project.

Table 1: Ongoing Plutonium Pit-Production-Related Capital Asset Projects at Los Alamos National Laboratory, as of August 2022

Project	Summary of general purpose	Most recent Critical Decision (CD) and date of decision	Anticipated construction completion date (CD-4 milestone achievement)
Los Alamos Plutonium Pit Production Project (LAP4)	LAP4 is the most expensive pit-production-related capital asset project ongoing at Los Alamos National Laboratory (Los Alamos), with scheduled completion in 2028, according to the fiscal year 2023 project data sheet. This project provides the critical equipment procurement, installation, and infrastructure upgrades necessary to enable the manufacturing of 30 pits per year within Plutonium Facility 4 (PF-4). It will add processing equipment (such as new lathes and mills), a new training center, and another secure entry point for worker access to Technical Area 55. The project repurposes spaces within PF-4, including removing existing equipment and support systems as necessary to accommodate the new pit production equipment. The scope includes design, construction, and installation of processing equipment, support systems, utilities infrastructure, physical infrastructure, and security features to reach the capability to produce 30 pits per year.	CD-1 (April 2021)	Fiscal year 2028
Chemistry and Metallurgy Research Replacement Project PF-4 Equipment Installation Phase 2 (PEI2)	This subproject continues the work of a previous Chemistry and Metallurgy Research Replacement equipment installation (known as PEI1) to maximize space in PF-4 and to establish an enduring plutonium analysis capability. 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. These plutonium analysis capabilities will also support various National Nuclear Security Administration (NNSA) plutonium missions beyond pit production.	CD-1 (August 2014)	Fiscal year 2026 to 2029
Chemistry and Metallurgy Research Replacement Project Radiological Laboratory Utility Office Building (RLUOB) Hazard Category 3	This subproject will reconfigure and maximize space for more intensive plutonium analysis capabilities within the RLUOB facility. Construction of the facility was completed in 2010 and it was outfitted with equipment as part of previous subprojects. The project will maximize use of RLUOB 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 NNSA nuclear hazard category. Upgrading RLUOB from a radiological facility to a Hazard Category 3a nuclear facility would allow for the building to hold 400 grams of Pu-239 equivalent, up from a prior limit of 38.6 grams. These plutonium analysis capabilities and the expanded material limit will also support various NNSA plutonium missions beyond pit production.	CD-1 (August 2014)	Fiscal year 2026 to 2028
Transuranic Liquid Waste (TLW) Treatment Facility Upgrade Project	Pit production and related activities will increase the amount of transuranic waste produced at Los Alamos. The TLW project will process this waste and seeks to enhance the safety of transuranic waste disposition by replacing an outdated facility. The purpose of this project is to construct a new, more robust structure for temporary storage and treatment of transuranic liquid waste.	CD-2/3 (January 2022)	Fiscal year 2027

Technical Area 55 Reinvestment Project, Phase III (TRP III)	This project addresses a recognized safety vulnerability in Technical Area 55, and PF-4 within it, by replacing an obsolete fire detection system with a new one designed to be compliant with the Americans with Disabilities Act and National Fire Protection Association codes. This project replaces, modifies, and upgrades the existing fire alarm system in the technical area. More specifically, it replaces the existing supervisory panel, adds area-wide fire detection throughout PF-4, installs components designed to be compliant with current fire protection standards, and separates the fire alarm functions of the nuclear facility and non-nuclear facilities with dedicated fire alarm panels for each.	CD-1/2/3 (May 2021)	Fiscal year 2027

Source: GAO analysis of NNSA data. | GAO-23-104661

Note: Hazard Categories are based on the consequences of unmitigated release of radioactive and chemical materials. In plutonium's case, hazard categories are determined by the amount of plutonium a building will hold. Each category represents the potential for certain consequences in the event of an accident. Contractors must perform work in accordance with the DOE-approved safety basis for such a building.

Further, as discussed above, the 30-pit-per-year capability at Los Alamos also relies on a significant number of previously completed capital asset projects, such as several Chemistry and Metallurgy Research Replacement subprojects. While the enhanced plutonium analysis capabilities resulting from Chemistry and Metallurgy Research Replacement subprojects, both completed and ongoing, also support Los Alamos's other plutonium missions, a 30-pit-per-year production capability cannot be achieved without full completion of the Chemistry and Metallurgy Research Replacement project.

Maintenance and Recapitalization Projects at Los Alamos

A third group of efforts includes smaller facility maintenance and recapitalization projects proposed for existing infrastructure in Technical Area 55, the PF-4 facility, RLUOB, nuclear waste facilities, and supporting buildings that are necessary for pit production and the other plutonium missions at Los Alamos. Now managed by the Office of Infrastructure, recapitalization projects are generally estimated to cost less than $25 million and to take under 5 years to complete.[48]

These projects, according to NNSA, are essential for continued operations of all of NNSA's plutonium missions. They cover a wide range

[48]In a July 2022 reorganization, NNSA abolished the Office of Safety, Infrastructure, and Operations (NA-50) and moved its functions related to site maintenance and recapitalization efforts to the new Office of Infrastructure. This new Office of Infrastructure consolidates responsibility for all of NNSA's infrastructure activities, including managing capital asset acquisitions previously managed by the Office of Acquisition and Project Management.

of critical needs for plutonium operations, such as seismic upgrades, a water loop replacement, and a boiler system upgrade, among others. These projects are intended to make facilities at Los Alamos reliably available for programmatic work, address pressing Safety Board concerns, and meet State of New Mexico Environment Department requirements.[49] See appendix IV for a description of these projects from NNSA's fiscal year 2023 budget justification.

New Supporting Office Buildings Projects at Los Alamos

Further, in its fiscal year 2023 budget justification, NNSA noted plans for a fourth type of effort—constructing several new office and support buildings in the next 5 years to provide capacity for the 1,600 FTEs it plans to hire. Managed by the Office of Infrastructure, these projects have total estimated costs of $50 million or below and therefore are not required to be managed under the DOE order governing capital asset projects. Also, unlike the unique nuclear construction under the large capital asset projects, these are to be standard office buildings that, according to NNSA, are lower risk due to their commercial-like nature and will generally follow project management practices developed for smaller, less risky construction projects. According to the fiscal year 2023 budget justification, NNSA plans to begin work on a Plutonium Modernization support building in fiscal year 2023. In addition, it plans to begin construction of four additional buildings at Los Alamos from fiscal year 2024 through 2027. These buildings will support the pit production capability and other plutonium missions.

The building for which funding in fiscal year 2023 is requested, the Plutonium Modernization Operations and Waste Management Building, is planned to be a two-story office facility in Technical Area 63.[50] It is planned to house conference rooms and 300 workstations to enable Plutonium Modernization program operations, including transuranic and non-transuranic waste management, packaging, transportation, and support; and nuclear material movement and storage. This building will

[49]The Safety Board has expressed concern over a number of safety controls at PF-4, including fire suppression and confinement ventilation systems, and how those systems may perform in the event of an earthquake. See Defense Nuclear Facilities Safety Board Letter to Secretary Perry on *Safety Basis for the Plutonium Facility at Los Alamos National Laboratory*, Nov. 15, 2019. The New Mexico Environment Department permits hazardous waste disposal and conducts environmental monitoring at Los Alamos.

[50]According to NNSA officials, the name of this building will change to the Parajito Corridor Office Complex.

also support other plutonium missions, such as stockpile surveillance, surplus plutonium disposition, and Pu-238 production. The other planned future support building projects include a Plutonium Engineering Support Building and a Plutonium Program Accounting Building.

Program Activities at Los Alamos Managed by Other NNSA Offices

Finally, in addition to the program activities that are directly managed and funded under the Plutonium Modernization program, other NNSA offices and programs manage some of the program scope for establishing the pit production capability at Los Alamos. These include:

- **Office of Defense Nuclear Security (NA-70).** NA-70 maintains security; oversees physical, information, and personnel security measures; advises on security aspects of capital asset projects; oversees hiring of additional heavily armed protective forces; and administers security clearances.
- **Office of Environment, Safety, and Health (NA-ESH).** NA-ESH manages handling, staging, and certifying of waste for offsite shipment and ultimate disposal.[51] The Office of Environment, Safety, and Health also manages the certification of packages of non-waste pit production materials and the pits themselves for offsite transport.
- **Office of Secure Transportation (NA-15).** NA-15 provides secure transportation of plutonium, pits, other special nuclear material, and nuclear weapons between NNSA, DOE and DOD sites.
- **DOE Office of Environmental Management.** NNSA must coordinate waste efforts with Office of Environmental Management legacy waste activities and adhere to Environmental Management waste acceptance criteria for transuranic waste handling, shipping, and storage, as well as for ultimate disposal.[52] The Office of Environmental Management, NNSA, and their Los Alamos contractors coordinate with Environmental Management's shipping contractor to transport transuranic waste from Los Alamos to WIPP.

[51]Prior to the July 2022 NNSA reorganization, these activities were under the Office of Safety, Infrastructure, and Operations (NA-50).

[52]GAO has ongoing work reviewing the Office of Environmental Management's legacy waste efforts at Los Alamos.

These program activities, while necessary for pit production, also support Los Alamos's other plutonium missions. See appendix III for additional information on other plutonium missions at Los Alamos.

Establishing the Savannah River Pit Production Capability Relies on One Major Project and Program Activities

Most of NNSA's scope of work to establish a pit production capability at Savannah River currently relies on a single large capital asset project called the SRPPF, managed by the Office of Infrastructure. This contrasts with the multiple project and program activities at Los Alamos. See appendix V for a comparison of pit production infrastructure development at Savannah River and Los Alamos. Savannah River does not have an existing pit production capability, and NNSA's current plans are for SRPPF to include all required capabilities necessary to establish an effective, responsive, and resilient pit production capability at the site. In addition to constructing the main pit manufacturing building and equipment, the SRPPF project includes collocation of plutonium analysis capabilities, production support capabilities, security infrastructure, and other support facilities like waste handling, training, and office space. Program activities at Savannah River will focus on operations; qualification and certification of the production process; and hiring, staffing, and training.

SRPPF

The SRPPF repurposes the site and main building of the cancelled Mixed Oxide Fuel Fabrication Facility (MFFF), also known as the MOX project.[53] The proposed SRPPF is to be a refurbishment of the existing MFFF building, an over-400,000-square-foot reinforced concrete structure. According to project documents, no major structural renovations are expected and the current layout of the MFFF will support the internal design expectations for the SRPPF, though annex buildings will be added. See figure 7 for a photo of the MFFF site and a rendering of SRPPF.

[53]See GAO, *Project Management: DOE and NNSA Should Improve Their Lessons-Learned Process for Capital Asset Projects,* GAO-19-25 (Washington, D.C.: Dec. 21, 2018) for information on the MFFF and the MOX project.

Figure 7: Site of Savannah River Plutonium Processing Facility, South Carolina
These photos show various buildings on the site of the incomplete Mixed Oxide Fuel Fabrication Facility (top left) that the Savannah River Plutonium Processing Facility (SRPPF) plans to repurpose (bottom right). Other abbreviations in bottom right: TRU = transuranic; MLLW = Mixed Low Level Waste; PIDAS = Perimeter Intrusion Detection and Assessment System.

Source: Savannah River Site. | GAO-23-104661

The refurbishment calls for materials and equipment that had been installed for MOX, most of which are not reusable for pit manufacturing, to be dismantled and removed. Further, according to project documents, NNSA plans to locate any new facilities on land that had been previously disturbed by MFFF construction. Therefore, some of the earliest SRPPF activities are to prepare the site and dispose of the remaining equipment and materials from MFFF. In addition, according to NNSA officials, security and nuclear safety upgrades to the site need to be completed before some construction and installation of sensitive pit manufacturing equipment can begin. They must also be completed before the introduction of special nuclear material.

At CD-1, the project design phase reached in June 2021, NNSA planned to manage the SRPPF capital asset project in five subprojects. As of August 2022, NNSA was evaluating the best way to sequence and organize the work as it revised its project management strategy and its plan for achieving CD-2. NNSA currently plans to reach CD-2 no later than fiscal year 2025. According to NNSA officials, the number of subprojects may change, but the overall scope of the effort will remain the same. The scope of the SRPPF project includes:

1. **Process Buildings.** This subproject includes preparing the main process building, which is the converted shell of MFFF Building 226-F, and entails the preparation and modification of the building and installation of process equipment and infrastructure. In addition to all pit manufacturing processes and equipment, this subproject will include plutonium analysis laboratories. Annexes are planned to be built adjacent to the existing building. This subproject also includes building process support facilities, such as chemical storage; a chemical waste pad; electrical supply and distribution; diesel generators for emergency power; a sand filter; water tanks; and transuranic waste storage and loading facilities. In addition, procurement of long-lead process equipment, such as gloveboxes, and other long-lead equipment for security are included in this planned subproject.
2. **Utilities/Site/Infrastructure**. This planned subproject includes the installation of buried utilities, site grading, road construction, a buried waste stream line to an effluent treatment facility, and dismantlement and removal of selected existing structures.
3. **Administration Building.** This planned subproject includes construction of a Construction and Maintenance support building and related site work and utilities.
4. **Safeguards and Security.** This planned subproject includes construction or installation of entry control facilities; protective force rooms; a perimeter intrusion detection and assessment system; a security system; and central and secondary alarm stations.
5. **Training and Operations Center.** This planned subproject includes construction and modification of existing facilities into the High Fidelity Training and Operations Center and installation of equipment to support personnel training.

Plutonium Modernization Program Activities at Savannah River

Program activities will focus on two areas, according to NNSA documents—human capital and production capabilities. With respect to human capital, a SRPPF project document estimates that around 2,000 FTEs will need to be hired and trained several years prior to beginning operations. With regard to production capabilities, since Savannah River has never before produced pits, NNSA documents state that the Savannah River staff will adapt Los Alamos's pit production processes to SRPPF's configuration and learn the full pit production process. This includes manufacturing pits, qualifying the manufacturing process, and certifying the resulting pits as suitable for use in the nuclear weapons stockpile.

NNSA's 50-pit-per-year planning document states that "SRPPF will rely heavily on outside expertise from Los Alamos and Lawrence Livermore National Laboratory (Livermore), however it cannot practically depend solely on outside personnel for its detailed knowledge of pit manufacturing." Thus, Savannah River must develop operations, maintenance, and technical staff and develop on-site pit manufacturing knowledge as broadly as possible before SRPPF is operational in order to meet NNSA's "accelerated start-up schedule." In 2020, Savannah River began sending staff to Los Alamos to learn how to produce pits, which it plans to continue for the next decade. In addition, Savannah River officials stated that they hope to apply lessons-learned from Los Alamos when designing SRPPF to create process improvements and avoid some of the constraints and challenges Los Alamos faces in operating within the confines of PF-4 and its other existing facilities. The Plutonium Modernization program will also be initiating several small projects to purchase and install equipment in an existing Savannah River building to help develop and train the workforce prior to completion of the High Fidelity Training and Operations Center and SRPPF. Qualification and certification activities planned for Savannah River, already well underway at Los Alamos, will require coordination across the nuclear security enterprise, according to NNSA documents.

Additional Pit Production Work Scope is Being Carried Out at Other NNSA and Office of Environmental Management Sites

Pits will be produced at Los Alamos and SRPPF, but a fully functional pit production capability relies on additional programmatic and supporting activities at Livermore, Nevada, Kansas City, Pantex, and WIPP. Unless otherwise noted, this scope of work is funded through the Plutonium Modernization program. Other sites, as indicated in figure 8 below, include

- **Livermore.** As the design agency for the W87-1 warhead—the first warhead designed for newly produced pits since the Cold War—Livermore is responsible for qualifying the pit production process and certifying that the pits produced meet the intent of its design. Qualification and certification requires a variety of tests, such as production evaluations, engineering certification testing, physics certification testing, and the replacement of some equipment. The testing is led and overseen by Livermore personnel; however, some tests are conducted at Nevada and some are done at Los Alamos.
- **Nevada.** Specialized NNSA facilities—such as a facility that provides safe structures for dynamic experiments using high explosives and subcritical quantities of special nuclear material, and a facility to evaluate material properties at high-shock pressures and temperatures—are located at Nevada and used primarily by Livermore and Los Alamos for pit qualification and certification activities.[54] The Nevada site supports the availability and operation of these facilities. Additionally, Nevada performs temporary storage (referred to by NNSA as staging) program activities that support the whole Plutonium Modernization program.
- **Kansas City.** Kansas City produces various non-nuclear components necessary for pit production, including components used to qualify and certify that non-nuclear components are of war reserve quality. These parts require a great deal of precision manufacturing to exacting specifications. Thus, Kansas City needs to prove it can make the parts within the specifications, and that it can do so consistently, according to NNSA contractors and officials. Since the parts are needed for pit assemblies, parts need to be completed ahead of the pits themselves. Kansas City planned to have qualified parts in 2022, allowing Livermore and Los Alamos to produce and qualify the first production unit (FPU) pit in fiscal year 2024.

[54]These facilities include the Device Assembly Facility and the Joint Actinide Shock Physics Experimental Research (JASPER) Facility. According to NNSA officials, these facilities have multiple funding sources in addition to the Plutonium Modernization program.

- **Pantex.** Pantex disassembles weapons and temporarily stores pits from retired weapons, the source of plutonium for new pits. Once new pits are produced, Pantex will stage finished pits and then assemble them into weapons.[55] According to NNSA officials, at the present time, pit production activity is limited at Pantex, but its activity will increase once war reserve production at Los Alamos begins.
- **WIPP**. WIPP is managed by DOE's Office of Environmental Management and serves as the nation's sole repository for disposal of defense-generated transuranic waste, to include waste from pit production activities. According to officials, prompt waste acceptance is particularly important for Los Alamos, which has a limited on-site storage capacity. If WIPP is delayed in accepting waste shipments from Los Alamos, pit production activity could be slowed or paused.

  WIPP's ability to continue accepting waste beyond 2025 depends on the completion of several large capital asset projects and related regulatory approvals from the New Mexico Environment Department. Our previous work highlights challenges WIPP faces completing capital asset projects on time to expand the space available to store waste and the importance of improving planning for potential disruptions to WIPP operations.[56] In a March 2022 report, we found that DOE had not developed a corrective action plan to address identified root causes of cost increases and schedule delays for construction projects at WIPP.[57] Additionally, we found that DOE faces risks related to construction and regulatory delays for completing additional physical space at WIPP that is needed for the transuranic waste cleanup program. We recommended, among other things, that DOE update the WIPP risk register to include specific regulatory, construction, and other risks, together with adequate

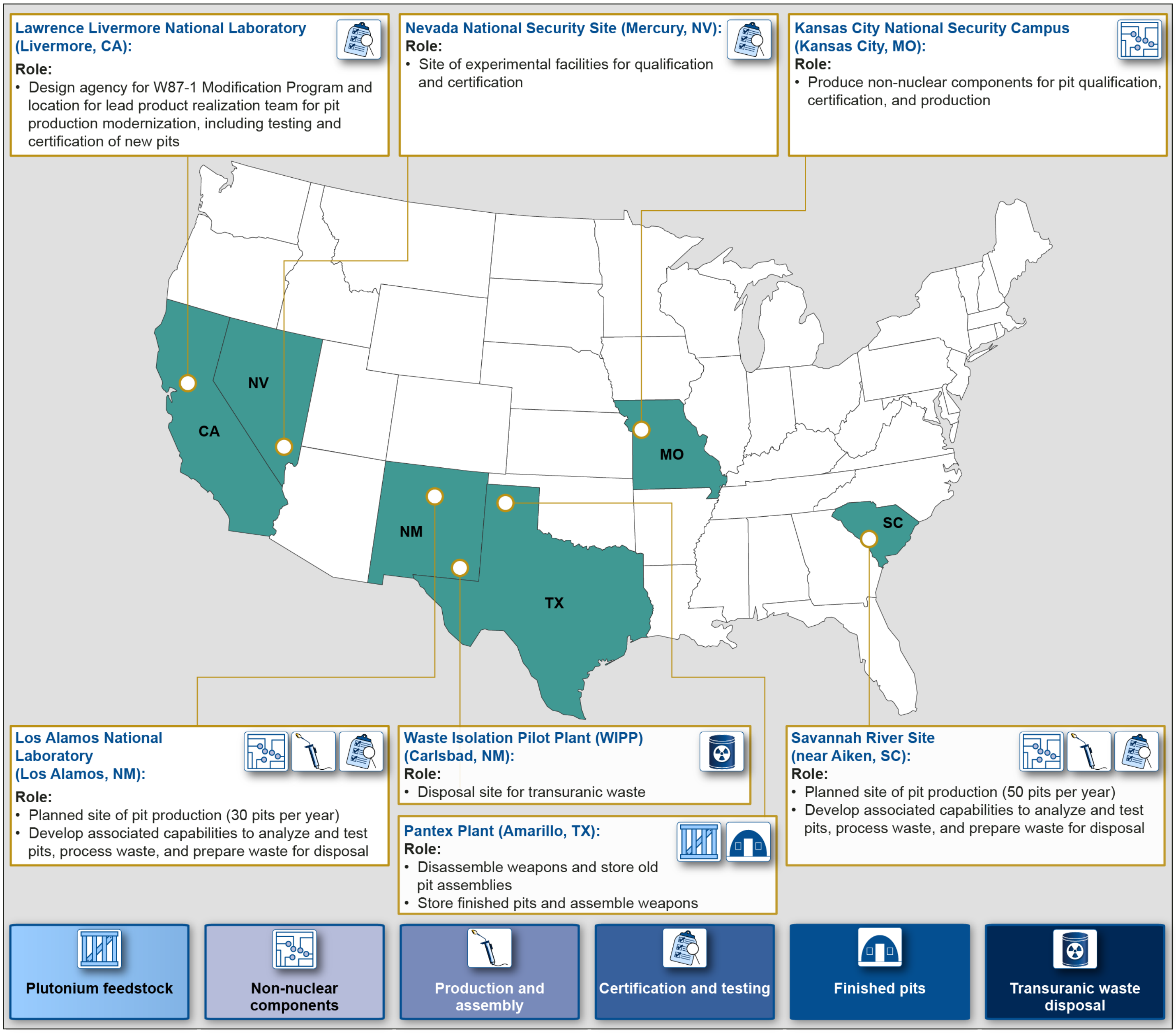
[55]This includes machining the pits' high explosives. For more information on NNSA's high explosives capabilities see GAO, *Nuclear Weapons: Additional Actions Could Help Improve Management of Activities Involving Explosive Materials*, GAO-19-449 (Washington, D.C.: June 17, 2019).

[56]GAO, *Nuclear Waste Disposal: Better Planning Needed to Avoid Potential Disruptions at Waste Isolation Pilot Plant,* GAO-21-48 (Washington, D.C.: Nov. 19, 2020). We recommended that the Assistant Secretary for Environmental Management ensure that (1) the WIPP IMS adheres to GAO best practices to avoid production schedule delays and (2) a plan is in place to mitigate potential risks to DOE's transuranic waste cleanup program posed by potential interruptions to waste disposal operations at the facility. DOE has updated its WIPP IMS to address the areas that did not follow best practices. As of January 2022, DOE was developing a National TRU Program Recovery Planning Guide in response to the second recommendation.

[57]GAO, *Waste Isolation Pilot Plant: Construction Challenges Highlight the Need for DOE to Address Root Causes*, GAO-22-105057 (Washington, D.C.: Mar. 15, 2022).

mitigation strategies. According to DOE's comments on the report, DOE plans to update the WIPP Risk Register to include specific regulatory, construction, and other risks, as well as adequate mitigation strategies. DOE stated it anticipates the risk register will be updated by early 2023.

Figure 8: Roles of Department of Energy Sites in Plutonium Pit Production



Source: GAO analysis of National Nuclear Security Administration information. | GAO-23-104661

NNSA's Pit Production Projects and Program Activities Are Managed under Different Directives and Coordinated by Multiple Teams

As shown in table 2, NNSA's overall scope of work to achieve an 80-pit-per-year capability is overseen by the Plutonium Modernization program, but projects and activities contributing to that scope of work are managed by several different offices within NNSA, each of which use different directives. To help align the diverse projects and activities and coordinate among the different management requirements that offices use, NNSA has established a Matrixed Execution Team and several other matrixed inter-office teams.

Table 2: Directives Used by Department of Energy (DOE) Offices for Activities to Support Achievement of Plutonium Pit Production Capability

Activity	Managing office	Directive
Thirty-pit-per-year production capability at Los Alamos National Laboratory		
Programmatic activities including pit design and development, equipment installation, and staff hiring	Office of Defense Programs – Plutonium Program Office	Defense Programs *Program Execution Instruction*
Qualification and certification activities	Office of Defense Programs – Plutonium Program Office	NNSA Supplemental Directive 452.3-2 *Phase 6.x Process*
Construction of the Chemistry and Metallurgy Research Replacement Project PF-4 Equipment Installation Phase 2 (PEI2) project	Office of Infrastructure (funding from Defense Programs' Plutonium Modernization program)[a]	DOE Order 413.3B *Program and Project Management for the Acquisition of Capital Assets*; NNSA Supplemental Directive 413.3 *Program and Project Management for the Acquisition of Capital Assets*
Construction of the Chemistry and Metallurgy Research Replacement Radiological Laboratory Utility Office Building Hazard Category 3 project	Office of Infrastructure (funding from Defense Programs' Plutonium Modernization program)[a]	DOE Order 413.3B; NNSA Supplemental Directive 413.3
Construction of Los Alamos Plutonium Pit Production Project (LAP4)	Office of Infrastructure (funding from Defense Programs' Plutonium Modernization program)[a]	DOE Order 413.3B; NNSA Supplemental Directive 413.3
Construction of the Transuranic Liquid Waste Treatment Facility Upgrade Project (TLW)	Office of Infrastructure (funding from Defense Programs' Plutonium Modernization program)[a]	DOE Order 413.3B; NNSA Supplemental Directive 413.3
Construction of the Technical Area 55 Reinvestment Project, Phase III (TRP III)	Office of Infrastructure (funding from Defense Programs' Plutonium Modernization program)[a]	DOE Order 413.3B; NNSA Supplemental Directive 413.3
Maintenance and Recapitalization Projects at Los Alamos	Office of Infrastructure	NA-50 *Program Management Plan*; *NNSA Master Asset Plan*[b]

Activity		Managing office	Directive
	New Supporting Office Building Projects at Los Alamos	Office of Infrastructure	Enhanced Minor Construction – Commercial (EMC2) Pilot Guidance[c]
	Safeguards and Security program	Office of Defense Nuclear Security	DOE Order 470.4B *Safeguards and Security Program*
	Certification of packages used to transport plutonium between sites	Office of Environment, Safety, and Health[d]	DOE Order 461.1C *Packaging and Transportation for Offsite Shipment of Materials of National Security Interest*
	Transportation of plutonium between sites	Office of Defense Programs – Office of Secure Transportation	DOE Order 461.1C
	Waste handling (on-site)	Office of Environment, Safety, and Health[d]	Waste Isolation Pilot Plant waste acceptance criteria
	Waste disposal (off-site)	Office of Environmental Management	Waste Isolation Pilot Plant waste acceptance criteria
Fifty-pit-per-year pit production capability at Savannah River Site			
	Programmatic activities, such as hiring staff	Office of Defense Programs – Plutonium Program Office	Defense Programs *Program Execution Instruction*
	Qualification and certification activities	Office of Defense Programs – Plutonium Program Office	Phase 6.x Process
	Construction of Savannah River Plutonium Processing Facility (SRPPF), including process buildings, utilities infrastructure, site infrastructure, administration buildings, safeguards and security infrastructure, and a training and operations center.	Office of Infrastructure (funding from Defense Programs' Plutonium Modernization program)[a]	DOE Order 413.3B; NNSA Supplemental Directive 413.3
	Safeguards and Security program	Office of Defense Nuclear Security	DOE Order 470.4B
	Certification of packages used to transport plutonium between sites	Office of Environment, Safety, and Health[d]	DOE Order 461.1C
	Transportation of plutonium between sites	Office of Defense Programs – Office of Secure Transportation	DOE Order 461.1C
	Waste handling (on-site)	Office of Environment, Safety, and Health[d]	Waste Isolation Pilot Plant waste acceptance criteria
	Waste disposal (off-site)	Office of Environmental Management	Waste Isolation Pilot Plant waste acceptance criteria

Source: GAO analysis of NNSA Documents. | GAO-23-104661

Note: All offices discussed are part of DOE's National Nuclear Security Administration (NNSA) other than the Office of Environmental Management.

[a]Until the July 2022 NNSA reorganization this activity was managed by the Office of Acquisition and Project Management.

[b]NA-50 was the business unit code for NNSA's Office of Safety, Infrastructure, and Operations, which was reorganized in July 2022. Its project management functions were transferred to the new Office of Infrastructure, which is still using the NA-50 Program Management Plan to manage NNSA's recapitalization and maintenance portfolios.

[c]EMC2 is a pilot program developing project management guidance for capital asset acquisitions estimated to cost between $25 million and $50 million. DOE Order 413.3B applies to capital asset acquisitions estimated to cost more than $50 million.

[d]Until the July 2022 NNSA reorganization, this activity was managed by NNSA's Office of Safety, Infrastructure, and Operations.

While each office within NNSA and DOE follows different policies written specifically to manage the types of efforts for which they are responsible, the way these different requirements are applied is not always straightforward. For example, the Office of Defense Programs, managing its programs under its *Program Execution Instruction*, has designated the Plutonium Modernization program as Enhanced Management B.[58] This management category is generally subject to less formal and rigorous requirements than management categories for weapons modernization programs or capital asset acquisition.

However, several of the projects contributing to the pit production capability, and which are funded through the Plutonium Modernization program, are capital asset acquisitions with estimated costs above $100 million. These projects are managed under the rigorous project management standards in DOE Order 413.3B and NNSA's supplemental directive, standards that exceed the requirements for the Plutonium Modernization program itself. For example, each of the capital asset projects is managed by a certified federal project director, a member of the Senior Executive Service who monitors cost and schedule through a certified earned value management system and defined critical decision points.[59] Enhanced Management B programs are not required to have either. In an October 2020 report, the National Academies noted that the program manager for the Plutonium Modernization program lacked the authority to oversee the senior executives of other offices integrated in pit production activities.

Additionally, some efforts within the scope are managed by other offices under different directives. For example, the Office of Infrastructure is

[58]The *Program Execution Instruction* identifies four program management categories (in order of most rigorous to least): Capital Acquisition Management, Enhanced Management A, Enhanced Management B, and Standard Management. Other NNSA offices use other management guidance.

[59]Earned value management measures the value of work accomplished in a given period and compares it with the planned value of work scheduled for that period and with the actual cost of work accomplished. As a key management concept, earned value management provides improved oversight of projects. By using the metrics derived from these values to understand performance status and to estimate cost and time to complete, earned value management can alert managers to potential problems sooner than expenditures alone can. See GAO-20-195G.

managing construction of support building projects with estimated costs of less than $50 million under a pilot program, Enhanced Minor Construction–Commercial (EMC2), because DOE Order 413.3B does not apply to these projects. However, writing the guidance to manage these projects is also part of the pilot. According to NNSA documents, the pilot is making use of minor construction project management processes that use commercial construction practices and environmental, safety, and health standards, rather than Order 413.3B requirements. According to NNSA officials, schedule milestones will be developed for these projects following a streamlined process with an accepted alternative to earned value management.

To help manage the program and project activities that need to be integrated across their different management structures and requirements in order to achieve its pit production capability, NNSA has established several teams for inter-office and inter-site collaboration. The primary coordination body is the Plutonium Pit Production Matrixed Execution Team. The Matrixed Execution Team involves representatives from each NNSA office involved in pit production, as well as representatives from NNSA field offices at Los Alamos and Savannah River, and contractor representatives from Los Alamos and Savannah River.[60] The Matrixed Execution Team is responsible for synchronizing resources, schedules, and ongoing activities, as well as resolving conflicts that may arise among member offices.

In addition, the Office of Infrastructure (formerly Office of Acquisition and Project Management) forms Federal Integrated Project Teams for each DOE Order 413.3B capital asset project. These Federal Integrated Project Teams are cross-functional groups of individuals led by and responsible to a federal project director for the successful execution of a capital asset project of substantial size. Federal Integrated Project Teams also include federal and contractor representatives.

[60]The full Matrixed Execution Team membership is: Office of Defense Programs (Chair); Office of Safety, Infrastructure, and Operations (Office of Infrastructure and Office of Environment, Safety, and Health, since July 2022); Office of Defense Nuclear Security; Los Alamos Field Office; Savannah River Field Office; Office of Acquisition and Project Management (Office of Infrastructure, since July 2022); NNSA Office of Management and Budget; and contractor representatives from Savannah River, Los Alamos, and Livermore. Associate members only attend meetings as needed, and include the Office of Secure Transportation; the Office of the Associate Administrator for Information Management and Chief Information Officer; Office of Defense Nuclear Nonproliferation; Office of General Counsel; Cost Estimating and Program Evaluation; and field office and contractor representatives from Kansas City.

NNSA and its contractors also participate in a variety of other pit production coordination groups and meetings, including Quarterly Program Reviews; Plutonium Modernization Monthly Program Meetings; Senior Management Team Meetings for SRPPF and LAP4; and weekly or biweekly meetings on program operations at each site. According to NNSA officials, significant issues are generally raised to the Matrixed Execution Team and in Quarterly Program Reviews, as well as to the Nuclear Weapons Council for coordination with the Department of Defense. For further information on NNSA's various matrixed teams for collaboration, see appendix VI.

Most NNSA and contractor officials stated that they thought the Matrixed Execution Team was generally collaborating and coordinating effectively. But an October 2020 report by the National Academies of Sciences, Engineering, and Medicine and National Academy of Public Administration raised concerns about the resources and technical expertise available to the Plutonium Modernization program as well the program manager's authority resolving program issues (see text box).

Nuclear Security Enterprise Governance and Management Case Study: National Academies of Sciences, Engineering, and Medicine and National Academy of Public Administration

A panel of the National Academies of Sciences, Engineering, and Medicine (NAS) and the National Academy of Public Administration (NAPA) charged with examining NNSA's efforts to address its governance challenges reported that the seniority of the Plutonium Modernization Program Manager and the position's lack of authority over the extensive network of programs and projects involved in pit production is insufficient to the task. NAS and NAPA conducted a case study of governance and management structures in the plutonium pit production program.

In the ensuing October 2020 report, *Governance and Management of the Nuclear Security Enterprise*, the panel recommended that NNSA "ensure that the management structures for its major programs provide a high level of authorities and capabilities to one strong program manager so that program manager can serve as the focal point for anticipating and resolving issues in the execution of the program." Specific concerns included the Plutonium Modernization Program Manager being outranked by representatives of functions they were responsible to integrate, not having those representatives as direct reports to the program manager, and insufficient resources and technical expertise in the program manager's office.

In response to the recommendation and those concerns, NNSA officials told us that they had increased federal and contractor staffing, which increased technical expertise and decreased reliance on site personnel. NNSA also highlighted the role of the Matrixed Execution Team, the chair of which is responsible for coordinating and resolving any conflicts in programmatic operations.

However, as noted by NAS and NAPA, members of the Matrixed Execution Team do not report to its chair, and the chair does not participate in employee performance evaluations. In interviews with us in 2021, Matrixed Execution Team members indicated they thought the body was functioning well—although several said it was early in the program and all functions were not yet fully engaged. Thus, it was too soon to determine if NNSA's increase in staff and continued engagement through the Matrixed Execution Team are sufficient to address the NAS and NAPA concerns.

Source: GAO 23-104661

NNSA Does Not Have a Comprehensive Schedule or Cost Estimate for Establishing its Pit Production Capability

The schedule NNSA developed and identified as an integrated master schedule includes some activities managed under its Plutonium Modernization program. However, this schedule captures only some sites' activities through the FPU in 2024—not all activities or milestones to achieve an 80-pit-per-year production capability. The schedule also does not assign resources to activities. As a result, NNSA's pit production schedule is not comprehensive. According to GAO's Schedule Guide, if a schedule is not comprehensive, it cannot be considered reliable. Similarly, NNSA has not developed a life cycle cost estimate, another important program management tool considered a best practice. NNSA has also not provided any other overall cost estimate for its effort to establish an 80-pit-per-year production capability. However, using NNSA's fiscal year 2023 budget justification we identified at least $18 billion to $24 billion in potential costs.

NNSA's Pit Production Capability Integrated Master Schedule Is Not Comprehensive

After developing a milestone chart and a plan for developing an IMS, NNSA reported in November 2021 it had developed an IMS for its pit production capability. However, the schedule it provided to us is not comprehensive because it (1) captures only the activities at two sites to manufacture a single pit (FPU) by 2024, (2) does not assign resources to these activities, and (3) minimally meets best practices for assigning durations for all activities. See table 3 for our full analysis of NNSA's FPU schedule with respect to the comprehensive characteristic.

According to our *Schedule Assessment Guide*, in order to be reliable an IMS should be, among other things, comprehensive.[61] This means that the schedule should integrate the complete scope of work reflected in the program's work breakdown structure, identify the resources necessary to

[61]A reliable IMS has four characteristics: it is comprehensive, well-constructed, credible, and controlled. GAO-16-89G.

accomplish that work, and establish realistic durations for all activities.[62] Since this FPU schedule was not comprehensive, we determined that it is not a reliable IMS and therefore did not assess the other three characteristics (well-constructed, credible, and controlled).

NNSA officials said that they did not include more information in the FPU schedule because they did not want to include immature information, such as cost and schedule information for projects like SRPPF that have not completed design (CD-2). They said they did not want to introduce uncertainty about dates and wanted to avoid releasing preliminary or unpalatable information that was subject to change.

Table 3: Summary Assessment of the National Nuclear Security Administration's First Production Unit Schedule Estimate for Its Pit Production Capability, Compared to Best Practices

Characteristic	Characteristic assessment[a]	Best practice	Individual assessment[b]
Comprehensive, reflecting • all activities as defined in the program's work breakdown structure • labor, materials, travel, facilities, equipment, and the like needed to do the work and whether those resources will be available when needed • how long each activity will take, allowing for discrete progress measurement with specific start and finish dates	Minimally met	1. Capturing all activities	Minimally Met
		2. Assigning resources to all activities	Not Met
		3. Establishing the durations of all activities	Minimally Met

Source: GAO analysis of NNSA schedule data. | GAO-23-104661

[a]The characteristic assessment rating was determined by assigning each best practice under the characteristic a number and taking the average. The numerical ratings and ranges of the resulting averages are: Fully met – 4.5–5.0; Substantially met – 3.5–4.4; Partially met – 2.5–3.4; Minimally met – 1.5–2.4; Not met – 1.0–1.4.

[b]Not Met – NNSA provided no evidence that satisfies any of the criterion; Minimally Met – NNSA provided evidence that satisfies a small portion of the criterion; Partially Met – NNSA provided evidence that satisfies about half of the criterion; Substantially Met – NNSA provided evidence that satisfies a large portion of the criterion; and Met – NNSA provided complete evidence that satisfies the entire criterion.

Prior to developing the FPU schedule they identified as an IMS in 2021, NNSA first developed a milestone chart—showing high-level milestones for the entire 80-pit-per-year effort—and updated that schedule monthly

[62]Resources can include labor, materials, travel, facilities, equipment, and level-of-effort activities. GAO-16-89G.

starting in October 2019.[63] NNSA provided a screenshot of this milestone chart that extends to fiscal year 2035. It more fully represents the entire scope of work of the program. However, this milestone chart does not include specific activities contributing to each milestone, cannot dynamically respond to changes in the program, and cannot be used to verify and validate proposed adjustments to the schedule for completing a production capability of 80 pits per year. According to the GAO *Schedule Assessment Guide*, an IMS constitutes a dynamic program schedule that includes the entire required scope of effort, including the effort necessary from all government, contractor, and other key parties for a program's successful execution from start to finish. As a result of these limitations to the high-level milestone chart we examined only the FPU schedule provided by NNSA.

In June 2020, the Plutonium Modernization program was designated an Enhanced Management B program, which required the development of an IMS, according to NNSA's *Program Execution Instruction*.[64] In 2021 Congress also required NNSA to produce an IMS for production of 30 pits per year at Los Alamos.[65]

In developing their schedule to meet this requirement, officials in charge of the Plutonium Modernization program submitted a plan to develop an IMS to Congress in June 2021. The plan noted that the program would incorporate data from multiple lower-level schedules into a single IMS managed by the Plutonium Modernization program office.[66] The purpose of the IMS, according to the June 2021 plan, would be to track the entire mission to build an 80-pit-per-year capability at Los Alamos and Savannah River. The IMS would include program scope directly managed by the Plutonium Modernization program; capital acquisition projects

[63]NNSA managed the Plutonium Modernization program under the Standard Management designation (the least rigorous of NNSA's four management categories) until June 2020. According to NNSA's *Program Execution Instruction*, Standard Management programs are only required to have a simple milestone-based schedule, rather than an IMS.

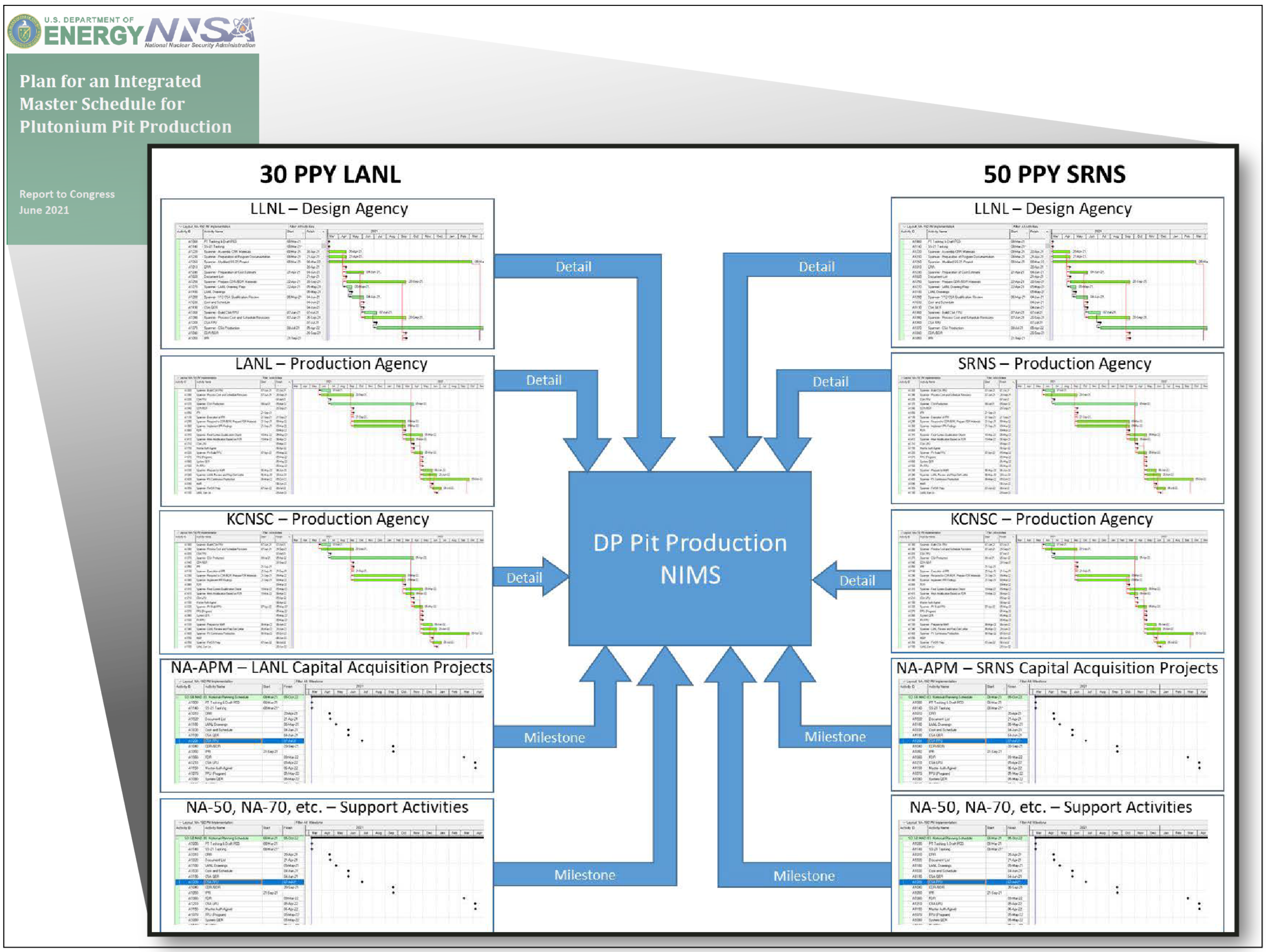
[64]The *Program Execution Instruction* does note that for Enhanced Management B programs, having a resource-loaded IMS is optional; however, according to GAO best practices, an IMS should be resource-loaded. For higher management categories like Enhanced Management A—used primarily for nuclear weapon life extension and modification programs—the IMS must be resource-loaded, according to the *Program Execution Instruction*.

[65]S. Rep. No. 117-39, at 367 (2021), to accompany S. 2792, a bill for the National Defense Authorization Act for Fiscal Year 2022.

[66]National Nuclear Security Administration, *Plan for an Integrated Master Schedule for Plutonium Pit Production* (Washington, D.C., June 2021).

managed by the Office of Acquisition and Project Management (Office of Infrastructure as of July 2022); and sustainment of mission-essential infrastructure at each site (see figure 9).

Figure 9: Excerpt of NNSA's Submittal to Congress of a Plan for a Pit Production Capability Integrated Master Schedule



PPY - Pits Per Year
LANL - Los Alamos National Laboratory
LLNL - Lawrence Livermore National Laboratory
KCNSC - Kansas City National Security Campus
NA-50 and NA-70 = NNSA offices of Safety, Infrastructure and Operations and Defense Nuclear Security
NA-APM - NNSA Acquisition and Project Management
SRNS - Savannah River Nuclear Solutions, Savannah River Site contractor

Source: National Nuclear Security Administration. | GAO-23-104661

According to NNSA officials, NNSA implemented the initial version of its IMS in October 2021. This initial version included activities from two sites—Livermore and Los Alamos—where activities were sequenced to determine the longest path to achieve FPU.[67] NNSA provided us this FPU version of the schedule that was updated through November 2021. NNSA officials stated multiple times that this FPU schedule was the schedule NNSA reported as achieving the requirements of an IMS.

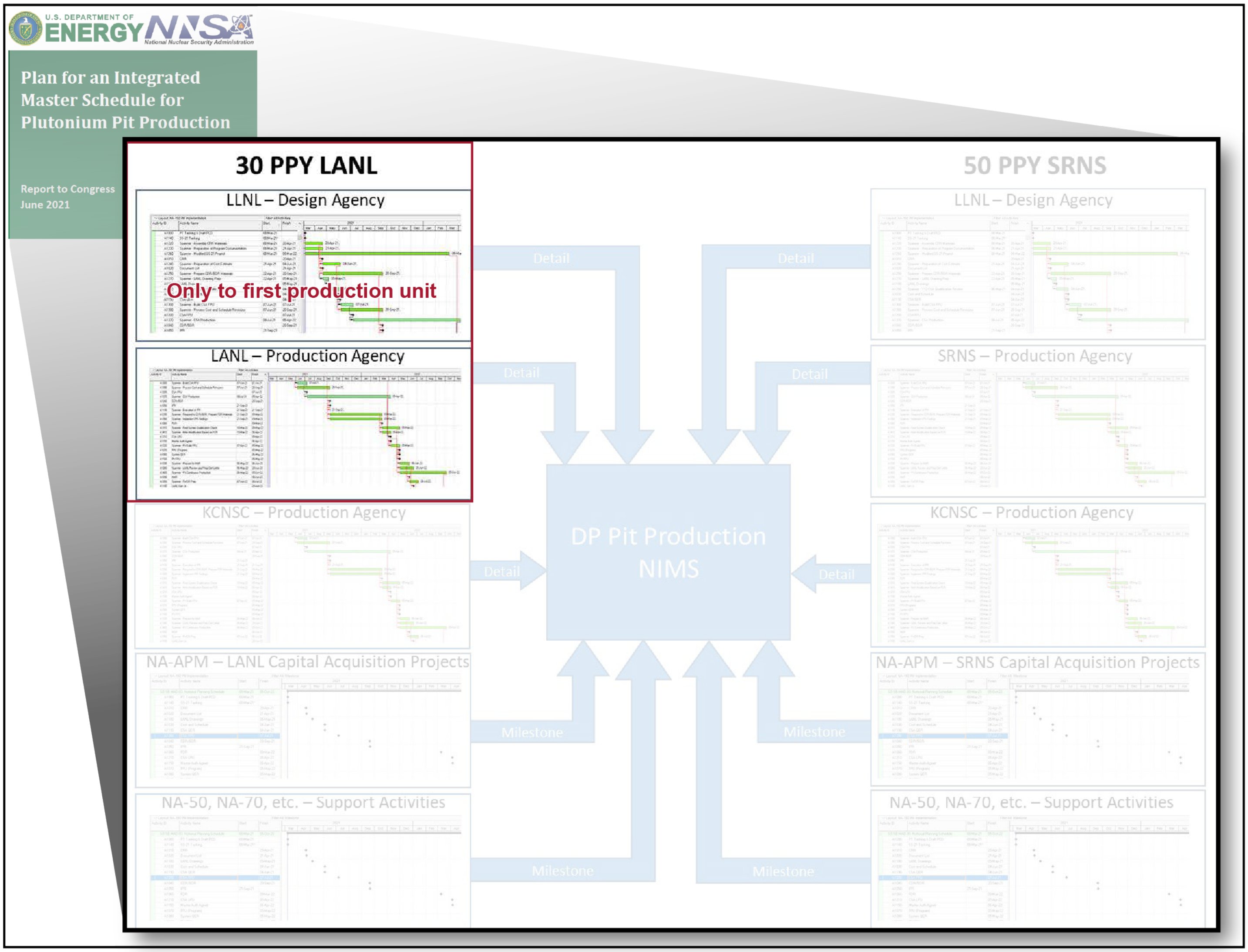
As noted in Table 3, we found that NNSA's schedule did not include all activities, resources, or activity durations and therefore could not be considered comprehensive. Because these elements of an IMS are missing, NNSA's FPU schedule for the pit production capability is not comprehensive, does not fully reflect the characteristics of a high-quality schedule, and cannot be considered reliable.

Schedule Does Not Include Many Key Activities

We found that the FPU schedule only accounted for activities at Los Alamos and Livermore through FPU in fiscal year 2024. It then included three major milestones—with no activities assigned to them—for production of 10 pits per year (by fiscal year 2025), 20 pits per year (by fiscal year 2026), and 30 pits per year (by fiscal year 2027) at Los Alamos (see figure 10).

[67]The FPU milestone occurs when DOD accepts the weapon's design and NNSA verifies that the first produced weapon meets the design.

Figure 10: Contents of the National Nuclear Security Administration's Pit Production Capability Schedule in Comparison to Its Plan



PPY - Pits Per Year
LANL - Los Alamos National Laboratory
LLNL - Lawrence Livermore National Laboratory
KCNSC - Kansas City National Security Campus
NA-50 and NA-70 = NNSA offices of Safety, Infrastructure and Operations and Defense Nuclear Security
NA-APM - NNSA Acquisition and Project Management
SRNS - Savannah River Nuclear Solutions, Savannah River Site contractor

Source: GAO analysis of NNSA data. | GAO-23-104661

No milestone information was included after fiscal year 2027. Further, the FPU schedule did not include any activities at any other sites involved in the pit production capability for achieving FPU or other milestones, including Savannah River, Kansas City, Nevada, or Pantex. In addition, while NNSA's schedule identified some major production milestones beyond FPU, it did not include major construction milestones for the capital asset acquisitions to achieve those production milestones, such as LAP4 at Los Alamos or SRPPF at Savannah River, even though separate schedules are available for these projects and could have been incorporated consistent with their levels of maturity.

NNSA officials said that because many project and program activities, particularly at Savannah River, are in earlier stages they are represented only as milestones in the high-level milestone chart. They said that capital asset projects, such as SRPPF and LAP4, will be integrated into the FPU schedule once those projects reach CD-2, when project cost and schedule baselines are established and approved. As of March 2022, these projects were expected to reach CD-2 in 2024. Officials also noted that they plan to add more information to the schedule as various programmatic activities mature, but there is no CD-2 equivalent to establish schedule and cost baselines for activities directly managed by the Plutonium Modernization program. Officials said that the schedule sequencing for activities for attaining the 10-pit-per-year production level will be added into the program's schedule beginning in fiscal year 2023.

Per the GAO *Schedule Assessment Guide*, a comprehensive IMS should reflect all the activities necessary to achieve a program's objective. In the case of the Plutonium Modernization program, this is through completion of the capability to produce 80 pits per year. A comprehensive IMS should recognize that uncertainties and unknown factors in schedule estimates can stem from, among other things, limited data. Effort beyond the near term that is less well defined is represented within the schedule as planning packages that are logically linked within the schedule to create a complete picture of the program from start to finish and to allow monitoring of a program's critical path.

Officials stated that they are using rolling wave planning—which is incremental conversion of high-level planning packages into detailed work packages—to add items to the FPU schedule as they come closer to being planned or constructed. They said that this is why milestones at Los Alamos for production of 10, 20, and 30 pits per year did not have activities assigned. Employing rolling wave planning in creating and updating an IMS is a useful technique to ensure that the most up-to-date information is included as schedule data matures. However, NNSA's schedule did not include all the hallmarks of a rolling wave IMS. Specifically, it did not include major milestones for the life of the program that are connected via schedule logic, nor did it include activities or milestones across all involved sites.

Beyond the near-term focus of the schedule, we found that NNSA's FPU schedule did not include any information such as major milestones or detailed activities, for work at several of the sites involved in establishing a pit production capability. For example, NNSA does not include Kansas City's activities in the FPU schedule. NNSA program officials said this is because Kansas City is already producing components for the program and production is tracked elsewhere. According to our schedule guide, because an IMS is used for coordination, among other things, the absence of information in the IMS (like keeping milestones in a separate, static schedule) can hinder coordination, increasing the likelihood of disruption and delay.

According to the GAO best practices, it is the responsibility of the government program management office to integrate all government and contractor work into one comprehensive program plan that can be used to reliably forecast key program dates. Failing to include all work for all deliverables—even activities that are at an early stage in planning—can lead to program members' incomplete understanding of the plan and its progress toward a successful conclusion.

Schedule Is Not Resource Loaded

We also found that the schedule was not resource loaded—that is, it did not identify the resources required to complete activities. NNSA's Defense Programs *Program Execution Instruction* does not require resource-loaded schedules for Enhanced Management B programs, of which the Plutonium Modernization program is one, but GAO's best practices state that an IMS should be resource loaded.

The GAO *Schedule Assessment Guide* notes that including resources in an IMS 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. 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.

According to the GAO *Schedule Assessment Guide*, even when using rolling wave planning, including resource information when activities are defined is important. Work scheduled for the near term should account for specific resource availability and productivity. Information on resource needs and availability in each work period assists the program office in forecasting the likelihood that activities will be completed as scheduled. If the current schedule does not allow insight into the current or projected allocation of resources, then the risk of the program's progress slipping is significantly increased.

NNSA officials said that they did not include resources in the schedule because they want to maintain separation of the cost and schedule baselines. Further, they do not believe that earned value management is required.[68] Officials also said that cost and schedule control accounts do align, and cost baselines and schedule baselines are processed and aligned on a monthly basis by the program. However, though NNSA provided cost baselines for some sites, it did not provide further information about how cost and schedule are aligned or controlled.

Schedule Does Not Include Duration of All Activities

Finally, the schedule minimally met the best practice of establishing durations for all activities (that is, how long each activity is estimated to take). We found that while all activities in the schedule had durations assigned, those durations were often longer than the updating period, which is monthly. In general, estimated durations for near-term activities should be no longer than the updating period established by the program, or activities should have at least one measurable event within that updating period. Our assessment determined that durations in the schedule are generally not short enough to be effectively managed, and

[68]We found in January 2018 that NNSA has established and strengthened requirements for using earned value management in its life extension programs. Specifically, the Office of Defense Programs' program management directive mandated that life extension programs use earned value management. We recommended in that report that an independent entity validate the earned value management systems used to ensure they meet national standards. As of September 2022, NNSA had partially implemented our recommendation by issuing directives requiring life extension programs to use earned value management systems that comply with national standards. NNSA has also been conducting surveillance reviews of contractor earned value management systems used in the W80-4 life extension program on a quarterly basis. GAO, *Nuclear Weapons: NNSA Should Adopt Additional Best Practices to Better Manage Risk for Life Extension Programs*, GAO-18-129 (Washington, D.C., Jan. 30, 2018). Additionally, DOE's Order 413.3B notes that capital asset acquisition programs must employ an EVM system compliant with recognized standards. U.S. Department of Energy, *Program and Project Management for the Acquisition of Capital Assets*, Order 413.3B (Washington, D.C., Nov. 29, 2010).

management may benefit from more tasks being broken down to facilitate the objective measurement of accomplishments.

The GAO *Schedule Assessment Guide* states that schedules should realistically reflect how long each activity will take. If activity durations are too long, the schedule may not have enough detail for effective progress measurement and reporting. When the duration of each activity is determined, the same rationale, historical data, and assumptions used for cost estimating should be used. Further, when durations are not based on the effort required to complete an activity; the resources available; resource efficiency; and other factors such as previous experience on similar activities, then there is little confidence in meeting the target deliverable date.

According to our *Schedule Assessment Guide*, without a comprehensive schedule, programs lack a fundamental management tool that can help ensure funds are used effectively by specifying when work will be performed in the future and measuring program performance against an approved plan. Moreover, without a comprehensive schedule, the timing of major events as well as the completion dates for all activities leading up to them is unclear, which means officials cannot determine if the program parameters are realistic and achievable. Finally, without a comprehensive schedule, officials do not have a means of understanding how changes to activities or resources affect the program overall.

We found in September 2020 that NNSA did not have assurance that it would be able to produce sufficient numbers of pits in time to sustain production of warheads for the W87-1 modification program as scheduled.[69] We recommended that the NNSA Administrator direct the Plutonium Modernization program to develop an IMS that meets best practices for schedule development. Congress also directed NNSA to produce an IMS for the production of 30 pits per year at Los Alamos no later than February 2022. Our analysis found that the schedule NNSA developed in response to this direction is not reliable because it is not comprehensive. Without a reliable IMS, officials overseeing programs like the W87-1—which includes newly manufactured pits in its design—cannot be certain how their programs might be impacted by changes to the pit production capability schedule.

[69]GAO-20-703.

Additionally, we found in January 2022 that DOD and NNSA have numerous interdependencies among their nuclear programs, including among the weapon and delivery platform systems of the strategic nuclear triad.[70] NNSA's pit production capability is a prime example—programs within NNSA and at DOD rely on pits produced by NNSA. Specifically, these include the W87-1 modification program and DOD's Sentinel ballistic missile. Significant changes to the pit production capability or schedule could potentially impact all of these programs, including their cost and schedule.

In order to plan well and communicate programmatic risks across the nuclear enterprise effectively, having an IMS for establishing a pit production capability is important. In January 2022, we recommended that the NNSA Administrator, in coordination with the Secretary of Defense, should establish a joint risk management process to periodically identify, analyze, and respond to risks that affect the U.S. nuclear enterprise and report, internally and externally, to relevant stakeholders, those risks and any associated mitigation efforts. Having an IMS that allows NNSA to track progress on producing one of the key components of nuclear weapons—plutonium pits—would help the Administrator anticipate risks to the program and plan mitigation strategies. This would greatly enhance the Administrator's ability to understand, plan for, and communicate risks to the U.S. nuclear enterprise to NNSA and DOD stakeholders. In its response to our January 2022 report, NNSA agreed with the intent of the recommendation. However, the agency has not yet implemented it, and we are continuing to monitor its efforts to do so.

We continue to believe in the importance of developing an IMS that meets best practices and that NNSA should fully address this recommendation by making its IMS comprehensive, including resource loading.

NNSA Does Not Have a Life Cycle Cost Estimate for Pit Production Costs

NNSA does not currently have a life cycle cost estimate for the complex web of program and project activities it is pursuing to establish a pit production capability. However, NNSA's fiscal year 2023 budget justification includes at least $18 billion to nearly $24 billion in potential future costs through the completion of SRPPF around 2035. In addition to

[70]GAO, *Nuclear Enterprise: DOD and NNSA Could Further Enhance How They Manage Risk and Prioritize Efforts,* GAO-22-104061 (Washington, D.C. Jan. 20, 2022).

not having a life cycle cost estimate consistent with best practices, NNSA has not provided any other overall cost estimate or compiled information covering what is known about the costs for the activities needed to establish an 80-pit-per-year production capability.

According to NNSA officials, a life cycle cost estimate for its pit production capability has not been completed because (1) it is difficult to attribute the costs of some activities that support multi-use facilities and broader plutonium capabilities; (2) the early stage of several capital asset projects means estimated costs have a fair amount of uncertainty, as do some aspects of program costs related to those projects; and (3) they had concerns that publicizing preliminary or uncertain information would lead to misinterpretation over increasing costs if preliminary numbers rise.

Our *Cost Estimating and Assessment Guide* states that cost estimates support decisions about funding one program over another and help agencies develop annual budget requests and evaluate resource requirements at key decision points. Moreover, the *Cost Estimating and Assessment Guide* says that having a realistic estimate of projected costs makes for effective resource allocation and increases the probability of a program's success. Having a life cycle cost estimate can enhance decision-making, especially in early planning and concept formulation of acquisition, as well as support budget decisions, key decision points, milestone reviews, and investment decisions, according to our *Cost Estimating and Assessment Guide*. For NNSA's pit production capability, a life cycle cost estimate could better inform decision-making regarding program management and funding, including by Congress. This includes potential tradeoffs both within the pit production effort and among NNSA's other priorities, such as reconstituting or recapitalizing capabilities for other nuclear weapons materials including depleted uranium, lithium, high explosives, tritium, and micro-electronics.[71]

While NNSA does not have a life cycle cost estimate for establishing its pit production capability, the agency is requesting significant resources for

[71]GAO, *Nuclear Weapons: NNSA Should Clarify Long-Term Uranium Enrichment Mission Needs and Improve Technology Cost Estimates*, GAO-18-126 (Washington, D.C.: Feb. 16, 2018); GAO, *Nuclear Weapons: NNSA Plans to Modernize Critical Depleted Uranium Capabilities and Improve Program Management*, GAO-21-16 (Washington, D.C.: Oct. 15, 2020); GAO-21-244; GAO-19-449; GAO, *Nuclear Weapons: National Nuclear Security Administration Needs to Ensure Continued Availability of Tritium for the Weapons Stockpile*, GAO-11-100 (Washington, D.C.: Oct. 7, 2010); and GAO, *Nuclear Weapons: NNSA Needs to Incorporate Additional Management Controls Over Its Microelectronics Activities,* GAO-20-357 (Washington, D.C: June 9, 2020).

the effort. Existing information from budget requests indicates that the cost to establish an 80-pit-per-year capability is substantial and NNSA officials said that it likely represents NNSA's largest investment in weapons production infrastructure to date. In the fiscal year 2023 NNSA budget justification, we identified at least $18 billion to nearly $24 billion in current and future budget requests for

- Plutonium Modernization program activities for fiscal years 2021 through 2027,
- supporting office building projects for fiscal years 2023 through 2027,
- maintenance and recapitalization projects for fiscal year 2023, and
- preliminary cost estimates for its pit production capability-related capital asset projects through completion of SRPPF. See table 4 and also appendix VII for a more detailed breakdown.

This does not include additional program funding after 2027 and maintenance projects after 2023.[72] NNSA does not expect to be able to meet its 80-pit-per-year capability until, at the earliest, 2032 to 2035.

Table 4: Information from National Nuclear Security Administration (NNSA) Budget Justification for Plutonium Pit Production Capability, Fiscal Year 2023

Project/program activities	Budget requests/estimates (Dollars in millions)
Los Alamos National Laboratory (Los Alamos) Capital Asset Projects, through fiscal year 2029[a]	$4,165–$5,607
Los Alamos Maintenance and Recapitalization Projects, fiscal year 2023	$45–46
Los Alamos Support Office Buildings Projects, fiscal years 2023–2027	$240–244
Savannah River Plutonium Processing Facility, through fiscal year 2035	$6,900–11,100
Plutonium Modernization Program, fiscal years 2021–2027	$6,940
Total	**$18,290–23,937**

Source: GAO analysis of NNSA fiscal year 2023 budget justification. | GAO-23-104661

Note: Each fiscal year, NNSA is required to submit to Congress its estimated programmatic budget request for an additional four fiscal years, per 50 U.S.C. § 2453(a). As a result, NNSA's budget justification for its fiscal year 2023 request also includes estimated requests for program activities in fiscal years 2024 through 2027. In contrast, for construction projects, NNSA's budget justifications include project data sheets that report total estimated project costs through construction completion. The data included in the table for Budget Requests/Estimates reflects program information for fiscal years 2021 through 2027, maintenance and recapitalization project requests for fiscal year 2023, and

[72]NNSA has already spent over $5 billion on plutonium infrastructure and programmatic work over the past two decades that has laid the groundwork for modern pit manufacturing at Los Alamos.

total project costs through the year the project is scheduled to be completed, based on the information included in NNSA's fiscal year 2023 budget justification.

[a]The five capital asset projects at Los Alamos are scheduled to reach CD-4 (completion of construction) between 2026 and 2029. See Table 1.

These budget estimates reflect many of the costs to achieve the pit production capability but do not reflect certain other costs once the capability has been established. For example, actual war reserve production costs are not included, and these costs will be included in the respective budgets for the life extension or weapons modernization programs needing the pit. Also not included are the regular operations and maintenance of facilities once constructed; capital asset and operations costs for WIPP that could be attributed to pit waste; and other activities across different enterprise sites that support the pit production capability, such as secure transportation.

NNSA officials state that information is too immature to put together a life cycle cost estimate. However, information, even if uncertain, does exist, such as that used to develop the above budget estimates for individual activities and inform projects' critical decisions. Best practices say 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. Indeed, some NNSA programs and projects under more rigorous management categories are required to produce a rough order of magnitude cost estimate—an estimate intended to provide a rough idea of the program's overall cost—before baselines are set, in order to help decision makers understand potential costs early in the life of the program.

The Plutonium Modernization program's efforts to establish NNSA's pit production capability are presently at least as expensive as most of the programs that are required to produce early life cycle cost estimates, based on current budget requests and the Future Years Nuclear Security Program that together estimate budget requests for the next five years. For example, the W87-1 modification program was projected to cost between $8.6 and $14.8 billion as of fiscal year 2019;[73] about half as much as the current potential costs for a pit production capability.

The GAO *Cost Estimating and Assessment Guide* notes that a life cycle cost estimate informs decision-making, especially in the early planning and formulation of a program. Design trade-off studies conducted in this period can be evaluated on the basis of cost as well as on a performance

[73]GAO-20-703.

and technical basis. A life cycle cost estimate can support budgetary decisions, key decision points, milestone reviews, and investment decisions. NNSA has cost ranges from CD-1 for all projects that could contribute to an early life cycle cost estimate for the entire effort. It had not used these to create such an estimate for its pit production capability as of June 2022.

Given the significant current and future spending associated with establishing NNSA's pit production capability, developing a life cycle cost estimate could improve NNSA's decision-making and enhance the efficiency and effectiveness of efforts to achieve an 80-pit-per-year capability. It would also allow NNSA to provide better information to Congress to assist with congressional decision-making. A cost estimate is a critical element in any acquisition process, including acquisition of a capability like pit production. It also helps decision makers by providing a realistic view that can be used to plan the work necessary to develop, produce, operate, and maintain a program.

Conclusions

The re-establishment of pit production capabilities is one of the most complex and potentially costly efforts presently operated by NNSA. The program involves activities at the majority of sites in NNSA's nuclear security enterprise, with the construction of multiple new facilities and recapitalization of others. These efforts include hiring thousands of new staff and creating hundreds of pits from plutonium, an exceedingly dangerous material. To help manage the program, both the Defense Programs' *Program Execution Instruction* and GAO best practices note the importance of using manag ement tools such as a work breakdown structure, an IMS, and a life cycle cost estimate.

Of these three management tools called for by best practices, the Plutonium Modernization program has not yet produced two—an IMS that meets GAO best practices and a life cycle cost estimate of activities needed to establish a pit production capability of 80 pits per year. Further, NNSA officials have stated that they do not know when they might produce a complete IMS. Because they are waiting for schedules and cost estimates to mature, the program could be several years advanced before a full IMS or cost estimate is available.

Given the complexity and cost of the Plutonium Modernization program, NNSA could benefit from developing an integrated master schedule, as we previously recommended, and a corresponding life cycle cost estimate to improve NNSA's management of the program. These tools can still reflect the preliminary nature of some information and incorporate higher fidelity information as schedule and cost information matures. This would allow NNSA to communicate progress to other programs within the agency and to DOD stakeholders. These tools would also aid congressional decision-making and enhance the efficiency and effectiveness of efforts to achieve an 80-pit-per-year capability.

Recommendation for Executive Action

The NNSA Administrator should ensure the head of the Plutonium Modernization program develops a life cycle cost estimate for establishing NNSA's pit production capability that aligns with GAO cost estimating best practices. (Recommendation 1)

Agency Comments and Our Evaluation

We provided a draft of this report to NNSA for review and comment. NNSA provided written comments, which are summarized below and reproduced in Appendix VIII. NNSA also provided technical comments, which we incorporated as appropriate.

In its written comments, NNSA concurred with our finding that the plutonium program is a complex and challenging undertaking involving many programs and sites across NNSA's nuclear security enterprise. The agency also agreed with our recommendation to develop a life cycle cost estimate that aligns with GAO best practices for cost estimating. In their letter, NNSA officials said they plan to develop a life cycle cost estimate following the establishment of baseline cost and schedule estimates for the Savannah River Plutonium Processing Facility and the Los Alamos Plutonium Pit Production Project. They plan to complete the life cycle cost estimate by September 30, 2025. The letter stated NNSA will continue refining its integrated master schedule (IMS) for plutonium pit production to be in alignment with GAO best practices.

We continue to point out that, based on our analysis of the schedule NNSA provided, NNSA does not currently have an IMS. It has a milestone schedule as well as an activity-based schedule through production of the first pit at Los Alamos—that includes the activities at some, but not all, sites performing relevant activities—neither of which meets the characteristics of an IMS as outlined in our report and in GAO's

Schedule Assessment Guide. We reiterate our recommendation from September 2020 that NNSA needs to produce an IMS in line with GAO best practices.

We also note that, according to NNSA's plans, the program will have reached major milestones, including the first production unit pit (fiscal year 2024) and production of 10 pits per year (fiscal year 2025), without either a life cycle cost estimate or an IMS if these tools are not developed before fiscal year 2026. During this time, NNSA will have spent billions of dollars without having an overall idea of total program costs, or when program objectives, to include the capability to produce 80 pits per year, will be reached.

We stated in our report that developing a cost estimate and IMS should not be hindered by the preliminary nature of some of the information. Preliminary information can still provide guidance for the program and important information for stakeholders, and be updated with higher-fidelity information as it becomes available. We encourage NNSA to develop both its life cycle cost estimate and IMS using GAO best practices as soon as possible, rather than waiting for CD-2 baselines that may themselves be delayed. We further encourage NNSA to view the life cycle cost estimate and the IMS as tools for managing a complex and expensive program, rather than as static documents.

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

If you or your staff 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 significant contributions to this report are listed in appendix IX.

Allison Bawden
Director, Natural Resources and Environment

List of Committees

Chair
Ranking Member
Committee on Armed Services
United States Senate

Chair
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

Chair
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 examine (1) the scope of NNSA's efforts to achieve the required production capability of 80 pits per year and NNSA's management of that scope of work; and (2) the extent to which NNSA has met GAO best practices for the integrated master schedule and a life cycle cost estimate for achieving the capability to manufacture 80 pits per year.

Our scope included examining all of NNSA's program and projects activities undertaken to achieve an 80-pit-per-year capability. We examined activities that are part of the Office of Defense Programs' Plutonium Modernization program, whose mission NNSA describes as providing funding for efforts across the nuclear security enterprise to restore the nation's capability to produce 80 plutonium pits per year. We also examined pit production capability activities managed by other NNSA offices. We analyzed NNSA's program schedule for pit production capability, and documentation related to costs of the capability.

For objective one, we analyzed various NNSA reports, memoranda, and program and project management documents to generate and describe an inventory of activities needed to achieve plutonium pit production and the management structures for those activities.[1] In our interviews with NNSA officials and contractor representatives, and Office of Environmental Management staff who will be responsible for addressing nuclear waste generated through the pit manufacturing process, we asked about the range of NNSA's program and project activities, and management practices involved in achieving a pit production capability. We spoke with officials in the following NNSA and contractor offices during the course of our audit:

- Office of Defense Programs, Plutonium Program Office (NA-191)

[1]For example, Department of Energy, *Pit Production at Los Alamos National Laboratory* (Washington, D.C.: May 2020); Department of Energy, *Pu Pit Production Engineering Assessment* (Apr. 5, 2018; updated Apr. 20, 2018); Department of Energy, *Fiscal Year 2021 Stockpile Stewardship and Management Plan – Biennial Plan Summary* (Washington, D.C.: Dec. 2020).

- Office of Acquisition and Project Management (NA-APM)
- Office of Safety, Infrastructure, and Operations (NA-50)
- Office of Defense Nuclear Security (NA-70)
- Office of Secure Transportation (NA-15)
- Office of the Associate Administrator for Information Management and Chief Information Officer (NA-IM)
- Office of Defense Nuclear Nonproliferation (NA-20)
- Cost Estimating and Program Evaluation (NA-1.3)
- Office of Management and Budget (NA-MB)
- Office of General Counsel (NA-GC)
- Los Alamos Field Office
- Savannah River Field Office
- DOE Office of Environmental Management
- Los Alamos National Laboratory (Los Alamos), New Mexico
- Savannah River Site (Savannah River), South Carolina
- Lawrence Livermore National Laboratory, California
- Kansas City National Security Campus, Missouri

For objective two, to assess the reliability of the schedule and estimated costs for achieving NNSA's pit production capability, we reviewed documentation on the Plutonium Modernization program's November 2021 FPU schedule provided by NNSA. NNSA provided some data on program costs, but does not have a lifecycle cost estimate. As a result, we were unable to carry out a full analysis of the program cost estimate.

To assess the reliability of the November 2021 Plutonium Modernization schedule, we evaluated documentation supporting the schedule, such as narratives provided by NNSA and Project Controls Procedures. We assessed the schedule documentation against leading practices for developing a comprehensive schedule identified in GAO's *Schedule Assessment Guide.* We also interviewed Plutonium Modernization program officials responsible for developing and managing the schedule to understand their practices for creating and maintaining the provided schedule. We noted in our report the instances where the quality of the schedule data impacted the reliability of the schedule.

In performing our analyses, we determined the extent to which the schedule was prepared in accordance with best practices that GAO previously has identified as fundamental to a reliable schedule. GAO's *Schedule Assessment Guide* includes 10 such best practices that map to four characteristics of a high-quality, reliable schedule—they are comprehensive, well-constructed, credible, and controlled. We analyzed the detailed schedule provided and populated a workbook as a part of that analysis to highlight potential areas of strengths and weakness in schedule logic, use of resources, and task duration. We also interviewed government and contractor officials regarding their scheduling practices. We shared the criteria against which we evaluated the schedule provided by NNSA and our preliminary findings with program management officials. We then discussed our preliminary assessment results with the officials and lead schedulers for the programs. When warranted, we updated our analyses based on the agency response and additional documentation provided to us.

Based on our analysis of the November 2021 schedule, we found that the entire scope of work for the Plutonium Modernization program—to manufacture 80 pits per year across Los Alamos and Savannah River—is not included in a logically sequenced, dynamic schedule. Additionally, the provided schedule does not contain activities at all NNSA sites necessary to reach 80 pits per year. As a result, we carried out an abbreviated analysis and assessed only the best practices associated with the comprehensive characteristic of a reliable schedule.

To analyze potential costs, we reviewed NNSA and DOE budget information from fiscal years 2020, 2021, 2022, and 2023—the most recent available at the time of our review—for information related to program funding for the pit production effort. We also reviewed NNSA planning documents and reports including NNSA's Fiscal Year 2021 and 2022 Stockpile Stewardship and Management Plans; the most recent capital asset project critical decision documents (for pit manufacturing-related construction projects) available at the time of our review; independent reviews of NNSA's pit production plans; and program management tools for potential cost estimates at both the individual project and overall program level.[2]

[2]Institute for Defense Analyses, *Independent Assessment of the Plutonium Strategy of the National Nuclear Security Administration* (Alexandria, Virginia: Mar. 2019); Department of Energy, *DP Program Execution Instruction* (Nov. 15, 2013; updated Sept. 23, 2021).

Appendix II: Previously Proposed, Cancelled, and Completed Plutonium Infrastructure Projects and Programs

Over the past two decades, NNSA and DOE developed several proposals—none of which came to fruition—to establish a permanent pit production capability and related activities subsequent to the closure of DOE's Rocky Flats Plant in 1989.[1] These included:

Modern Pit Facility. NNSA approved the mission need in fiscal year 2002 for what it called the Modern Pit Facility to create a large production capacity for pits. However, the conference report accompanying the fiscal year 2006 NNSA appropriation stated that it provided no funding for the Modern Pit Facility and directed NNSA to focus on improving its manufacturing capability at Los Alamos National Laboratory (Los Alamos). As a result, NNSA suspended the Modern Pit Facility project indefinitely.

Consolidated Nuclear Production Center. In October 2005, the Secretary of Energy Advisory Board issued a report recommending the creation of a Consolidated Nuclear Production Center that would consolidate a modern set of production facilities, to include plutonium operations, in one location. However, NNSA did not support the board's task force recommendation to create a Consolidated Nuclear Production Center because the agency thought that the center was not affordable, feasible, or capable of meeting near-term stockpile requirements.

Consolidated Plutonium Center. In October 2006, NNSA offered a proposal to address long-standing problems with the condition and responsiveness of nuclear weapon production facilities. NNSA proposed

[1]The minimal pit production capability established at Los Alamos between 2007 and 2012 was never considered permanent.

to build a new, consolidated plutonium center at an existing DOE site that would replace PF-4 at Los Alamos. NNSA suspended its work on the plutonium center after the explanatory statement accompanying the fiscal year 2008 NNSA appropriation stated that no funding was provided for the plutonium center.

Plutonium Modular Approach. The fiscal year 2014 National Defense Authorization Act authorized NNSA to spend funds on a strategy described as constructing a series of modular structures to complement the plutonium functions of PF-4 at Los Alamos. NNSA's October 2017 analysis of alternatives study for the pit production mission found that the Plutonium Modular Approach was not a viable alternative to reach 80 war reserve pits per year by 2030 because of space limitations in the planned facilities.

NNSA took steps, however, to improve plutonium infrastructure at Los Alamos during this time. Some work begun during this period is ongoing and is part of the set of activities to modernize plutonium infrastructure at the site; other activities have been completed. NNSA spent billions of dollars on past infrastructure projects and program activities at Los Alamos, including:

The Technical Area 55 Reinvestment Project. NNSA undertook the Technical Area 55 Reinvestment Project to add about 25 years of expected life to the operation of Los Alamos's Plutonium Facility 4 (PF-4) and its safety systems by upgrading, replacing, and retrofitting facility and infrastructure systems, such as ventilation, electrical, and utilities. NNSA approved the Technical Area 55 Reinvestment Project in 2005 and later divided the project into three distinct capital asset acquisition projects: the Technical Area 55 Reinvestment Project, Phase I; the Technical Area 55 Reinvestment Project, Phase II; and the Technical Area 55 Reinvestment Project, Phase III. Phase I reached completion in 2010 at a total project cost of $19 million. Phase II reached completion in 2014 with a total project cost of $20 million. Phase III is an ongoing capital asset project at Los Alamos.

Nuclear Materials Safeguards and Security Upgrades Project. NNSA conducted the first phase of this project to upgrade security in Technical Area 55 in the early 2000s. Phase II security upgrades at Technical Area 55 began in 2009 and were completed in December 2013 at a total cost of $244 million. Work scope included new security fencing to protect special nuclear material held at Los Alamos and upgrades of entry access control facilities.

Chemistry and Metallurgy Research Replacement (CMRR) Project. The CMRR project at Los Alamos is an ongoing capital asset acquisition project whose scope and mission parameters have changed significantly since its inception. In 2005, NNSA approved the CMRR project to replace the aging Chemistry and Metallurgy Research Facility (CMR) that has supported the laboratory's plutonium work since the 1950s. NNSA conducted plutonium analysis in CMR to support its mission in maintaining the nation's nuclear weapons stockpile. When NNSA approved the CMRR project in 2005 it included the design and construction of two new facilities—a large nuclear facility (the Chemistry and Metallurgy Research Replacement-Nuclear Facility) and a combination radiological laboratory and office building—to house plutonium analysis equipment to replace what remained in the CMR facility. NNSA constructed the Radiological Laboratory Utility Office Building (RLUOB) facility and within it installed a set of plutonium analysis equipment in 2013. In August 2014, after increases in estimated costs, NNSA cancelled plans to construct the Chemistry and Metallurgy Research Replacement-Nuclear Facility. The first three subprojects of CMRR, including at least $350 million in design costs for the cancelled nuclear facility, had a total cost of $835 million. In 2014, DOE officials approved the implementation of the first part of NNSA's new plutonium strategy, the revised CMRR project, which included two subprojects: (1) the RLUOB Equipment Installation Phase 2 subproject (REI2) and (2) the PF-4 Equipment Installation (PEI) subproject. In November 2015, NNSA further restructured the CMRR project into four separate subprojects, which directly support pit production by expanding required plutonium analysis capabilities. Two subprojects address PF-4 and two RLUOB.

- **PF-4 Equipment Installation Phase 1 (PEI1).** This subproject improved initial plutonium analysis capabilities inside PF-4 by providing space through decontamination and disposal of old gloveboxes and relocating existing equipment and processes to other rooms in PF-4. NNSA completed this installation in January 2021.
- **RLUOB Equipment Installation Phase 2 (REI2).** This subproject outfitted RLUOB with equipment to expand its plutonium analysis capability allowing for a transfer of these activities from the old CMR building. NNSA completed REI2 in December 2021.
- **PF-4 Equipment Installation Phase 2 (PEI2).** This subproject continues the work of PEI1 to maximize space in PF-4 to establish an enduring plutonium analysis capability.
- **Re-categorizing RLUOB to Hazard Category 3 (RC3).** This subproject will reconfigure and maximize space for more intensive

plutonium analysis capabilities within RLUOB as well as allow RLUOB to process and analyze a greater quantity of plutonium.[2]

Two of these projects, PEI1 and REI2, were completed in 2021 at a total cost of $794 million.

Plutonium Program Activities. NNSA received $3.6 billion in funding for plutonium and pit-related programmatic activities across the complex between fiscal years 2005 and 2020, an average of $226 million a year, according to DOE budget requests. For example, Plutonium Sustainment (replaced by Plutonium Modernization in fiscal year 2021) supported preventive maintenance and upgrade of key equipment for metal preparation and welding; provided the capability to manufacture parts and components for tests, science, and the enduring stockpile; and continued the development of technology and manufacturing processes for different types of plutonium pits, among numerous other activities over the years.

[2]Upgrading the Radiological Laboratory Utility Office Building (RLUOB) to a hazard category 3 nuclear facility would allow for the building to hold 400 grams of Pu-239 equivalent, up from a prior limit of 38.6 grams. This re-categorization will allow RLUOB to conduct some work that had been anticipated to occur in the Chemistry and Metallurgy Research Replacement-Nuclear Facility prior to that project's cancellation.

Appendix III: Additional Plutonium Missions at Los Alamos National Laboratory

As the National Nuclear Security Administration's (NNSA) designated Plutonium Center of Excellence, Los Alamos National Laboratory (Los Alamos) is responsible for a variety of other plutonium missions beyond plutonium pit production. These additional plutonium missions require activities at facilities in Los Alamos's Technical Area 55, including its Plutonium Facility 4, be conducted concurrently with pit production activities in those facilities. Additional plutonium missions at Los Alamos include the following:

- **Radioisotope Thermoelectric Generator Production.** Produce radioisotope thermoelectric generators, which are lightweight, compact power systems that provide electrical power using the heat from the natural radioactive decay of plutonium 238 (Pu-238).
- **Pu-238 Production.** Produce Pu-238 heat sources for use by the National Aeronautics and Space Administration in radioisotope thermoelectric generators for space exploration.[1]
- **Stockpile Surveillance.** Evaluate pits returned from the nuclear weapons stockpile to support annual stockpile assessments and to inform future pit designs.
- **Subcritical Experiments.** Produce plutonium components for assembly into devices used in subcritical experiments. Subcritical experiments involve the use of high-explosive detonations to drive subcritical quantities of special nuclear material, typically plutonium, to weapon-relevant conditions in order to characterize its response.[2]

[1]See GAO, *Space Exploration: DOE Could Improve Planning and Communication Related to Plutonium-238 and Radioisotope Power Systems Production Challenges*, GAO-17-673 (Washington, D.C.: Sept. 8, 2017) for more information on DOE production of Pu-238 for NASA.

[2]GAO has on-going work looking at NNSA's program to enhance its subcritical experiments capability.

Subcritical experiments are conducted at the Nevada National Security Site.

- **Fundamental Science.** Perform fundamental science on the material properties and aging of plutonium.
- **Surplus Plutonium Disposition.** Process plutonium into forms suitable for disposition to support nonproliferation goals.[3]
- **Americium Oxide Production.** Recover americium for the DOE Office of Science. Americium-241 is a radioactive isotope that is recovered at Los Alamos from the plutonium purification process used in pit production.
- **3013 Container Surveillance and Monitoring.** Provide data used to assess the safe long-term storage of thousands of DOE Standard 3013 containers used to store plutonium-bearing materials across the DOE complex.

[3]See GAO, *Surplus Plutonium Disposition: NNSA's Long-Term Plutonium Oxide Production Plans Are Uncertain,* GAO-20-166 (Washington, D.C.: Oct. 23, 2019) for more information on NNSA's Surplus Plutonium Disposition program.

Appendix IV: Plutonium-Related Maintenance and Recapitalization Projects at Los Alamos National Laboratory

Efforts managed by the National Nuclear Security Administration's (NNSA) Office of Infrastructure include numerous smaller facility maintenance and recapitalization projects proposed for existing infrastructure that are necessary for pit production and the other plutonium missions at Los Alamos National Laboratory (Los Alamos).[1] These projects are generally estimated to each cost less than $25 million and take under 5 years to complete.

These projects, according to NNSA, are necessary for continued operations of the plutonium enterprise and cover a wide range of needs for plutonium operations, such as seismic upgrades, a water loop replacement, and a boiler system upgrade among others. These projects are intended to make facilities at Los Alamos reliably available for programmatic work, address pressing Defense Nuclear Facilities Safety Board concerns, and meet the State of New Mexico Environment Department requirements.[2] Examples of these projects are described in table 5, based on the projects included in NNSA's fiscal year 2023 budget justification.

[1]In a July 2022 reorganization, NNSA abolished the Office of Safety, Infrastructure, and Operations (NA-50) and moved its functions related to site maintenance and recapitalization efforts to the new Office of Infrastructure.

[2]Established by statute in 1988, the Defense Nuclear Facilities Safety Board is an independent establishment in the executive branch that has broad oversight responsibilities regarding the Department of Energy's defense nuclear facilities. The Safety Board has provided independent analysis, advice, and recommendations to the Secretary of Energy regarding the adequacy of public health and safety protections at these facilities. The New Mexico Environment Department permits hazardous waste disposal and conducts environmental monitoring at Los Alamos.

Table 5: Plutonium-Related Maintenance and Recapitalization Projects at Los Alamos National Laboratory Included in Fiscal Year 2023 Budget Justification

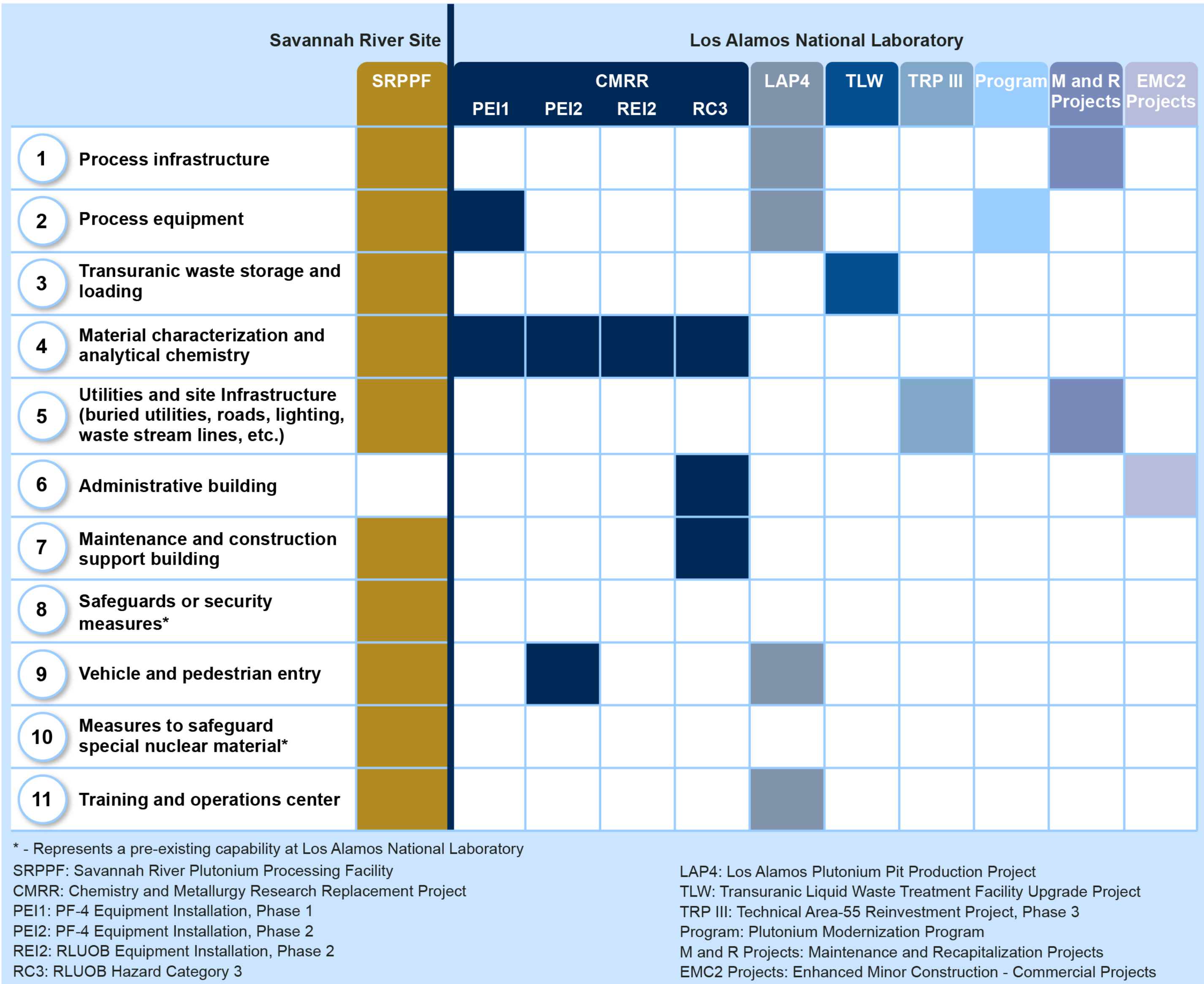
Project	Amount of funding requested for fiscal year 2023 (Dollars in thousands)
Plutonium Facility 4 (PF-4) Zone 2 Bleed Off Fans Replacement	$12,147
PF-4 Zone 1 Exhaust Fan Replacement	$1,868
Radioactive Liquid Waste Treatment Facility Clarifier Number 2 Stabilization	$859
PF-4 PC-3 Fire Suppression System Seismic Modifications	$9,750
PF-4 Vacuum Services Replacement	$11,228
Technical Area 55 Fire Suppression Water Line for Security Facilities (Minor Construction)	$9,472
Total	**$45,324**

Source: NNSA fiscal year 2023 budget justification. | GAO-23-104661

Appendix V: Comparison of Pit Production Infrastructure Development

The National Nuclear Security Administration's (NNSA) plans for producing 30 pits per year at Los Alamos National Laboratory (Los Alamos) involve multiple programs, several large capital asset projects, and a variety of smaller supporting projects. In contrast to Los Alamos, most of NNSA's efforts to establish a plutonium pit production capability at the Savannah River Site currently rely on a single large capital asset project—the Savannah River Plutonium Processing Facility (SRPPF). See figure 11 for a comparison. This reflects, in part, the Savannah River Site's currently limited role in plutonium operations and infrastructure—where surplus plutonium and small-scale dilution of plutonium for disposal is staged—while Los Alamos has had a much greater role in plutonium operations using existing infrastructure, including several non-pit plutonium missions.

Figure 11: Comparison of Pit Production Infrastructure Development at Two Sites



Source: GAO analysis of National Nuclear Security Administration information. | GAO-23-104661

Appendix VI: NNSA's Matrixed Teams for Inter-Office Collaboration on Plutonium Pit Production

The complexity and breadth of NNSA's efforts to achieve an 80-pit-per-year production capability requires the coordination of several NNSA offices and inter-office teams. In addition, NNSA is dependent on Department of Energy Office of Environmental Management project and programmatic activities for waste handling, shipping to the Waste Isolation Pilot Plant, and disposal. To help manage the diverse pit production capability program and project activities and their different management structures and objectives, NNSA has established several matrixed teams for inter-office collaboration. These include the following:

Plutonium Pit Production Matrixed Execution Team (MET). NNSA established the Plutonium Pit Production MET in 2019 and formalized its membership and activities in a November 2020 charter. The MET is a cross-functional body of senior level NNSA executives that is intended to provide ongoing support for the Office of Defense Programs' effort to meet the requirement to produce no fewer than 80 war reserve pits per year during 2030. According to NNSA officials and the MET charter, it is a collaborative forum to review and synchronize resources, schedules, and ongoing activities, but it is not a steering or management body that governs the pit production program. According to the charter, the MET Chair shall resolve conflicts that arise from resource limitations (including funding and staff) and constrained schedules among cross-cutting NNSA divisions. The MET is chaired by a Principal Assistant Deputy Administrator from NNSA's Office of Defense Programs (NA-10), and its principal members include senior leaders from the Office of Infrastructure (NA-90);[1] Office of Defense Nuclear Security (NA-70); Office of

[1]Until NNSA's July 2022 reorganization, principal members now from the Office of Infrastructure represented the Offices of Acquisition and Project Management (NA-APM) and Safety, Infrastructure and Operations (NA-50).

Environment, Safety, and Health (NA-ESH);[2] the Los Alamos Field Office (NA-LA), and the Savannah River Field Office (SRFO).

Pit Production Product Realization Team. The Product Realization Team (PRT) synchronizes activities in order to achieve first production unit (FPU) in fiscal year 2024 and other production milestones leading to production of 30 pits per year in 2026. Its focus is coordinating multi-site process qualification and product certification activities to achieve war reserve pit production at Los Alamos National Laboratory (Los Alamos). Lawrence Livermore National Laboratory leads the PRT as the design agency, with membership by Los Alamos and the Kansas City National Security Campus as the production agencies. Officials from the Plutonium Program Office serve as the principal federal representatives on the PRT. Officials from the W87-1 modification program and Savannah River are observers of the current PRT. As pit production activities increase in support of the 50-pit-per-year milestone at Savannah River, a second PRT will be implemented, according to the W87-1 Interface Agreement from 2019. The PRT updates NNSA program management on progress, issues, and corrective actions during monthly NNSA program meetings, MET meetings, and Quarterly Program Reviews. The PRT was initiated in 2013 to focus on the next pit type for production. The PRT identifies, tracks, and reports progress towards achieving FPU with a focus on certifying that pits meet the criteria of the three phases of product realization—Development, Process Prove-in, and Qualification Evaluation—before they can be deemed war reserve, or ready for inclusion in the stockpile.

Federal Integrated Project Team. A Federal Integrated Project Team (FIPT) is organized and chartered for the specific purpose of delivering a capital asset project of substantial size. According to the Savannah River Plutonium Processing Facility's (SRPPF) FIPT Charter, an FIPT is the cross-functional group of individuals organized and responsible through the federal project director for the successful execution of the project. Team members represent all major functional areas associated with the project and are encouraged to be proactive and make recommendations that may affect the project on behalf of their organizations. As the project progresses, FIPT membership is expected to change and incorporate the

[2]Until NNSA's July 2022 reorganization, the principal member now from the Office of Environment, Safety, and Health (NA-ESH) represented the Office of Safety, Infrastructure and Operations (NA-50).

necessary skills and expertise required for particular phases of the project.

In the case of plutonium pit production, an FIPT is in place for any capital asset project with an appointed federal project director such as SRPPF, the Chemistry and Metallurgy Research Replacement subprojects, and the Los Alamos Plutonium Pit Production Project. Members include NNSA, management and operating contractors, project owner representatives, design agent representatives, construction agent representatives, subcontractors, and other related personnel. The federal project director, who is part of the Office of Infrastructure, is the FIPT's primary point of contact for day-to-day interactions between the various NNSA headquarters offices. The federal project director also coordinates with the Plutonium Program Office to communicate project status and discuss issues or concerns. FIPT members may report to other NNSA or DOE organizational managers, but they are assigned to the project and will be subject to the direction of the FIPT lead. The Director of the Plutonium Program Office, who is also the Plutonium Modernization Program Manager, is responsible for the programmatic requirements, mission need, and budgeting for the capital asset projects. The Plutonium Program Office authorizes and distributes funding for the projects and represents the Office of Defense Programs as the programmatic risk owner. The FIPT also includes the NNSA contracting officer and representatives for Environment, Safety, and Health; Nuclear Safety, Security; Quality Assurance; and other subject matter experts. Subprojects can have their own Federal Integrated Project Teams. For example, for SRPPF, there are deputy federal project directors who are responsible for managing the execution of assigned subprojects and leading subproject Federal Integrated Project Teams.

Other Coordination Groups and Meetings. NNSA and its contractors also participate in a variety of other pit production coordination groups and meetings, including Quarterly Program Reviews; Plutonium Modernization Monthly Program Meetings; Senior Management Team Meetings for SRPPF and the Los Alamos Plutonium Pit Production Project; and weekly or biweekly meetings on program operations at each site. Significant issues are generally raised to the MET and in Quarterly Program Reviews, as well as to the Nuclear Weapons Council for coordination with the Department of Defense.

Appendix VII: NNSA's Budget Estimates for Establishing the Plutonium Pit Production Capability

Table 7 presents the cost-related information for the 80-pit-per-year production capability using NNSA's budget requests from the Fiscal Year 2023 budget justification for NNSA's Weapons Activities account and individual capital asset project documentation. These estimates are of varying quality and maturity based on the rigor of management and reporting requirements applied to the specific program or project and, as such, are limited in reliability for an accurate, total program cost estimate. For example, capital asset projects managed under DOE Order 413.3B are required to have life cycle cost estimates and earned value management, while programs and smaller projects are not. Further, depending on the stage of development and approval of the capital asset project, earlier estimates are ranges, while others are baselined point estimates. This table does not include completed capital asset projects at Los Alamos National Laboratory as of August 2022 or pit-production-related program costs prior to 2021.

Table 6: Budget Estimates for Plutonium Modernization from NNSA's Fiscal Year 2023 Budget Justification

Project/program activities	Budget requests/estimates (Dollars in millions)
Chemistry and Metallurgy Research Replacement Project Plutonium Facility 4 Equipment Installation Phase 2 (PEI2), Los Alamos, through fiscal year 2029	$675–$744
Chemistry and Metallurgy Research Replacement Project Radiological Laboratory, Utility, and Office Building (RLUOB) Hazard Category 3 (RC3) Project, Los Alamos, through fiscal year 2028	$339–$512
Transuranic Liquid Waste Treatment Facility Upgrade Project (TLW), Los Alamos, through fiscal year 2027	$215
Technical Area 55 Reinvestment Project, Phase III (TRP III), Los Alamos, through fiscal year 2027	$236
Los Alamos Plutonium Pit Production Project (LAP4), Los Alamos, through fiscal year 2028	$2,700–$3,900
Los Alamos Maintenance and Recapitalization Projects, fiscal year 2023	$45–$46

Project/program activities	Budget requests/estimates (Dollars in millions)
Los Alamos Support Office Buildings Projects, fiscal years 2023-2027	$240–$244
Savannah River Plutonium Processing Facility (SRPPF), Savannah River, through fiscal year 2035	$6,900–$11,100
Plutonium Modernization Program, fiscal years 2021-2027	$6,940
Total	**$18,290–$23,937**

Source: NNSA fiscal year 2023 budget justification. | GAO-23-104661

Note: Each fiscal year, NNSA is required to submit to Congress its estimated programmatic budget request for the current fiscal year and an additional four fiscal years, per 50 U.S.C. § 2453(a). As a result, NNSA's budget justification for its fiscal year 2023 request also includes estimated requests for program activities in fiscal years 2024 through 2027. In contrast, for construction projects, NNSA's budget justifications include project data sheets that report total estimated project costs through construction completion. The data included in the table for Budget Requests/Estimates reflects program information for fiscal years 2021 through 2027, maintenance and recapitalization project requests for fiscal year 2023, and total project costs through the year the project is scheduled to be completed, based on the information included in NNSA's fiscal year 2023 budget justification.

Appendix VIII: Comments from the National Nuclear Security Administration

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

December 29, 2022

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

Dear Ms. Bawden:

Thank you for the opportunity to review the Government Accountability Office (GAO) draft report, *Nuclear Weapons: NNSA Does Not Have a Comprehensive Schedule or Cost Estimate for Pit Production Capability*, (GAO-23-104661). The Department of Energy's National Nuclear Security Administration (NNSA) appreciates the GAO review of our efforts to establish a pit production capability. This is a complex and challenging undertaking involving the collective efforts of many programs and sites across NNSA's nuclear security enterprise.

We agree with the auditors' recommendation to develop a life cycle cost estimate for NNSA pit production capability that aligns with GAO best practices for cost estimating. NNSA will develop its life cycle cost estimate following the establishment of baseline cost and schedule estimates for the Savannah River Plutonium Processing Facility and the Los Alamos Plutonium Pit Production Project. The life cycle cost estimate will, to the extent practical, align with GAO best practices for cost estimating. The estimated date for completing development of the life cycle cost estimate is September 30, 2025. The NNSA Integrated Master Schedule for pit production, which was implemented in October 2021, will continue to mature over time to become more fully in alignment with GAO best practices for schedule development.

Our subject matter experts have also provided technical and general comments under separate cover for your consideration to enhance the clarity and accuracy of the report. If you have any questions about this response, please contact Dean Childs, Director, Audits and Internal Affairs, at (202) 836-3327.

Sincerely,

Jill H

Jill Hruby

Agency Comment Letter

Text of Appendix VIII: Comments from the National Nuclear Security Administration

December 29, 2022

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U.S. Government Accountability Office
Washington, DC 20548

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Sincerely,

Jill Hruby

Appendix IX: GAO Contacts and Staff Acknowledgments

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In addition to the contact named above, Jonathan Gill (Assistant Director), Ryan Gottschall (Analyst in Charge), John Armstrong, Antoinette Capaccio, Alisa Carrigan, Juaná Collymore, Cindy Gilbert, Bridget Grimes, Jennifer Leotta, Corinna Nicolaou, and Sara Sullivan made key contributions to this report. Also contributing to this report were David Best, Penney Harwell Caramia, Charlotte Hinkle, Thomas McCabe, Phillip McIntyre, and Mary Weiland.

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