United States Government Accountability Office

Report to Congressional Committees

November 2018

NUCLEAR WEAPONS

NNSA Has Taken Steps to Prepare to Restart a Program to Replace the W78 Warhead Capability

GAO-19-84

November 2018

NUCLEAR WEAPONS

NNSA Has Taken Steps to Prepare to Restart a Program to Replace the W78 Warhead Capability

GAO Highlights

Highlights of GAO-19-84, a report to congressional committees

Why GAO Did This Study

The Department of Defense and NNSA have sought for nearly a decade to replace the capabilities of the aging W78 nuclear warhead used by the U.S. Air Force. NNSA undertakes LEPs to refurbish or replace the capabilities of nuclear weapons components. In fiscal year 2014, NNSA was directed to suspend a program that was evaluating a capability that could replace the W78 and also be used by the U.S. Navy. NNSA's most recent estimate—reported in October 2018—was that the combined program would cost about $10 billion to $15 billion. NNSA has been directed by the 2018 Nuclear Posture Review to restart a program to replace the W78 for the Air Force in fiscal year 2019. The 2018 Nuclear Posture Review also directed NNSA and the Navy to further evaluate whether the Navy could also use the warhead.

Senate report 115-125 included a provision for GAO to review NNSA's progress on the program to replace the W78.

GAO's report describes NNSA's steps in key early planning areas—including program management, technology assessment, and coordination with facilities and capabilities—to prepare to restart a program to replace the W78. GAO reviewed documentation on areas such as program management, technologies, and facilities needed for the program, and interviewed NNSA and DOD officials.

What GAO Recommends

GAO is not making recommendations. NNSA and DOD provided technical comments, which GAO incorporated as appropriate.

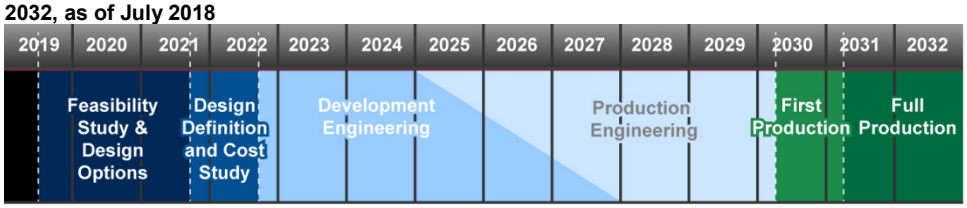
View GAO-19-84. For more information, contact Allison B. Bawden at (202) 512-3841 or bawdena@gao.gov.

What GAO Found

The Department of Energy's National Nuclear Security Administration (NNSA) has taken steps to prepare to restart a life extension program (LEP) to replace the capabilities of the Air Force's W78 nuclear warhead—a program which was previously suspended. According to NNSA officials, these steps are typically needed to conduct any LEP. Therefore, they can be undertaken despite the current uncertainty about whether the final program will develop the warhead for the Air Force only or for both the Air Force and the Navy. Specifically, NNSA has taken the steps described below:

- **Program management.** NNSA has begun to establish the program management functions needed to execute a W78 replacement program, as required by NNSA's program execution instruction. For example, NNSA has started to develop a risk management plan to define the process for identifying and mitigating risks. In addition, NNSA has created a preliminary schedule to restart the program in fiscal year 2019 in the feasibility and design options phase with the goal of producing the first unit in fiscal year 2030. (See figure)
- **Technology assessment.** In May 2018, NNSA completed an assessment of 126 technologies for potential use in a W78 replacement. These included nine technologies that are needed to replace obsolete or no longer available technologies or materials. These are considered "must-do" because they are the only technologies or materials available to meet minimum warhead requirements established by the Department of Defense and NNSA. NNSA officials said that in fiscal year 2019 they will use the assessment to further evaluate technologies for potential use in the warhead.
- **Coordination with facilities and capabilities.** NNSA's program manager is identifying the facilities and capabilities needed to provide components for the warhead. This information will be used to produce a report that identifies aspects of the program—including facilities and capabilities to support it—that could affect the program's schedule and technical risk. However, several of the needed facilities must be built or repaired, and these activities are separately managed and supported outside the W78 replacement program—representing a critical external risk to the program. As mitigation, the program intends to coordinate with the offices that oversee these facilities to draft agreements that describe the work to be performed and timeframes, among other things.

Preliminary W78 Warhead Replacement Program Restart Schedule Fiscal Year 2019 through 2032, as of July 2018



Source: National Nuclear Security Administration. | GAO-19-84

Contents

Abbreviations

DOD	Department of Defense
DOE	Department of Energy
EVM	earned value management
ICBM	intercontinental ballistic missile
IW1	Interoperable Warhead 1
LEP	life extension program
MRL	manufacturing readiness level
NNSA	National Nuclear Security Administration
NPR	Nuclear Posture Review
PPD	Presidential Policy Directive
SLBM	submarine launched ballistic missile
TRL	technology readiness level

U.S. GOVERNMENT ACCOUNTABILITY OFFICE
441 G St. N.W.
Washington, DC 20548

November 30, 2018

Congressional Committees

For nearly a decade, the Department of Defense (DOD) and the Department of Energy's (DOE) National Nuclear Security Administration (NNSA) have sought to replace the capabilities of the W78 nuclear warhead—one of two U.S. Air Force intercontinental ballistic missile (ICBM) warheads.[1] Critical components within the W78 are aging, and the military's requirements for, among other things, the safety and security features of this warhead have changed since it entered the stockpile in 1979. NNSA is responsible for delivering nuclear warheads to the U.S. Air Force and the U.S. Navy, which are organized under DOD, for use in their weapons delivery systems.[2] NNSA and DOD undertake life extension programs (LEPs) to refurbish or replace nuclear weapons components to, among other things, extend the lives of these weapons and enhance the safety and security of the stockpile.

The Nuclear Weapons Council is the joint DOD and DOE activity responsible for matters related to executive-level management of the nuclear weapons stockpile. The Nuclear Weapons Council serves as the focal point for interagency analyses and decisions to maintain and manage U.S. nuclear weapons, and reviews and approves proposed LEPs. When undertaking an LEP, DOD, with input from NNSA, defines the performance, safety, and security requirements for the warhead—known as the military characteristics—which DOD refines over time and finalizes before NNSA begins production. NNSA develops warhead designs to meet these requirements and is ultimately responsible for producing the warheads. The Nuclear Weapons Council is also used to resolve larger questions regarding design and costs for LEPs.

The April 2010 Nuclear Posture Review (NPR)—which described presidential policy on the role of nuclear weapons in national security—directed NNSA and DOD to study options to replace the capabilities of the W78 nuclear warhead in an ICBM system. The NPR also directed the

[1]The second ICBM warhead is known as the W87.

[2]NNSA is a separately organized agency within DOE responsible for the nation's nuclear weapons, nonproliferation, and naval reactor programs. Among other things, NNSA's mission is to maintain and enhance the safety, security, reliability, and performance of the U.S. nuclear weapons stockpile.

agencies to study whether the resulting warhead could also be fielded by the U.S. Navy in its submarine launched ballistic missile (SLBM) system, making the weapon an "interoperable" warhead.[3] In September 2010, DOD and NNSA began assessing concepts for an interoperable warhead to extend the life of the W78 and the Navy's W88 warhead.[4] DOD subsequently began drafting military characteristics that captured a set of joint Air Force and Navy requirements, including an interoperable nuclear explosive package—the explosive core of the weapon—and adaptable nonnuclear components for the Air Force's ICBM and Navy's SLBM systems.[5]

From 2011 through 2014, NNSA, with input from DOD, assessed concepts for the warhead based on the draft military characteristics and completed initial feasibility studies analyzing various warhead design options. NNSA concluded, on the basis of these studies, that the initial design concepts that it proposed could, in principle, be fielded in both Air Force and Navy delivery systems. During this period, the warhead replacement program was initially referred to as the W78 LEP, then as the W78/88-1 LEP,[6] and then subsequently as the Interoperable Warhead

[3]DOD, *Nuclear Posture Review Report* (Washington, D.C.: April 2010).

[4]The Navy has two SLBM warheads—the W88 and the W76. NNSA is currently extending the life of the W76 through an LEP called the W76-1.

[5]A ballistic missile nuclear warhead consists of nuclear and nonnuclear components enclosed within an aeroshell supplied by either the Air Force or the Navy. The nuclear components consist of a primary and a secondary enclosed within a radiation case—referred to as the nuclear explosive package. When detonated, these nuclear components produce the weapon's explosive force, or "yield." The array of nonnuclear components within the weapon control and support the detonation sequence and help ensure its safety and security from human tampering and from environmental effects.

[6]An August 2014 close-out report prepared by Lawrence Livermore National Laboratory (Lawrence Livermore) stated that the potential capabilities of the W78/88-1 could include a capability that could be an LEP for the W88, replace a portion of the W76-1s, or provide a "hedge" to mitigate risks posed by unforeseen technical problems with the W88 or W76-1 or posed by changes in the international security environment. Since 1994, the United States has retained a stockpile of nondeployed weapons to provide a hedge.

1 (IW1).[7] During this four year period, NNSA expended about $114.5 million on the program, according to information provided by NNSA.

In fiscal year 2014, in part because of budget constraints, the Nuclear Weapons Council directed NNSA to suspend the program for an anticipated 5 years, with resumption planned in fiscal year 2020.[8] At the time the program was suspended, NNSA had selected the major components of the nuclear explosive package to replace the capabilities of the W78 and briefed the Nuclear Weapons Council on some of those choices.[9]

In February 2018, DOD issued a new NPR that revised nuclear weapons policy and programs.[10] Rather than endorsing the interoperable warhead concept, it directed NNSA and DOD to restart the program to replace the W78 warhead and to continue to investigate the feasibility of fielding the nuclear explosive package in a Navy SLBM system. It also directed NNSA to restart the W78 replacement warhead program a year early, in fiscal year 2019, to better align its schedule with the Air Force's schedule for modernizing its ICBM system.[11] NNSA's most recent preliminary cost estimate—reported in October 2018 and based on a program to provide a warhead to both the Air Force and Navy—was that the program would

[7]NNSA called the warhead IW1 because it was to be the first of three "interoperable warheads" that the agency planned to develop and produce between about 2020 and 2050. These interoperable warheads were part of the Nuclear Weapons Council's long-term plan for the stockpile adopted in January 2013 and called the "3+2 strategy." In addition to the three interoperable warheads, the plan included development of two air-delivered weapons. This plan aimed to achieve goals established by the 2010 NPR to reduce the number of warhead types and retain the smallest possible nuclear stockpile consistent with the need to deter adversaries, reassure allies, and hedge against technical or geopolitical surprise, among other things.

[8]According to NNSA officials, during fiscal years 2015 through 2017, NNSA expended an additional $4.3 million using "carry over" funding from prior fiscal years to support activities to close out the W78/88-1 LEP and evaluate the impacts of the program suspension on the existing W78 and W88 warheads.

[9]The program plans to replace the W78 pit with one based on the W87 design. The pit is part of a weapon's primary.

[10]DOD, *Nuclear Posture Review* (Washington, D.C.: February 2018).

[11]According to the 2018 NPR, the Air Force's ICBM modernization program—which is intended to replace the outdated Minuteman III ICBM that carries the W78 and W87 warheads—is referred to as the Ground Based Strategic Deterrent. The 2018 NPR specifically directed that the W78 replacement program be advanced by one year to support fielding it on the new system by 2030.

cost about $10 billion to $15 billion from fiscal year 2019 through fiscal year 2041.[12]

The Senate Armed Services Committee report 115-125 accompanying S. 1519, a bill for the National Defense Authorization Act for Fiscal Year 2018, includes a provision for GAO to report on NNSA's progress on the IW1. This report describes the steps that NNSA has taken to prepare a W78 replacement program for restart.[13]

To describe the steps that NNSA has taken to prepare a W78 replacement program for restart, we focused on the agency's planning and activities during fiscal years 2015 through 2018. In particular, we focused on planning activities related to program management and personnel, technology development and assessment, and coordination with facilities and capabilities because they are key areas in the early planning phases of NNSA's LEP process. We reviewed documentation on NNSA's planning for program management, technologies, and facilities for a W78 replacement program, such as internal briefing documents and a technology readiness assessment that NNSA completed in May 2018 in preparation to restart the program. We interviewed NNSA officials as well as contractors from Lawrence Livermore, Los Alamos National Laboratory (Los Alamos), and Sandia National Laboratories (Sandia) to obtain information about the planning for program management and personnel, technology, and facilities needed for the program. We interviewed contractors at these laboratories because they are involved in the design of the nuclear warheads and warhead components.[14] We also interviewed NNSA officials in the Office of Technology Maturation to learn about technology development related to a W78 replacement, and in the Office of Systems Engineering and Integration to learn about the results of the

[12]NNSA, *Fiscal Year 2019 Stockpile Stewardship Management Plan - Biennial Plan Summary*, Report to Congress (Washington, D.C.: October 2018). NNSA's plan, updated annually, is the agency's formal means of communicating to Congress information on NNSA's 25-year program of record to maintain the safety, security, and effectiveness of the nuclear stockpile.

[13]Because the plan for an interoperable warhead is uncertain, for the purposes of this report we refer to the program as the W78 replacement program. According to NNSA officials who reviewed a draft of our report, in September 2018 the Nuclear Weapons Council endorsed the name "W87-1" for the program when it restarts at the end of November 2018.

[14]We are separately reviewing manufacturing capacity planning at NNSA's Kansas City National Security Campus which procures and produces nonnuclear components of nuclear weapons.

technology readiness assessment and the potential impact of the program on facilities within the nuclear security enterprise. We also interviewed officials from DOD's Office of the Deputy Assistant Secretary of Defense for Nuclear Matters, the Air Force Nuclear Weapons Center, the Navy Strategic Systems Programs, and the U.S. Strategic Command to learn about their roles in preparing to restart the program and in setting requirements for the warhead.

We conducted this performance audit from October 2017 to November 2018, in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

This section describes (1) NNSA's weapons design and production sites; (2) the framework for managing LEPs, known as the Phase 6.X process, and NNSA's program execution instruction; and (3) NNSA's technology development and assessment process.

NNSA Weapons Design and Production Sites

NNSA oversees three national security laboratories—Lawrence Livermore in California, Los Alamos in New Mexico, and Sandia in New Mexico and California. Lawrence Livermore and Los Alamos are the design laboratories for the nuclear components of a weapon, while Sandia works with both to design nonnuclear components and as the system integrator. Los Alamos led the original design of the W78, but Lawrence Livermore is leading current efforts to design the replacement warhead.

NNSA also oversees four nuclear weapons production plants—the Pantex Plant in Texas, the Y-12 National Security Complex in Tennessee, the Kansas City National Security Campus in Missouri, and the Savannah River Site in South Carolina.[15] In general, the Pantex Plant assembles, maintains, and dismantles nuclear weapons; the Y-12 National Security Complex produces the secondary and the radiation case; the Kansas City

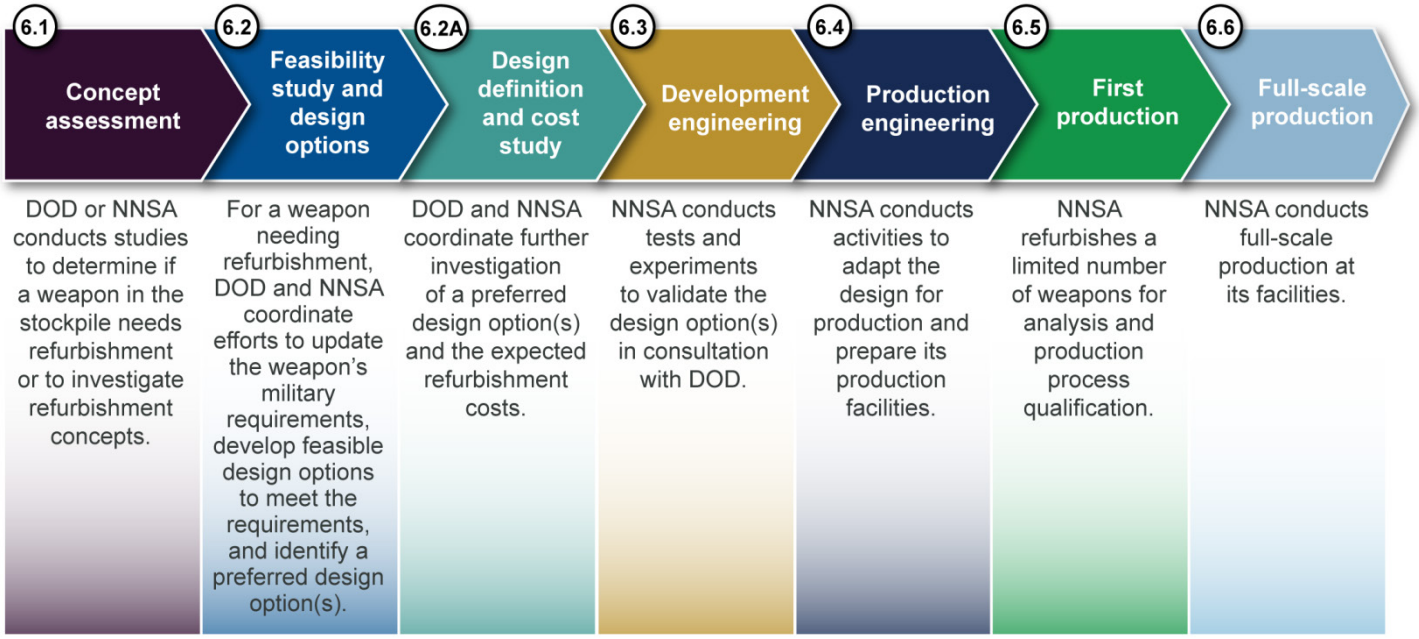
[15]The Pantex Plant and Y-12 National Security Complex are managed and operated by a single contractor, Consolidated Nuclear Security.

National Security Campus produces nonnuclear components; and the Savannah River Site replenishes a component known as a gas transfer system that transfers boost gas to the primary during detonation.

Phase 6.X Process for Managing LEPs and NNSA's Program Management Directive

DOD and NNSA have established a process, known as the Phase 6.X process, to manage life extension programs.[16] According to a Nuclear Weapons Council document, NNSA's Office of Defense Programs will follow this process to manage a W78 replacement program. As shown in figure 1, this process includes key phases or milestones that a nuclear weapon LEP must undertake before proceeding to subsequent steps.

Figure 1: Phase 6.X Process for Managing Warhead Life Extension Activities for Nuclear Weapons



Abbreviations
DOD Department of Defense
NNSA National Nuclear Security Administration

Source: Nuclear Weapons Council. | GAO-19-84

[16]DOD and NNSA, *Procedural Guideline for the Phase 6.X Process* (Washington, D.C.: December 2015).

In January 2017, while the program was still suspended, NNSA issued a supplemental directive that defines additional activities that NNSA offices should conduct in support of the Phase 6.X process.[17] For example, as discussed below, NNSA's supplemental directive established a new requirement during Phase 6.1 (Concept Assessment) that NNSA conduct a technology readiness assessment of technologies proposed for potential use in the warhead. In addition, NNSA's Office of Defense Programs issued a program execution instruction that defines enhanced program management functions for an LEP and other programs.[18] This instruction also describes the level of program management rigor that the LEP must achieve as it advances through the Phase 6.X process.

NNSA's Technology Development and Assessment Process

According to NNSA's *Fiscal Year 2018 Stockpile Stewardship Management Plan*, NNSA extends the life of existing U.S. nuclear warheads by replacing aged nuclear and non-nuclear components with modern technologies. In replacing these components, NNSA seeks approaches that will increase safety, improve security, and address defects in the warhead. Several technologies are frequently developed concurrently before one approach is selected. According to NNSA's *Fiscal Year 2018 Stockpile Stewardship Management Plan*, this approach allows selection of the option which best meets warhead requirements and reduces the risks and costs associated with an LEP. NNSA conducts technology readiness assessments to provide a snapshot in time of the maturity of technologies and their readiness for insertion into a program's design and schedule, according to NNSA's guidance.[19] NNSA's assessments also look at the ability to manufacture the technology. NNSA measures technological maturity using technology readiness levels (TRLs) on a scale from TRL 1 (basic principles developed) through TRL 9 (actual system operation). Similarly, NNSA measures manufacturing readiness using manufacturing readiness levels (MRL) on a scale from MRL 1 (basic manufacturing implications identified) through MRL 9 (capability in place to begin full rate production). According to NNSA's guidance, NNSA recommends but does not require that an LEP's critical technologies reach TRL 5 (technology components are integrated with

[17]NNSA, *Phase 6.X Process*, Supplemental Directive, SD 452.3-2 (Jan. 19, 2017).

[18]NNSA, *DP Program Execution Instruction: NA-10 Program Management Tools and Processes* (January 2016).

[19]NNSA, *Defense Programs, Technology Readiness Assessment Implementation Guide Revision 3* (Washington, D.C.: January 2018).

realistic supporting elements) at the beginning of Phase 6.3 (Development Engineering).[20] At the end of Phase 6.3, it recommends that a technology be judged to have achieved MRL 5 (capability to produce prototype components in a production relevant environment). However, according to NNSA officials, lower TRLs and MRLs may be accepted in circumstances where a technology is close to achieving the desired levels or the program team judges that the benefit of the technology is high and worth the increased risk that it may not be sufficiently mature when the program needs it.

NNSA Has Taken Steps to Prepare to Restart a Program to Replace the W78 Nuclear Warhead Capability

NNSA has taken steps to prepare to restart a program to replace the W78 nuclear warhead capability. According to NNSA officials, these steps are typically needed to conduct any LEP. Therefore, they can be undertaken despite the uncertainty about whether the final program will develop the warhead for the Air Force only or for both the Air Force and the Navy. Specifically, NNSA has (1) taken initial steps to establish the program management functions needed to execute the program and assemble personnel for a program management team; (2) assessed technologies that have been under development while the program was suspended that could potentially be used to support a W78 replacement; and (3)

[20]We reported in January 2018 that NNSA has not established requirements for LEPs to ensure that their critical technologies meet TRL benchmarks at key Phase 6.X decision points. We recommended that the Administrator of NNSA should require its programs to ensure that LEP critical technologies meet specific TRL benchmarks at decision points, or otherwise document with program executive approval their rationale for not meeting these benchmarks. NNSA stated that it has already taken steps to include specific suggested benchmarks at decision points, but we continue to believe that without establishing a requirement to meet specific TRL benchmarks at decision points or to document with program executive approval the rationale for not meeting these benchmarks in cases where an LEP's critical technology does not meet a specific TRL, NNSA may not have a sufficiently developed process for assessing and accepting technical risk. See 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).

initiated plans for the facilities and capabilities needed to provide the nuclear and nonnuclear components for the warhead.[21]

At the time of our review, NNSA and DOD officials stated that, in response to the 2018 NPR, they planned to restart a program that would focus on replacing the capabilities of the W78 for the Air Force; however, the extent to which the program would focus on providing a nuclear explosive package for the Navy was uncertain.[22] DOD officials said that the Navy plans to complete a study examining the feasibility of using the nuclear explosive package developed for the W78 replacement warhead in its SLBM system by the end of fiscal year 2019.[23] According to DOD officials, the Nuclear Weapons Council will make a decision about developing an interoperable warhead for the Air Force and the Navy based on the results of the study but, as of August 2018, had not established time frames for making that decision. According to Air Force and NNSA officials, if the Nuclear Weapons Council decided that the Navy should participate in the program, then NNSA would not need to redo the work planned for fiscal year 2019.

Program Management and Personnel

NNSA has taken initial steps to establish the program management functions needed to execute the program and assemble personnel for a program management team, as follows:

[21]According to NNSA officials, to complete program readiness activities such as development of initial drafts of program documents in fiscal year 2018 and the technology readiness assessment (discussed below), NNSA used federal staff and federal support contractor staff paid with funds available under its federal salaries and expenses appropriation. According to NNSA officials, NNSA has not had direct program funds available for a W78 replacement or IW1 life extension program since the IW1 program was suspended in fiscal year 2014. NNSA's fiscal year 2019 budget justification included a request for approximately $53 million under its weapons activities appropriation to support direct program activities in fiscal year 2019.

[22]According to NNSA officials who reviewed a draft of our report, NNSA will not restart the program in fiscal year 2019 until the agency delivers a report to Congress. Specifically, the conference report accompanying the bill to provide fiscal year 2019 appropriations for NNSA directed NNSA to provide to the appropriations committees an updated estimate of the cost and schedule for the W78 replacement warhead development and production, among other things. This report is due no later than 60 days after enactment and prior to commencement of Phase 6.2. H.R. Rep. No. 115-929, at 165 (2018). The bill was enacted on September 21, 2018. Pub. L. No. 115-244 (2018).

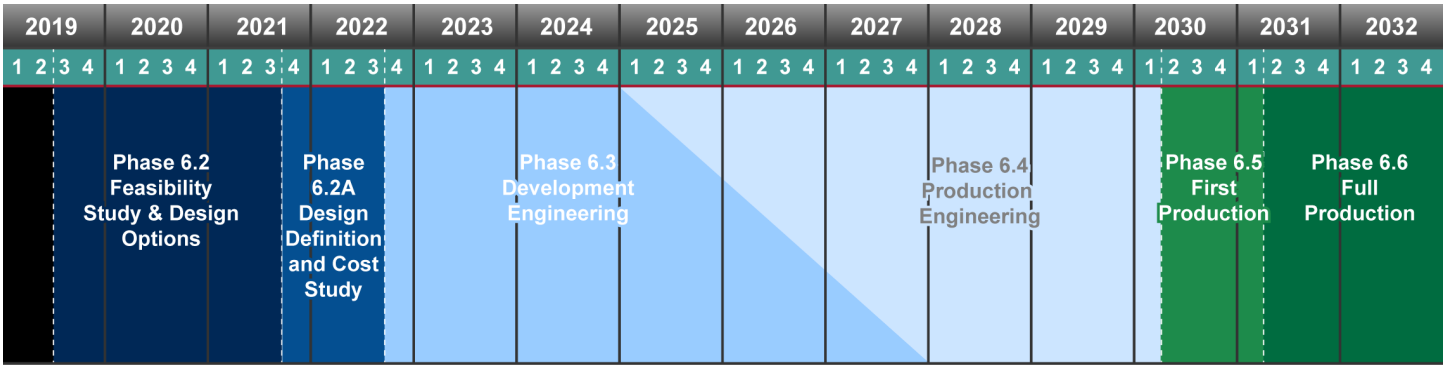
[23]The Navy's fiscal year 2019 budget justification included a request for $48 million for fiscal year 2019 to study the feasibility of using a W78 replacement warhead in its SLBM system.

- **Program management.** In fiscal year 2018, NNSA started to establish the program management functions needed to execute a W78 replacement program, as required in the Office of Defense Programs' program execution instruction. In preparation for the program restart, NNSA assigned a manager for a W78 replacement program who is taking or plans to take steps to implement these functions. For example, among other steps, the W78 replacement program manager told us that he had started developing the risk management plan to define the process for identifying and mitigating risks that may impact the program. The program manager also said NNSA had started to adapt a standardized work breakdown structure for life extension programs to define and organize the W78 replacement program's work scope for restart.[24] An initial version of this work breakdown structure would be completed before the program restarts in fiscal year 2019, according to the program manager. Further, as NNSA refines the scope of work, the agency will refine and tailor the work breakdown structure. At the time of our review, this work was under development and therefore we were not able to review these plans and tools.

  In addition, as of July 2018, NNSA had created a preliminary schedule for a W78 replacement program under the Phase 6.X process (see fig. 2).

[24]A work breakdown structure is a product-oriented breakdown of the work scope into discrete elements of work to provide a means for integration of cost, schedule, and scope of each element.

Figure 2: NNSA's Preliminary W78 Warhead Replacement Program Restart Schedule under the Phase 6.X Process from Fiscal Year 2019 through 2032, as of July 2018



Source: National Nuclear Security Administration. | GAO-19-84

Notes: The numbers 1,2,3,4 below the year refer to the quarters of the fiscal year. The Department of Defense and Department of Energy's National Nuclear Security Administration (NNSA) have established a process, known as the Phase 6.X process, to manage life extension programs such as the W78 replacement program. NNSA will restart the program in Phase 6.2 (Feasibility and Design Options). NNSA completed Phase 6.1 (Concept Assessment) and initially started Phase 6.2 in June 2012 before the program was suspended in fiscal year 2014.

According to NNSA's preliminary schedule, the program will:

- Restart in Phase 6.2 (Feasibility and Design Options) in the third quarter of fiscal year 2019. NNSA previously completed Phase 6.1 and was authorized by the Nuclear Weapons Council to start Phase 6.2 in June 2012. During Phase 6.2, NNSA plans to, among other things, select design options and develop cost estimates of the selected design options.
- Conduct Phase 6.2A (Design Definition and Cost Study) for one year beginning in the fourth quarter of fiscal year 2021. During this phase, for example, NNSA plans to develop a preliminary cost estimate for the program, called a weapons design and cost report, and also produce an independent cost estimate.
- Start Phase 6.3 (Development Engineering) in the fourth quarter of fiscal year 2022 and transition to Phase 6.4 (Production Engineering) in the mid-2020s. During these phases, NNSA will develop the final design as well as begin producing selected acquisition reports, which detail the total program cost, schedule, and performance, among other things. According to the W78 program manager, the military characteristics will be finalized in Phase 6.4 and before that point DOD will continue to update the requirements.

- Achieve production of the first warhead—Phase 6.5—by the second quarter of fiscal year 2030 so that it can be fielded on the Air Force's planned Ground Based Strategic Deterrent that same year.
- Start Phase 6.6 (Full Scale Production) by the second quarter of fiscal year 2031.

When the program restarts in fiscal year 2019, NNSA intends to develop or finalize initial versions of other plans and tools such as a requirements management plan, according to the program manager.[25] (See appendix I for a detailed description of the steps NNSA is taking or plans to take to establish the program management functions needed to execute a W78 replacement program, according to the manager for the W78 replacement program.)

The program manager also told us that as the program progresses through Phases 6.2 (Feasibility and Design Options), 6.2A (Design Definition and Cost Study), and 6.3 (Development Engineering), NNSA will increase the maturity of the program management processes and tools, consistent with the Office of Defense Programs' program execution instruction. For example, in Phases 6.2 and 6.2A, NNSA intends to establish an earned value management system (EVM)—used to measure the performance of large, complex programs.[26] In Phase 6.3, NNSA will further develop the system to be consistent with DOE and industry standards, as specified in the

[25]A requirements management plan is used to organize and manage requirements ranging from high-level, policy and strategic documents down to production requirements at the contractor level. NNSA guidance directs that a database be used to manage the requirements.

[26]An EVM system is a management tool that measures the value of work accomplished in a given period and compares it with the planned value of work scheduled and the actual cost of work accomplished. EVM is a means of conducting cost and schedule performance analysis. It provides an objective view of program status and can alert program managers to potential problems sooner than expenditures alone can.

program execution instruction.[27] NNSA officials said they will need to achieve sufficient program management rigor in Phase 6.3 to effectively report to Congress on the status and performance of the program as NNSA develops cost and schedule baselines.

- **Personnel.** At the time of our review, NNSA was reconstituting a program management team. Specifically, as mentioned above, NNSA assigned a new program manager in March 2017. In the spring of 2018, NNSA began assigning additional federal staff and contractor support to help ramp up the program in advance of the fiscal year 2019 restart date. According to the program manager, he expected to complete a plan in the late summer or early fall of 2018 that NNSA could use to hire additional federal staff needed to manage the program in fiscal year 2019. The advanced development and implementation of staffing plans prior to each phase of an LEP was a key lesson learned from an NNSA review of another LEP—the W76-1.[28]

Technology Development and Assessment

While the program was suspended, NNSA supported other programs that developed weapons technologies—including materials and manufacturing processes—that could potentially be used by the W78 replacement program and potentially by other future life extension programs.[29] Specifically, according to NNSA officials, NNSA supported the development of technologies through ongoing LEPs (such as the W80-4 LEP) and other technology maturation projects (such as the Joint

[27]We reported in January 2018 that NNSA has not adopted two best practices related to the use of EVM that could help the agency better manage risk for its LEPs, which are having an independent entity both validate EVM systems against the EVM national standard and conduct surveillance reviews on EVM systems. We recommended that the Administrator of NNSA should require an independent entity to (1) validate that contractor EVM systems used for LEPs meet the EVM national standard, and (2) conduct surveillance reviews of contractor EVM systems used for LEPs to ensure that they maintain compliance with the EVM national standard through program completion. NNSA stated that it agreed with our recommendations but also stated that it has already addressed them, as discussed in our January 2018 report. We reported that we disagree and believe that further action is needed to address the two recommendations. See 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).

[28]NNSA, *Defense Programs W76-1 Life Extension Program Lessons Learned Study*, (Washington, D.C.: Aug. 3, 2017).

[29]NNSA officials told us that they cannot disaggregate the spending on these programs to quantify an amount of spending attributable to benefit a specific future warhead program such as a W78 replacement program.

Technology Demonstrator) that could support future LEPs.[30] For example, the W80-4 program has supported development at Lawrence Livermore of certain new materials as a risk mitigation strategy in case certain legacy materials used in the secondary are not available. According to NNSA officials, NNSA will likely continue to develop these new materials for use in future weapons, including the W78 replacement. In addition, contractors at Lawrence Livermore told us that test demonstrations conducted under the Joint Technology Demonstrator have helped to mature potential technologies for a W78 replacement. Examples they cited included additively manufactured mounts and cushions for securing and stabilizing the nuclear explosive package inside the Air Force's aeroshell.[31]

In May 2018, in anticipation of the restart of a W78 replacement program and to retroactively address NNSA's new supplemental requirement to conduct a technology readiness assessment in Phase 6.1, NNSA's Office of Systems Engineering and Integration completed a technology readiness assessment that evaluated the maturity of technologies potentially available for the W78 replacement program.[32] According to NNSA officials, the assessment identified and evaluated technologies that NNSA would have available for the next LEP, irrespective of whether the final program will replace the W78 warhead in ICBMs only or will also be used in the Navy's SLBMs.

The assessment evaluated 126 technologies based on proposals from the laboratories and production sites. As shown in table 1 below, the

[30]The W80-4 LEP is supported by the Office of Defense Programs' Office of Major Modernization and is focused on extending the life of the W80 cruise missile warhead. The Joint Technology Demonstrator is supported by the Office of Defense Programs' Office of Technology Maturation under its Demonstrator Initiatives program. The Joint Technology Demonstrator is a strategic collaboration between the United States and United Kingdom dedicated to the design and development of a series of joint tests demonstrating new safety, security, and advanced manufacturing technologies. The Joint Technology Demonstrator is intended to buy down risk in preparation for future systems, such as the W78 replacement, by exercising the capability to design, develop, produce, and certify nuclear weapon components.

[31]Additive manufacturing refers to advanced, next-generation manufacturing processes that focus on the use of technology that prints three-dimensional objects, also known as 3D printing.

[32]NNSA's Office of Systems Engineering and Integration was directed to conduct the assessment in March 2017. Because the assessment was initiated before DOD released the 2018 NPR, the assessment used the warhead name, IW1, which was the Nuclear Weapons Council's name for the suspended program of record at the time.

proposals related to key functional areas of the warhead, including the nuclear explosive package and the arming, fuzing, and firing mechanism—which provides signaling that initiates the nuclear explosive chain.[33] For the W78 warhead replacement, DOD divided the military characteristics into two categories: threshold or minimum requirements (or "needs") and objective or optional requirements (or "wants"). NNSA's assessment grouped the technologies into one of three categories, as follows.[34]

- **Must do.** A technology deemed "must do" means that it is the only technology available that can meet a minimum requirement (or "need") for the warhead to function. The technology that previously fulfilled this requirement is generally obsolete or no longer produced, and there are no alternatives.
- **Must do (trade space).** "Must do (trade space)" technologies fulfill a minimum requirement (or "need") for the warhead, but there are two or more technologies that could meet this need. NNSA must evaluate and select which technology it will use to fulfill the need.
- **Trade space.** "Trade space" technologies are those that can meet an optional requirement (or "want") for the warhead.

[33]The other functional areas were cabling, electronics, and sensors; gas transfer system; neutron generators—which provides neutrons at specific timing and rates to initiate weapon function; material, production, and surveillance; and surety—which refers to management of the four areas of risk in a nuclear weapon: (1) safety, (2) security, (3) control of unauthorized use or detonation (i.e., use control), and (4) reliability.

[34]According to NNSA's assessment, future decisions about system design could lead NNSA to recategorize some of the technologies.

Table 1: Numbers of Technologies that the National Nuclear Security Administration (NNSA) Evaluated for Inclusion in a W78 Warhead Replacement, by Functional Area of the Warhead and Specified Categories

Functional area	Must do	Must do (trade space)	Trade space
Arming, fuzing, and firing	3	10	11
Cabling, electronics, and sensors	1	3	10
Gas transfer system	0	2	0
Neutron generators	0	4	0
Nuclear explosive package	1[a]	15[a]	9[a]
Material, production, and surveillance	1[a]	13[a]	34[a]
Surety	3	12	11[a]
Total	**9**	**59**	**75**

Source: NNSA's Technology Readiness Assessment for the Interoperable Warhead-1/W78 replacement. May 2018. | GAO-19-84

Notes: The "must do" category means the technology is the only technology to meet a minimum requirement (or "need") for the warhead; the "must do (trade space)" category means the technology is one of several technologies that meet a minimum requirement (or "need"); and the "trade space" category means the technology is one of several technologies that can meet an optional requirement (or "want").

[a]Indicates overlap of technologies in functional areas. NNSA evaluated a total of 126 technologies.

Among the nine "must do" technologies that NNSA evaluated, for example, was a new manufacturing process being developed at Sandia to produce a type of magnesium oxide—needed for use in the thermal batteries that power the warhead's firing mechanism—that is no longer available from a vendor and for which NNSA's existing supplies are limited. For this new process, the assessment team estimated that it had completed TRL 1 (basic principles developed) but had not yet reached MRL 1 (basic manufacturing implications identified). The technology readiness assessment noted that for technologies with a TRL of 3 or less, an MRL of 1 or less is expected. In addition, according to the report, Sandia estimated that it may cost about $7.1 million to develop the material and manufacturing process to TRL 5 and MRL 4 during fiscal years 2018 through 2023—when the program is slated to reach Phase 6.3—to achieve a level of readiness where it could potentially be included in the design of the W78 replacement warhead.

Among the 59 "must do (trade space)" technologies that NNSA evaluated were, for example, two new gas transfer system technologies developed by Sandia that may offer advantages compared with the existing technology. A gas transfer system is a required capability (or "must do")

but, according to the technology readiness assessment report, NNSA needs to compare the costs, benefits, and risks of these new technologies with the traditional technology (i.e., evaluate the "trade space") and make a selection among them. The first new technology was a gas transfer system bottle made out of aluminum that could be cheaper, weigh less, and last longer than the gas transfer system used in the W78. According to the technology readiness assessment report, the assessment team estimated the aluminum-based bottle had completed TRL 2 but did not have enough information to estimate an MRL. Sandia estimated that it would cost about $6.5 million to achieve TRL 5 and MRL 4 during fiscal years 2018 through 2023.[35] The second Sandia technology involved an advanced gas transfer system technology. The assessment team estimated that this technology had completed TRL 3 but did not have enough information to estimate an MRL. Sandia estimated that it would cost about $5.4 million to achieve TRL 5 and MRL 4 during fiscal years 2018 through 2023.[36] According to the technology readiness assessment report, NNSA will need to further evaluate these approaches as well as the traditional technology to make a selection for a W78 replacement program.

The 75 "trade space" technologies that the assessment team evaluated included, for example, several proposed by Lawrence Livermore, Los Alamos, and Sandia for providing an advanced safety feature to prevent unauthorized detonation of the warhead. As mentioned above, when NNSA extends the life of existing U.S. nuclear warheads it also seeks approaches that will increase the safety and improve security of the warhead.[37] According to the report, the laboratories proposed similar concepts that varied in maturity levels and estimated costs for further development. Specifically, the assessment team estimated the Lawrence

[35]According to a Sandia representative, Sandia expects the technology's MRL to transition from MRL 1 to MRL 3 rapidly once NNSA's production sites have funding and staff to partner with Sandia on the W78 replacement program activities.

[36]According to a Sandia representative, the TRL and MRL for this gas transfer system technology would be higher if the decision were made to not include certain capability.

[37]According to NNSA officials, Presidential Policy Directive (PPD)-35 requires NNSA to seek approaches to enhance safety and security of the stockpile when undertaking an LEP. According to NNSA's implementation guide for PPD-35, the directive, among other things, establishes policies and objectives for nuclear weapon safety, security, incident response, and use control capabilities and activities. It also sets a goal for NNSA to incorporate internal use control during weapon refurbishments and external use control to reduce near-term risks. NNSA, *Defense Programs PPD-35 Implementation Guide: Use Control Requirements* (June 2016).

Livermore and Los Alamos technologies to have completed TRL 4 and Sandia's proposal to have completed TRL 3. Regarding MRLs, the assessment team also estimated Lawrence Livermore's technology to have completed MRL 1, Los Alamos's technology to be at MRL 1, and did not have enough information to estimate the MRL for Sandia's technology. In addition, according to the report, Lawrence Livermore estimated costs of about $31.2 million to $45.6 million to further mature its technology during fiscal years 2018 through 2023. Los Alamos estimated costs of about $72.1 million to $154.5 million to further mature its technology during the same period. Sandia estimated costs of about $8.2 million to further mature its technology during the same period. Because the feature is not a minimum requirement, NNSA officials told us that they are continuing to evaluate the costs, benefits, and risks of including the feature.

According to NNSA's manager for the W78 replacement program and key staff involved in preparing to restart the program, when the program restarts in fiscal year 2019 they will use the assessment to identify specific technologies or groups of technologies (i.e., trade spaces) to further evaluate for potential use in the warhead. These officials said they will continue evaluating technologies and make selections of preferred options at the same time that the warhead's program requirements and priorities are refined during Phases 6.2 and 6.2A. According to the program manager, NNSA will produce a technology development plan for technologies selected for a W78 replacement during Phase 6.2 and 6.2A and that will identify the current readiness levels of the technologies, key risks, and estimated costs to bring them to TRL 5 in Phase 6.3.

In addition, the technology readiness assessment team made several recommendations to the NNSA Deputy Administrator for Defense Programs regarding the development of technologies that could provide benefits to the nuclear security enterprise overall. For example, the assessment team observed that 21 of the proposed technologies for a W78 replacement involved the use of additive manufacturing. The assessment noted that, if successful, these technologies could reduce component production costs and schedule risks for future LEPs compared to current methods. The team recommended that the Office of Defense Programs conduct an analysis to validate these capabilities and develop a nuclear enterprise-wide effort to address additive manufacturing for a W78 replacement, future LEPs, and other applications. According to the NNSA official who led the assessment, at the time of our review, the assessment team was preparing to present its enterprise-wide recommendations to the Office of Defense Program's

senior leadership; therefore, specific follow-on actions had not yet been decided.

Coordination with Facilities and Capabilities

The manager of the W78 replacement program said that he has begun to identify the facilities and capabilities at the laboratories and production sites that will be needed to provide the nuclear and nonnuclear components for a W78 replacement, and plans to draft formal agreements to help ensure coordination with them. According to the program manager, collecting the information that identifies facilities and capabilities—including a rough idea of key milestone dates for when the program will need to use them—is the first step in producing a major impact report, which is required upon completion of Phase 6.2 and accompanies the final Phase 6.2 study report delivered to the Nuclear Weapons Council. Among other things, a major impact report identifies aspects of the program—including facilities and capabilities to support it—that could affect the program's schedule and technical risk, according to the Phase 6.X guidelines.

According to an NNSA official and contractor representatives, many of the existing nuclear and nonnuclear components of the W78 are outdated or unusable and a W78 replacement will need all newly manufactured components. As a result, NNSA will need to exercise numerous manufacturing capabilities in support of this effort, and the facilities and capabilities must be ready to support the work. However, many of the facilities that may be needed to provide components for a W78 replacement program are outdated and are undergoing modernization to either build new facilities or repair existing facilities and capabilities, which represents a critical external risk to the program. According to NNSA's *Fiscal Year 2018 Stockpile Stewardship and Management Plan*, these planned modernization activities will require sustained and predictable funding over many years to ensure they are available to support the weapons programs. Some examples of NNSA activities to build or repair facilities and capabilities that will provide nuclear or nonnuclear components for a W78 replacement warhead—and which may have

schedule, cost, or capacity issues that could impact the program—include:[38]

- **Plutonium pit production facilities.** NNSA does not currently have the capability to manufacture sufficient quantities of plutonium pits for a W78 replacement program. NNSA's *Fiscal Year 2018 Stockpile Stewardship and Management Plan* stated that the agency will increase its capability to produce new pits over time, from 10 pits per year in fiscal year 2024 to 30 pits per year in fiscal year 2026, and as many as 50 to 80 pits per year by 2030.[39] NNSA is refurbishing its pit production capabilities at Los Alamos to produce at least 30 pits per year. In addition, in May 2018, NNSA announced its intention to repurpose the Mixed Oxide Fuel Fabrication Facility at the Savannah River Site in South Carolina to produce at least an additional 50 pits per year by 2030. NNSA officials told us that they will need both the Los Alamos and Savannah River pit production capabilities to meet anticipated pit requirements for the W78 replacement program and for future warhead programs.
- **Uranium processing facilities.** NNSA's construction of the Uranium Processing Facility at the Y-12 National Security Complex will help ensure NNSA's continued ability to produce uranium components for the W78 replacement program. NNSA plans to complete the facility for no more than $6.5 billion by the end of 2025—approximately 4 years before the scheduled delivery of the first production unit of a W78 replacement program warhead. This effort is part of a larger NNSA plan to relocate and modernize other enriched uranium

[38]We have recently completed or planned work on each of these facilities. For recently completed work, see: GAO, *Modernizing the Nuclear Security Enterprise: A Complete Scope of Work Is Needed to Develop Timely Cost and Schedule Information for the Uranium Program*, GAO-17-577 (Washington, D.C.: Sept. 8, 2017); *DOE Project Management: NNSA Needs to Clarify Requirements for Its Plutonium Analysis Project at Los Alamos*, GAO-16-585 (Washington, D.C.: Aug. 9, 2016); and *DOE Project Management: NNSA Should Ensure Equal Consideration of Alternatives for Lithium Production*, GAO-15-525 (Washington, D.C: July 13, 2015).

[39]The Nuclear Weapons Council affirmed to Congress in 2014 that it needs NNSA to develop a capability to produce 50 to 80 pits per year. In addition, under the Carl Levin and Howard P. "Buck" McKeon National Defense Authorization Act for Fiscal Year 2015, NNSA must be able to produce not less than 10 war reserve pits during 2024, not less than 20 war reserve pits during 2025, not less than 30 war reserve pits during 2026, and demonstrate the ability to produce 80 pits per year during 2027 for no less than a 90-day period. The act also gave the Secretaries of Energy and Defense the option of delaying the 80-pits-per-year demonstration date to 2029 if DOD and DOE justify the delay in a joint report.

capabilities performed in a legacy building at the Y-12 National Security Complex to other existing buildings or in newly constructed buildings.

- **Lithium production facility.** NNSA will require lithium for a W78 replacement warhead. The United States no longer maintains full lithium production capabilities and relies on recycling as the only source of lithium for nuclear weapon systems. According to the *Fiscal Year 2018 Stockpile Stewardship and Management Plan*, NNSA has analyzed options to construct a new lithium production facility, and a conceptual design effort is next, with an estimated completion date of fiscal year 2027 for the new facility. Until the facility is available, NNSA has developed a bridging strategy to fill the interim supply gaps.
- **Radiation-hardened microelectronics facility.** Nuclear warheads, such as a W78 replacement warhead, include electronics that must function reliably in a range of operational environments. NNSA has a facility at Sandia that produces custom, strategic radiation-hardened microelectronics for nuclear weapons. In August 2018, NNSA officials told us that this facility, known as Microsystems and Engineering Sciences Applications, can remain viable until 2040—but would need additional investment.

The W78 replacement program manager told us that the need for newly manufactured components coupled with the scale of NNSA's modernization activities means that a comprehensive coordination effort will be necessary to ensure that the facilities and capabilities are ready to provide components for the warhead by the end of the 2020s. Because these activities are separately managed and supported outside the W78 replacement program, NNSA considers progress on them to represent a critical external risk to the program.

NNSA is taking or plans to take some action to mitigate this external risk at the program and agency level. One step that the program plans to take to address this risk is to draft formal agreements—called interface requirements agreements—with other NNSA program offices that oversee the deliverables and schedules for the design, production, and test facilities that are needed for the program. These agreements describe the work to be provided by these external programs, including milestone dates for completing the work; funding; and any risks to cost, schedule, or performance. The W78 program manager stated that they are generally drafted toward the end of Phase 6.2 through Phase 6.2A and largely finalized in Phase 6.3—though small adjustments may be made into Phase 6.4 (Production Engineering).

At the agency level, in response to a direction in the 2018 NPR, NNSA officials told us that the agency is also developing an agency-wide integrated master schedule that is intended to align NNSA's enterprise-wide modernization schedule with milestone delivery dates for nuclear weapons components.[40] The W78 program manager and other NNSA officials told us that the information they provide on the facilities and capabilities needed, as well as milestone dates, will be integrated into this schedule and used to help ensure that the facilities and capabilities are ready to support the program.

Agency Comments

We provided a draft of this report to NNSA and DOD for comment. NNSA and DOD provided technical comments, which we incorporated as appropriate.

[40]Specifically, the 2018 NPR included direction to NNSA, among other things, to develop an NNSA roadmap that sizes production capacity to modernization and hedging requirements.

We are sending copies of this report to the appropriate congressional committees, the Secretaries of Defense and 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 members 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 the report are listed in appendix II.

Allison B. Bawden
Director, Natural Resources and Environment

List of Committees

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

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

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

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

Appendix I: NNSA's Program Management Functions to Execute a W78 Replacement Program

The table below identifies the steps NNSA is taking or plans to take to establish the program management functions needed to execute a W78 replacement program. NNSA was directed by the Nuclear Weapons Council to suspend the program in fiscal year 2014 and the 2018 Nuclear Posture Review directed NNSA to restart the program in fiscal year 2019. The NNSA Office of Defense Program's program execution instruction defines enhanced program management functions for a warhead life extension program (LEP) such as the W78 replacement program and other programs.[1] The instruction also describes the level of program management rigor that the LEP must achieve as it advances through the Department of Defense and NNSA process for managing life extension programs called the Phase 6.X process. This process includes key phases or milestones that a nuclear weapon life extension program must undertake before proceeding to subsequent steps. NNSA completed Phase 6.1 (Concept Assessment) and started Phase 6.2 (Feasibility and Design Options) activities before the program was suspended in fiscal year 2014. NNSA, therefore, plans to restart the program in Phase 6.2.

Table 2: Steps NNSA Is Taking or Plans to Take to Establish Program Management Functions Needed to Execute a W78 Warhead Replacement Program

Program management function	NNSA's ongoing and planned steps
Program planning	The National Nuclear Security Administration's (NNSA) manager of the W78 warhead replacement program stated that a program plan—the governing document that establishes the means to define, execute, monitor, and control NNSA projects—is currently in development and the initial release will be completed by program restart in fiscal year 2019.
Systems engineering	NNSA's program manager said the system engineering plan was in development and the initial release will be available when the program restarts in fiscal year 2019.
Interface management	NNSA's program manager said interface requirements agreements will be developed starting in fiscal year 2019 based on the results of the technology readiness assessment completed in fiscal year 2018. These agreements will be updated and additional agreements may be developed as needed thereafter.
Requirements management	NNSA's program manager said a requirements management plan was in development for an initial release in fiscal year 2019. It is intended to describe the requirements management process including use of a database management system.

[1]NNSA, *DP Program Execution Instruction: NA-10 Program Management Tools and Processes* (January 2016).

Program management function	NNSA's ongoing and planned steps
Work breakdown structure	NNSA's program manager said the program had started to adapt a standardized work breakdown structure for life extension programs to define and organize the W78 replacement program's work scope for restart. As the program transitions to Phase 6.3 (Development Engineering) starting at the end of fiscal year 2022, NNSA plans to mature the structure to be compliant with Department of Energy (DOE) and industry standards and use the structure to develop scope, cost, and schedule baselines for the warhead program.
Decision analysis	NNSA's program manager said decision analysis—about warhead design and technology options—will likely occur in fiscal year 2021 through 2022 as part of Phase 6.2 and Phase 6.2A. It is to be conducted jointly with the Department of Defense (DOD) through the Nuclear Weapons Council in accordance with Phase 6.X process guidance, as well as DOD and NNSA requirements.
Risk and opportunity management	NNSA's program manager said that a risk management plan that will describe the risk management process and use of a database management system was being developed and would be released when the program restarts in fiscal year 2019.
Integrated schedule	NNSA's program manager said that an integrated master schedule will be developed in fiscal year 2019. As the program completes Phases 6.2 and 6.2A and transitions to Phase 6.3 during fiscal year 2022, NNSA plans to select and define a preferred design option for the warhead. At that time, NNSA plans to mature the integrated master schedule using a tailored approach to DOE and industry standards and use the schedule as a baseline against which to measure program performance.
Cost estimating	NNSA's program manager said that the program will create a Weapon Design and Cost Report at the end of Phase 6.2A. In addition, NNSA's Office of Cost Estimating and Program Evaluation plans to complete an independent cost estimate after Phase 6.2A in late fiscal year 2022. NNSA plans to establish a baseline cost estimate during early Phase 6.3 in fiscal year 2023 to measure performance against.
Performance management	NNSA's program manager said that NNSA will create a plan in fiscal year 2019 to describe performance management for the program. In particular, he said that during Phase 6.2 and 6.2A, the program will use an earned value management system, as appropriate. As the program transitions to Phase 6.3 starting at the end of fiscal year 2022, NNSA plans to select and define a preferred design option for the warhead. At this time, NNSA plans to mature the earned value management system using a tailored approach to DOE and industry standards and use it to measure performance.
Change control and configuration management	NNSA's program manager said that the program will develop a change control and configuration management plan in fiscal year 2019. The plan is intended to describe the processes that will be used to identify, track, and control changes to the program's deliverables or products once the program has a baseline.

Program management function	NNSA's ongoing and planned steps
Reviews and reporting	NNSA's program manager said that, among other types of reviews, a requirements review is planned to occur in fiscal year 2020. In addition, during Phases 6.2 and 6.2A, several reviews with NNSA leadership are planned to occur in coordination with key decisions and Nuclear Weapons Council interactions. Quarterly program reviews with NNSA leadership are planned to occur when the program enters Phase 6.3.
Lessons learned/best practices	NNSA's program manager said that a Phase 6.2 and 6.2A lessons learned report will be created in fiscal year 2023.

Source: Information from NNSA's federal program manager for the W78 replacement program. | GAO-19-84

Note: DOD and NNSA have established a process, known as the Phase 6.X process, to manage life extension programs such as the W78 replacement program. NNSA will restart the program in Phase 6.2 (Feasibility and Design Options). NNSA completed Phase 6.1 (Concept Assessment) and initially started Phase 6.2 in June 2012 before suspending the program in fiscal year 2014.

Appendix II: GAO Contact and Staff Acknowledgments

GAO Contact

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

Staff Acknowledgments

In addition to the individual named above, William Hoehn (Assistant Director), Brian M. Friedman (Analyst in Charge), and Julia T. Coulter made significant contributions to this report. Also contributing to this report were Antoinette Capaccio, Pamela Davidson, Penney Harwell Caramia, Greg Marchand, Diana Moldafsky, Cynthia Norris, Katrina Pekar-Carpenter, and Sara Sullivan.