EXECUTIVE SUMMARY

The National Nuclear Security Agency (NNSA) requires a sustained production capacity of no fewer than 80 pits per year (ppy) by 2030. Since 1989, when the Rocky Flats Plant was closed, the nation has had little capability to manufacture new plutonium pits that can go into the stockpile, called War Reserve (WR) pits. A limited capability of 10 WR ppy was exercised at Los Alamos National Laboratory (LANL) in the early 2000s, but no WR pits have been produced since 2012. At this time, NNSA is developing and installing capability at LANL in Plutonium Facility (PF)-4 to produce 30 ppy by 2026. The Analysis of Alternatives (AoA) for meeting pit production requirements, completed in September 2017, assessed alternatives to close this identified mission gap in the NNSA's pit production capability. The AoA is a post Critical Decision (CD)-0, pre-CD-1 activity to identify a preferred alternative for conceptual design in preparation for the Deputy Secretary of Energy to make a program decision at CD-1.

The **AoA analysis resulted in the identification of two preferred alternatives, with a recommendation to conduct engineering analyses and pre-conceptual design activities on both alternatives in support of conceptual design for CD-1.** The refurbishment and repurposing of the Mixed-Oxide Fuel Fabrication Facility at Savannah River Site has the most favorable cost and schedule for achieving a sustained 80 WR ppy production rate, but introduces the qualitative risk of reconfiguring a partially completed facility for a new mission in a new location. The other recommended alternative, new construction of an 80 WR ppy facility at LANL, has the lowest qualitative siting risk, but less favorable cost and schedule, and introduces risk associated with new construction of hazard category (HC)-2 facility space that includes regulatory milestones historically difficult to navigate in early design (e.g., NQA-1 and NEPA). The identification of two preferred alternatives for more detailed engineering analysis and conceptual design has precedence within the department to be addressed outside of the AoA process.

The 80 WR ppy requirement was validated prior to the start of the AoA by the Nuclear Weapons Council based on pit aging and directed military requirements. The pit production requirement is an annual "at least" production rate derived from the delivery schedule for certified, life extended nuclear weapons to the Department of Defense (DOD). Consequently, a sustained production rate of 80 ppy must be achieved with high confidence. In the context of the AoA analysis, high confidence was defined as a greater than 90% probability of achieving the required throughput (9 out of every 10 production years, the facility is expected to produce at least 80 WR pits). This constraint differs significantly from the Plutonium Sustainment Program's 30 WR ppy annual production goal. The 30 WR ppy capability is an "on average" requirement, defined as a 50% confidence in the production throughput.

The AoA Team evaluated functional and process requirements for achieving the 80 WR ppy mission requirement. These requirements informed the development of equipment and processing space estimates, which were key components of the analytical conclusions and the cost estimate ranges produced by the AoA. In order to adequately develop the equipment and space estimates, the AoA team developed a stochastic discrete event simulation of the pit production process to project pit manufacturing throughput for a given equipment set. The final equipment set was developed by adjusting equipment as needed to remove production- and logistics-based bottlenecks to ensure an 80 WR ppy throughput at high confidence. Following verification and validation of the model and the resultant equipment set by the AoA team production experts, subject matter experts estimated space needs based on analysis of analogous projects. Space needs were developed for both HC-2 and non-HC-2 functions,

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using a best value approach by moving support functions to non-HC-2 space whenever possible. Two key outcomes resulted from the equipment and space analysis:

- First, the equipment set for 80 WR ppy does not fit in the modular layout envisioned at CD-0 for the initial modular building strategy proposal.
- Second, the difference between a 50 WR ppy equipment set and an 80 WR ppy equipment set is within the range of error and, therefore, did not have an appreciable effect on the determination of the preferred alternatives. 50 ppy capability was evaluated in the context of splitting production capacity by continuing to rely on PF-4 for 30 ppy and producing 50 in another facility.

The AoA Team assessed a range of options that included both building new and refurbishing existing facilities to achieve the required annual production rate while not interfering with the mission objectives for the Plutonium Sustainment program and other required plutonium missions. The AoA Team determined that the original modular building strategy as proposed at CD-0 is not a viable option for the 80 WR ppy production requirement. Three aspects of this strategy prevent it from meeting mission requirements:

- PF-4 is only capable of an estimated 30 ppy (on average) after planned upgrades.
- Renovation of existing processing areas within PF-4 makes the 30 WR ppy sustainment capability unachievable by 2026 and presents schedule risks to other current missions not present in other options.
- An 80 WR ppy equipment set (at high confidence), requires over three times more HC-2 processing space than provided by two 5,000 square foot modules.

Although the modular building strategy envisioned at CD-0 utilizing PF-4 does not meet the functional and process requirements for an 80 WR ppy production, after a new 80 WR ppy capability is established, PF-4 can return to the research and development mission for which it was built.

A key finding of this AoA was the high schedule risk for all alternatives. There are two types of schedule risk, risk associated with the complexity of the schedule (complexity) and risk associated with the ability to execute the schedule as envisioned (executability). Complexity risk is related to the difficulty associated with design and procurement of processing equipment and the design and construction of a HC-2 facility. Complexity risk is reflected in the schedule analysis, and compounds with a phased approach to design and construction. Executability risk is related to resources, efficiency, and personnel. Executability risk is reflected in the cost estimating section. Although the complexity analysis indicated a 2030 schedule is achievable under ideal circumstances, the associated cost analysis demonstrated that executability risk would delay achievement of 80 WR ppy to 2033 at the earliest for any alternative.

Based on the AoA analyses, the Program Secretarial Officer has directed further refining each of the two preferred alternatives by executing an engineering analysis prior to conceptual design. The results of the engineering effort, coupled with the AoA analysis, will be used to inform a decision memorandum from the Program Secretarial Officer and enable pursuit of a full conceptual design package on a single preferred alternative.

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