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Nuclear Weapons: United States Should Rebuild Its Plutonium Pit Manufacturing Capability

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KEY TAKEAWAYS

Plutonium pits are the cores of modern nuclear weapons, but most pits in the nuclear stockpile are aging and will eventually reach the end of their service lives.

The United States should improve its pit production capabilities in the next decade in order to maintain a viable nuclear deterrent into the future.

Congress should support and fund the NNSA's plan to produce at least 80 pits per year by 2030 and position the U.S. to increase production capability.

Plutonium pits are the cores of modern nuclear weapons. Since 1989, when the Rocky Flats Colorado pit production plant was shut down, the United States has not been able to produce plutonium pits in any appreciable quantities. Most of the plutonium pits in the current nuclear stockpile were manufactured between 1978 and 1989 and will reach the end of their service lives eventually, even though there is a disagreement on how long the United States can maintain pits in its stockpile before replacing them.[1] Producing plutonium pits for the current U.S. nuclear weapons arsenal is a challenging process that requires specialized equipment, demands specific materials, generates toxic waste and hazardous materials, and—perhaps most importantly—requires unique hands-on skills. The United States should invest in its pit production capabilities

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in the next decade in order to maintain a viable nuclear deterrent into the future. It should also plan for its pit production requirements to increase should assumptions that guide the current requirement of 80 pits per year (ppy) change.

What Is a Plutonium Pit?

Modern nuclear weapons require plutonium pits. In a thermonuclear warhead, the hollow plutonium pit is surrounded by explosives in a primary stage.[2] When explosives in the primary stage detonate, the implosion wave compresses and heats plutonium, which goes supercritical. The explosion from the primary stage then triggers the secondary stage, in which the warhead releases most of its energy. Plutonium has several isotopes, some of which are used in space probes (Pu-238). The isotope Pu-239 used in nuclear warheads is a mix that contains other Pu isotopes.

Plutonium is an extremely challenging material to work with. It does not exist in nature except in trace amounts and is created in a nuclear reactor when uranium atoms absorb neutrons.[3] It is radioactive, readily oxidizes in air, and can exist in several different and complex solid state phases.[4] The use of plutonium allowed weapons designers to design smaller warheads with relatively larger yields.[5] This allowed more warheads to be placed on the top of ballistic missile delivery vehicles, maximizing the destructive power of each missile.

During the pit manufacturing process, plutonium is purified and then molded into a hollow spherical shape. For a nuclear warhead to perform as expected, the pits must operate exactly as designed. The problem is that plutonium pits decay as they age, increasing the impurity of the material, and these changes introduce uncertainties regarding the overall performance of a pit and, by extension, a warhead.

Problems with the Current Stockpile

The United States has never had as old a nuclear warhead stockpile on average as it has today and lacks nuclear weapon testing data for warhead designs and components of comparable age, thus eroding the scientific foundation for assessing the nuclear performance of weapons in the U.S. stockpile over time.[6] The publicly reported average stockpile age is misleading in that the National Nuclear Security Administration (NNSA) resets the age of a warhead to zero when it conducts a major Life Extension Program (LEP) on it, even though an LEP may use the same pit as the original warhead. Given that nuclear weapons will continue to play a prominent role in U.S. national security strategy for decades to come, plutonium pit aging and the need to replace them in a manner that does not compromise the U.S. nuclear deterrent is one of the major drivers behind the need to establish a long-term pit production capability.

Scientists disagree about how long a plutonium pit can last in a nuclear weapon. Estimates vary from 45–60 years to over 100 years.[7] Some pits in the U.S. stockpile are approaching the 45-year benchmark already and may need to be replaced soon.[8] Further, the effects of plutonium pit aging are not linear; rather, they accumulate, initially rather slowly, over the course of decades. This makes predictions regarding their expected military performance—and the urgency of replacing them—more difficult.

The NNSA has been studying and monitoring aging processes with respect to plutonium pits. Plutonium pits in the current stockpile were deployed during a relatively short time frame due to the large production capacity of Rocky Flats and therefore can be expected to age out, or otherwise fail, at roughly the same time. This could cause the United States to lose a large part of its nuclear capability at one time until defective pits can be replaced with new ones.[9] Given the relatively small planned pit production capacity (the Rocky Flats facility could produce many hundreds of pits per year), the United States would have a very difficult time dealing with a systemic plutonium pit issue in its warheads in a responsive manner.

Policymakers and analysts also disagree on how large the U.S. inactive stockpile ought to be. U.S. inability to produce nuclear warheads in any appreciable quantities and inflexibility in the nuclear weapons complex itself likely drives up the number of inactive warheads needed.[10] In addition to replacing pits in the current stockpile, active and inactive, the United States must be able to produce pits for stockpile surveillance needs and for logistics spares.[11] Moreover, because plutonium pit production is an extremely complicated process that must meet high environmental and safety standards, the buildings that house processes related to the project are relatively costly and complicated to construct.

U.S. Post–Cold War Pit Production Efforts

During the Cold War, the United States produced between 1,000 and 2,000 plutonium pits per year. That capability vanished with the closing of the Rocky Flats pit production facility in 1989 over environmental and safety violations. The United States restored a small-scale plutonium pit production capability at the Plutonium Facility-4 (PF-4) facility at Los Alamos National Laboratory (LANL). The facility produced a maximum of 11 pits per year (ppy) for a very limited time frame.[12] The United States has attempted to restore some pit production capabilities at LANL, the Modern Pit Facility (MPF), the Chemistry Metallurgy Research Replacement facility (CMRR), and the Pit Disassembly and Conversion facility. These projects were cancelled for various reasons, sometimes after significant initial investments.

The MPF, proposed under the George W. Bush Administration, was to produce up to 450 ppy, although later assessments lowered that production rate significantly. The MPF was to be "agile," which the NNSA defined as "ability to rapidly change from production of one pit type to another, ability to simultaneously produce multiple pit types, or the flexibility to produce pits of a new design in a timely manner."[13] The MPF production requirement was significantly higher than today's requirement of 80 ppy by 2030. The facility was supposed to be operational in 2020 and cost about $4 billion, but it was cancelled in January 2004 due to congressional opposition.[14] During the MPF debate, the NNSA argued that a long-term pit production facility is necessary to support long-term stockpile needs as pits age and to hedge against a potential systemic failure in a pit type.[15]

Opponents of the project (who often oppose other plutonium pit production plans) argued not only that U.S. plutonium pit production requirements are excessive and can be met using an existing infrastructure and that the pits age appreciably slower than the NNSA claims[16]—but also that the current facilities in which plutonium work is done are old.[17]

In 2008, the George W. Bush Administration required the NNSA to produce plutonium pits in the range of 50–80 ppy and planned for a development of the CMRR facility to replace the 1950s-era Chemistry and Metallurgy Research facility. According to a Bush and Obama Administration official, a level of 50–80 ppy was thought to be consistent with existing PF-4 production capabilities plus the analytical chemistry capacity anticipated for the planned Nuclear Facility (CMMR-NF). However, NNSA officials in 2006 believed that a capacity in the range of 125 ppy was needed to respond to anticipated requirements and provide some resilience to surprise. Thus the significant risk involved in the 50–80 ppy level—the best that could be done at Los Alamos—was acceptable in their view.[18] The CMRR construction started in January 2006.

When plutonium pit productions requirements were set, the United States was hoping for a much more cooperative relationship with the Russian Federation than it has today. Since then, Russia invaded two countries (Georgia in 2008 and Ukraine in 2014) and is producing new nuclear weapon capabilities outside the New Strategic Arms Reduction Treaty (New START) framework.[19] The treaty sets ceilings for long-range nuclear systems between the United States and the Russian Federation, but the recent tension between Moscow and Washington has created uncertainty with regard to Russia's nuclear modernization efforts and doctrine.

An additional potential complication on the near horizon is China expanding its nuclear arsenal. The Department of Defense (DOD) believes that China is going to double its nuclear arsenal in the next 10 years.[20] This is not to say that requirements are necessarily wrong at this time but to underscore that future uncertainties demand flexibility and ability to scale up. If officials in 2006 believed a capability in the range of 125 ppy was needed but 50–80 ppy was the best the United States could do given circumstances, the gap between what might be needed today and what the United States is capable of producing may be even wider today.

Both Russia and China maintain active, competent, and capable nuclear warhead production complexes, including potentially conducting yield-producing experiments in ways that the United States believes violates the (U.S. Senate–rejected) Comprehensive Test Ban Treaty.[21]

CMMR-NF

The CMRR was to consist of three phases: (1) the Radiological Laboratory Utility Office Building (RLUOB), (2) the RLUOB Equipment Installation effort, and (3) the CMMR-NF.[22] The 2005 cost estimate for the project ranged from $745 million to $975 million, but the cost estimate for the CMMR-NF increased to as much as $5.8 billion in 2012.[23] The RLUOB began operations in 2014.[24]

In 2018, the NNSA assessed that the RLUOB could accommodate as much as 10 times more "material-at-risk" inventory (from 38.6 grams of "plutonium equivalent material" to 400 grams), making it a Hazard Category 3 Nuclear Facility.[25] The change, currently still being implemented, would allow the NNSA to conduct a broader range of analytical chemistry and materials characterization processes in this more modern building rather than in an aging existing CMR facility.[26]

The plutonium production effort was deemed so critical to U.S. nuclear weapon sustainment needs that the Senate attached a condition to the New START Resolution of Ratification that the President will "accelerate to the extent possible the design and engineering phase of the Chemistry and Metallurgy Research Replacement (CMR-R)."[27] In reality, the third phase of the CMRR was deferred by "at least 5 years" in the Obama Administration's fiscal year (FY) 2013 budget request because of a tough fiscal environment following the Budget Control Act of 2011.[28] CMRR-NF was formally cancelled in August 2014 with the NNSA proposing an alternative path forward.[29] Congress did not significantly step in to hold the Administration accountable for the change.

The NNSA adopted a two-part strategy to provide plutonium infrastructure and analytical capability absent the CMRR-NF construction in January 2014.[30] The first part was to use existing buildings to accommodate some of the necessary equipment as the CMRR phased out, and the second part consisted of an analysis of the potential to build modular facilities where more high-hazard and high-security missions could be performed.[31]

A More Significant Plutonium Pit Production Capability

On May 10, 2018, the Nuclear Weapons Council certified the NNSA's and DOD's plan to produce plutonium pits at two sites: at least 30 ppy in Los Alamos, NM, by 2026 and at least 50 ppy at Savannah River Site, SC, in the 2030 time frame.[32] The NNSA and DOD argue that the two-site approach "improves the resiliency, flexibility, and redundancy" of the U.S. nuclear security enterprise because it does not rely "on a single production site."[33]

The NNSA is planning on repurposing the mixed oxide fuel fabrication facility (also known as the MOX facility) to house several processing functions for plutonium pits.[34] In Los Alamos, the RLUOB would house analytical chemistry and material characterization while PF-4 would house the rest of the activities.[35] The plan encountered controversy in Congress, but after terminating the MOX site in 2018, the NNSA reached a "comprehensive settlement agreement with MOX Services and its parent companies" in November 2019, which allowed it to proceed with the revised approach for plutonium pit production.[36]

Sustaining a Viable Nuclear Deterrent

In the coming decades, the United States is planning on modernizing all the legs of the nuclear triad (intercontinental-range ballistic missiles, bombers, and strategic submarines) and recapitalizing corresponding nuclear warheads and infrastructure required to support these programs. The United States has postponed this effort since the end of the Cold War because it thought that nuclear weapons were increasingly obsolescent. And while the United States stopped or scaled down all nuclear weapons modernization activities, other countries increased their nuclear weapons capabilities.[37]

The *2018 Nuclear Posture Review* requires the NNSA to "provide the enduring capability and capacity to produce plutonium pits at a rate of no fewer than 80 pits per year by 2030."[38] It notes that a "delay in this would result in the need for a higher rate of pit production at higher cost."[39]

In the coming decades, all U.S. nuclear warheads will require LEPs. Analytical capability to assess warheads' pits is a necessary prerequisite for this monumental effort. The NNSA is currently in the process of delivering the B61-12 gravity bomb to the Air Force and W88 Alteration 370 and W76-2 warheads to the Navy.[40] It has to achieve the first production unit of the W80-4 warhead by fiscal year (FY) 2025, complete its LEP by 2031, and ensure alignment with the DOD's Long-Range Standoff cruise missile replacement program.[41] It has to support fielding the Air Force's Ground-Based Strategic Deterrent by the FY 2030 and sustain the B83-1 warhead until a suitable replacement for its capabilities is found.[42] These activities are in addition to the NNSA's vast spectrum of activities that involve monitoring and maintaining the stockpile and other nonproliferation and national security missions.

Policy Recommendations

In order to sustain the nation's ability to maintain a viable nuclear deterrent into the future, Congress should:

- **Support and fund the NNSA's plan to produce at least 80 pits a year by 2030.** So far, Congress has been supportive of the NNSA's plans to meet the 80-ppy requirement and has sufficiently supported the NNSA's plutonium pit production plans. The Administration and Congress should provide sufficient funding between now and when the facilities become operational, which means making the case for producing plutonium every year.

- **Implement hedging strategies to allow increased pit production if necessary.** The United States should be able to scale up its plutonium pit production in the future if a national security crisis arises. The nuclear area is a perfect avenue for actors such as China and Russia to outmaneuver the competition, because, unlike them, the United States currently lacks modern systems, warheads, and flexible and resilient infrastructure. Creating a plutonium pit production hedge is a prudent step and a worthy investment in U.S. national security.

- **Ensure that the NNSA and DOD plan on mitigating a plutonium pit production shortfall should the current plan not be executed on time.** The current plutonium pit production plan depends on the timely execution of the necessary construction in which plutonium work can be performed. As the experience with the previous plutonium pit production plans illustrates, the NNSA does not have a good track record of executing large construction projects on time and on budget. Strategies to mitigate the potential production shortfall are necessary, and the NNSA ought to prepare and provide these strategies to Congress for review.

The Administration should take the following steps to ensure the nation does not lack a sufficient pit production capability:

- **Maintain leadership attention on the plutonium pit production issue.** Continued attention and advocacy will be essential to accomplishing the plutonium production goals by 2030. The NNSA, DOD, and the Department of Energy will have to make the case for continued funding for the pit production capabilities during the annual appropriations and authorizations process. They will also have to make the case to the general public, particularly in New Mexico and South Carolina, where the plutonium work will reside.

- **Improve the NNSA's capability to estimate projected costs.** More broadly speaking, strengthening the NNSA's ability to better estimate large facility construction costs (including plutonium production costs) would allow the agency to rebuild credibility damaged by years of skyrocketing construction cost estimates and subsequent project cancellations. While some adjustments to program costs are normal, fivefold increases like in the case of CMRR are simply unacceptable.

Conclusion

Congress and the Administration should support continued investment into facilities and know-how to reconstitute plutonium pit production capabilities in order to maintain a viable deterrent into the future and review whether U.S. pit production requirements are guided by sound assumptions.

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Endnotes

1. The United States had about 3,800 nuclear warheads in its stockpile in 2017, the last year for which an unclassified number is available. See Department of Defense, "Stockpile Numbers: End of Fiscal Years 1962–2017," 2018, https://open.defense.gov/Portals/23/Documents/frddwg/2017_Tables_UNCLASS.pdf (accessed September 5, 2020).
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