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Independent Assessment of the Plutonium Strategy of the National Nuclear Security Administration

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March 2019

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IDA Paper P-10524

H 19-000102

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Preparation of this report cost the Department of Defense a total of approximately $840,000 in Fiscal Year 2019.

Department of Defense
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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 or the sponsoring organization.

Other requests for this document shall be referred to Office of the Secretary of Defense for Nuclear Matters, 3050 Defense Pentagon, Room 3B884, Washington, DC 20301-3050.

Acknowledgments
Thank you to Frederick R. Crawford, Paul H. Richanbach, and James D. Silk for performing technical review of this document. Thanks also to General Larry Welch and Stephen J. Guidice for their insights.

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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, there have been numerous attempts 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)

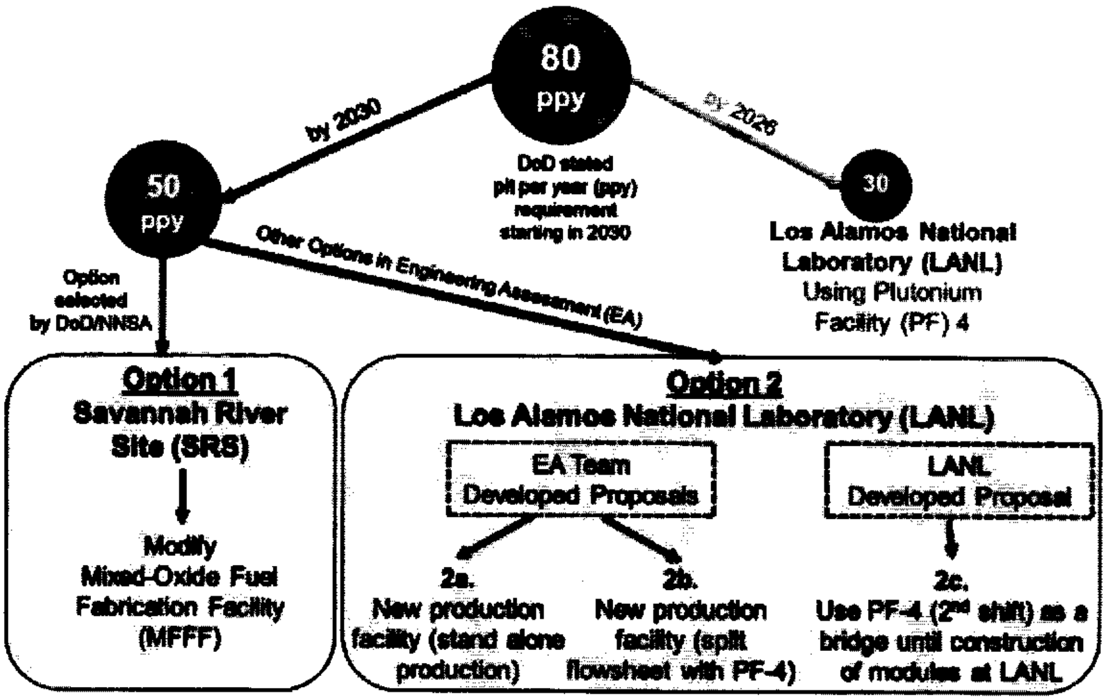
The AoA evaluated potential solutions for meeting the stated pit production requirement of at least 80 ppy by 2030. The AoA team identified nearly 400 alternatives. Initial screening removed most alternatives from consideration, including all alternatives that would have split the production process 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, the EA considered 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

Section 3120 of the John S. McCain National Defense Authorization Act for Fiscal Year 2019 mandated that "the Secretary of Defense, in consultation with the Administrator for Nuclear Security, shall enter into a contract with a federally funded research and development center to conduct an assessment of the plutonium strategy of the [NNSA]." IDA was selected to perform this assessment, and this paper summarizes the results.

The IDA analysis addressed all of the topics specifically called out in the legislation, including:

- An analysis of the EA and AoA;
- An assessment of the risks and benefits of each of the four major options considered by the EA;
- A description of NNSA risk reduction strategies; and
- An assessment of the strategy of manufacturing up to 80 ppy at PF-4 through the use of multiple labor shifts and additional equipment.

Topics out-of-scope for IDA's assessment, 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.

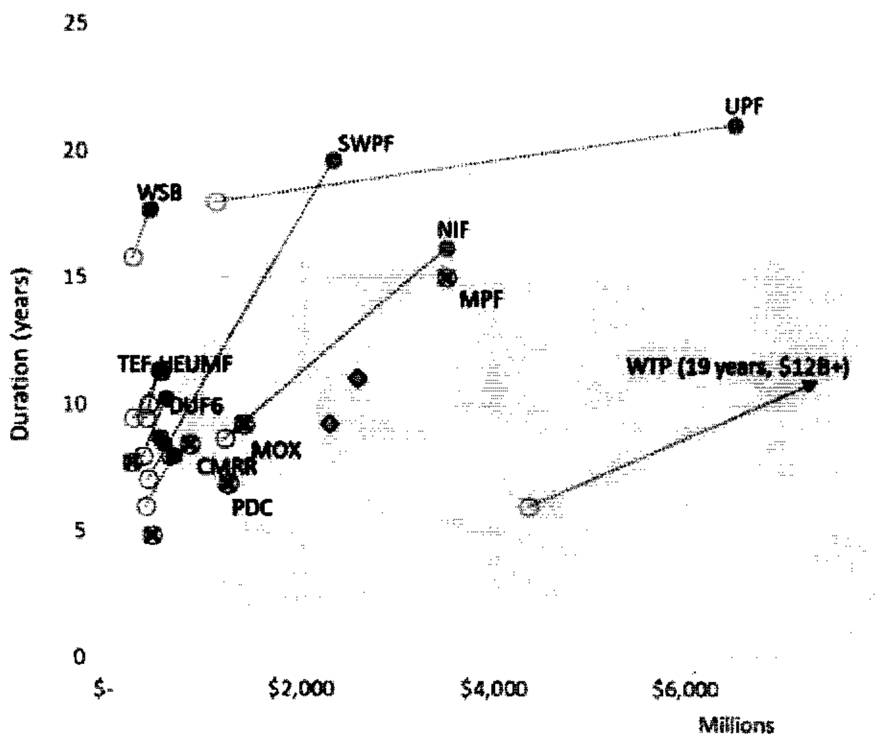
Methodology

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

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, though 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

IDA was also asked to evaluate the proposal for maximizing production ("surging") in PF-4 by installing additional equipment and running a second production shift. Given the schedule difficulties noted above, attempting to surge at LANL offers the only possibility for producing significantly more than 30 ppy by 2030. IDA's assessment is that producing more than 30 ppy using a two-shift "surge" at LANL appears technically possible, but would be very challenging to execute and could jeopardize executing the PSP as well as other LANL programs. Producing 80 ppy using this strategy is unlikely.

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 transport/transfer complexity 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. Many of the risk mitigation strategies in the AoA and EA are not related to executing an action to reduce the risk, but rather to initiating a study to characterize the risk or acknowledging that careful planning and coordination will be required. In other words, many of the risk mitigation strategies have not yet been initiated. Moreover, in the EA results briefing, NNSA presented a list of proposed strategies to accelerate the schedule, with the goal of achieving the 2030 full rate production deadline. IDA found these proposed efforts to be inconsistent with best practices and likely counterproductive. A key milestone will be achieving the PSP goal of 30 ppy at LANL. Successfully demonstrating a pit production capability at this scale would greatly increase confidence in the eventual ability to produce 80 ppy. Careful and skilled management and consistent, focused leadership will be required for this effort to reconstitute plutonium pit production capabilities to succeed where many previous efforts have failed.

Summary of Main Findings

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. Trying to increase production at PF-4 by installing additional equipment and operating a second shift is very high risk.
4. Effort to identify and address risks is underway, but is far from complete.
5. Strategies identified by NNSA to shorten schedules will increase the risks of schedule slip, cost growth, and cancellation.

Abbreviations

AC	Analytical Chemistry
AoA	Analysis of Alternatives
ARIES	Advanced Recovery and Integrated Extraction System
BMP	Material Processing Building
BTS	Technical Support Building
CD	Critical Decision
CEPE	Office of Cost Estimation and Program Evaluation
CEQ	Council on Environmental Quality
CMR	Chemistry and Metallurgy Research Facility
CMRR	Chemistry and Metallurgy Research Replacement
CONOPS	Concept of Operations
CUB	Combined Utility Building
DA	Design Agency
DNFSB	Defense Nuclear Facility Safety Board
DoD	Department of Defense
DOE	Department of Energy
DUF6	Depleted Uranium Hexafluoride
EA	Engineering Assessment
ECMS	Enterprise Construction Management Services
EIA	Energy Information Agency
EIS	Environmental Impact Statement
ELD	Equipment Layout Drawing
EM	Environmental Management
FTE	Full-Time Equivalent
GAO	Government Accountability Office
HC	Hazard Category
IDA	Institute for Defense Analyses
INL	Idaho National Laboratory
IWTU	Integrated Waste Treatment Unit
LANL	Los Alamos National Laboratory
LLNL	Lawrence Livermore National Laboratory

LMI	Logistics Management Institute
M&O	Management and Operating
MAR	Material-at-Risk
MC	Materials Characterization
MCU	Materials Characterization Unit
MEB	Mechanical and Electrical Building
MFA	Management Focus Area
MFFF	Mixed-Oxide Fuel Fabrication Facility
MNS	Mission Need Statement
MOX	Mixed Oxide
MPF	Modern Pit Facility
NAP	NNSA Policy
NEPA	National Environmental Policy Act of 1969
NIF	National Ignition Facility
NNSA	National Nuclear Security Administration
NNSS	Nevada National Security Site
NPR	Nuclear Posture Review
NWC	Nuclear Weapons Council
OAI	Office of Audits and Inspections
OIG	Office of the Inspector General
ORR	Operational Readiness Review
PDC	Pit Disassembly and Conversion
PEI1	PF-4 Equipment Installation Phase 1
PEI2	PF-4 Equipment Installation Phase 2
PEIS	Programmatic Environmental Impact Statement
PF-4	Plutonium Facility
ppy	Pits per year
PRD	Program Requirements Document
PSM	Personnel Support Module
PSO	Program Secretarial Officer
PSP	Plutonium Sustainment Program
Pu	Plutonium
PuE	Enhanced Plutonium
PX	Pantex Plant
RC3	Recategorizing RLUOB to HC-3
REI2	RLUOB Equipment Installation Phase 2

RLUOB	Radiological Laboratory Utility Office Building
ROD	Record of Decision
ROM	Rough Order of Magnitude
SA	Supplemental Analysis
SME	Subject Matter Expert
SPEIS	Supplemental Programmatic Environmental Impact Statement
SRNL	Savannah River National Laboratory
SRPPF	Savannah River Plutonium Processing Facility
SRS	Savannah River Site
SSCs	Structures, Systems, and Controls
SSM	Stockpile Stewardship and Management
SWEIS	Site-Wide Environmental Impact Statement
SWPF	Salt Waste Processing Facility
TA-55	Technical Area 55
TPC	Total Project Cost
UPF	Uranium Processing Facility
US	United States
WBS	Work Breakdown Structure
WIPP	Waste Isolation Pilot Plant
WR	War Reserve
WSB	Waste Solidification Building
WTP	Waste Treatment and Immobilization Plant