INSTITUTE FOR DEFENSE ANALYSES

Independent Assessment of the Two-Site Pit Production Decision: Executive Summary

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May 2019

IDA Document NS D-10711
H 19-000304

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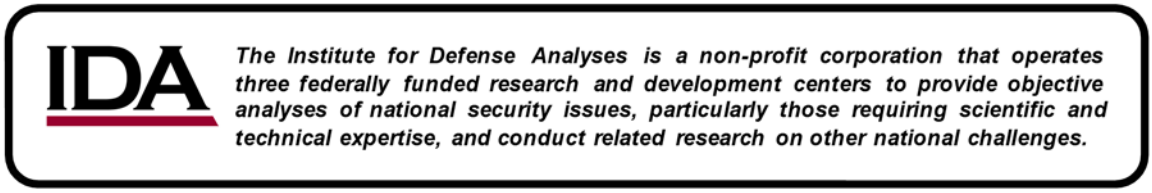

About this Publication

This work was conducted by the Institute for Defense Analyses (IDA) under contract HQ0034-14-D-0001, project AP-7-4585, "Assessment of Plutonium Strategy," for the Deputy Assistant Secretary of Defense for Nuclear Matters in the Office of the Assistant Secretary of Defense for Nuclear, Chemical, and Biological Defense Programs. The views, opinions, and findings should not be construed as representing the official position of either the Department of Defense, the National Nuclear Security Administration, or the sponsoring organization.

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Executive Summary

Background

At the height of the Cold War, the United States produced between 1,000 and 2,000 plutonium pits per year (ppy) at the Rocky Flats Plant near Denver, Colorado. Since the shutdown of Rocky Flats in 1989, numerous attempts have been made to reconstitute this capability. The most successful effort was a limited production run at Los Alamos National Laboratory (LANL), which produced 31 pits for the W-88 warhead over a period of five years. In May 2016, the National Nuclear Security Administration (NNSA) began an Analysis of Alternatives (AoA) for reconstituting a plutonium pit production capability.

Analysis of Alternatives (AoA)

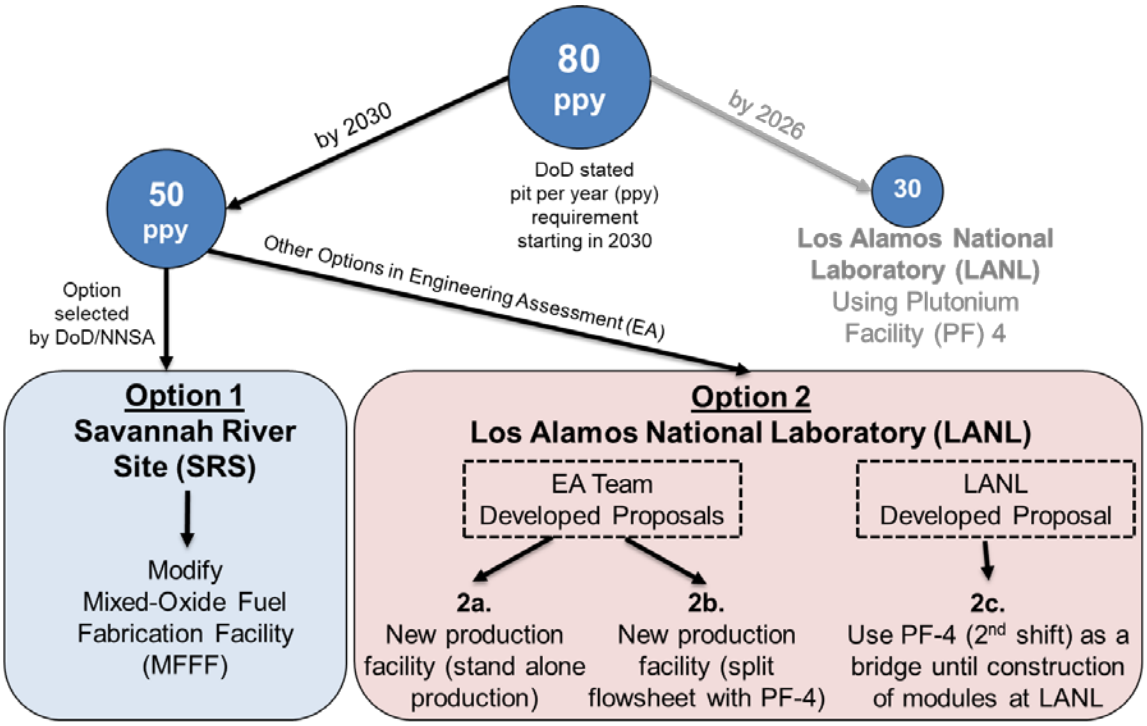
The AoA evaluated potential solutions for meeting the stated pit production requirement of at least 80 ppy by 2030. The AoA team identified nearly 400 alternatives. Initial screening removed most of the alternatives from consideration, including all alternatives that would have split the production process amongst multiple facilities. After screening, five alternatives remained: new construction at either LANL, the Savannah River Site (SRS), or Idaho National Laboratory (INL); or refurbishment and repurposing of existing facilities at SRS or INL. Two preferred alternatives for producing 80 war reserve ppy by 2030 emerged from the AoA: (1) the refurbishment and repurposing of the Mixed-Oxide Fuel Fabrication Facility (MFFF) at SRS, or (2) new construction of a pit production facility at LANL. These alternatives were recommended for further engineering analysis.

Engineering Assessment (EA)

The EA was initiated promptly after the AoA. The EA team was tasked with evaluating the preferred alternatives identified by the AoA, to "refine and better inform the selection of an alternative and to support conceptual design." However, the options assessed by the EA team differed from the preferred alternatives identified by the AoA—most notably, options for manufacturing only 50 ppy (as opposed to 80 ppy in the AoA), on the assumption that 30 ppy would be produced at LANL's Plutonium Facility (PF-4) as part of the Plutonium Sustainment Program (PSP). The EA considered the following options for producing 50 ppy (also shown in the figure on the following page):

- Option 1 (Modify the MFFF at SRS)
- Option 2a (Build a new production facility at LANL, outside of PF-4)

- Option 2b (Build a new, smaller production facility at LANL, and split production with PF-4)
- Option 2c (Build production modules at LANL and use additional equipment and extra shifts in PF-4 as a bridge until modules are complete)



Summary of Pit Production Options Explored by the Engineering Assessment (EA)

The EA team evaluated the engineering feasibility of these four options, developed schedule and cost estimates, and assessed qualitative risks. The EA did not make specific recommendations regarding which option should be pursued.

Decision Announcement

On May 10, 2018, the Department of Defense (DoD) and NNSA released a joint statement announcing that the Nuclear Weapons Council (NWC) had certified the NNSA's recommended solution—to repurpose the MFFF to produce at least 50 ppy while also maximizing pit production activities at PF-4 to produce at least 30 ppy—to be acceptable and that this approach represented a "resilient and responsive option to meet [DoD] requirements."

IDA Tasking

The 2019 Senate Energy and Water Development (SEWD) Appropriations Bill directed that NNSA "contract with a third-party federally-Funded Research and

Development Corporation to conduct an independent assessment of the NNSA's decision to conduct pit production operations at two sites." NNSA selected the Institute for Defense Analyses (IDA) to conduct this assessment, as IDA was concurrently performing an independent assessment of NNSA's plutonium strategy mandated by the 2019 John S. McCain National Defense Authorization Act (NDAA).

Portions of the NDAA-mandated plutonium strategy assessment were extracted to address the SEWD language. In addition to an assessment of the decision to conduct pit production operations at two sites, the SEWD language requested "an analysis of the four options evaluated in the recent Plutonium Pit Production Engineering Assessment, all identified risks, engineering requirements, workforce development requirements, and other factors considered." Topics out-of-scope for both assessments, and therefore not included in this paper, include the rationale for the stated requirement of 80 ppy by 2030, options for DoD should the requirement not be met by 2030, and the likelihood of LANL successfully achieving an ongoing production rate of at least 30 ppy by 2026 as called for in the PSP.

Methodology

IDA reviewed the AoA and the EA, supporting documentation, and related analyses performed by LANL and the Logistics Management Institute (LMI). IDA met with the AoA and EA teams on several occasions to ask questions on specific topics, interviewed a broad array of experienced subject matter experts, and conducted site visits at Lawrence Livermore National Laboratory (LLNL), LANL, and SRS. IDA also collected and analyzed historical cost, schedule, and performance data on previous Department of Energy (DOE) programs; federal guidance and instructions; and related open-source materials.

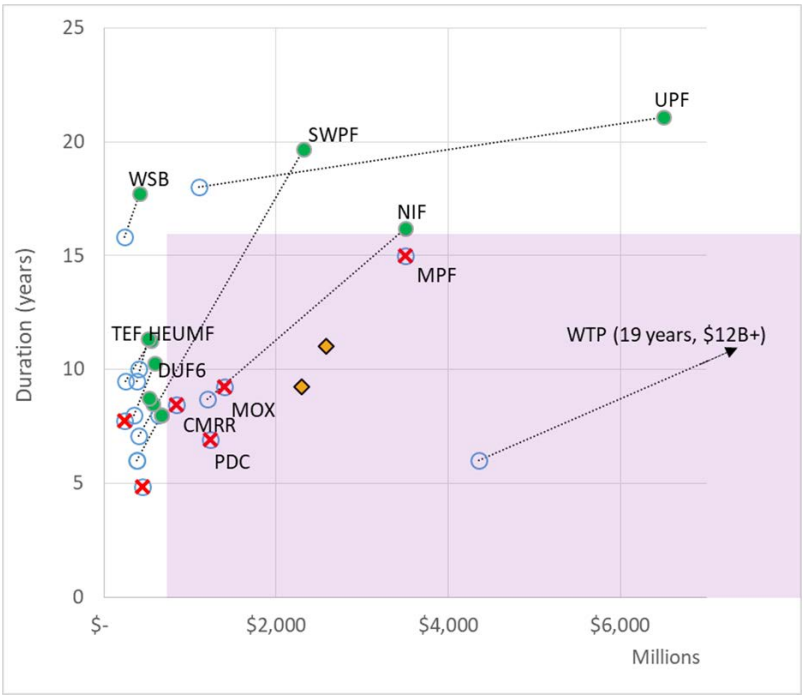
IDA Assessment

The DoD-NNSA joint decision statement notes that the two-site solution improves the resiliency, flexibility, and redundancy of our Nuclear Security Enterprise by not relying on a single production site. This mirrors language found in the 2018 Nuclear Posture Review (NPR), which calls for "an effective, responsive, and resilient nuclear weapons infrastructure." This language implies that resiliency was a key decision criterion.

In deciding to have two geographically separated production facilities, DOE clearly gains resilience from external threats and hazards. A natural disaster, man-made event, or accident outside one facility would likely not affect production operations at the second facility in a different state, whereas a similar incident could—and likely would—affect production in collocated or dependent production facilities. Resilience against shutdowns and other incidents inside the facility, however, is more difficult to assure. Even with facilities located at two different sites, so long as training and operating procedures are linked, issues at one facility may affect operations at the other.

IDA's independent assessment concludes that all of the options considered in the EA are extremely challenging. Each is potentially achievable given sufficient time, resources, and management focus, although not on the schedules or budgets currently forecasted. None of the rejected alternatives is demonstrably superior to the option announced by DoD/NNSA and certified by the NWC. That said, pursuing an aggressive schedule creates major risk to achieving an 80-ppy production capability under any option.

Put more sharply, eventual success of the strategy to reconstitute plutonium pit production is far from certain. DOE historical data make clear that difficulties are to be expected in a project of this scale and complexity. IDA examined past NNSA programs and could find no historical precedent to support starting initial operations (Critical Decision-4, or CD-4) by 2030, much less full rate production. Many similar projects (e.g., the Modern Pit Facility, Chemistry Metallurgy Research Replacement-Nuclear Facility, and Pit Disassembly and Conversion Facility) were eventually cancelled. Of the few major projects that were successfully completed, all experienced substantial cost growth and schedule slippage; we could find no successful historical major project that both cost more than $700 million and achieved CD-4 in less than 16 years (see figure below).



Notes: Open circles correspond to initial estimates, connected to final actuals via dotted lines. The red Xs indicate projects that were eventually cancelled and never completed. The two diamonds are cost and schedule estimates for EA Option 1 and EA Option 2a.

Cost and Schedule Growth and Cancellation Risk for Completed and Cancelled DOE Projects

Both the AoA and EA identified numerous risks. Examples of technical and operational risks cited include (1) the ability to accommodate changes in requirements or

processes; (2) the existence and adequacy of analytical chemistry and materials characterization laboratory facilities; (3) the ability to stage, store, and ship waste; (4) the availability of vault space; (5) increased qualification/certification burden; and (6) the complexity of transport/transfer of radioactive material. There were also significant risks cited associated with building the necessary skilled production and support workforce, as well as risks associated with safety and security.

Work to identify and address risk is underway, but it is clear there is more work to be done. A key milestone will be achieving the PSP goal of 30 ppy at LANL. Successfully demonstrating a pit production capability at that scale would greatly increase confidence in the ability to produce 80 ppy eventually. Careful, skilled management and consistent, focused leadership will be required for this effort to succeed where many previous efforts have failed.

Summary of Main Findings

Three main findings are extracted verbatim from the NDAA-mandated assessment of the NNSA plutonium strategy:

1. Eventually achieving a production rate of 80 ppy is possible for all options considered by the EA, but will be extremely challenging.
2. No available option can be expected to provide 80 ppy by 2030. DoD should evaluate how to best respond to this requirement shortfall.
3. Effort to identify and address risks is underway, but is far from complete.

To explicitly address the SEWD request for "an independent assessment of the NNSA's decision to conduct pit production operations at two sites" we highlight one additional finding:

4. If "resilience" is taken to mean a two-site solution, only one EA option—the option ultimately selected—met this criterion. It does so at an increased cost from a one-site solution, based on a comparison of preliminary cost ranges provided in the EA, although large uncertainties exist in all of the cost estimates at this stage.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
xx-05-2019	Final	Oct 2018 - April 2019

4. TITLE AND SUBTITLE

Independent Assessment of the Two-Site Pit Production Decision: Executive Summary

5a. CONTRACT NUMBER

HQ0034-14-D-0001

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

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5d. PROJECT NUMBER

5e. TASK NUMBER

AP-7-4585

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

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Alexandria, VA 22311-1882

8. PERFORMING ORGANIZATION REPORT NUMBER

IDA Document NS D-10711
H 19-000304

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

Department of Energy/National Nuclear Security Administration
Plutonium Program Office, NA-192.3
1000 Independence Ave. SW
Washington, DC 20585

10. SPONSOR/MONITOR'S ACRONYM(S)

DOE/NNSA

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

This non-standard, Executive Summary is publicly releasable. It was taken from IDA Paper P-10632, "Independent Assessment of the Two-Site Pit Production Decision," Unclassified//Official Use Only.

14. ABSTRACT

In May 2016, the National Nuclear Security Administration (NNSA) began an Analysis of Alternatives (AoA) for reconstituting plutonium pit production. Two preferred alternatives for producing 80 war reserve pits per year (ppy) were identified: the refurbishment and repurposing of the Mixed-Oxide Fuel Fabrication Facility (MFFF) at the Savannah River Site (SRS), or construction of a new facility at Los Alamos National Laboratory (LANL). An Engineering Assessment (EA) was chartered to evaluate the SRS and LANL options in more detail, under the assumption that 30 of the required 80 ppy would be produced in the existing PF-4 facility at LANL. In May 2018, the Nuclear Weapons Council certified that the NNSA-recommended option (producing 50 ppy at MFFF and 30 ppy at LANL) was acceptable. The 2019 Energy and Water Development Appropriations Bill directed a federally funded research and development center to conduct an independent assessment of the NNSA's decision to conduct pit production operations at two sites. To avoid unnecessary duplication of effort, IDA was asked to extract relevant information from its concurrent NDAA-mandated plutonium strategy assessment to fulfill this requirement.

15. SUBJECT TERMS

Nuclear Weapon Production; National Nuclear Security Administration; NNSA; Nuclear Weapons Council; NWC; Plutonium Pit; Analysis of Alternatives; AoA; Engineering Assessment; EA; MFFF; MOX; PF-4; Savannah River; SRS; Los Alamos; LANL

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Michele, John
Unclassified	Unclassified	Unclassified	Same as Report	9	19b. TELEPHONE NUMBER *(Include area code)* (202) 586-2491

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Standard Form 298 (Rev. 8/98)
Prescribed by ANSI Std. Z39.18