Based on the unfavorable schedule, high risk of disruption to ongoing missions in PF-4, no noticeable advantage in cost due to having to build or renovate space for metal preparation, these alternatives were recommended for elimination from further consideration.

5.3.2.4 Alternatives Involving 80 ppy Production in PF-4 Were Recommended for Elimination from Further Consideration

Table 5–6 lists estimated space needs for production of 80 ppy at high confidence in comparison to space usage in PF-4 after CMRR project and Plutonium Sustainment programs install AC/MC capabilities and production equipment for approximately 30 ppy, respectively.[14] Note that PF-4 is assumed to provide adequate building services, so to simplify the comparison, the space needed for building services is not included in this table.

Table 5–6. Comparison of PF-4 usage and 80-ppy space requirements

Area Name	80 pits per year	PF-4 Space Allocation (Program of Record for 30 pits per year)	Additional Space Needed for 80 pits per year	Missions in PF-4 that Could Be Relocated
	Estimated (square feet)			
Process equipment including building working space	42,400	19,500	**22,800**	
Support Functions within processing facility	68,000	54,600	**13,500**	
Total	**110,400**	**74,100**	**36,300**	
ARIES				5,500
Plutonium-238				9,400
	KEY: ARIES = Advanced Recovery and Integrated Extraction System			

The AoA team estimates an additional 36,000 ft^2 would be required to support the 80-ppy mission. Even if it is assumed that support functions available in PF-4 (such as the vault, shipping and receiving, production development, material management, etc.) are adequate, an additional 22,800 ft^2 in PF-4 would be necessary to support 80 ppy at high confidence.

Since PF-4 does not have adequate space for an 80 ppy mission, these alternatives were recommended for elimination from further consideration.

5.3.2.5 Alternatives Moving Pu-238 Missions and ARIES Out of PF-4 to Create Space for Pit Production were Recommended for Elimination from Further Consideration

Moving plutonium-238 production missions and ARIES out of PF-4 frees up just less than 15,000 ft^2 that could be repurposed for pit production. This is less than half of the space the AoA team estimates is needed to support the pit production mission, and these options come with cost and schedule issues that make them undesirable.

[14] See Chapter 2 for a discussion of equipment and space estimates and the difference between production at high confidence and production on average.

The plutonium-238 production mission cannot be gapped due to mission requirements described in the PRD. A new capability would need to be at full-rate production before space in PF-4 becomes available for repurposing. Based on LANL estimates for demolition and decontamination of gloveboxes within PF-4, the earliest that production activities could begin in the plutonium-238 spaces is FY 2036 for this alternative. This assumes:

- an optimistic schedule for establishing a new capability starting in FY 2018 (3 years to CD-2, 3-year construction, and 2-year startup);
- D&D of Area 200 (gloveboxes and ventilation system) estimated to take at least 4 years;
- outfitting estimated to take approximately 5 years (gloveboxes and ventilation system); and
- startup estimated to take 2 years.

In addition to the cost of repurposing the space within PF-4, there is an additional cost to build or refurbish approximately 10,000 ft^2 for the plutonium-238 processing area somewhere else.

Assuming the ARIES mission is no longer needed for the current plutonium disposition program, the space occupied by ARIES could be eliminated without any mission risk. However, note that the ARIES equipment also currently supports the Material Recycle and Recovery. D&D of these spaces cannot begin until the ongoing MR&R mission in those spaces is complete, estimated to be in the 2027 timeframe.

Retrofitting the ARIES space for pit production is estimated to take roughly 10 to 12 years, including startup, based on LANL current plans for similar work in room 409 in PF-4. The earliest the ARIES space could begin to support production of pits is estimated to be no earlier than 2038. In short, moving ARIES may provide an additional 5,500 ft^2 of space that could begin producing pits in the late 2030s, but there are programmatic risks in doing so and it does not provide nearly enough space to support the 80-ppy mission.

These alternatives were also assessed to be high risk due to a very high probability that ongoing operations in PF-4 will be affected at the significant or critical level and a very high probability that ongoing operations adversely affect the ability to produce 80 ppy or vice versa at the significant or critical level. In particular, the demolition of contaminated gloveboxes and ventilation systems and installation of new gloveboxes and ventilation create unacceptably high risk to achieving of the 30-ppy capability planned in PF-4.

Based on the unfavorable schedule, disruption to plutonium-238 operations, high risk of disruption to ongoing missions in PF-4, no noticeable advantage in cost due to having to build or renovate space for the plutonium-238 mission, these alternatives were recommended for elimination from further consideration.

5.3.2.6 Alternatives Involving Splitting Production Between PF-4 and Another Facility were Recommended for Elimination from Further Consideration

Several alternatives involving splitting production between PF-4 and another facility (at various locations) were developed, i.e., 30 ppy at PF-4 and 50 ppy in another facility. These alternatives would capitalize on the capability for 30 ppy that is currently being installed in PF-4 by the Plutonium Sustainment Program, and supplement it with a new capability somewhere else.

Table 2–4 shows the total number of pieces of equipment needed for 30 ppy, 50 ppy, and 80 ppy at high confidence. If PF-4 can produce 30 ppy at high confidence, the difference between adding 50 ppy somewhere else and establishing an 80 ppy capability is 22 pieces of equipment requiring about 6,350 ft^2. The marginal cost for the additional space to get to 80 ppy is small.

The AoA Team estimates that the 30 ppy capability currently planned in PF-4 through the Plutonium Sustainment Program (the Status Quo alternative) will produce almost 30 ppy on average, similar to LANL's estimate for the capability. To provide 80 ppy at high confidence, the equipment needed to get to 30 ppy at high confidence must be added to PF-4 in the 30/50 ppy split cases.

The AoA team estimates that an additional seven pieces of equipment, requiring about 2,000 ft^2, would need to be added to PF-4 to get to 30 ppy at high confidence. **Table 5-7** shows the equipment requirements for the 30/50 ppy split case vs the 80 ppy case.

Table 5–7. Number of pieces of equipment for 30/50 ppy case vs 80 ppy case

30/50 ppy Split Case	80 ppy Case
201	**133**

The 30/50 ppy split cases require almost 70 pieces more total equipment, require additional reconfiguration of about 2,000 ft^2 of space in PF-4, and add long-term production risk and surveillance costs due to multiple production lines. The savings provided by a reduction of 6,350 ft^2 in the production facility is marginal and is offset by the above considerations. Therefore, the 30/50 split production alternatives were recommended for elimination from further consideration.

5.3.2.7 The Initial Modular Building Strategy, as Envisioned at CD-0 Does Not Meet Mission Requirements

The Initial Modular Building Strategy, as envisioned at CD-0 involved reconfiguring PF-4 and the construction of two modules with 5,250 square feet of processing space each. LANL did not provide an official proposal for how this concept would achieve the 80 ppy mission requirement without compromising other required plutonium missions. Instead, LANL had several concepts for establishing various capabilities in the modules and reconfiguring PF-4. Many of these were incorporated into the AoA alternative set, for example, splitting production capacity, and moving metal preparation operations, plutonium-238 operations or ARIES are included in the AoA alternatives. After showing that those concepts have unfavorable cost, schedule or risk profiles, and no identifiable offsetting benefit, the AoA Team double checked the modular building concept.

Using the comparison of space available in PF-4 for pit production and space needed for 80 ppy at high confidence shown in **Table 5-6**, the modular concept proposed at CD-0 would need seven total modules to create an additional 36,000 ft^2 of production space. **Figure 5-1** provides a scaled drawing of the available space in PF-4 for pit production, and the proposed modules in comparison with the additional required space.

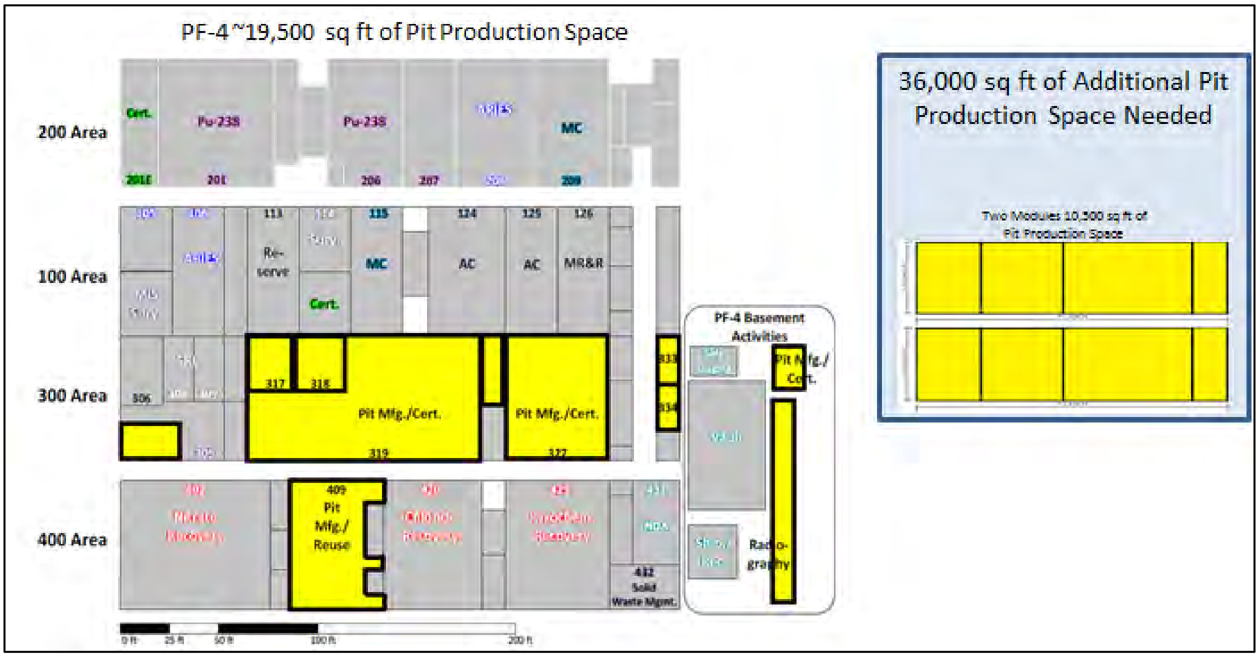


Figure 5-1. Scaled representation of PF-4, proposed modules, and additional space needed for 80 ppy

The Initial Modular Building Strategy, as envisioned at CD-0 (two modules, each providing 5,250 ft^2 of production space) is inadequate to support the 80 ppy mission at high confidence.

5.3.3 Remaining Alternatives

The recommendations for elimination of non-viable alternatives as described above were presented to the PSO in June 2017.

PF-4 was constructed in the mid-1970s with a planned useful lifetime of 50 years. It began operations in 1978, at which time it had ample margin to accommodate changes in safety and regulatory requirements. Over the last 35 or more years, that margin has been consumed with increasingly stringent nuclear safety requirements. By the time an 80-ppy production capability could be established in PF-4, the building would be over 50 years old. It will be problematic for PF-4 to support additional changes in nuclear safety risk tolerance, increased pit manufacturing activity, and higher capacity for plutonium missions such as pit reuse and rework. This is primarily due to the increase in MAR and resulting offsite accident dose, the age of the facility, and the available processing space capacity and condition.

Based on the preliminary AoA analyses, the PSO determined that continuing to rely on PF-4 for the Nation's enduring pit production capability presented unacceptably high mission risk for the following reasons:

- **Jeopardizes program of record:** Efforts to remove contaminated gloveboxes and install new equipment in an operating manufacturing space, beyond what is already planned under the Plutonium Sustainment program, creates unacceptably high risk to achieving 30 ppy by 2026.
- **Space and capacity constraints:** The AoA Team estimates about 110,000 ft^2 of HC-2, SC-1 processing space is necessary to produce 80 ppy with high confidence.[15] PF-4 has about 74,000 ft^2 of suitable space, 36,000 ft^2 short. Even if missions such as ARIES and plutonium-238 component manufacturing, totaling about 14,000 ft^2, were relocated, the total processing space in PF-4 would still be approximately 22,000 ft^2 short.

The recommendations for elimination of alternatives from further consideration, as described above, were approved. The following five alternatives were retained for detailed cost, schedule, risk, and effectiveness evaluation:

- New construction at LANL
- New construction at SRS
- New construction at INL
- Refurbishment of FPF at INL
- Refurbishment of MFFF at SRS

Note that under each of these final alternatives, the full 80-ppy production line plus metal preparation would occur in a single location. **Table 5–8** shows the elimination of other potential alternatives to produce this final list.

[15] Total for the HC-2, SC-1 production facility is estimated to be approximately 130,000 ft^2, including building services such as process ventilation and security class utilities.

Table 5–8. Final alternatives selection

LANL	LANL/SRS	LANL/INL	LANL/Pantex or NNSS
Status Quo at PF-4			
~~Split Production Capacity PF-4 As-Is (30 ppy), plus New Construction (Modules)~~	~~Split Production Capacity 30 ppy PF-4 50 ppy MFFF~~	~~Split Production Capacity 30 ppy PF-4 50 ppy FPF~~	~~Split Production Capacity 30 ppy PF-4 50 ppy New Construction~~
~~Split Production Capacity Move Pu-238 Pit production in PF-4 plus New Construction (Modules)~~	~~Split Production Capacity 30 ppy PF-4 50 ppy K-Area Reactor~~	~~Split Production Capacity 30 ppy PF-4 50 ppy New Construction~~	
~~Split Production Capacity Move Aries, Pit production in PF-4 plus New Construction (Modules)~~	~~Split Production Capacity 30 ppy PF-4 50 ppy WSB~~		
~~Split Production Capacity Move Pu-238 and Aries, Pit production in PF-4 plus New Construction (Modules)~~	~~Split Production Capacity 30 ppy PF-4 50 ppy New Construction~~		
Move Pit Production 80 ppy production in new construction PF-4 - existing mission w/o production	Move Pit Production 80 ppy production MFFF PF-4 - existing mission w/o production	Move Pit Production 80 ppy production FPF PF-4 - existing mission w/o production	~~Move Pit Production 80 ppy production New Construction PF-4 - existing mission w/o production~~
	~~Move Pit Production 80 ppy production K-Area Reactor PF-4 - existing mission w/o production~~	Move Pit Production 80 ppy production New Construction PF-4 - existing mission w/o production	
	~~Move Pit Production 80 ppy production WSB PF-4 - existing mission w/o production~~		
	Move Pit Production 80 ppy production New Construction PF-4 - existing mission w/o production		

Key:
PF = Plutonium Facility; ppy = pits per year

6 Cost Estimate

6.1 Overview

The AoA's cost team examined total project cost (TPC) and life cycle cost (LCC) for each of the alternatives assessed to be the most viable: new construction at LANL, INL, or SRS and refurbishment of existing facilities at INL or SRS. This included estimates for facility construction and refurbishment, equipment procurement and installation, waste management, operations and maintenance, and other recurring expenses expected over the course of the pit production mission. These cost estimate ranges were based primarily on actual cost data from analogous projects of similar scope, as well as the AoA team's analysis of the amount of space and equipment required to achieve and sustain 80 ppy.

Table 6-1 shows the gross square footage used in the cost estimates for each of the five remaining alternatives. For each alternative, the AoA Team evaluated the capabilities at the site, and added cost to construct facility space for those capabilities unavailable, or inadequate to support the 80 ppy capability. For support facilities within the SC-1 boundaries, the team assumed all new build options would require construction of these facilities within the established SC-1 area. At LANL, depending on where the pit production facility is located, there may be some capacity available on-site for some of these functions. The MFFF complex at SRS was found to have sufficient facility space adjacent to the processing facility for these functions. For the support capabilities outside the PIDAS, such as classified beryllium and graphite machining, and graphite coating, the AoA Team notes that some of these capabilities could be provided by existing facilities at LANL. However, the AoA Team made a conservative assumption that these facilities would be co-located with the pit production capability.

Table 6–2. Gross square footage by alternative

Functional Area	LANL New	SRS MFFF	SRS New	INL FPF	INL New
Total HC-2 Production Facility	*130,000*	*130,000*	*130,000*	*130,000*	*130,000*
Support facilities within the SC-1 boundaries	67,500	-	67,500	67,500	67,500
Support facilities outside the SC-1 boundary	[redacted]				
Actinide Chemistry	-	-	-	-	-
Material Characterization	-	-	-	-	-
Admin Building 80 ppy	-	-	26,000	26,000	26,000
Classified SS Machining	-	-	-	-	-
Cold Machining & Tooling	-	-	-	-	-
Electrical Power	-	-	-	-	-
Other Utilities	-	-	-	-	-
Medical Facilities	-	-	-	-	-
Environmental Monitoring	-	-	-	-	-

Actinide Chemistry	-	-	-	-	-
Material Characterization	-	-	-	-	-
TRU liquid Waste	-	-	-	-	-
TRU Solid Waste	-	-	-	-	-
Actinide Chemistry	-	-	-	-	-
Material Characterization	-	-	-	-	-
LL Rad Liquid Waste	-	-	-	-	-
Classified Be. Machining	2,500	15,000	15,000	15,000	15,000
Graphite Coating	-	13,000	13,000	13,000	13,000
Classified Graphite Machining	6,000	13,000	13,000	13,000	13,000
Standards & Calibration	17,000	-	-	-	-
Classified Uranium Machining	-	-	-	-	-
PIDADS/PIDAS (linear feet)	1,700	3,000	2,600	2,600	2,600
Low Level Solid Waste	-	-	-	-	-
Security Cat I	-	-	-	-	-

The cost estimate ranges were developed using Government Accounting Office (GAO) and NNSA best practices for an early stage, pre-baseline construction project. Because these are early estimates with little design definition, a higher level parametric/analogous estimating approach was chosen over a "bottom-up" approach. This decision was based on the fact that bottom-up approaches are more likely to exclude key elements of scope, as well as severely underestimate both the cost and uncertainty associated with the project.

Parametric cost-estimating relationships provided the team with scaling factors to take into account technical differences (such as facility size and complexity) that are unique to the project. The parametric approach also provided uncertainty distributions around each one of the input parameters, and these distributions were then integrated into a total uncertainty distribution using a Monte Carlo simulation. The result of this integrated, data-based, cost-estimating approach was a cost-probability distribution. This cost-probability distribution was developed for each of the five alternatives that passed the initial screening and accounted for differences in scope, complexity, location, and available support facilities. This is further detailed in Appendix F.

To capture all relevant scope of the project, a work breakdown structure (WBS) was developed. This WBS ensured the complete scope required for each alternative was considered and analyzed. Data were collected from multiple sources in order to capture completed project actuals, analogous estimates, and subject matter expert observations. These data were used to estimate the costs of systems engineering, integration and program management, HC-2 facility structure, utilities, fixtures and office equipment, pit production equipment, support equipment and facilities, operations and maintenance, recapitalization, and waste processing. **Table 6–2** describes the approach and applicable data used to estimate each WBS element. A fully detailed explanation of the methodology to estimate each element is provided in Appendix F, Basis of Cost Estimate.

6.2 Facility Costs

Facility construction costs were parametrically derived based on dollars per gross building square footage. Project costs from the Construction Project Data Sheets (CPDS) from over 50 NNSA projects were collected for all of the 1993 through 2018 DOE Congressional Budget Requests. Project costs were broken out into yearly Project Engineering and Design, Other Project Costs (OPC), and Construction. Six Cost Estimating Relationships (CERs) for new construction and one refurbishment CER were developed using comparable NNSA projects based on hazard categories per DOE STD 1027-92. The facility costs were a major cost differentiator between refurbishment and new construction alternatives.

Table 6–2. Work Breakdown Structure for the Plutonium Pit Production AoA cost estimate

WBS Element	Methodology	Analogies
Facility structure, utilities, fixtures, and office equipment	Parametric based on analogous NNSA facilities	HEUMF, WSB, TEF, MFFF, MPB
Pit production equipment	Parametric based on analogous NNSA equipment procurements	CMM 1 and 2, casting upgrades, new ER, DMU 35, Pu assay, DC arc, radio chemistry, Y-12 GB-C, Y-12 Assembly GB, ARIES, RLUOB
Support equipment and facilities	Parametric based on analogous NNSA facilities	TRUWF, TRULWF, SAB, NIF, LLW, MESA, PF, HEPF, HESE, NSSB, DISL, NTSRFS, WETL
Subsystems engineering, integration and program management	Percentage based on NNSA analogous projects	PF-4 (PEI I/II), MOX, WSB, NFRR, CEF, BEC, TEF, SNMCRF
Operations and maintenance	Percentage based on PF-4 actuals	LANL (TA-55)
Recapitalization	2 to 4% of facility and equipment costs	Industry standard for recapitalization (rate is dependent on new versus refurbished facility)
Waste	Parametric based on production rate	PF-4, MPF estimates

Key:
ARIES = Advanced Recovery and Integrated Extraction System; BEC = Beryllium Capability; CEF = Component Evaluation Facility; CMM = coordinate measuring machine; DC =Direct Current; DMU = the brand name of the milling machine; ER = electro-refining; GB = glovebox; HEUMF = Highly Enriched Uranium Materials Facility; LANL = Los Alamos National Laboratory; MFFF = Mixed Oxide Fuel Fabrication Facility; MPB = ...; MPF = Modern Pit Facility; MOX = mixed oxide; NFRR = Nuclear Facility Risk Reduction; NIF = National Ignition Facility; NNSA = National Nuclear Security Administration; NTSRFS = Nevada Test Site Replacement Fire Stations; Pu = plutonium; RLUOB = Radiological Laboratory Utility Office Building; SAB = Salvage and Accountability Building; SNMCRF = Special Nuclear Material Component Requalification Facility; TA = Technical Area; TEF = Tritium Extraction Facility; TRULWF = Transuranic Liquid Waste Facility; TRUWF = Transuranic Waste Facility; WETL = Weapons Evaluation Test Laboratory; WSB = Waste Solidification Building; Y-12 = Y-12 National Security Complex

6.3 Pit Production Equipment

The output from Defense Programs' Plutonium Processing discrete event model was the basis for estimating equipment procurement, design, and installation costs. As discussed above, a list of all manufacturing equipment was generated from this model for 50- and 80-ppy production rates. Once the AoA team had developed the equipment and space estimate, CERs were developed for plutonium processing equipment procurement activities based on actual costs from competed projects at LANL and Y-12 with comparable scope (shown below in **Table 6–3**). The required equipment footprint is the dependent variable in a CER of cost to square foot.

Table 6–3. NNSA actual equipment projects

Project Name	Site
Coordinate Measuring Machine #1 (CMM #1)	LANL
Glovebox (CPR P88Y2765)	Y-12
Assembly glovebox (CPR P88Y2426)	Y-12
Advanced Recovery and Integrated Extraction System (ARIES)	LANL
DC Arc Plasma Spectrometer and glovebox	LANL
DMU-35 mill and glovebox	LANL
Plutonium assay capability (design/procure/install for multiple gloveboxes) to support heat source program	LANL
Radio chemistry (design/procure/install for multiple gloveboxes) to support heat source program	LANL
Electro-refining (ER) line upgrade	LANL
Coordinate Measuring Machine #2 (CMM #2)	LANL

Key: *CMM = coordinate measuring machine CPR = brand name for the glovebox; DC = direct current; DMU = brand name for the milling machine; LANL = Los Alamos National Laboratory;*

6.4 Support Equipment and Facilities

SME team members visited prospective sites to assess additional support space and equipment needed to fulfill the 80-ppy mission. The infrastructure team provided capabilities and required list of equipment, facility footprint, and its corresponding HC. The facility construction equipment CERs discussed in Appendix F were used to calculate the additional costs associated with each capability. These values were based on historical NNSA projects and equipment procurements.

6.5 Systems Engineering, Integration and Program Management

Systems Engineering and Integration (SE&I) and Program Management (PM) were estimated as a level of effort task. It was estimated as a percentage of the base facility construction and equipment cost using comparable NNSA HC-2 actuals.

6.6 Operations and Maintenance

Production, maintenance, and operations costs only capture the cost to manage the facility, maintain the facility, and recapitalize both process and support equipment. Operations, production, and process monitoring will be a future program cost and therefore are outside the scope of this AoA. Additionally, costs will be similar for all alternatives and will not drive any acquisition decision.

The annual maintenance and utility costs where estimated as a function of the gross square footage (GSF) of the facility. Annual cost data were collected from LANL beginning in FY 2008 through FY 2012 for the current PF-4 facility. These data were then expressed as a function of GSF from year to year to derive a cost/GSF/year CER. These annual data were then used to get an average and standard deviation of costs per square foot of an active HC-2 facility. This CER was then applied to the space estimates for each alternative to give an estimate and uncertainty for the annual cost.

6.7 Recapitalization

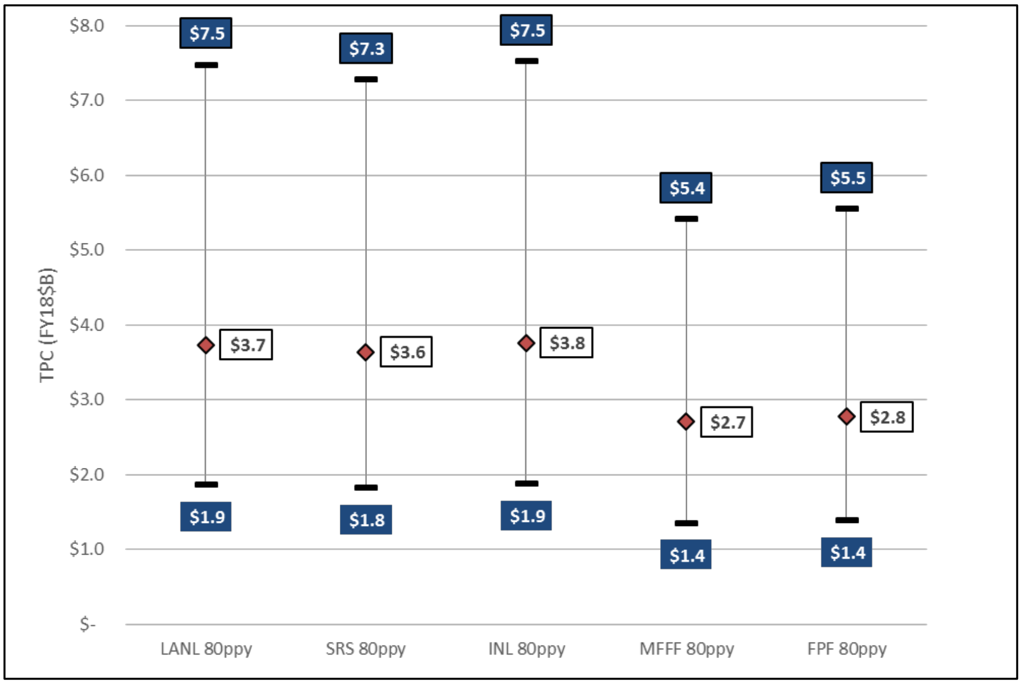
Process and support equipment recapitalization was assumed to be 2 to 4 percent of the acquisition cost annually. This cost was multiplied through the 50-year life-cycle in order to determine the total O&M life-cycle cost.

6.8 Waste

Three categories of waste were estimated: transuranic (TRU) waste, low level waste (LLW), and nonhazardous waste. The amount of waste produced at various pit production rates was previously estimated by the Modern Pit Facility (MPF) project and by LANL for the Plutonium Sustainment project (30 ppy) at PF-4. These waste processing, transportation, and disposal rates are discussed in detail in Appendix F.

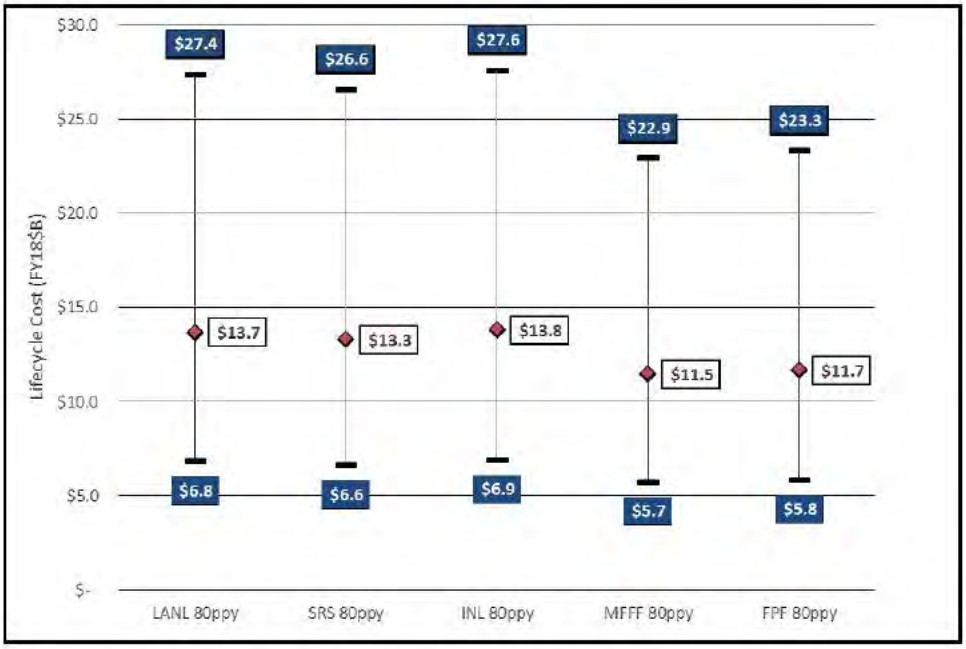
6.9 Summary: Cost Ranges for Alternatives

Figure 6–1 shows the TPC estimate ranges for each of the five final alternatives selected, and **Figure 6–2** shows the life-cycle cost estimate ranges. The number depicted by the red diamond in **Figure 6–1** represents the mean cost estimate from each alternative distribution.



Key: FPF = Fuel Processing Facility; FY = fiscal year; INL = Idaho National Laboratory; LANL = Los Alamos National Laboratory; MFFF = MOX Fuel Fabrication Facility; ppy = pits per year; SRS = Savannah River Site; TPC = total project cost.

Figure 6-1. Total project cost ranges through CD-4 for alternatives



Key: FPF = Fuel Processing Facility; FY = fiscal year; INL = Idaho National Laboratory; LANL = Los Alamos National Laboratory; MFFF = MOX Fuel Fabrication Facility; ppy = pits per year; SRS = Savannah River Site; TPC = total project cost.

Figure 6-2: Life-cycle cost ranges for alternatives

The number depicted by the red diamond in Figure 6–2 represents the mean cost estimate from each alternative distribution. This was an analysis of alternatives for a capital acquisition project, and we do not include the cost to produce a pit in the facility lifecycle cost estimate. We do, however, include the costs to operate, maintain, and recapitalize the facility and applicable equipment. NA-10 leadership decided that the actual cost of producing a pit was outside of the scope of the AoA. Additionally, the cost to produce a pit would not be a distinguishing factor when comparing various alternatives.

7 Schedule Estimate

7.1 Schedule Overview

The AoA Team performed the schedule analysis for the AoA using the GAO Schedule Assessment Guide, as applicable to a pre-conceptual design project. Because of the early stage of project definition and scope, the team employed parametric analysis, using DOE line item construction project actuals, subject-matter expertise, and past construction project precedence with a focus on aspects of a project likely to distinguish between alternatives prior to CD-1. The resultant estimates have wide uncertainty ranges, which is consistent with the current level of project definition. Actuals were compiled from several sources, including budget materials, NNSA's Office of Acquisition and Project Management (APM) project data, and the Office of NEPA Policy and Compliance's Lessons Learned Quarterly Reports (LLQRs). All the schedule estimates span from the close of the AoA process, where additional pre-CD-1 activities are still required, through ramp-up to 80 WR ppy production, to allow like-for-like comparisons among alternatives.

7.2 General Schedule Assumptions

The five alternatives evaluated by the AoA Team in detail are (1) a new production facility at SRS, (2) a new production facility at INL, (3) a new production facility at LANL, (4) the refurbishment/retrofit of MFFF at SRS, and (5) the refurbishment/retrofit of FPF at INL. The AoA Team made two primary assumptions in the development of the schedule estimates:

- Although site conditions and execution challenges will vary between the SRS, LANL, and INL alternatives, and those variations in site conditions/challenges may contribute to significant differentiating elements between the schedules for the alternatives, it is not possible at this time for the AoA team to estimate how differences between the sites will change the schedule results for a new facility.
- Similarly, based on site visits to MFFF and FPF by the evaluation team and a preliminary assessment of the technical conditions of these facilities, the team concluded that it is not possible at this time for the AoA team to predict how differing facility conditions might differentiate the project schedules for the retrofit/refurbishment of these facilities.

Therefore, the schedule development and analysis was collapsed to two scenarios/schedules: new facility and refurbished/retrofitted existing facility.

Additional major assumptions include the following:

- All alternatives assumed to require an environmental impact statement (EIS).
- Options and strategies for any combined CD-2/3 and/or advanced CD-3a will be used, where applicable.
- Funding will be provided at a point in time and rate/level that supports project development, execution, testing, startup, commissioning, process prove-in, and FPU delivery.
- The schedules developed for each option do not explicitly consider quantified consequences of each risk identified in the risk analysis but these are collectively captured in "optimistic, median, or pessimistic" cases.
- The schedules are not resource loaded, commensurate with the current, pre-conceptual design stage of the alternatives.

- AoA Decision and Start CD-1 Package will be developed by 10/2/17.

Additional assumptions and bases for the development of the two primary schedule scenarios are listed in Appendix G.

7.3 Work Breakdown Structure

The schedule sub-team developed generic schedules for each of the two remaining scenarios (new versus retrofit) to a level 5 WBS consistent with the common WBS used by the cost sub-team. WBS elements are consistent with the milestone phases and activities in the schedules. Approximately 100 unique activities were identified for each scenario, logically linked with predecessors and successors and assigned durations. The activities were linked based on:

- prescribed processes,
- DOE standards and guides,
- best management practices (BMPs) and standard operating procedures (SOPs) for DOE STD 413.3 and regulatory requirements,
- other relatable DOE project execution precedents, and
- subject matter expertise for each of the project acquisition/execution activities.

The major activities of the schedule map into the following level two elements of the common WBS:

- Systems Engineering & Integration
- Program Management
- Training
- Capital Asset
- Operations and Maintenance

Table 7- 1 shows the mapping between the schedule activities and the common WBS.

Table 7–1. Common WBS and schedule activities

WBS	Title	Schedule Activities
1.0	Pit Production Strategy	New Facility/Refurb
1.1	Systems Engineering & Integration	Title I and II Design
1.2	Program Management	Milestone Reviews and Approvals, NEPA Activities, Procedures Development
1.3	Training	Personnel Training
1.4	Development, Test, and Evaluation	
1.5	Production	

WBS	Title	Schedule Activities
1.0	**Pit Production Strategy**	**New Facility/Refurb**
1.6	Capital Assets	
1.6.1	Land	
1.6.2	Structures	
1.6.2.1	Facility	Construction
1.6.2.1.1	Facility Structures	
1.6.2.1.2	Facility Utilities	
1.6.2.1.3	Furniture, Fixtures & Office Equipment	
1.6.2.1.4	Process/Scientific/Technical Equipment	Procurement, Equipment Install, Testing, start-up and Commissioning
1.6.2.2	Support Equipment & Facilities	
1.6.2.3	Site Work	Site Prep
1.6.4	Intellectual Property	
1.7	Operations and Maintenance	
1.7.1	Operations	WR Process Qualification, Production Ramp-up
1.7.2	Maintenance	
1.7.3	Recapitalization	
1.8	Waste	
1.9	Transportation	

The AoA Team notes that activities after testing, start-up and commissioning are largely equal across all alternatives because the alternatives all reflect a common facility throughput capacity. These activities are fundamentally the same in scope across alternatives.

7.4 Schedule Estimate Assumptions and Basis of Estimates

At a fundamental level, the major differences between the two schedule scenarios (new versus retrofit) consist of the level of effort and time required for the design, procurement, installation, and construction of relevant SSCs analyzed by engineering discipline.

7.5 Schedule Estimates Methodology

The schedule analysis for this AoA leveraged several data collection efforts to inform the parametric schedule assessment for all alternatives, consistent with GAO best practices for schedule assessments and commensurate with the early stages of project definition and scope. Several project actuals (15 new build projects, 10 refurbishment projects [see Appendix G for complete list]) were used to calculate a schedule estimate basis. Actuals were used throughout the estimate, where applicable. When actuals where unavailable, the AoA team relied on subject-matter expertise to inform activity schedules and produce a range of uncertainty.

The schedules are not resource-loaded (that is, considering people, materials, procurements, etc., over time). Resource-loaded schedules will be developed after conceptual design, when more specific information about the full work scope is available. Attempts to resource-load a schedule at the current level of design maturity (pre-conceptual design) would require many assumptions without a developed basis and would likely fail to capture the range of outcomes still possible at this early stage. Such practices run counter to the GAO best practices for schedule assessments. Similar to cost estimating, a parametric analysis of schedule is most appropriate at this stage of project definition.

Executability of any budget profile cannot be determined fully until a more complete design is developed, near full scope is understood, and resources are loaded into the schedule. These, activities are most appropriate after a conceptual design. The estimates produced for this AoA focused on aspects of project schedule most likely to differentiate between alternatives, to aid in alternative selection.

The defining difference between the alternatives, in terms of schedule, was whether to build a new facility or refurbish an existing one. The mean duration of refurbishment alternatives is significantly shorter than for new construction. This means a refurbishment option that requires modification to an existing structure represents the shortest project schedule. However, the range of uncertainty in the scope of the refurbishment options is higher, so the schedule ranges for those alternatives is larger. The results show that the high end (most pessimistic) of the schedule range for the refurbish alternatives overlaps the low end (most optimistic) of the new build alternatives. To better define the scope and activity timelines associated with the preferred alternative, an engineering analysis to support conceptual design is recommended as a next step.

7.6 Schedule Estimate Findings

The team's schedule estimates are based on quantitative, parametric schedule analysis, leveraging project actuals from similar activities across the nuclear security enterprise. **Table 7-2** and **Figure 7-1** show the schedule estimate results.

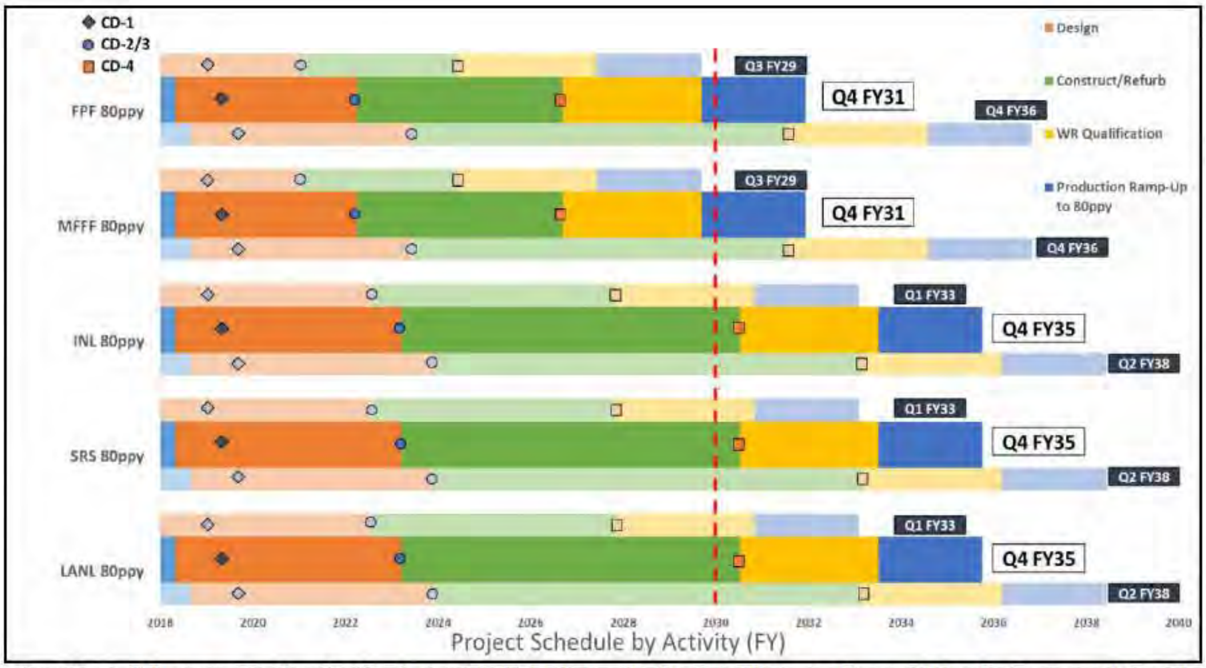
The area that drives the most schedule differentiation between alternatives is the construction phase. The pit process qualification and ramp-up to 80-ppy production are the same length for all alternatives and are significant contributors to the overall schedule. Under the current analysis, all alternatives are assumed to require a full EIS, and National Environmental Policy Act (NEPA) activities are not expected to be on the critical path for any alternative.

The schedule results show that only the refurbishment options have any chance, (albeit with some risk) of meeting the 2030 full rate production goal.

Table 7–2. Start and completion dates for all alternatives

		Start	Worst	Expected	Best
Refurbishment	MFFF – 80 ppy FPF – 80 ppy	10/2/2017	11/22/2035	5/8/2031	6/4/2029
New build	LANL – 80 ppy INL – 80 ppy SRS – 80 ppy	10/2/2017	6/30/2037	3/2/2035	10/28/2032

Key: FPF = Fuel Processing Facility; INL = Idaho National Laboratory; LANL = Los Alamos National Laboratory; MFFF = MOX Fuel Fabrication Facility; ppy = pits per year; SRS = Savannah River Site



Key: FPF = Fuel Processing Facility; FY = fiscal year; INL = Idaho National Laboratory; LANL = Los Alamos National Laboratory; MFFF = MOX Fuel Fabrication Facility; ppy = pits per year; Q = quarter; SRS = Savannah River Site; WR = War Reserve

Figure 7–1. Schedule results for all alternatives

One area of particular concern for the team was the potential effect of NEPA activities on overall project timelines. With actuals collected from LLQRs, the team created a range for the EIS timeline. Since NEPA activities typically run concurrently with design, the EIS currently would not be on the critical path for any of the alternatives considered. An EIS process would have to last over 5 years in order to cause delays to project execution, and this usually results from an unusually controversial project. This finding is further examined in Section 9.9, Sensitivity Analyses.

8 Evaluation of Alternatives – Risk and Effectiveness

8.1 Overview

In addition to the cost and schedule estimates presented in Chapters 6 and 7, the AoA team performed a detailed risk assessment, an evaluation of the effectiveness metrics identified in the Study Plan, and an assessment of additional considerations identified during the study. These detailed analyses were performed for the five remaining alternatives:

- LANL (new build)
- SRS (new build)
- SRS (refurbish MFFF)
- INL (new build)
- INL (refurbish FPF)

8.2 Final Risk Assessment

This section summarizes the risk assessment conducted by the AOA team. For more details about the risk assessment, see Appendix E.

8.2.1 Identified Threats

The AoA team identified threats in two areas. The first threat area is applicable to the period of construction up to the point when the facility begins the routine production of 80 ppy (Table 5–1). For the purposes of calculating the probability that a certain threat will actually occur during this period, the team assumed that the duration of construction and startup will be approximately 10 years. The second threat area pertains to the operating lifetime of the facility, assumed to be 50 years (Table 5–2).

8.2.2 Risk Matrix

The AoA team assessed the magnitude of the risk corresponding to each of the threats listed in Tables 5–1 and 5–2, making use of the risk matrix methodology described in DOE's *Risk Management Guide* (DOE, 2011). The risk matrix is reproduced in **Table 8–1**, with some minor changes. The probabilities are assigned numbers from 1 through 5, with 1 being very high and 5 being very low. The consequences are also labeled 1 through 5, with 1 being the highest consequence (crisis) and 5 being the lowest consequence (negligible).

In the text of this chapter, every time a combination of probability and consequence is identified it is noted as probability/consequence/risk for the convenience of the reader so that it is not necessary to refer back to the risk matrix. For example, a very high probability (1) and a significant consequence (3) correspond to a high risk (H); this is represented by the notation "1/3/H." Similarly, a high probability (2) and a significant consequence (3) correspond to a moderate risk (M), or 2/3/M for short. Likewise, a low probability (4) and a negligible consequence (1) correspond to a low risk (L), or 4/1/L.

Table 8–1. Risk matrix for Plutonium Pit Production Analysis of Alternatives[a]

		Consequences				
		Negligible (5)	**Marginal (4)**	**Significant (3)**	**Critical (2)**	**Crisis (1)**
Probability	Very high (1) >90%	Low (L)	Moderate (M)	High (H)	High (H)	High (H)
	High (2) 75% to 90%	Low (L)	Moderate (M)	Moderate (M)	High (H)	High (H)
	Moderate (3) 26% to74%	Low (L)	Low (L)	Moderate (M)	Moderate (M)	High (H)
	Low (4) 10% to25%	Low (L)	Low (L)	Low (L)	Moderate (M)	Moderate (M)
	Very low (5) <10%	Low (L)	Low (L)	Low (L)	Low (L)	Moderate (M)

[a] Matrix and probabilities from DOE *Risk Management Guide*, DOE G 413.3-7 (DOE, 2011).

Numbers 1-5 against probability and consequences added for the purposes of this AoA.

Probability of occurrence:

Construction: calculated during the period from CD-2 to startup (assume 10 years).

Operation: calculated during the lifetime of facility beginning at startup (assume 50 years).

8.2.3 Summary of Risks

Table 8–2 summarizes the risk scores for each of the alternatives retained for detailed evaluation. Alternatives that rely on PF-4 to reliably deliver part or all of the required 80 ppy were not retained for detailed evaluation. However, these alternatives have been collected under one generic heading, PF-4 Alternatives, and are included in the following analysis for comparison. Note that site specific risks developed and evaluated during the alternatives development effort and documented in Appendix D were pulled into this analyses where warranted.

Table 8-2 first lists risks for which (a) the risk is high for at least one alternative and (b) the risk discriminates between alternatives. These are followed by risks that are high for all alternatives. After that, risks are listed for which (a) no risk is high, (b) at least one risk is moderate, and (c) the risk discriminates between alternatives. This allows the reader to see at a glance which high risks are true discriminators. Appendix E provides a full risk table, including risks that are moderate and/or low for all alternatives.

Table 8–2. Summary of results of risk assessment for short list of alternatives ordered from high to low

Risk Category	ID#	Brief Description of Threat	PF-4 Alts.	LANL New	SRS MFFF	SRS New	INL-FPF	INL New
High Risks that Discriminate Between Alternatives	C-10	Construction or repair and modifications impact ongoing site or facility operations, or ongoing site or facility activities impact construction or repair and modifications.	1/3/H or 1/2/H	5/5/L	5/5/L	5/5/L	5/5/L	5/5/L
	O-1	Pit manufacturing adversely affects other site or facility projects, or other site or facility projects adversely affect pit production.	1/3/H or 1/2/H	5/5/L	5/5/L	5/5/L	5/5/L	5/5/L
	C-23	If MFFF is chosen for the pit manufacturing facility, potential difficulties arise while closing out the current project with Areva.	N/A	N/A	1/3/H	N/A	N/A	N/A
High Risks that Apply Equally to All Alternatives	C-4	Sufficient line item funds are not available (either in individual fiscal years or in total), resulting in a delay to completion of construction and startup.	2/2/H	2/2/H	2/2/H	2/2/H	2/2/H	2/2/H
	C-8	More stringent interpretations of safety requirements during design and construction require significant facility structural or service system upgrades.	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H
	C-9	Additional security provisions (*e.g.*, clearances, escorts, fences, changes in the design basis threat) beyond those planned are imposed.	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H
Moderate Risks that Distinguish Between Alternatives	C-11	Existing facilities require more work than planned to meet applicable codes and standards (i.e., latent conditions may unexpectedly come into play). Equivalently, unforeseen conditions in existing facilities during repair or upgrades result in more work than planned.	3/3/M	N/A	4/3/L	N/A	2/3/M	N/A
	C-24	Difficulties arise while transferring the MFFF facility licensing basis from NRC to DOE.	N/A	N/A	2/3/M	N/A	N/A	N/A
	C-5	Intra-agency and/or inter-agency disputes delay project and introduce extra costs or unwanted restrictions on the project.	5/4/L	5/4/L	3/3/M	3/3/M	3/3/M	3/3/M
	C-2	National and/or local policy/public opposition result in delays and extra costs.	3/3/M	3/3/M	2/3/M	2/3/M	2/3/M	2/3/M
	C-20	An external flood occurs during construction.	5/3/L	5/3/L	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)
	O-17	An external flood occurs during operation.	5/3/L	5/3/L	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)

8.3 Evaluation of Effectiveness Metrics and Other Considerations

In addition to cost, schedule, and risk, the AoA team independently evaluated several performance metrics and intangible benefits and disadvantages of the alternatives that should be considered in the decision. The following "effectiveness metrics" were defined in the Study Plan:

- Ability to meet objective requirements (defined to be a higher level of capacity that the program would like to have over and above the threshold "must-have" levels)
- Capacity for pit reuse operations simultaneously with pit remanufacturing
- Ability to accommodate surge requirements
- Geographical dispersion of operations
- Flexibility for future changes in mission requirements
- Lifetime of the solution

Table 8–3 shows the assessment of each alternative with respect to the defined effectiveness metrics. The qualitative assessment of these aspects of the alternatives was performed by independent SMEs with expertise in pit manufacturing at the Rocky Flats Plant, operations research, and program management (including former federal project managers for MFFF and TEF). All alternatives were found to be essentially equal for these metrics.

In addition to these, the team also addressed several other considerations discussed during the course of the study, such as impact on Office of Secure Transportation, NEPA concerns, workforce issues, waste production, and separation of production agency and research and development functions.

- **NEPA:** All alternatives will likely require an EIS. Even on the high end of the schedule estimates for an EIS, NEPA activities are not on the critical path for any of the alternatives. NEPA is not a discriminator.
- **Workforce:** Regardless of where the pit production mission is located, the chosen site will require a significant increase in staffing. Though LANL has experienced staff, and therefore has an advantage for training incoming technicians, workers are not as available at LANL as the other sites. SRS has better availability of workforce than LANL or INL, but no resident experience in pit production. Overall, workforce issues were assessed to be equivalent for LANL and SRS and a little worse for INL.
- **Transportation (Office of Secure Transportation, OST):** Regardless of where the pit production mission is located, pits used for feed material will be transported from Pantex, and finished pits will be transported back to Pantex. The only difference in OST shipments expected between alternatives would be the requirement to transport a very small number of pits to LANL for surveillance if pit production is at another site. This is not expected to be a discriminator.
- **Waste:** Regardless of where pit production is located, the process will produce approximately the same amount of waste.
- **Separation of the R&D mission from the production agency:** Though discussed by production experts as an advantage, separation of the R&D mission from the production agency could also result in loss of synergies. There are advantages and disadvantages both ways.

Based on these evaluations, the team recommends the decision be based on trade-offs between cost, schedule, and risk.

Table 8–3. Evaluation of effectiveness metrics

Effectiveness Metric	SRS Refurbish MFFF	INL Refurbish FPF	LANL New Construction	SRS New Construction	INL New Construction
Supports Objective Reqs as stated in the Program Requirements Document					
Pit Prod, DOE-NE, DOE-OS, NA-20	Yes, Yes, Yes, Yes	Yes, Yes, Yes, Yes	Yes, Yes, Yes, Yes	Yes, Yes, Yes, Yes	Yes, Yes, Yes, Yes
Capacity for pit reuse operations simultaneously with pit remanufacturing.	Yes – **Space available for expanded capacity if necessary**	Yes – **Space available for expanded capacity if necessary**	Yes	Yes	Yes
Ability to accommodate surge	Yes – multiple shifts	Yes – multiple shifts	Yes – multiple shifts	Yes – multiple shifts	Yes – multiple shifts
Geographical dispersion of functions – separation of function from production					
Pu Science / Design Agency	Design agency and Pu Science separate from production Some additional transport of materials (surveillance)	Design agency and Pu Science separate from production Some additional transport of materials (surveillance)	No organizational separation between design agency and production	Design agency and Pu Science separate from production Some additional transport of materials (surveillance)	Design agency and Pu Science separate from production Some additional transport of materials (surveillance)
Metal Prep	No separation	No separation	No separation	No separation	No separation
Ability to accommodate changes in mission reqs – provides flexibility	Yes - PF-4 could be used, plus **ample flex space available**	Yes - PF-4 could be used, plus **moderate flex space available**	Yes - PF-4 could be used, plus **some flex space available**	Yes - PF-4 could be used, plus **some flex space available**	Yes - PF-4 could be used, plus **some flex space available**
50 Year Lifetime?	Yes	Yes	Yes	Yes	Yes
Organizational Interfaces		**More difficult – DOE-NE site**			**More difficult – DOE-NE site**
Legal Challenges – Settlement Agreements	Yes, low likelihood of interference	Yes, high likelihood of interference		Yes, low likelihood of interference	Yes, high likelihood of interference

Key: LANL = DOE NE = Department of Energy Office of Nuclear Energy; DOE-OS = Department of Energy Office of Science; INL = Idaho National Laboratory; Los Alamos National Laboratory; NA-20 = NNSA's Office of Defense Nuclear Nonproliferation; PF = Plutonium Facility; Pu = plutonium; SRS = Savannah River Site

9 Results and Conclusions

This chapter summarizes information provided in the previous chapters, discusses key results, and provides conclusions and recommendations made based on key results. This chapter also presents, the sensitivity analyses performed to investigate the robustness of the conclusions to changes in key assumptions. Finally, recommended next steps are discussed.

9.1 Space Requirements

The AoA team estimated space requirements for the pit manufacturing area based on the equipment list developed using the stochastic discrete event simulation. The space required for support functions and supporting infrastructure were also estimated based on facility tours, interviews with facility managers, and subject matter expertise. **Table 9–1** shows the total square footage needed for 30 ppy, 50 ppy and 80 ppy. Details on these analyses are provided in Chapter 2.

Table 9-1. Summary of space requirements for 30, 50, and 80 ppy (square feet)

Functional Area	30 Pits Per Year	50 Pits Per Year	80 Pits Per Year
Process equipment	13,300	18,000	21,200
Building working space	13,300	18,000	21,200
Support functions within processing facility	54,600[16]	57,000	68,000
Building services	39,700	16,700	19,600
Total HC-2 Production Facility	***137,000[17]***	***110,000***	***130,000***
Support facilities inside the PIDADS	All available at LANL	46,800	67,500
Support infrastructure outside the PIDADS	All Available at LANL	95,000	122,700

9.2 Alternatives

The AoA team used a thorough and iterative process to develop a robust set of alternatives for evaluation. A set of 40 alternatives was approved by the PSO as shown in **Table 9-2**. The process is discussed in Chapter 4.

[16] Support functions in PF-4 (currently at 54,000 square feet) were assumed to be adequate for 30 ppy. Note that in PF-4, these functions support all the missions ongoing in the facility, not just pit production.
[17] Includes other mission functions performed in PF-4 such as ARIES, plutonium-238 processing, and surveillance & certification.

Table 9–2. Table of alternative configurations

LANL	LANL/SRS	LANL/INL	LANL/Pantex or NNSS
Status Quo at PF-4			
Split Production Capacity PF-4 As-Is (30 ppy), plus New Construction (Modules)	**Split Production Capacity** 30 ppy PF-4 50 ppy MFFF	**Split Production Capacity** 30 ppy PF-4 50 ppy FPF	**Split Production Capacity** 30 ppy PF-4 50 ppy New Construction
Split Production Capacity Move Pu-238, Pit production in PF-4 plus New Construction (Modules)	**Split Production Capacity** 30 ppy PF-4 50 ppy K-Area Reactor	**Split Production Capacity** 30 ppy PF-4 50 ppy New Construction	
Split Production Capacity Move Aries, Pit production in PF-4 plus New Construction (Modules)	**Split Production Capacity** 30 ppy PF-4 50 ppy WSB		
Split Production Capacity Move Pu-238 and Aries, Pit production in PF-4 plus New Construction (Modules)	**Split Production Capacity** 30 ppy PF-4 50 ppy New Construction		
Move Pit Production 80 ppy production in new construction PF-4 - existing mission w/o production	**Move Pit Production** 80 ppy production MFFF PF-4 - existing mission w/o production	**Move Pit Production** 80 ppy production FPF PF-4 - existing mission w/o production	**Move Pit Production** 80 ppy production New Construction PF-4 - existing mission w/o production
	Move Pit Production 80 ppy production K-Area Reactor PF-4 - existing mission w/o production	**Move Pit Production** 80 ppy production New Construction PF-4 - existing mission w/o production	
	Move Pit Production 80 ppy production WSB PF-4 - existing mission w/o production		
	Move Pit Production 80 ppy production New Construction PF-4 - existing mission w/o production		

LANL	LANL/SRS	LANL/INL	LANL/Pantex or NNSS
Split Flowsheet 80 ppy minus Metal Prep in new construction PF-4 retains Metal Prep	**Split Flowsheet** 80 ppy minus Metal Prep in MFFF PF-4 retains Metal Prep	**Split Flowsheet** 80 ppy minus Metal Prep in FPF PF-4 retains Metal Prep	**Split Flowsheet** 80 ppy minus Metal Prep in new construction PF-4 retains Metal Prep
	Split Flowsheet 80 ppy minus Metal Prep in K-Area Reactor PF-4 retains Metal Prep	**Split Flowsheet** 80 ppy minus Metal Prep in new construction PF-4 retains Metal Prep	
	Split Flowsheet 80 ppy minus Metal Prep in WSB PF-4 retains Metal Prep		
	Split Flowsheet 80 ppy minus Metal Prep in New Construction PF-4 retains Metal Prep		
Split Flowsheet Metal Prep in new construction 80 ppy production in PF-4	**Split Flowsheet** Metal Prep in MFFF 80 ppy production in PF-4	**Split Flowsheet** Metal Prep in FPF 80 ppy production in PF-4	**Split Flowsheet** Metal Prep in New Construction 80 ppy production in PF-4
	Split Flowsheet Metal Prep in K-Area Reactor 80 ppy production in PF-4	**Split Flowsheet** Metal Prep in New Construction 80 ppy production in PF-4	
	Split Flowsheet Metal Prep in WSB 80 ppy production in PF-4		
	Split Flowsheet Metal Prep in New Construction 80 ppy production in PF-4		

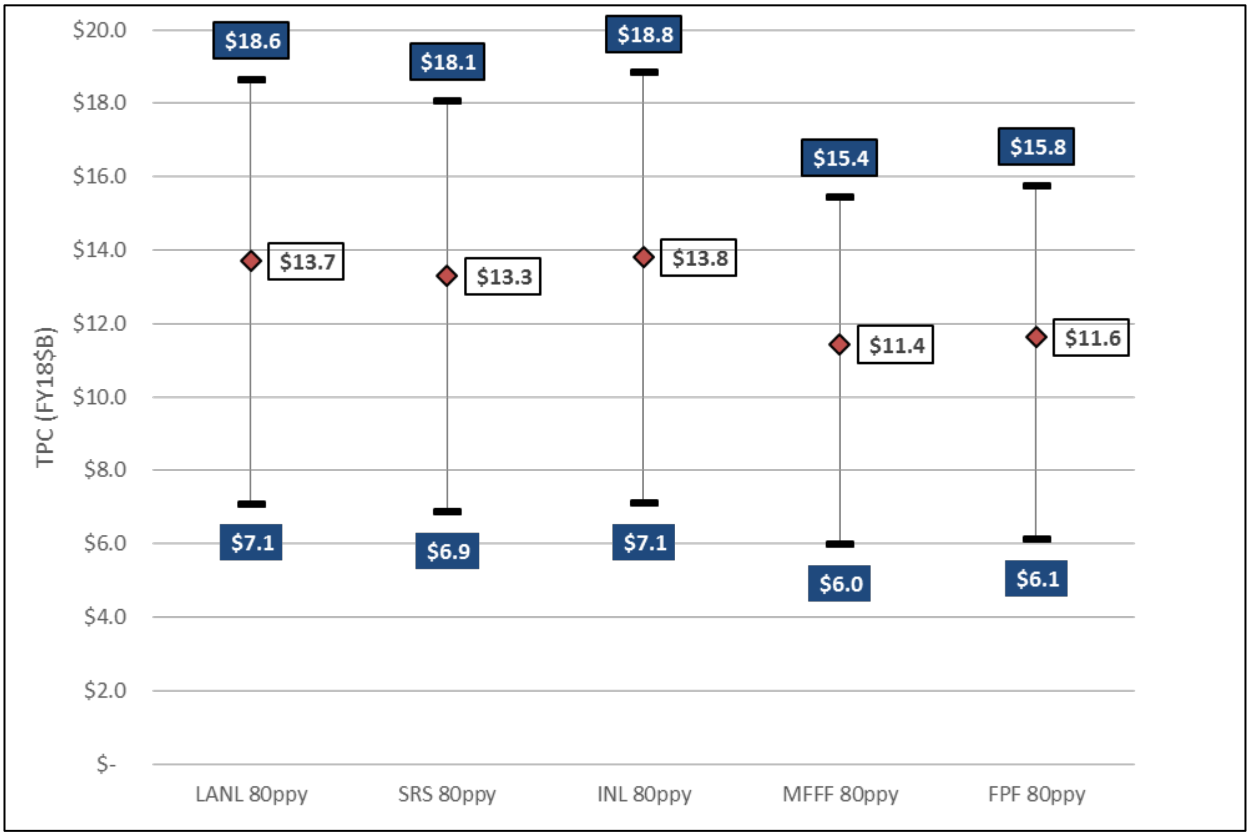
9.3 Initial Evaluation and Identification of Alternatives Not Retained for Full Evaluation

Based on screening against requirements, initial space, cost, schedule, and risk evaluations, all but five of the alternatives were eliminated from the most detailed schedule, cost, and effectiveness analyses. This is discussed in Chapter 5. The final alternatives recommended for detailed evaluation were all from the "Move Pit Production" group, involving establishing an 80-ppy capability, including metal preparation, in one of the following five places:

- LANL – new build
- SRS – new build
- INL – new build
- SRS – refurbish MFFF
- INL – refurbish FPF

9.4 Cost Results

The AoA's cost team examined TPC and LCC for each of the alternatives assessed to be the most viable: new construction at LANL, INL or SRS and refurbishment of existing facilities at INL or SRS. This included estimates for facility construction and refurbishment, equipment procurement and installation, waste management, operations and maintenance, and other recurring expenses expected over the course of the pit production mission. These cost estimates were based primarily on actual cost data from analogous projects of similar scope, as well as the AoA team's analysis of the amount of space and equipment required to achieve and sustain 80 ppy. **Figure 9–1** shows the life-cycle cost estimates for the five most viable alternatives. Additional details on the cost estimates are provided in Chapter 6.



Key: FPF = Fuel Processing Facility; INL = Idaho National Laboratory; MFFF = Mixed Oxide Fuel Fabrication Facility; LANL – Los Alamos National Laboratory; ppy = pits per year; SRS = Savannah River Site; TPC = total project cost; FY = fiscal year

Figure 9–1. Life-cycle cost estimates for new construction and refurbishment alternatives

9.5 Schedule Results

The team's schedule estimations are based on quantitative, parametric schedule analysis, leveraging project actuals from similar activities across the nuclear security enterprise. **Table 9-3** and **Figure 9-2** summarize the schedule estimate results.

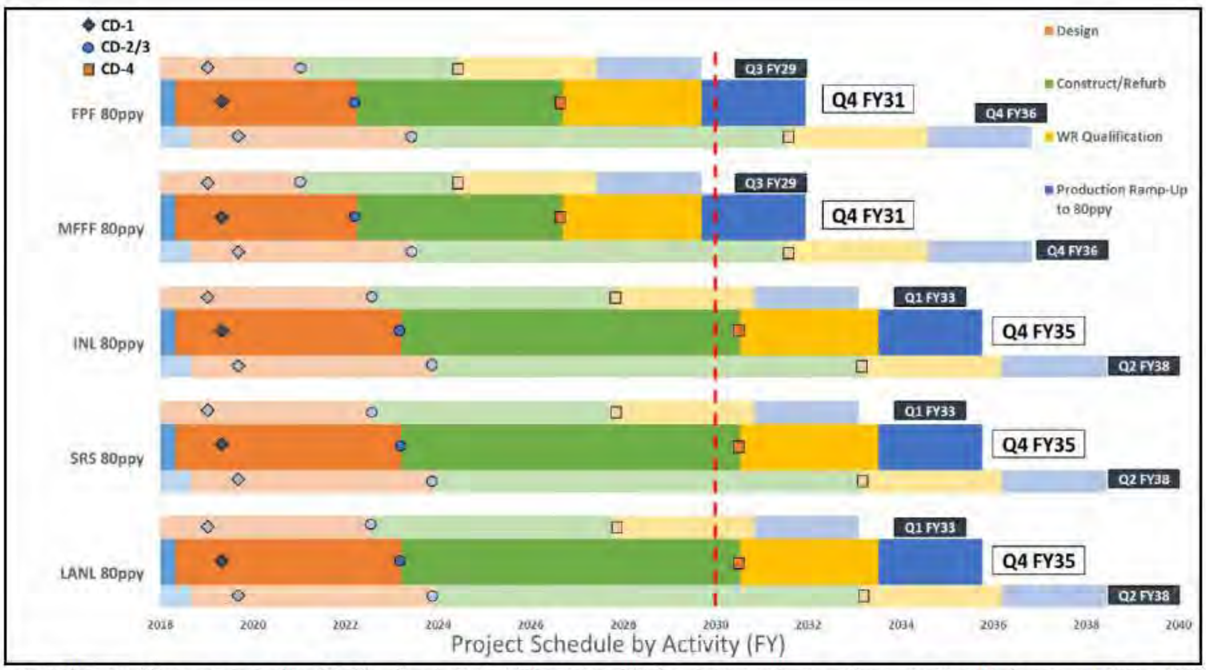
The area that drives the most schedule differentiation between alternatives is the construction phase. The pit process qualification and ramp-up to 80-ppy production are the same length for all alternatives and are significant contributors to the overall schedule. Based on current assumptions and data, all alternatives are assumed to require a full EIS, and National Environmental Policy Act (NEPA) activities are not expected to be on the critical path for any alternative.

The defining difference between the alternatives, in terms of schedule, was whether to build a new facility or refurbish an existing one. The mean duration of refurbishment alternatives is significantly shorter than for new construction. This means a refurbishment option that requires modification to an existing structure represents the shortest project schedule. However, the range of uncertainty in the scope of the refurbishment options is higher, so the schedule ranges for those alternatives is larger. The results show that the high end (most pessimistic) of the schedule range for the refurbish alternatives overlaps the low end (most optimistic) of the new build alternatives. The schedule results show that only the refurbishment options have any chance, albeit with some risk, of meeting the 2030 full rate production goal.

Table 9–3. Start and completion dates for all alternatives

		Start	Worst	Expected	Best
Refurbishment	MFFF – 80 ppy FPF – 80 ppy	10/2/2017	11/22/2035	5/8/2031	6/4/2029
New build	LANL – 80 ppy INL – 80 ppy SRS – 80 ppy	10/2/2017	6/30/2037	3/2/2035	10/28/2032

Key: FPF = Fuel Processing Facility; INL = Idaho National Laboratory; LANL = Los Alamos National Laboratory; MFFF = MOX Fuel Fabrication Facility; ppy = pits per year; SRS = Savannah River Site



Key: FPF = Fuel Processing Facility; FY = fiscal year; INL = Idaho National Laboratory; LANL = Los Alamos National Laboratory; MFFF = MOX Fuel Fabrication Facility; ppy = pits per year; Q = quarter; SRS = Savannah River Site; WR = War Reserve

Figure 9–2. Schedule results for all alternatives

9.6 Risk Assessment, Effectiveness Metrics, and Other Considerations

The risk assessment includes evaluation of threats during construction and during operations for each of the alternatives. **Table 9–4** summarizes results for the five most viable alternatives, along with an assessment of risk for alternatives that retain pit production in PF-4. These latter were eliminated primarily due to unacceptably high mission risk, so it seemed appropriate to include those results here. More detail on the risk assessment can be found in Chapter 8, and Appendix E.

Table 9–4. Summary of results of risk assessment for viable alternatives ordered from high to low

	ID#	Brief Description of Threat	PF-4 Alts.	LANL New	SRS MFFF	SRS New	INL FPF	INL New
High Risks that Discriminate Between Alternatives	C-10	Construction or repair and modifications impact ongoing site or facility operations, or ongoing site or facility activities impact construction or repair and modifications.	1/3/H or 1/2/H	5/5/L	5/5/L	5/5/L	5/5/L	5/5/L
	O-1	Pit manufacturing adversely affects other site or facility projects, or other site or facility projects adversely affect pit production.	1/3/H or 1/2/H	5/5/L	5/5/L	5/5/L	5/5/L	5/5/L
	C-23	If MFFF is chosen for the pit manufacturing facility, potential difficulties arise while closing out the current project with Areva.	N/A	N/A	1/3/H	N/A	N/A	N/A
High Risks that Apply Equally to All Alternatives	C-4	Sufficient line item funds are not available (either in individual fiscal years or in total), resulting in a delay to completion of construction and startup.	2/2/H	2/2/H	1/2/H	1/2/H	2/2/H	2/2/H
	C-8	More stringent interpretations of safety requirements during design and construction require significant facility structural or service system upgrades.	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H
	C-9	Additional security provisions (e.g., clearances, escorts, fences, changes in the design basis threat) beyond those planned are imposed.	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H
Moderate Risks that Distinguish Between Alternatives	C-11	Existing facilities require more work than planned to meet applicable codes and standards (i.e., latent conditions may unexpectedly come into play). Equivalently, unforeseen conditions in existing facilities during repair or upgrades result in more work than planned.	3/3/M	N/A	4/3/L	N/A	2/3/M	N/A
	C-24	Difficulties arise while transferring the MFFF facility licensing basis from NRC to DOE.	N/A	N/A	2/3/M	N/A	N/A	N/A
	C-5	Intra-agency and/or inter-agency disputes delay project and introduce extra costs or unwanted restrictions on the project.	5/4/L	5/4/L	3/3/M	3/3/M	3/3/M	3/3/M
	C-2	National and/or local policy/public opposition result in delays and extra costs.	3/3/M	3/3/M	2/3/M	2/3/M	2/3/M	2/3/M
	C-20	An external flood occurs during construction.	5/3/L	5/3/L	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)
	O-17	An external flood occurs during operation.	5/3/L	5/3/L	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)

In addition to cost, schedule, and risk, the AoA team independently evaluated several performance and intangible benefits and disadvantages of the alternatives that should be considered in the decision. The following "effectiveness metrics" were defined in the Study Plan:

- The ability to meet objective requirements (defined to be a higher level of capacity over and above the threshold "must-have" levels)
- Capacity for pit reuse operations simultaneously with pit remanufacturing
- Ability to accommodate surge requirements
- Geographical dispersion of operations
- Flexibility for future changes in mission requirements
- Lifetime of the solution

All alternatives were found to be essentially equal for these effectiveness metrics.

In addition to these, the team also addressed several other considerations discussed during the course of the study, such as impact on Office of Secure Transportation, NEPA concerns, workforce issues, waste production, and separation of production agency and research and development functions.

- **NEPA:** All alternatives will likely require an EIS. Even on the high end of the schedule estimates for an EIS, NEPA activities are not on the critical path for any of the alternatives. NEPA is not a discriminator.
- **Workforce:** Regardless of where the pit production mission is located, the chosen site will require a significant increase in staffing. Although LANL has experienced staff and, therefore, has an advantage for training incoming technicians, workers are not as available at LANL as the other sites. SRS has better availability of workforce than LANL or INL, but no resident experience in pit production. Overall, workforce issues were assessed to be equivalent for LANL and SRS and a little worse for INL.
- **Transportation (OST):** Regardless of where the pit production mission is located, pits used for feed material will be transported from Pantex, and finished pits will be transported back to Pantex. The only difference in OST shipments expected between alternatives would be the requirement to transport a very small number of pits to LANL for surveillance if pit production is at another site. This is not expected to be a discriminator.
- **Waste:** Regardless of where pit production is located, the process will produce the same amount of waste.
- **Separation of the R&D mission from the production agency:** Though discussed by production experts as an advantage, separation of the R&D mission from the production agency could also result in loss of synergies. There are advantages and disadvantages both ways.

Table 9-5 summarizes the results of these evaluations. Based on these results, the team recommends the decision be based on trade-offs between cost, schedule, and risk.

Table 9-5. Evaluation of effectiveness metrics

Effectiveness Metric	SRS Refurbish MFFF	INL Refurbish FPF	LANL New Construction	SRS New Construction	INL New Construction
Supports Objective Reqs as stated in the Program Requirements Document					
Pit Prod, DOE-NE, DOE-OS, NA-20	Yes, Yes, Yes, Yes	Yes, Yes, Yes, Yes	Yes, Yes, Yes, Yes	Yes, Yes, Yes, Yes	Yes, Yes, Yes, Yes
Capacity for pit reuse operations simultaneously with pit remanufacturing.	Yes – **<u>Space available for expanded capacity if necessary</u>**	Yes – **<u>Space available for expanded capacity if necessary</u>**	Yes	Yes	Yes
Ability to accommodate surge	Yes – multiple shifts	Yes – multiple shifts	Yes – multiple shifts	Yes – multiple shifts	Yes – multiple shifts
Geographical dispersion of functions – separation of function from production					
Pu Science / Design Agency	Design agency and Pu Science separate from production Some additional transport of materials (surveillance)	Design agency and Pu Science separate from production Some additional transport of materials (surveillance)	No organizational separation between design agency and production	Design agency and Pu Science separate from production Some additional transport of materials (surveillance)	Design agency and Pu Science separate from production Some additional transport of materials (surveillance)
Metal Prep	No separation	No separation	No separation	No separation	No separation
Ability to accommodate changes in mission reqs – provides flexibility	Yes - PF-4 could be used, plus **<u>ample flex space available</u>**	Yes - PF-4 could be used, plus **<u>moderate flex space available</u>**	Yes - PF-4 could be used, plus **<u>some flex space available</u>**	Yes - PF-4 could be used, plus **<u>some flex space available</u>**	Yes - PF-4 could be used, plus **<u>some flex space available</u>**
50 Year Lifetime?	Yes	Yes	Yes	Yes	Yes
Organizational Interfaces		**<u>More difficult – DOE-NE site</u>**			**<u>More difficult – DOE-NE site</u>**
Legal Challenges – Settlement Agreements	Yes, low likelihood of interference	Yes, high likelihood of interference		Yes, low likelihood of interference	Yes, high likelihood of interference

Key: LANL = DOE NE = Department of Energy Office of Nuclear Energy; DOE-OS = Department of Energy Office of Science; INL = Idaho National Laboratory; Los Alamos National Laboratory; NA-20 = NNSA's Office of Defense Nuclear Nonproliferation; PF = Plutonium Facility; Pu = plutonium; SRS = Savannah River Site

9.7 Findings

There are several findings worth noting based on the analyses conducted during the course of the AoA.

9.7.1 The Initial Modular Building Strategy, as Envisioned at CD-0, Is Inadequate to Support the 80-ppy Mission with High Confidence

The Initial Modular Building Strategy, as envisioned at CD-0 involved reconfiguring PF-4 and the construction of two modules with 5,250 square feet of processing space each. LANL did not provide an official proposal for how this concept would achieve the 80 ppy mission requirement without compromising other required plutonium missions. Instead, LANL had several alternatives for establishing various capabilities in the modules and reconfiguring PF-4. Many of these were incorporated into the AoA alternative set, for example, splitting production capacity, and moving metal preparation operations, plutonium-238 operations or ARIES are included in the AoA alternatives. As shown in Chapter 5, those particular concepts have unfavorable cost, schedule or risk profiles, and no identifiable offsetting benefit. The following discussion describes

Table 9–6 shows estimated space needs for production of 80 ppy at high confidence in comparison to space available in PF-4 after CMRR and Plutonium Sustainment programs install AC/MC capabilities and production equipment for approximately 30 ppy.[18] Note PF-4 is assumed to provide adequate building services, so to simplify the comparison, the space needed for building services is not included in this comparison.

Table 9–6. PF-4 production space

Process Area	80 pits per year	PF-4 Space Allocation (Program of Record for 30 pits per year)	Additional Space Needed for 80 pits per year	Missions in PF-4 that Could Be Relocated
	Estimated (square feet)			
Process equipment including building working space	42,300	19,500	**22,800**	
Support Functions within processing facility	68,100	54,600	**13,500**	
Total	**110,400**	**74,100**	**36,300**	
ARIES				5,500
Plutonium-238				9,400
	KEY: ARIES = Advanced Recovery and Integrated Extraction System			

The AoA team estimated that an additional 36,000 ft^2 is required to support the 80-ppy mission. Even assuming that support functions such as the vault, shipping and receiving, production development, material management, etc., available in PF-4 are adequate, an additional 22,800 ft^2 over and above what is provided by PF-4 is necessary to support 80 ppy at high confidence. In addition, attempting to reconfigure PF-4 once sustainment objectives are reached presents very high risk to the 30-ppy mission.

[18] See Chapter 2 for a discussion of equipment and space estimates and the difference between production at high confidence and production on average.

Using the module design proposed at CD-0, it would take seven total modules to create an additional 36,000 ft^2 of production space. The CD-0 cost range for two modules was $1.5 to 3 billion, so a ROM cost estimate for seven modules would be $5.25 to 10.5 billion. **Figure 9-3** provides a scaled drawing of the available space in PF-4 for pit production, and the proposed modules in comparison with the additional required space.

(b)(3) UCNI

The Initial Modular Building Strategy, as envisioned at CD-0 (two modules, each providing 5,250 ft^2 of production space) is inadequate to support the 80 ppy mission at high confidence.

In June 2017, based on preliminary AoA results, the PSO determined that continuing to rely on PF-4 for the Nation's enduring pit production capability presented unacceptably high mission risk for the following reasons:

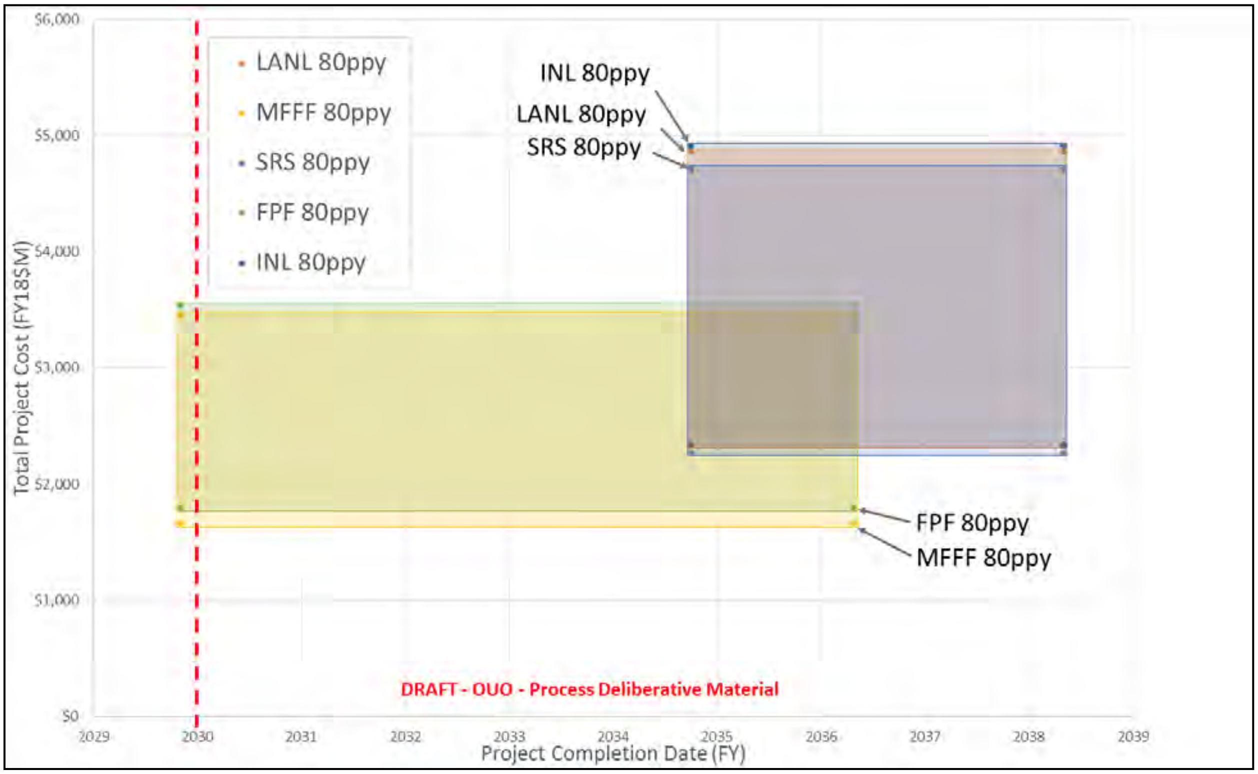
- **Jeopardizes program of record:** Efforts to remove contaminated gloveboxes and install new equipment in an operating manufacturing space, beyond what is already planned under the Plutonium Sustainment program, creates unacceptably high risk to achieving 30 ppy by 2026.
- **Space and capacity constraints:** The AoA Team estimates about 110,000 ft^2 of HC-2, SC-1 processing space is necessary to produce 80 ppy with high confidence.[19] PF-4 has about 74,000

[19] Total for the HC-2, SC-1 production facility is estimated to be approximately 130,000 ft^2, including building services such as process ventilation and security class utilities.

ft^2 of suitable space, 36,000 ft^2 short. Even if missions such as ARIES and plutonium-238 component manufacturing, totaling about 14,000 ft^2, were relocated, the total processing space in PF-4 would still be approximately 22,000 ft^2 short.

9.7.2 Refurbish Alternatives Have the Most Favorable Cost and Schedule Outcomes

The two refurbish alternatives (MFFF and FPF) are more likely to cost less and have more favorable schedules. However, given the large range of uncertainty, which is driven by a pre-conceptual design, the worst-case cost and schedule estimates for refurbishment overlap with the best-case cost and schedule estimates of the new build options, as shown in **Figure 9–4.**



Key: *FPF = Fuel Processing Facility; FY = fiscal year; INL = Idaho National Laboratory; LANL = Los Alamos National Laboratory; MFFF = Mixed Oxide Fuel Fabrication Facility; ppy = pits per year; SRS = Savannah River Site*

Figure 9–4. Cost and schedule ranges for final alternatives

9.7.3 Pit Production is Unlikely to be at Full Capacity by the 2030 Timeline, Even in the Most Optimistic Cases

A key outcome of this AoA was the emphasis on 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, design of a HC-2 facility, and the actual 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 provided a 2030 schedule 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.

9.8 Sensitivity Analyses

Results show that the refurbishment alternatives are likely to have more favorable cost and schedule outcomes than new build alternatives. Sensitivity analyses were performed to test the robustness of these results to changes in assumptions. The AoA team examined the major assumptions from Section 1.4, and other key assumptions made throughout the study to determine whether the outcome of the analysis would be invalidated if the assumption proved wrong. In all cases, except the assumption that pit production must be performed in the United States by an approved M&O contractor[20], the most likely effect on the analysis if the assumption is proven wrong would be a change in the required size of the production facility. Based on this, the AoA Team performed sensitivity analyses to determine the HC-2 facility size range expected to produce the same result.

In addition to this, the AoA Team examined uncertainty in the cost and schedule estimates. The Team determined that there may be some factors unique to the Refurbish MFFF alternative, namely that there may be a delay in obtaining the facility, which may overturn the results. The Team performed sensitivity analysis on the schedule estimates to determine how long a delay could be absorbed before the results no longer hold.

9.8.1 Sensitivity Analyses for Cost Estimates

Sensitivity analysis was conducted using Monte Carlo simulation and the parametric cost-estimating relationships that provided scaling factors to account for technical differences such as facility size and complexity. The parametric approach provided uncertainty distributions around each one of the input parameters that were then integrated into a total uncertainty using the Monte Carlo simulation. The result of this approach is a cost-probability distribution that accounts for the sensitivity of individual cost drivers. For example, the input square footage to the cost estimate was taken as a distribution of likely square footage values instead of a point estimate of square footage and integrated, with other factors, into the cost model. The Monte Carlo analysis ran 10,000 different "scenarios" in which the input parameters changed (based on actual data) and resulted in a distribution of potential outcomes. This distribution was developed for each of the five alternatives that passed the initial screening, taking into account differences in scope, complexity, location, and available support facilities. This is explained in more detail in Appendix F.

9.8.2 Sensitivity Analyses for Schedule

The AoA Team notes that a greater schedule difference between alternatives than is currently estimated could occur under certain conditions. For example, the AoA team's schedule estimate assumes that every alternative will require a full EIS but does not distinguish between the duration of an EIS at different sites. If an EIS was expected to take longer at one site than another, this could result in a greater schedule difference or a change in the result that refurbish alternatives have more favorable schedules. Unique circumstances, such as a delay in the MFFF availability date, could also cause that alternative's schedule to diverge from the current estimate.

[20] Assumption 7: Pit production must be performed in the United States in government-owned facilities and by approved management and operating (M&O) partners. No commercial vendor or foreign government alternatives were considered.

To examine how long the refurbishment schedules would have to slip before the refurbishment alternatives were equal to the new build alternatives, the team adjusted the critical path for the refurbishment schedule until the two schedules were equal. The schedule for refurbishment alternatives would have to slip by 3.8 years before being equal to the schedule for new build alternatives.

9.8.3 Space Sensitivity Analyses and Impact on Cost

As described, the AoA team estimated the space required for pit manufacturing and support functions to meet mission requirements, as summarized in **Table 9–7**.

Table 9–7. Production area for 80 ppy

HC-2, SC-1 Production Facility Area for 80 ppy	Space (square feet)
Pit production area	42,400
Support functions	68,000
Building services	19,600
Total	***130,000***

Current results show that the refurbishment alternatives have lower expected costs than new build alternatives. This is because the cost of equipment procurement and installation are expected to be about equal across the alternatives, and the renovation cost of an existing facility is expected to be lower than the cost of building a new facility, primarily due to the avoidance of the extensive civil work required to build a new facility.

In addition to the Monte Carlo analyses performed for the cost estimates, the AoA team explored how an increase or decrease in the space estimates might affect the final result. The costs of both refurbishment alternatives and new build alternatives will increase if space estimates increase and decrease if space estimates decrease. However, costs for new build alternatives change a larger amount for a given difference in square footage due to the cost of building new HC-2 footprint.

This means that the refurbishment alternatives will still cost less than the new build alternatives if the actual space requirements are larger than the AoA team estimates, as costs for new construction will grow faster than costs for refurbishment. This is true unless the space estimates are so underestimated that the actual space needed is more than is available at the existing facility. For the MFFF refurbishment alternative, there is over 400,000 ft^2 of available HC-2 space in the MOX Processing Building (BMP) and Aqueous Polishing Building (BAP). It is very unlikely that the AoA space estimate of 130,000 ft^2 of HC-2 space is underestimated by more than a factor of three. For the FPF refurbishment alternative, the total available square footage is closer to 170,000 ft^2. If the AoA space estimate is underestimated by more than 30 percent, the conclusion that refurbishing FPF is a lower cost alternative than building a new facility may no longer hold.

On the other hand, if the required space is less than the team's estimate, it is possible that the cost of the new build alternatives could approach the cost of the refurbishment alternatives. Since the space for the pit manufacturing area was estimated based on an equipment list developed using a model developed by the AoA team, this is a natural place to explore whether decreases in the estimate will affect the final result.

The model incorporated data from previous LANL experience in pit manufacturing, but the LANL experience was a limited run and possibly not representative of the performance of a steady-state manufacturing-focused plant. Some efficiencies in process time, equipment repair time, reject rates, and possibly even equipment breakdown rates are likely to be achieved with greater experience, resulting in less equipment needed to get the same throughput.

To explore the bounds of the impact of the space estimate, the AoA team attempted to determine how far off the estimate would have to be to change the result. Even if the cost to refurbish an existing facility is held constant, the space estimate must be 70,000 ft^2 smaller for the mean of the new build alternatives to reach the mean of the refurbishment alternatives. Since the cost to refurbish an existing facility will also be less if the equipment set is smaller, the actual reduction in space required to make the two cases equal will be even larger than 70,000 ft^2.

Though it is possible that the current equipment needs are overestimated, it is unlikely that the AoA estimate is over estimated by more than a factor of two as compared to actual requirements. This is borne out by two comparisons. First, the AoA team estimated 68,100 ft^2 for HC-2 support functions. PF-4 currently has 54,600 ft^2 dedicated to these functions without an 80-ppy capability. At most, the AoA estimate for these functions is overestimated by 13,500. Secondly, the comparison shown in **Table 9-8** from the Modern Pit Facility and a 125-ppy capability in PF-4 plus new construction[21] shows that the AoA space estimate for the primary pit manufacturing functions is on par with previous estimates.

Table 9–8. Space requirement estimates for 103 ppy and 125 ppy average output at PF-4 and the proposed Modern Pit Facility

	AoA 80 ppy 93 percent Confidence, Approximately 103 ppy on Average	LANL PF-4 125 ppy average	MPF 125 ppy average
Metal preparation	3,320	5,600	4,800
Foundry	8,330	9,800	8,750
Machining	11,051	16,200	10,450
Assembly	11,477	9,925	15,500
Total of identified functions	34,178	41,525	39,500

Key: AoA = Analysis of Alternatives; LANL = Los Alamos National Laboratory; MPF = Modern Pit Facility; ppy = pits per year

In conclusion, it is very unlikely that the AoA team's space estimates are so far off as to change the result that refurbishing an existing facility is a lower cost option than building a new facility.

9.9 Conclusions

The AoA results show that refurbishing an existing facility has the most favorable cost and schedule to reach 80-ppy production rate by the 2030s.

MFFF is a new facility built to current safety and security standards and has more than sufficient space to meet mission requirements. Its host site, SRS, has most of the secondary infrastructure needed to support pit production. Additionally, there are no active missions ongoing in the building, therefore the refurbishment and installation of the pit production mission would not disrupt other work and would not have to be carried out in an active security area, which reduces cost, schedule, and risk. However, there is considerable uncertainty in the amount and nature of the refurbishment and considerable risk that policy influence or contractual issues will delay the start of the project.

While refurbishing the Fuel Processing Facility at INL offered many of the same benefits as refurbishing MFFF, FPF is an older and smaller facility, and the AoA team assessed that FPF carries greater risk of unexpected delays and cost increases due to changes to hazard, seismic, and security category standards

[21] LANL Report LA-CP-05-0256L, *TA-55 Pit Manufacturing Responsive Infrastructure and Capacity Study* (2005)

since its construction. The FPF option would also involve hosting a major NNSA mission at a non-NNSA site, and ongoing legal issues between the State of Idaho and DOE further complicate this alternative.

New construction options at INL, SRS, and LANL would likely entail longer schedules and higher costs than the refurbishment options due to the larger scope of work involved.

This assessment is the result of the AoA team's initial alternative screening, followed by an extensive investigation of each viable alternative's relevant attributes, including footprint, security features, and design and construction methods, as well as cost and schedule estimates based on past capital construction projects with similar scope and requirements for safety and security. **Table 9–9** lists the comparative estimates for each viable alternative, including identified risks and opportunities.

Evaluation of other alternatives revealed drawbacks. Specifically, the AoA team found that the initial strategy proposed at CD-0 involving reconfiguration of space in PF-4 augmented by the construction of two modules would not provide sufficient production space to support 80 ppy at high confidence. Based on the AoA team's analysis, this strategy would require up to five additional modules. Attempting to reconfigure PF-4 to accommodate additional missions or capacity also jeopardizes the ability to achieve the 30-ppy program of record.

Based on the available information, the MFFF refurbishment alternative appears to have the most favorable cost and schedule outcomes to provide the required 80-ppy capability. The AoA team acknowledges that the uncertainty inherent in modifying an existing facility to accommodate a new mission necessitates structural analysis and an evaluation of the extent of the required renovation at a more detailed level than provided by the AoA to validate the cost and schedule estimates and uncover any additional risks associated with this strategy. The team recommends conducting an engineering analysis to determine the extent of refurbishment activities to accommodate pit manufacturing.

Additionally, based on the above-mentioned risks for the refurbishment alternatives and the possibility of delays in obtaining the MFFF facility, the team recommends pursuing initial CD-1 activities, such as value engineering and initial conceptual design, for at least one other alternative. The FPF refurbishment alternative has cost and schedule profiles similar to the MFFF refurbishment alternative but higher risk of cost increases and schedule delays, as well as ongoing legal issues with the state government. Of the new build alternatives, there is little cost or schedule distinction between the three most promising sites, SRS, LANL, and INL. Therefore, the choice of building site may reasonably be made based on the decision maker's judgement of risks, benefits, and disadvantages.

Table 9–9. Comparative estimates for each viable alternative

<table>
<tr><th>Approach</th><th colspan="2">Refurbishment</th><th colspan="3">New Facility Construction</th></tr>
<tr><th>Alternative</th><th>SRS MFFF</th><th>INL FPF</th><th>INL</th><th>SRS</th><th>LANL</th></tr>
<tr><th>CD-4 Cost Range (FY18$B)</th><td>1.4 – 5.4</td><td>1.4 – 5.5</td><td>1.9 – 7.5</td><td>1.8 – 7.3</td><td>1.9 – 7.5</td></tr>
<tr><th>CD-4 Schedule Range</th><td colspan="2">FY24 – 31</td><td colspan="3">FY27 – 33</td></tr>
<tr><th>80 ppy Schedule Range</th><td colspan="2">FY29 – 36</td><td colspan="3">FY33 – 38</td></tr>
<tr><th rowspan="6">Risks</th><td colspan="4">Potentially contentious state government</td><td></td></tr>
<tr><td colspan="4">No experience with pit production</td><td></td></tr>
<tr><td colspan="2">Delays in facility availability cause schedule delays</td><td colspan="3"></td></tr>
<tr><td colspan="2">Potential structural issues with refurbishment</td><td colspan="3"></td></tr>
<tr><td>Change in safety basis from NRC to DOE</td><td colspan="3"></td><td>Workforce availability</td></tr>
<tr><td></td><td colspan="2">Organizational Interface - Not an NNSA Site (DOE-NE site)</td><td colspan="2"></td></tr>
<tr><th rowspan="3">Opportunities</th><td colspan="2">Ample space for future flexibility</td><td colspan="2"></td><td>Experienced pit production techs</td></tr>
<tr><td>Current NNSA production agency</td><td colspan="2"></td><td colspan="2">Current NNSA production agency</td></tr>
<tr><td>NNSA Site Office</td><td colspan="2"></td><td colspan="2">NNSA Site Office</td></tr>
</table>

Key: CD = Critical Decision; DOE-NE = Department of Energy Office of Nuclear Energy; FPF = Fuel Processing Facility; FY = fiscal year; INL = Idaho National Laboratory; LANL = Los Alamos National Laboratory; MFFF = Mixed Oxide Fuel Fabrication Facility; NNSA = National Nuclear Security Administration; NRC = Nuclear Regulatory Commission; ppy = pits per year; SRS = Savannah River Site

PSO review of the AoA analysis resulted in the identification of two preferred alternatives, with a recommendation to conduct engineering analyses on both alternatives in support of conceptual design for CD-1. The refurbishment and repurposing of the Mixed-Oxide Fuel Fabrication Facility (MFFF) at Savannah River Site has the most favorable cost and schedule for achieving a sustained 80 WR ppy production rate, but introduces qualitative risk of re-siting the pit manufacturing capability to an existing facility. The other recommended alternative, new construction of an 80 WR ppy facility at Los Alamos National Laboratory has the lowest qualitative siting risk, but introduces risk associated with new construction of hazard category (HC)-2 facility space that will include regulatory milestones that have historically been difficult to define 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 and is a scope of work better suited outside of the AoA process.

Appendix A. Infrastructure Analysis

A.1 Introduction

The Analysis of Alternatives (AoA) Infrastructure Sub-Team (IST) has completed an assessment of the infrastructure required should the National Nuclear Security Administration (NNSA) decide to construct a facility capable of manufacturing 80 pits per year (ppy) at Los Alamos National Laboratory (LANL), the Savannah River Site (SRS), or Idaho National Laboratory (INL).

Using a combination of written input, telephone discussions, and visits to each of the sites, the IST conducted a review of the infrastructure necessary to support the manufacture of 80 ppy. The IST reviewed the following categories at each location:

Capital infrastructure and functions

- Analytical chemistry (AC)
- Material characterization (MC)
- Perimeter Intrusion, Detection, Assessment, and Delay System (PIDADS)
- Standards and calibration
- Waste treatment and management
  - Low level liquid waste treatment
  - Low level solid waste management
  - Transuranic (TRU) liquid waste treatment
  - TRU solid waste management
- Miscellaneous
  - Classified beryllium (Be) machining
  - Classified graphite machining
  - Classified stainless steel machining
  - Classified uranium machining
  - Graphite coating

Plant core infrastructure

- Security Category 1 facility support
- Normal and off-normal power systems and supply
- Gas, water, and redundant electrical systems
- Medical facilities (capable of dealing with alpha contamination)
- Environmental monitoring (on- and off-site)
- Sanitary wastewater facility

Operating infrastructure

- Production control system
- Manufacturing policies and procedures and training systems

- Material control system
- Safeguards and accountability system
- Qualified operators and technicians
- NNSA Weapon Quality Policy (NAP-24) and certified materials

A.2 Los Alamos National Laboratory

LANL has most of the necessary infrastructure in place to support an 80 ppy capacity. During its inquiry, the IST determined that additional infrastructure resources (footprint and/or equipment) beyond those currently in LANL's plans are required for AC, MC, standards and calibration, graphite fabrication, and security. Additionally, the risks identified with solid TRU waste storage and shipping warrant additional systems analysis to determine whether additional capacity is needed.

Most of these infrastructure additions are relatively low in cost (a few million dollars) in comparison to the anticipated total cost for a project of this scope. However, it is not clear that the cost to expand the PIDADS is appropriately reflected in the current estimated project costs derived from the Cost Estimate and Program Evaluation metrics. LANL asserts that the cost of the PIDADS is included in the per- square-foot cost derived from an evaluation of other relevant facilities, but these costs are not specifically identified and none of these facilities included a completed and functioning PIDADS.

Based on the recent Nuclear Materials Safeguards and Security Upgrades Project at LANL, it is estimated that it will cost over $40,000 per linear foot of PIDADS extension for the modules, assuming they are built within the footprint originally designated for the Chemistry and Metallurgy Research Replacement (CMRR) Nuclear Facility. This extension is likely to require approximately 1,800 linear feet of new PIDADS plus an allowance for tie-ins at each end. This LANL project installed approximately 5,000 linear feet of PIDADS at a cost of $245 million. Using these costs as a baseline indicates that the new PIDADS extension will cost on the order of $100 million, a significant cost that current cost estimates do not appear to cover.

Numerous other infrastructure elements necessary for a capacity to produce 80 ppy were not included in the scope of this evaluation after having been judged as highly unlikely to significantly impact this capital acquisition project. For example, the Kansas City National Security Campus (KCNSC) provides many of the non-nuclear supplies, components, and materials used in pit fabrication but was not included in this evaluation due to its capacity and ability to deal with fluctuating requirements.

This section evaluates three categories at LANL: a) capital items and functions; b) plant core infrastructure, and c) operating infrastructure. The IST compiled the information below from some or all of three sources: a) questionnaires that the IST sent beforehand; b) interviews; and c) facility tours. The members of the IST who attended the interviews and the tours at LANL during the week of September 16, 2017, were:

Name	Organization	Phone
Chris Bader	TechSource	480-650-2099
Vann Bynum	TechSource	505-603-9018
Geoff Kaiser	Leidos	301-340-9015

A.2.1 Capital Items and Functions

This section describes the information gathered on the following capital items and functions: analytical chemistry, material characterization, PIDADS, standards and calibration, waste treatment and management (low level and TRU liquid waste, low level and TRU solid waste), and miscellaneous (classified beryllium machining, classified stainless steel machining, classified graphite machining, classified uranium machining, and graphite coating).

A.2.1.1 Analytical Chemistry

Objective:

The objective of the AC unit review was to determine if sufficient capability and capacity is available to perform testing, analysis, and verification of material parameters required to produce a compliant and quality pit at a production rate of 80 ppy by the year 2030. The AC unit supports the development, qualification, and production phases of pit manufacturing by performing tests and analysis to evaluate compliance with specifications and consistency of the manufacturing processes.

Facility Description:

After completion of the CMRR project the AC unit will have laboratory facilities in the Technical Area 55 (TA-55) Plutonium Facility (PF-4) building and the Radiological Laboratory Utility Office Building (RLUOB). Most their effort will be performed in the RLUOB. The primary activity in PF-4 is preparation of samples to be tested at RLUOB and some other analytical tests. The area currently planned for AC is 17,772 ft^2 divided into 2397 ft^2 at PF-4 and 15,375 ft^2 at RLUOB.

Review Process:

Several meetings about AC were held at various locations. The participants were as follows (though not all attended every session):

Name	Organization	Phone
Chris Bader	TechSource	480-650-2099
Terry Singell	PADWP	505-665-2243
Bob Putnam	PADWP	505-500-2445
Vann Bynum	TechSource	505-603-9018
Carol Brown	NA-LA	505-667-5794
Alice Stemmons	C-AAC	505-667-9591
Ann Schake	C-AAC	505-667-0988
Leisa Davenhall	IPM	505-665-2943
Geoff Kaiser	Leidos	301-340-9015
Drew Kornreich	AET-2	505-667-2095

Discussion:

The AC and Applied Engineering Technology (AET) organizations have analyzed several different sets of requirements and assumptions. The resulting conclusion was that the AC unit will require more Hazards Category III laboratory area and additional equipment to support a capacity of 80 ppy. The fundamental differences between the calculations are based on assumptions of work rules driven by safety and security, and resultant efficiency factors. These assumptions are coupled with technical requirements related to number and types of chemical tests required for each pit build, and the workload from other NNSA programs. These analyses have indicated that additional floor space and equipment may be required.

Preliminary Risk Considerations:

1. The risk is that plans to increase the allowable material-at-risk (MAR) in RLUOB to 400 grams of plutonium-239 (gPu) fail. With the current baseline limit on MAR in RLUOB of 38.6 gPu, it will likely be impossible for the AC group to support a production rate of even 10 ppy. If this risk is realized, the consequences will be catastrophic for the 80 ppy program, so the risk is very high

even if the probability is low or very low. Not increasing RLUOB MAR, or not finding some work-around, is not an option if the 80 ppy program is to proceed at LANL.

2. Even if the allowable MAR in RLUOB is increased to 400 gPu, sample masses required in current analytical chemistry processes (radiochemistry, trace elements, mass spectroscopy, and ceric titration) would create a situation where the limit would be exceeded during steady state production at 80 ppy if programmatic work were to continue (LANL would obviously never exceed this limit. Instead LANL would take other actions, such as curtailing programmatic work, before meeting or exceeding this limit). Technology development efforts are underway to allow reduced sample size in all of radiochemistry/trace element/mass spectroscopy, and ceric titration.

3. Success in these efforts is required to be certain that the AC group can cope with 80 ppy and the Advanced Recovery and Integration Extraction System (ARIES) program needs at both average and maximum workloads. Success in either ceric titration or in the combined radiochemistry/trace element/mass spectroscopy reduced MAR developments is needed to assure sufficient capability for the average 80 ppy and ARIES analytical chemistry needs. The risk is that technology development will fail and that pit production will fall short of 80 ppy. The IST is unable to estimate the level of this risk because the probability of failure of the technology development efforts in radiochemistry/trace element/mass spectroscopy, and ceric titration is currently unknown to them.

4. Even if the allowable MAR in RLUOB is increased to 400 gPu, and sample masses required in current analytical chemistry processes (radiochemistry, trace elements, mass spectroscopy, and ceric titration) are reduced, the AC group will require a considerable increase in space and equipment to cope with the needs of the 80 ppy program. The risk is that this equipment is not made available and production falls short of 80 ppy. The IST has learned that LANL's analyses of the amount of space and equipment required have changed several times and the IST has recommended that LANL resolve their operating assumptions consistent with programmatic guidance. Until this uncertainty is resolved, it is difficult to assign a level to this risk. However, given there is ample time to allow for the purchase and installation of this equipment and to hire and train additional operators, the risk should be low to very low.

A.2.1.2 Material Characterization

Objective:

The objective of the review of the Material Characterization Unit (MCU) was to determine if there is sufficient capability and capacity to perform testing, analysis, and verification of the manufacturing process parameters to produce a compliant and quality pit. The MCU supports the manufacturing organization in the development, qualification, and production phases of the program by performing material testing and analysis that evaluates compliance with specifications and consistency of the manufacturing processes.

In addition to the Development and Qualification phase, during the production campaign W-87 pits will be randomly selected from the production line and tested by the MCU to ensure the qualified processes are stable and yielding consistent and compliant results.

Facility Description:

After completion of the CMRR project the MCU will occupy two laboratory facilities in the TA-55 area and a target fabrication facility in TA-50. The laboratories in TA-55 are currently located in separate buildings, one in PF-4 occupying 5,672 ft^2 of Laboratory area, and the other in the RLUOB occupying 1,875 ft^2

Examples of equipment contained within these laboratories include an electron microprobe, optical microscopes, a micro hardness tester, a tensile tester, a dilatometer, an auger spectroscope, gas analyzers, and other sophisticated equipment. This equipment is used to evaluate material characteristics after performing manufacturing processing such as casting, welding, and joining to ensure manufacturing parameters meet specification requirements.

Review Process:

A meeting was held in the TA55-0400-3101 conference room on September 27, 2016, at 1:00 PM. The purpose of the meeting was to review and discuss answers to previously provided questions and determine if there were any issues and concerns. The following people attended:

Name	Organization	Phone
Chris Bader	TechSource	480-650-2099
Geoff Kaiser	Leidos	301-340-9015
Dave Moore	MST-16	505-665-0645
Jeremy Mitchell	MST-16	505-665-3934
David Pugmire	MST-16	505-664-0028
Franz Freibert	MST-16	505-667-6879
Terry Singell	PADWP	505-665-2243
Bob Putnam	PADWP	505-500-2445
Vann Bynum	TechSource	505-603-9018

Discussion:

The MCU has expressed concern regarding its ability to support the schedule for non-recurring testing and analysis required to develop and qualify the manufacturing parameters for the W-87 production processes. These concerns are based on the extensive effort to develop and qualify pit production processes for the W-88 program, and compounded by the uncertainty associated with working with a different design agency, Lawrence Livermore National Laboratory (LLNL). Discussion of the issues involved identified several primary approaches to reduce the non-recurring workload, as follows:

1. Offload part of the characterization effort to another laboratory, presumably LLNL since the material is primarily plutonium and LLNL has previously insisted on characterizing the samples from their designs. Savannah River might also have this capability.
2. Apply multiple shift(s).
3. Evaluate the development and qualification schedule, perhaps to start earlier than planned.
4. Use all the above strategies simultaneously.

In addition to the noted concern regarding the development and qualification workload, the MCU has identified new equipment and laboratory space requirements to support 80 ppy. The equipment items identified are: a) electron microprobe ($1.4 million), b) micro hardness tester ($50 thousand), and c) three optical microscopes ($180 thousand). It was noted that installation of the electron microprobe will require an additional 200 ft^2 of laboratory space. Installation of the equipment in the laboratory area is expensive and according to the MCU might cost as much as the electron microscope itself.

Preliminary Risk Considerations:

1. There will be a "spike" in needed material characterization during development and qualification of the pit production process. Currently, the MCU does not know how long it will have available to cope with such a spike, nor whether it has the necessary instruments and personnel. The worst case would be that the ability to produce 80 ppy is delayed by an unspecified number of months

or years. This risk could be mitigated by allocating additional space to MCU or by using offsite (*e.g.,* LLNL) capability.

2. The MCU might have insufficient capability to perform the MC work necessary during steady state production of 80 ppy. As a result, LANL will be unable to meet its target of 80 ppy or extensive deviations, which might or might not be acceptable, and will have to be approved by the design agency. This risk is likely to be very low since LANL could identify the additional required space for MC or could use offsite (e.g., LLNL) capability.

3. In the future, there will be a need to produce some pits of a different type(s). This will require further development and qualification of the pit production process that will challenge the MCU's capabilities. It might also cause an unknown number of years delay in the ability to produce the different pit type(s). However, this is so far in the future that there will be ample time for LANL to manage the introduction of the different type of pit. This ought to be a low risk because of the long period available for planning.

A.2.1.3 Perimeter Intrusion, Detection, Assessment, and Delay System

Objective:

The objective of the review was to determine the current planning by the LANL Mission Assurance, Security and Emergency Response (MASER) team for protecting the Security Category 1 modular buildings, or possible alternatives, planned for construction for performing plutonium processing activities. An advance questionnaire was provided to the MASER team requesting information to support a meeting at LANL to review the potential security project and its requirements.

Description:

The PIDADS is a sophisticated perimeter protection system and barrier that currently surrounds the exterior of PF-4 and supporting buildings. The PIDADS provides physical security obstruction and detection systems to prevent adversaries from gaining access to nuclear materials. The PIDADS consists of three layers of protective fencing and numerous instruments and cameras to detect and identify hostile forces. The objective of the PIDADS review was to determine what will be required to provide protection to the new plutonium buildings within the designated area in TA-55.

Review Process:

A meeting was held on September 29, 2016, at LANL Building TA3-1409-105A, to discuss the impact on security systems as a result of building two Security Category 1 Plutonium Modules at TA-55, adjacent to and west of the RLUOB to accommodate a requirement to produce 80 pits per year by 2030. The following people attended:

Name	Organization	Phone
Chris Bader	TechSource	480-650-2099
David M. Telles	SAFE-DO	505-665-5913
Darryl Overbay	ADMASER	505-667-5911
Vann Bynum	TechSource	505-603-9018
Geoff Kaiser	Leidos	301-340-9015
Dennis Basile	PMI	505-660-6757
Bob Putnam	PADWP	505-500-2445
Randy Fraser	ADMASER	505-606-0291
Gart Torres	ADMASER	505-665-8983
Carol Brown	NA-LA	505-667-5794
Terry Singell	PADWP	505-665-2243

Discussion:

The TA-55 security structure underwent an extensive upgrade that was completed in 2014 at a cost of \$245 million. Improvements were made to the detection systems, approximately 5,000 linear feet of triple barrier perimeter fencing were installed, upgrades were made to the personnel access facility, and a perimeter road was established to allow Protection Force vehicular access around the outside of the security fence.

To provide for the proposed two new modules, or other Security Category 1 structures, will require an additional 1800 linear feet of triple barrier fencing and security systems, plus an allowance for two new personnel access control points. The access points will be located between the limited area and the protected area (RLUOB to the underground tunnel) and between the protected area and the material access area (underground). In addition to the PIDADS extension several new equipment items will be required, including emergency doors, alarms, cameras, an elevator, and other equipment.

The interior PIDADS perimeter area will provide a 400-foot x 400-foot footprint that will require an offset from the interior protective fence. But this should yield 300 feet x 300 feet (90 thousand ft^2) of buildable space for constructing Security Category 1 and support buildings. This area can accommodate up to four 5,000 ft^2 laboratory area modules with additional support buildings, or other various modular sizes and combinations as may be determined. However, the Critical Decision 0 (CD-0) cost estimate only considered two modules. Building additional modules in that space after the PIDADS is extended will likely be prohibitively expensive.

Estimated Cost:

1. The rough order of magnitude estimated cost in 2016 dollars for providing LANL with the required PIDADS and equipment is as follows:
2. PIDADS: 1800 linear feet, plus approximately 200 feet estimated tie in to pedestrian access points = 2,000 linear feet.
3. The cost of the extra linear feet is as follows: (\$245 million – 15 percent design) = \$208 million ÷ 5000 feet = \$41.6 thousand/foot X 2000 feet = \$83.2 million + 5 percent design change + 5percent escalation = \$91.8 million.
4. Equipment: Miscellaneous instrumentation, control center, alarms, cameras, elevator, and security doors = \$20 million. (LANL maintains that these costs are within their existing cost estimate).
5. Total rough order of magnitude estimated cost \$91.8 + 20.0 million = \$111.8 million rounded up to \$115.0 million.

Required Completion:

The additional PIDADS systems and operational alarms, cameras, and other items will need to be completed, checked out, and operational ready prior to the start of nuclear operations in the plutonium modules or other structures.

Other Relevant Information:

According to the MASER team, if pit manufacturing were moved to a green field site, the cost to establish the same level of security infrastructure and capability that exists at LANL would be at least \$1 billion. This would appear to be a significant discriminator against such a site.

Preliminary Risk Considerations:

Two types of risks could have a significant effect on plutonium operations:

1. If the Design Basis Threat changes, this could require potentially large expenditures to reconfigure the physical security infrastructure, with unknown delays to and cost for the pit production program. This would affect other facilities and operations at LANL. Based on experience, there is a high probability that security requirements could change during development and qualification for the pit production process. The costs could vary from small to very large, so the risk level remains indeterminate but could well be high or very high.

2. There is always the possibility that the MASER team will have to shut down the LANL site for an unknown period in response to some future threat. This would lead to delays in pit production of unknown length and cost. Any other site would face the same risk, so this is not a discriminator between sites.

A.2.1.4 Standards and Calibration

Objective:

The objective of the review of the Standards and Calibration Laboratory was to determine if LANL planning has provided for a hot calibration laboratory to check contaminated instruments after the calibration interval has expired. This requirement was established by the NNSA Quality Assurance Program to verify that expired contaminated instruments are still accurate to specification and to ensure that all product tested has been accepted using instruments that are still accurate.

This issue developed during the W-88 pit campaign where the post check after the calibration interval had expired could not be verified due to lack of an area capable of performing calibration of contaminated instruments. The solution at the time required the design agency to accept the product on a Special Exception Request.

Facility Description:

The IST met in the existing Calibration Laboratory and discussed the issue and requirements for a Hot Calibration Laboratory, and also toured the facility.

The laboratory is in the west end of Building TA3-039 which was built in 1953 as a general machine shop. The Calibration Laboratory space was formerly part of the machine shop where beryllium was machined and processed. The facility has been remediated, modified, and upgraded to accommodate the Calibration Laboratory.

Several issues were noted during the review and tour. Most are created by the condition of the facility and the environmental requirements needed to support calibration of precise and sensitive instruments. Items noted include inability to meet vibration isolation, inconsistent stability and control of temperature and humidity, and the lack of clean and stable electrical power. Remediating these issues is complicated by the presence of beryllium contamination within the facility. These issues need to be addressed to ensure LANL's scientific programs and projects are provided with accurate and consistent measurements.

Review Process:

A meeting was held on September 27, 2016, at TA-03, Building 039, conference room 15Q at 10:00 AM. The purpose of the discussion was to review answers to the previously provided questions and determine if issues and concerns remain. The following people attended:

Name	Organization	Phone

Audrey Hakonson Hayes	ASM-SCL	505-667-9364
Robert Baer	ASM-SCL	505-665-4995
Chris Martinez	ASM-SCL	505-667-1292
Kenneth Nadeau	ASM-SCL	505-695-5723
Madeleine Faubert	LAFO	505-666-0113
Maribel Dominguez	AFO	505-665-9788
Geoff Kaiser	Leidos	301-340-9015
Terry Singell	PADWP	505-665-2243
Vann Bynum	TechSource	505-603-9018

Discussion:

The Calibration Laboratory currently occupies 12,100 ft^2 of non-radiological area within TA-3, Building 039. The increase in the work to accommodate the W87 build rate of 80 ppy and to support the requirement for a hot calibration area calls for an estimated 1000 ft^2 of non-radiological space and 500 ft^2 of radiological laboratory space to perform hot calibration checks. New instruments required for the workload increase as well as the Hot Calibration Laboratory expansion are estimated by the calibration team at $4.5 million. An equipment list was provided.

Preliminary Risk Considerations

1. The building that houses the Standards and Calibration Laboratory is contaminated with beryllium. The risk is that methods for controlling beryllium in the atmosphere fail and one or more workers are diagnosed with berylliosis, leading to immediate shutdown of the building and causing delays in projects that rely on the Standards and Calibration Laboratory (*e.g.,* development and qualification of the pit production process).
2. The old heating, ventilating, and air conditioning system makes it difficult to control temperature, thus reducing throughput and causing delays in projects that rely on the Standards and Calibration Laboratory (e.g., development and qualification of the pit production process).

A.2.1.5 Waste Treatment and Management

This subsection reviews treatment and management of low-level liquid waste, low-level solid waste, liquid TRU waste, and solid TRU-waste

A.2.1.5.1 Low-level Liquid Waste

Objective:

The objective of the review of the Low-Level Liquid Waste Facility that supports pit manufacturing at TA-55 was to determine if sufficient capacity exists, or is planned, to accommodate the forecast low-level radiological liquid waste generated by the production of 80 ppy by the year 2030.

Facility Description:

A new Low-Level Liquid Waste Facility is currently under construction at TA-50. The facility will consist of approximately 4,600 ft^2 of process area, 2,300 ft^2 of drum storage, wet laboratory, and control room, and 3,100 ft^2 of utilities and other support systems. In addition, six 50,000-gallon effluent storage tanks are being retained to provide backup in case of a process disruption. Of this 300,000-gallon capacity, 100,000 gallons will be used for routine operations with 200,000 gallons designated for emergency use (e.g., sprinkler activation within a facility or an event like the Cerro Grande fire). The facility is capable of processing 5 million liters per year. The project is nearing completion, expected to finalize construction in 2017 and be operational in 2018. The estimated cost is $82.7 million.

Review Process:

A meeting was held on September 26, 2016, at TA-50, Building 0001, in conference room 107 at 9:30 AM. The purpose of the meeting was to review and discuss answers to the previously provided questions and determine if there are any issues and concerns. The following people attended:

Name	Organization	Phone
Chris Bader	TechSource	480-650-2099
Hugh McGovern	RLW-OPS	505-606-0572
Geoff Kaiser	Leidos	301-340-9015
Bill Schwettmann	ADPSM-IPM	505-667-8211
Simon Balkey	AET-2	505-667-1526
Alvin Aragon	RLW-OPS	505-606-1575
Vann Bynum	TechSource	505-603-9018
Chris Del Signore	RLW-OPS	505-665-5956
Carol Brown	NNSA-LA	505-667-5794
Terry Singell	PADWP	505-665-2243

Discussion:

The current Low-level Liquid Radioactive Waste Facility is being replaced by a new process building that is almost complete, located at TA-50. The target date for construction completion is 2017 and it is planned to be operational in 2018. The new facility has capacity to adequately support on a one shift, four-day basis, a production rate of 80 ppy in 2030. The new facility is designed for a service life of 50 years, whereas the components are expected to perform for 30 years. Six 50,000-gallon low-level effluent storage tanks will be retained (with a capacity of approximately one million liters) with up to 100,000 gallons available as backup storage space if needed. The other 200,000 gallons are reserved for dealing with emergency situations such as a deluge sprinkler activation or a situation like the Cerro Grande fire.

Preliminary Risk Considerations:

1. Almost all the influent to the Low-Level Liquid Radioactive Waste Facility comes from facility equipment or facility support functions. Increasing pit production to 80 ppy would add only 1-2 percent to net influent volume (Ref. 2). Therefore, any potential risks that the facility might pose to a production rate of 80 ppy are low.

2. The IST believes that there is still a residual risk because LANL has not rigorously updated its analysis of the generation of liquid low level radioactive waste (LLW) in the past 5 years and has not estimated the quantities of liquid LLW that might be generated by the two potential modules (or of alternatives that would support an 80 ppy capacity). LANL could exceed the capacity of its liquid LLW treatment system necessitating a curtailment in pit production and other mission activities.

3. LANL presented a conservative upper bound of 4.7M liters per year of needed radioactive liquid waste-low level processing capability including a production rate of 80 ppy. The planned capacity of the new radioactive liquid waste-low level processing plant is 5 million liters per year. However, the IST believes that there are some liquid LLW flows that may not have been fully accounted for and that, in some unlikely circumstances, the capacity of the liquid LLW processing facility could be exceeded. This risk should, however, be low or very low.

A.2.1.5.2 Low-Level Solid Waste

Objective:

The objective of the review of the solid Low-Level Waste Facility supporting pit manufacturing at TA-55 was to determine if sufficient capacity exists to accommodate the management and disposition of solid LLW generated by the production of 80 ppy by the year 2030.

Facility Description:

The solid LLW storage and shipping area is located at TA-54, a few miles southeast of TA-55. The site receives low-level radiological waste from waste generators that is verified by Waste Management personnel who observe the packaging process. The Waste Operations organization then performs a non-destructive assay test to confirm the waste meets the low-level radiological requirements and performs other testing to ensure the waste does not contain improper contents. After inspection, the waste shipment is loaded and transported to either the DOE waste facility at the Nevada National Security Site (NNSS) or to other approved and authorized commercial sites for disposition and burial.

Review Process:

A meeting was held on September 26, 2016, at TA-63, Building 144, conference room 1008, at 2:00 PM. The purpose of the meeting was to discuss the Waste Operations capability and capacity to process LLW generated as a result of processing 80 ppy by 2030. The following people attended.

Name	Organization	Phone
Chris Bader	TechSource	480-650-2099
Denise Gelston	TWF Ops.	505-665-1552
Geoff Kaiser	Leidos	301-340-9015
Carol Brown	NA-LA	505-667-5794
Terry Singell	PADWP	505-665-2243
Simon Balkey	AET-2	505-667-1526
Andrew Montoya	WM –DO	505-665-1654
Vann Bynum	TechSource	505-603-9018

Discussion:

The Waste Operation Division is responsible for processing the LLW at LANL and packages and ships compliant waste to NNSS or other authorized and approved commercial companies licensed to process and store low-level radiological waste.

The Waste Operation Division has demonstrated the capacity to process and ship over 700 cubic meters of solid LLW in one month using a one shift operation. Experience has demonstrated that the volume of LLW generated from TA-55 is not particularly tied to pit production rate; but, rather the frequency of performing maintenance operations (*e.g.,* routine glove and filter replacements). The average volume of low-level solid waste generated by TA-55 is approximately 330 cubic meters per month. As previously stated Waste Operations has demonstrated a 700 cubic meter processing capability and is confident they can easily accommodate the 80 ppy requirement.

The Waste Operation Division also stated that a 15 thousand to 20 thousand ft^2 tented temporary structure could be made quickly available to provide several months of solid waste storage and added confidence in the event of shutdown of shipments due to some unforeseen upset.

In addition, the Waste Operation Division stated that no additional equipment is required other than to replace used and worn out items as they age.

Preliminary Risk Considerations:

LANL could lose its certification with NNSS and thus its ability to send drums there. The site would run out of solid LLW storage space and pit production would shut down. This is a plausible scenario because recently LANL lost its certification with NNSS for 13 months. However, it appears that this risk is easily mitigated because alternative commercial solid LLW disposal sites are available. Therefore, this risk is low.

A.2.1.5.3 Liquid Transuranic Waste

Objective:

The objective of the review of the TRU Waste Facility that supports Pit Manufacturing at TA-55 was to determine if sufficient capacity exists or is planned to accommodate the planned TRU radiological waste generated by the production of 80 ppy by the year 2030.

Facility Description:

The new TRU Liquid Waste Facility is located at TA-50. The facility consists of approximately 2,290 ft^2 of process area and 680 ft^2 of support. The facility is capable of processing 30 thousand liters per year of acid and caustic TRU waste by operating for one week each month. Operating one week per month optimizes staff use through sharing of resources with the Low-level Liquid processing plant. The effluent generation output to support 80 ppy in 2030 is forecast at 30,000 liters per year. If the waste quantities were to exceed 30,000 liters per year, then processing can be extended by running for longer periods. The project is in design and should start construction in 2018, with a completion target of 2022. The estimated cost is $80 – 90 million. The final estimated cost will be established when design is completed.

Review Process:

A meeting was held on September26, 2016, at TA-50, Building 0001, at 9:30 AM in conference room 107. The purpose of the meeting was to review and discuss answers to the previously provided questions and determine if there are any issues and concerns. The following people attended:

Name	Organization.	Phone
Chris Bader	TechSource	480-650-2099
Hugh McGovern	RLW	505-606-0572
Geoff Kaiser	Leidos	301-340-9015
Bill Schwettmann	ADPSM-IPM	505-667-8211
Simon Balkey	AET-2	505-667-1526
Alvin Aragon	RLW	505-606-1575
Vann Bynum	TechSource	505-603-9018
Chris Del Signore	RLW-OPS	505-665-5956
Carol Brown	NA-LA	505-667-5794
Terry Singell	PADWP	505-665-2243

Discussion:

The current TRU Radioactive Waste Facility is being replaced by a new facility that is nearing design completion. The target date for completion of the new facility is 2021 and it is planned to be operational in 2022. The facility has adequate capacity to support, on a one-shift, one-week-per-month basis, 30,000 liters per year, and it will support the pit production rate of 80 ppy by 2030. The new facility is designed for an equipment service life of 30 years and a facility life of 50 years.

Preliminary Risk Considerations:

It is possible to envision scenarios in which a shift in incoming feed type occurs that causes liquid TRU waste flows in excess of 29,000 liters per year from nitrate operations (the RFX, ATLAS, and plutonium-238 lines), chloride operations (EXCEL and CLEAR), and/or other sources such as chill water pumps and CMRR. However, the 29,000 liters per year is expected to be achieved with a one-shift operation for one week per month. This means that with appropriate adjustments to staffing incoming liquid TRU waste could be treated at a rate of up to 116,000 liters per year. Therefore, any risk arising from spikes in influent liquid TRU waste could easily be accommodated, so the associated risk is very low.

A.2.1.5.4 Solid Transuranic Waste

Objective:

The objective of the review of the Solid TRU Waste Facility that supports Pit Manufacturing at TA-55 was to determine if sufficient capacity exists to accommodate the management and disposition of TRU waste generated as a result of the production of 80 ppy by the year 2030.

Facility Description:

The TRU Solid Waste Facility is located at TA-63 adjacent to Pajarito Road and east of TA-55. The facility has completed construction and the assigned personnel are currently preparing for a series of operational reviews to determine readiness to start operations. The facility consists of an administrative building, five waste storage buildings, and one combined characterization and storage building. There are also two pads to accommodate trailers to perform Real Time Radiography and High Efficiency Neutron Counter characterization. A large thick sand barrier shields the facility from vehicular incursions. The facility has its own equipment storage building and a dedicated water storage tank for fire protection. The maximum storage capacity at the facility is 1,240 55-gallon drum equivalents.

Review Process:

A meeting was held on September 26, 2016, at the TA-63, Building 144, at 2:00 PM in conference room 1008. The purpose of the meeting was to review and discuss answers to the previously provided questions and determine if there are any issues and concerns. The following people attended:

Name	Organization	Phone
Chris Bader	TechSource	480-650-2099
Denise Gelston	TWF Ops.	505-665-1552
Geoff Kaiser	Leidos	301-340-9015
Carol Brown	NA-LA	505-667-5794
Terry Singell	PADWP	505-665-2243
Simon Balkey	AET-2	505-667-1526
Vann Bynum	TechSource	505-603-9018

Discussion:

The construction of a new TRU waste storage facility at TA-63 recently has been completed at a cost of $106 million. This new facility has a maximum drum storage capacity of 1,240 55-gallon drum equivalents when stacked three high, although the typical operational mode is to stack only two high. It was noted that TA-55 also has storage space for an additional 1,200 55-gallon drum equivalents for a total of 2,440 units. The TRU waste management team estimates that when TA-55 is producing at 80 ppy, generation will range between 1100 – 1500 55-gallon drum equivalents per year. At that generation rate, there is approximately 1.6 to 2.2 years of available storage.

The LANL TRU waste storage team noted that the Waste Isolation Pilot Plant (WIPP) has not been operational for over 2 years due to an incident,[1] and is concerned that more storage area may be necessary to ensure no disruptions to the pit program in the event of future shutdowns at WIPP. A member of the LANL team noted that WIPP has not demonstrated consistency in operational up time and would like to see a duplicate of LANL's new facility built at LANL to provide additional contingencies.

WIPP has a rigorous set of acceptance criteria. LANL has extremely limited capability and capacity to remediate non-WIPP compliant drums, which could further complicate the drum management situation. However, it was reported by LANL that the Pit Manufacturing Program has few problems being WIPP compliant and thus there is little increased risk from going to an 80 ppy capacity. However, other TRU generating programs (e.g., the plutonium-238 programs) do present a risk to the LANL capacity to deal with TRU solid waste, especially with respect to non-compliant drums.

Preliminary Risk Considerations:

1. WIPP experiences an event that causes it to be shut down for a sufficiently long time that TRU waste storage at LANL becomes full. Pit production shuts down for a period of months to years. At the time of writing, WIPP has just reopened after having been closed for 3 years. The event described in the risk description is highly plausible over the projected several-decade lifetime of pit production at LANL. Existing TRU waste storage capacity at LANL would be enough for 1.5 – 2 years at a production rate of 80 ppy. This risk is discussed in more detail in Appendix E. The AoA team concluded that the risk can be managed by constructing extra TRU storage capacity at marginal cost relative to the annual cost of operating the plutonium manufacturing facility, with a corresponding low risk.
2. WIPP experiences another event that causes it to be shut down. After it comes back on line, additional safety and regulatory constraints mean that it accepts and processes shipments at a much slower rate than before the event. This processing rate may be insufficient to accept TRU waste generated by 80 ppy so that after some years TRU waste storage at LANL becomes full and pit production ceases. This scenario is also realistic because, once WIPP comes back on line after its current shutdown it will be accepting and processing shipments for final disposal at a lower rate than before: similar or perhaps even more onerous restrictions are likely in the event of a future shutdown. In Appendix E the AoA team assess this risk as medium.
3. WIPP becomes full and is no longer able to accept solid TRU waste. Solid TRU capacity at LANL also becomes full and pit production shuts down. Additional TRU waste disposal capacity at WIPP or elsewhere is required to support the 80 ppy capacity. In Appendix E, the AoA team assesses this risk as low because it can be managed by construction of on-site TRU waste as needed, and it is virtually certain that, if WIPP were to become full, additional storage capacity would be built there.

A.2.1.6 Miscellaneous

This section contains information on several activities that are needed to support pit production, but which would not be expensive to implement (relative to the total cost of a pit production facility) should they not already be available at LANL. Alternatively, most of them could be readily outsourced.

[1] That observation was made at the time of the IST's visit to LANL in September 2016. The WIPP facility recently re-opened after a shut-down of over three years.

A.2.1.6.1 Classified Beryllium Machining

Objective:

The objective of the review of the Beryllium (Be) facility supporting Pit Manufacturing at TA-55 was to determine if sufficient capacity exist to provide Be components to support a pit manufacturing production rate of 80 ppy by the year 2030.

Facility Description:

The Be operation is performed at TA-3, Building 141. The entire facility is approximately 15,000 ft^2, including 3,300 ft^2 for administration, 9,800 ft^2 for production, and 1,960 ft^2 for support. The facility performs Be work for several programs throughout LANL. The facility is equipped with several conventional and computer numerical control (CNC) lathes, several conventional and CNC mills, one wire and one plunge electrical discharge machine, a coordinate measuring machine, and other equipment to support multiple projects. The production area has an essential Be dust collection safety system as well as a temperature and humidity controlled area to perform dimensional measurements. The building currently is not full and has several thousand ft^2 of unoccupied production area.

Review process:

A meeting was held on October 17, 2016, at TA-3, Building 1400, in the Director's conference room. The purpose of the meeting was to discuss and review the information provided to the IST in the provided questionnaire. The following people attended:

Name	Organization	Phone
Chris Bader	TechSource	480-650-2099
Terry Singell	PADWP	505-665-2243
Erwin Vest	PF-WFS	505-667-4904
Paul Holland	NA-LA	505-667-3168
Vann Bynum	TechSource	505-603-9018
Randy Flores	PF-WFS	505-665-3612

Discussion:

LANL stated that they can support 20 ppy as well as other NNSA programs with the current area and equipment. To achieve a production rate of 80 ppy would require an additional 1,500 ft^2 of production area and an expansion of 1,000 ft^2 of temperature and humidity controlled inspection area. Both requirements can fit into the existing facility, but would necessitate some re-arrangement and build out. The safety dust collection system would have to be expanded to support the added production area.

The LANL team also identified some additional equipment amounting to two additional CNC lathes and a new coordinate measuring machine to support inspection.

Preliminary risk Considerations:

No risks were identified other than very low.

A.2.1.6.2 Classified Stainless Steel Machining

LANL has the capability in its general machining facility within TA-39 to produce all stainless steel components but would need some additional conventional equipment. The need for classified stainless steel parts could also be met by outsourcing to a qualified supplier with an approved secure facility, or to KCNSC. Risks associated with this capability are assessed to be very low.

A.2.1.6.3 Classified Graphite Machining

Objective:

The objective of the review of the Graphite Machining facility supporting pit manufacturing at TA-55 was to determine if sufficient capacity exists to perform graphite machining operations that will support a pit manufacturing production rate of 80 ppy by the year 2030. This review considered allowances for mortality needs throughout the pit manufacturing process.

Facility Description:

The graphite machining operation is performed at TA-3, SM-66. The entire facility is approximately 200,000 ft^2, including 20,000 ft^2 for administration, 125,000 ft^2 for production, and 55,000 ft^2 for support and other. The area currently dedicated to graphite fabrication in support of pit manufacturing includes 2,500 ft^2 for administration, 2,000 ft^2 for production, and 2,500 ft^2 for support. The production area has a specialized ventilation process to capture the considerable amount of graphite dust particles that is released during the machining process. The building is approximately 56 years old, well maintained, and estimated by the current management to have approximately 40 more years of useful life with ongoing maintenance.

Review Process:

A meeting was held on October 19, 2016, at TA-3, SM-66, at the Division Leader's office. The purpose of the meeting was to discuss and review the information provided to the IST in the provided questionnaire. The IST had toured the graphite production area on September 28, 2016, and had a very good understanding of the processes required to support pit manufacturing. The following people attended:

Name	Organization	Phone
Chris Bader	TechSource	480-650-2099
Paul Dunn	MST	505-665-3180
Terry Singell	PADWP	505-665-2243
Paul Holland	NA-LA	505-667-3168
Vann Bynum	TechSource	505-603-9018
Geoff Kaiser*	Leidos	301-340-9015
Carol Brown*	NA-LA	505-667-5794

* Tour only

Discussion:

To accommodate a production rate of 80 ppy on a one-shift basis, the current production area will have to be enlarged from 2,000 ft^2 to 8,000 ft^2 including additional equipment and extended ventilation. The current administrative and support functions do not require additional area. The current production area contains eight lathes, five mills, and several electrical discharge machines. To accommodate 80 ppy will require the following new equipment items, 1) three coordinate measuring machines, 2) six lathes, and 3) two mills. Sufficient area is available within the facility to accommodate this mission.

Preliminary Risk Considerations:

No risks were identified other than those that are very low. Additional equipment and space will be needed to support 80 ppy, but this would seem to be easily achievable.

A.2.1.6.4 Classified Uranium Machining

While LANL has machined uranium in the past for the purposes of this AoA it is assumed that Y-12 will support with classified uranium machine parts.

A.2.1.6.5 Graphite Coating

Objective:

The objective of the review of the coating facility supporting pit manufacturing at TA-55 was to determine if sufficient capacity exists to perform coating operations that will support a pit manufacturing production rate of 80 ppy by the year 2030.

Facility Description:

The coating operation is performed at TA-3, SM-66. The entire facility is approximately 200,000 ft^2 and includes 20,000 ft^2 for administration, 125,000 ft^2 for production, and 55,000 ft^2 for support and other. The area currently dedicated to graphite coating for pit manufacturing includes 2,000 ft^2 for administration, 8,000 ft^2 for production, and 2,500 ft^2 for support. The production area does not require any special environmental or temperature controls. The building is approximately 56 years old, well maintained, and estimated by the current management to have approximately 40 more years of useful life with regular maintenance.

Review Process:

A meeting was held on October 19, 2016, at TA-3, SM-66, at the Division Leader's office. The purpose of the meeting was to discuss and review the information provided to the IST in the provided questionnaire. The following people attended:

Name	Organization	Phone
Chris Bader	TechSource	480-650-2099
Paul Dunn	MST	505-665-3180
Terry Singell	PADWP	505-665-2243
Paul Holland	NA-LA	505-667-3168
Vann Bynum	TechSource	505-603-9018

Discussion:

The current allocated space and equipment will be sufficient to accommodate a production rate of 80 ppy on a one-shift basis by the year 2030.

Preliminary Risk Considerations:

No risks were identified other than those that are very low.

A.2.2 Plant Core Infrastructure

Plant core and operating infrastructure elements were not part of the initial LANL review However, they have been added to improve the understanding of and to characterize other important elements of the site. Most of the information obtained for concerning plant core infrastructure (Section A.2.2) and Operating Infrastructure (Section A.2.3) resulted from initial discussions in September 2016, as well as LANL's experience obtained while supporting W88 development, qualification, and product deliveries within the past several years. Utility data were obtained and verified by LANL with the assistance of Mr. Bob Putnam.

A.2.2.1 Security Category I Facility Support

LANL has a Security Category I Facility in accordance with DOE Order 473.3, Protection Program Operations. This information was transmitted to the IST during the discussion on PIDADS on September 29, 2016. It was noted at that time that the investments in security systems at LANL have been substantial, and replacement value was estimated to be over $1.0 billion. The DOE Order is comprehensive, requiring protection of DOE assets including nuclear material and special nuclear material (SNM), buildings, Government Property, classified material, and personnel.

A.2.2.2 Normal/off normal Electrical Power

LANL operates within the Los Alamos Service Area. Power is imported to this service area by two transmission lines fed from separate substations in the Public Service Company of New Mexico system. The interconnection agreement requires a fully redundant transmission path, so the capacity is limited to the lesser of these two lines. The current import limit is 116 mega volt ampere (MVA) (peak summer day), with rapid deployment of existing on-site generation this capacity could be elevated to 131 MVA. Forecasts for LANL load growth include the projected demand to support pit production at TA-55 beginning in FY 2020 and described in the LANL Power Master Plan. The transmission-system import limit is expected to increase to 200 MVA by re-conducting both lines or installing a third transmission line in the 2022-2024 period when LANL's combined mission growth would increase demand above the current limit.

Supporting the pit production mission is not expected to require major distribution improvements.

A.2.2.3 Other Utilities

Water supply – LANL's water is supplied by the Los Alamos County groundwater collection system. Pit production water demand is included in the 2017 revision of the county's long-range water supply plan. Total available water rights for Los Alamos County/LANL is 6,741.3-acre feet per year, and maximum projected demand in the 50-year planning horizon is slightly more than 4,000-acre feet per year. Therefore, adequate water supply is available to support pit production at LANL.

Gas –_Pit production facilities are expected to be heated with natural gas. TA-55 is served by a 3-inch diameter gas main operating at 88 pounds per square inch gauge. Recent modeling indicates that gas delivery capacity greatly exceeds projected current and future demand.

A.2.2.4 Medical Facility

Los Alamos Medical Center is a state-of-the art nine-bed emergency room, which opened in January 2006, and is staffed 24 hours a day by board-certified physicians from Emergency Medical Services. For the most serious emergencies, the hospital has immediate access to an air ambulance service.

In cooperation with LANL, Los Alamos Medical Center also maintains an ultra-modern decontamination facility, fully equipped to handle medical trauma patients.

A.2.2.5 Environmental Monitoring

LANL has an extensive environmental management program consisting of several elements. While working closely with LANL organizations and the State of New Mexico the LANL Environmental Organization performs:

- Monitoring of air and water discharges to ensure quality standards are met
- Clean up and remediation of legacy waste sites
- Processing and shipping of hazardous and radioactive waste to approved permanent disposal facilities
- Development of waste minimization and early detection programs with functional organizations

A.2.2.6 Sanitary Waste Facility

LANL's secondary wastewater treatment plant has a design capacity of 0.6 million gallons a day and the average daily flow is well below 0.2 million gallons a day, so adequate capacity is available to serve pit production growth. The extension of sewer service to new facilities supporting pit production may be required to connect to the existing collection system.

A.2.3 Operating Infrastructure

This section includes discussion of production control, manufacturing policy, the material control system, safeguards and accountability, qualified operators and technicians, and the weapons quality program.

A.2.3.1 Production Control

LANL developed a production control system during the early process development phase of the W88 pit manufacturing project. The system evolved from manually ordering materials and processing work orders to a sophisticated Oracle-based system capable of processing multiple programs and projects simultaneously.

A.2.3.2 Manufacturing Policy

The Pit Manufacturing organization developed a manufacturing policy manual during the process qualification program for the W88 project. The document was based on the Weapons Quality Policy QC-1, and policies established by the DOE Albuquerque Production Management Office. The LANL policy manual identifies requirements to be applied to War Reserve (WR) products and established a consistency within the Nuclear Weapons Enterprise. Based on the policy document specific procedures were developed that provided the processes to be followed by LANL organizations. These procedures are periodically updated and maintained by the Pit Manufacturing and Weapons Quality Assurance organizations to reflect changes to requirements and improvements to processes. The DOE quality assurance requirements have recently been rewritten and retitled NNSA Weapon Quality Policy (NAP-24).

A.2.3.3 Material Control System

The Material Control System is documented within the Manufacturing Policy Manual. The processes for ordering, procuring, receiving, inspecting, stocking, issuing, and tracking are identified and documented by instructional procedures.

A.2.3.4 Safeguards and Accountability

The Safeguards and Accountability system at LANL assures that special nuclear materials are accounted for at all times. These processes and instrumentation are very sophisticated and provide for the dynamics and material movement incurred during the manufacturing process. The system is managed by LANL's Threat Identification and Response Organization and provides processes and technologies to improve measurement and reduce threats.

A.2.3.5 Qualified Operators and Technicians

The Pit Manufacturing organization has an extensive training program including the qualification of operators and technicians. The training requirements are established between the first level manager and employee and cover all aspects of their assignment from security, safety, manufacturing protocols, to the unique qualifications to perform a specific manufacturing process. The requirements are reflected in the Manufacturing Policy Manual and into the specific training procedure specifying initial and refresher requirements.

A.2.3.6 Weapons Quality Program

The DOE quality requirements are specified in the DOE policy NAP-24. It requires a Quality Assurance Plan (QAP) approved by LANL and the DOE Field Office. The QAP provides a methodology for implementation of the requirements identified in NAP-24. For the weapon programs at LANL this involves specific procedures identifying the processes and responsibilities for implementation of the requirements. These procedures have been in place for several years and are updated if requirements or processes change.

A.3 Savannah River Site

The IST concluded that SRS has most of the necessary infrastructure in place to support the manufacture of 80 ppy, including strong capabilities in solid and liquid waste treatment, standards and calibration, plant core elements such as facilities to support a category I security facility, adequate electrical power, medical support, and systems such as safeguards of nuclear materials, and production and quality assurance processes to support a production mission.

While SRS can produce complex machined parts, their capability and capacity is limited and consists of a small-scale shop supporting research and development activities for the Site. While SRS could support pit production on a limited basis it is noted all the machined items can either be obtained from other DOE sites or procured from classified commercial suppliers.

The IST determined that the Savannah River National Laboratory (SRNL) has highly qualified technical staff and excellent equipment capabilities currently performing AC and MC. A primary issue is that none of the laboratory buildings in which SRNL performs AC and MC are authorized to handle more than 200 grams of plutonium at one time. It is noted that this MAR limitation also affects the capability of LANL and INL and further underscores the need for either a review and increase of this limiting requirement, or support for the production requirement by providing additional Hazard Category II space to efficiently support required laboratory work.

During the IST review, it was discovered that LLNL is planning to perform some portion of the AC and MC for the 80 ppy baseline system. This assistance will be particularly needed during the process development and certification phase of the project. To determine the potential quantitative capability and ability to support pit manufacturing DOE should consider a review of LLNL for both MC and AC.

As was the case for the LANL review, some infrastructure elements are necessary to establish capacity to produce 80 ppy that were not included in the scope of this evaluation after they were judged highly unlikely to significantly impact any of the potential alternatives. For example, KCNSC provides many of the non-nuclear supplies and process materials used in pit fabrication but was not included in this evaluation due to its capacity and ability to deal with fluctuating requirements. However, it was determined that to support the current plans for 80 ppy KCNSC might require procurement and installation of additional conventional equipment.

This section is divided into three subsections: a) capital items and functions; b) plant core infrastructure, and c) operating infrastructure. The information compiled below was assembled from some or all of three sources: a) questionnaires that the IST sent to SRS beforehand; b) on-site interviews; and c) facility tours. The members of the IST who were present at SRS during the week of April 24 and who attended the interviews and the tours were:

Name	Organization	Phone
Chris Bader	TechSource Inc.	480-650-2099
Phillip Forsberg	NA-14	202-480-4735

Geoff Kaiser	Leidos	301-340-9015

Two SRS individuals were particularly helpful in setting up interviews and tours, and providing information:

Name	Organization	Phone
Jeff Allender	SRNL/NA-23 and EM	803-208-1291
Brian Pool	SRNS	803-208-0396

A.3.1 Capital Items and Functions

This section describes the information gathered on the following capital items and functions: analytical chemistry, material characterization, PIDADS, standards and calibration, waste treatment and management (low level and TRU liquid waste, low level and TRU solid waste), and classified machining of beryllium, stainless steel, graphite, uranium, and graphite coating.

A.3.1.1 Analytical Chemistry

Objective:

The objective of the review of AC at SRS was to determine if SRS has sufficient capability and capacity to perform testing, analysis, and verification of material parameters required to produce a compliant and quality pit at a production rate of 80 ppy. AC supports the development, qualification, and production phases of pit manufacturing by performing tests and analysis to evaluate compliance with specifications and consistency of the manufacturing processes.

Facility description:

SRS has an AC laboratory housed in wings B, C, and D of Building 773-A on the SRNL campus. Portions of the building are of different ages dating from the 1960s to the 1990s. SRNL estimates that these wings contain 15,300 ft^2, divided into 9,300 ft^2 for radiological analysis, 2,700 ft^2 for non-radiological analysis, and 3,300 ft^2 for administration. SRNL provided the following description of their equipment:

1. *Conventional/ off-the-shelf equipment and techniques for radioactive samples*: a variety of radiochemistry instrumentation and preparation capabilities such as: alpha, beta, and gamma spectrometers and liquid scintillation counters; inductively coupled plasma emission spectrometry (ICP-ES) and inductively coupled plasma mass spectrometry (ICP-MS); high-performance liquid chromatography; gas chromatography–mass spectrometry; atomic absorption; ion chromatography; a carbon analyzer; a titrator; a scanning electron microscope ; x-ray diffraction and x-ray fluorescence; and a particle size analyzer. All of them are single quantity, except for the radiochemistry instrumentation.

2. *Conventional/off-the-shelf instrumentation and techniques for non-radioactive samples*: ICP-ES and ICP-MS; Fourier transform infrared spectroscopy (FT-IR); high-performance liquid chromatography; gas chromatography–mass spectrometry; a nitrogen analyzer; atomic absorption; a carbon analyzer; a titrator; scanning electron microscope; and x-ray fluorescence (all are single quantity).

3. *Customized items of equipment*: a high-flux thermal neutron generator and a californium-252 source for neutron activation analysis.

The chemistry laboratory management estimated that the facility is currently used at about 25-35 percent of maximum capacity.

In addition, SRNL provides 24/7 analytical chemistry support for SRS processing facilities (e.g., H-Canyon, HB-Line, and the tank farms); plutonium oxide characterization (for HB-Line and LANL); nuclear materials storage for International Atomic Energy Agency and other off-site customers; and nuclear reference materials. This support is provided in what is known as F/H Laboratory in Buildings 772-F and 771-F (in F-Area). 772-F is a two-story steel reinforced concrete structure with 40,000 ft^2 on the first floor and 40,000 ft^2 on the second floor for support services. About 7,000 ft^2 is dedicated to office services. 771-F is a single story commercial steel building of approximately 32,000 ft^2 with 1,000 ft^2 dedicated to office space. SRNL provided the following description of the equipment in F/H Laboratory, which is primarily radiological:

1. *Conventional/off-the-shelf equipment and techniques*: alpha and beta spectroscopy; laboratory control samples; thermal ionization; mass spectrography; ICP-MS (2) and ICP-ES (2); uranium using kinetic phosphorescence analyzers and Davies-Gray titration; ion chromatography (2); interfacial tension; cerium fluoride titration; gas chromatography with flame ionization detector; and other wet chemistry.
2. *Customized items of equipment*: controlled potential coulometry (2).
3. *Other*: four shielded cells for sample aliquotting and basic wet chemistry; and separations chemistry capability (uranium, plutonium, and Neptunium ion exchange).

Review Process:

The review was carried out as follows:

1. The IST provided an infrastructure questionnaire that was filled out by Mark. J. Barnes of SRNL for the Area A laboratories and by Curtis W. Gardner of SRNL for F/H Laboratory.
2. The entire visiting AoA team went on an SRNL tour on the afternoon of Wednesday April 26, 2017.
3. SRS provided the following relevant documents and presentations for the IST to review:
   a. 002 SRS Systems Engineering Functional Analysis, pp. 123-128: SRNL Program Infrastructure Matrix and Support Buildings 002 SRNL Info Pod
   b. LANL-MPF-G-ESR-X-00015, *Analytical Chemistry and Material Characterization Needs in the Modern Pit Facility*
   c. Alice Murray, *Overview and Actinide Science and Radiochemistry Overview*, 4/26/17
   d. Ken Cheeks, *F/H Laboratory Overview*, 4/26/17
   e. Robert Sindelar, *Material Science Capabilities*, 4/26/17

In addition to Jeff Allender and Brian Pool, SRS and SRNL people who provided most of the information summarized in this portion of the IST's report were:

Name	Organization	Phone
1. Mark Barnes	SRNL	803-725-2104
2. Ken Cheeks	SRNL	803-952-3632
3. Curt Gardner	SRNL	803-952-4636
4. Alice Murray	SRNL	803-725-0440
5. Robert Sindelar	SRNL	803-725-5298

Discussion:

SRNL has a large and highly accredited AC capability with potential for considerable expansion. Areas of strength, which will be invaluable in the event that NNSA establishes an 80 ppy manufacturing facility at SRS, include:

- experience in lab design and set-up
- establishing analytical chemistry programs
- obtaining and maintaining accreditation
- staffing

SRNL has established relationships with various universities and is developing a stream of qualified analysts who will be available to replace retirees and if necessary, to increase staffing levels.

There appears to be ample space for considerable expansion of effort if needed in the existing laboratories. The principal question is how much Hazard Category 2 space will be required. This will depend on the nature of the mission (e.g., whether the proposed facility is for 50 ppy or 80 ppy, or whether SRNL will also have to support the originally intended mixed oxide [MOX] mission to dispose of 34 metric tons of weapons grade plutonium that is surplus to requirements). In any event, the SRNL A-Area laboratory is currently limited to a total of 200 grams of plutonium at one time to remain within MAR limits.

During the IST's visit to LANL (see above), it was clear that, even with a proposed allowable MAR of 400 grams of plutonium in RLUOB, there might be insufficient space in RLUOB and PF-4 for adequate AC support for the proposed 80 ppy manufacturing mission and the other plutonium programs at LANL. As noted above, whether this will be a problem at SRS will depend on the ultimate plutonium programs that are established there. Various upgrades to both the A-Area laboratories and F/H Laboratory would be necessary to support pit production. In addition, F/H Laboratory is in a property protection area and security upgrades would be required. These upgrades, primarily to acquire additional Hazard Category II space, would likely be expensive.

SRNL personnel recommended that, if it is known that a plutonium manufacturing facility will be established at SRS (whether for 50, 80, or some other expected ppy), it would be best to minimize transportation and improve manufacturing process flow time by co-locating the needed actinide chemistry capabilities with or adjacent to that facility. This concept was also recommended in the Modern Pit Facility study performed in early 2000's. Thus, it may be beneficial to set aside up to 20,000 ft^2 of AC space in the proposed pit manufacturing complex.

It should also be noted that if either the Mixed Oxide Fuel Fabrication Facility (MFFF) or K-reactor facilities are utilized for pit manufacturing there would be sufficient Hazard Category 1 space available to accommodate an AC Laboratory need of approximately 20,000 ft^2.

With respect to whether additional AC equipment may be needed, this also will evolve as SRS better understands the full scope of plutonium missions that it may be requested to undertake. SRNL currently believes that existing equipment is likely adequate, but the need will evolve with assigned missions.

Preliminary Risk Considerations:

The principal risk is that if an 80 ppy manufacturing facility is established at SRS, MAR limits in the buildings housing AC equipment will be insufficient to allow SRNL to process samples at the required rate. If this were to continue indefinitely, it would become impossible to deliver 80 WR ppy to Pantex. To mitigate or remove this risk, careful planning will be necessary to ensure that the necessary amount of Hazard

Category II space is made available for AC equipment. The lead time is such that this should be possible, and the risk is assessed to be low.

The IST learned at LANL that research efforts are underway to increase the sensitivity of analytical techniques so that much smaller sample sizes are required. This would increase the number of sampling analyses that are possible at any one time while remaining within a MAR limit such as 200 grams of plutonium. This is another avenue that SRNL could explore should there be a need to further mitigate the risk already described.

Another way to further mitigate this risk would be to reduce the number of samples required per pit. Based on experience at LANL, 18-20 five-gram plutonium metal samples were analyzed for every WR pit that was produced. However, this might be reduced to 6-6.5 five-gram samples per delivered pit if the initial metal could be delivered within certain well-defined specifications. This would make a total of about 500 samples per year for an 80 ppy program. With careful scheduling and improving the quality of incoming plutonium, this strategy could potentially be managed in a building with a 200-gram MAR ceiling.

In addition to the above, the AC risk could potentially be further mitigated by calling on the AC resources at LLNL or LANL.

Considering the several potential ways of mitigating this risk, the IST's preliminary determination is that risk is low.

A.3.1.2 Material Characterization

Objective:

The objective of the review of MC was to determine if SRS has sufficient capacity and capability to perform testing, analysis, and verification of the manufacturing process parameters to produce a compliant and quality pit at a production rate of 80 ppy by the year 2030. MC supports the manufacturing organization in the development, qualification, and production phases of the program by performing material testing and analysis to evaluate the compliance with specifications and consistency of the manufacturing processes.

In addition to the development and qualification phase, during the production campaign W-87 pits will be randomly selected from the production line and tested to ensure the qualified processes are stable and yielding consistent and compliant results.

Facility Description:

SRS' material characterization capabilities are currently housed in multiple locations, including 772-F (a Hazard Category 2 facility dating from the 1950s) and 772-1F (a Hazard Category 3 facility dating from the 1980s). F/H Laboratory is a Nuclear Materials Safeguard Category IV building with the amount of plutonium metal limited to 200 grams. SRS does not currently operate their facilities for the unique requirements of supporting pit manufacturing processes. It operates multiple characterization tasks for nuclear materials missions though few are directly applicable to a production process involving bulk metal components and feed streams.

In the past, the site has operated fuel fabrication facilities and production product characterization for Defense Programs feed materials. SRS expertise supports multiple smaller-scale missions including nuclear forensics for DOE, the Department of Homeland Security, the Defense Threat Reduction Agency, and foreign collaborators. In addition, SRNL hosts the Federal Bureau of Investigation forensics laboratory.

The core capabilities of F/H Laboratory are as follows:

a. Chromatography – IC, GC (TCD/FID)
b. Classical wet chemistry
c. Electrochemistry – Coulometry
d. Radio chemistry – alpha, gamma, LSC
e. Spectrometry – ICP-ES, ICP-MS, thermal Ionization mass spectroscopy (TIMS)
f. Shielded cell sample preparation (high rad)
g. Glove box sample preparation (high alpha)

Review Process:

The review was conducted as follows:

1. The IST provided an infrastructure questionnaire that was filled out by Jeff Allender.
2. The entire visiting AoA team went on an SRNL tour on Wednesday April 26, 2017.
3. SRS provided the following relevant documents and presentations for the IST to review:

- 002 *SRS Systems Engineering Functional Analysis*, pp. 123-128: SRNL Program Infrastructure Matrix and Support Buildings 002 SRNL Info Pod (Sic)
- LANL-MPF-G-ESR-X-00015, *Analytical Chemistry and Material Characterization Needs in the Modern Pit Facility*
- Alice Murray, *Overview and Actinide Science and Radiochemistry Overview*, 4/26/17
- Ken Cheeks, *F/H Laboratory Overview*, 4/26/17
- Robert Sindelar, *Material Science Capabilities*, 4/26/17
- *F/H Laboratories Area Overview*
- T.F Severynse, *Summary Report: Plutonium Research & Development Laboratory in K-Area Complex*, 4/10

In addition to Jeff Allender and Brian Pool, the SRNL person who provided most of the information summarized in this section of the IST's report was Robert Sindelar (803-725-5298).

Discussion:

The IST assesses that SRS has limited capability to support MC needs for an 80 ppy manufacturing facility, principally because of the 200-gram plutonium MAR limit in F/H Laboratory. The necessary facilities to accomplish the MC task would have to be designed, costed, and constructed as part of the overall pit manufacturing effort, considering the potential for some of the work to be done elsewhere, such as at LLNL or perhaps LANL.

It should also be noted that if either the MFFF or K-reactor facilities are used for pit manufacturing there would be sufficient Hazard Category I space available to accommodate a Material Characterization Laboratory need of approximately 8,000 ft^2.

Preliminary Risk considerations:

1. There will be a "spike" in needed material characterization during development and qualification of the pit production process. Currently, it is not known how long will be available to cope with such a spike, nor whether SRS has the necessary instruments and personnel. The worst case would be that the ability to produce 80 ppy is delayed by an

unspecified number of months or years. This risk could be mitigated by enhancing SRS' MC capability or by using offsite (e.g., LLNL) capability. The risk is judged to be low.

2. SRS may have insufficient capability to perform the MC work necessary during steady state production of 80 ppy. As a result, SRS will be unable to meet its target of 80 ppy or extensive deviations, which may or may not be acceptable, will have to be approved by the design agency. SRNL has previously demonstrated the feasibility of a Hazard Category I laboratory within the K-Area PIDADS to support the potential movement of pit surveillance and process development affected by the LLNL de-inventory, but those functions were subsequently assigned to LANL TA-55. The risk is judged to be low.
3. In the future (*e.g.,* after 2030) there will be a need to produce some pits of a different type(s). This will require further development and qualification of the pit production process that will challenge SRS' MC capabilities, and may cause a delay of an unknown number of years in the ability to produce the different pit type(s). However, this is so far in the future that there will be ample time for SRS to manage the introduction of the different type of pit. This ought to be a low risk because of the long period available for planning.

A.3.1.3 Perimeter Intrusion, Detection, Assessment, and Delay System

Objective:

The objective of the IST's review was to determine SRS' capabilities in the areas of perimeter intrusion, detection, assessment, and delay with respect to the potential installation of an 80 ppy pit manufacturing capability.

Description:

SRS' major Security Category 1 SNM storage facility is in the former K-reactor, which is protected by a modern PIDADS that is continuously evaluated against emerging and design-basis threats.

L-Area utilizes an old reactor building for spent fuel storage. It is a Security Category II building with a plutonium MAR of two kilograms and has a functional PIDAS – note the difference between a PIDADS, which has features incorporating the ability to delay an adversary, and a PIDAS, which enables detection and assessment, but not delay.

H-Canyon and HB-Line are Security Category I buildings. They have no PIDAS, but have been operating as Hazard Category 1 facilities after rigorous vulnerability assessments. They have been evaluated for supplemental PIDADS but this has not been judged to be required for the currently assigned mission.

Finally, the tritium area has a PIDAS, but it is largely inactive.

If the MFFF is brought into operation with its originally intended purpose of converting 34 metric tons of surplus weapons grade plutonium to fuel for nuclear reactors, or if it is used for some other plutonium mission such as pit manufacturing, it will be necessary to build a PIDAS around it. SRS provided an estimate of the cost to do this: $15.8 million in FY 2016 dollars for 5,170 linear feet, which works out at $3.1 thousand per linear foot.

It is instructive to compare this with the estimated cost of a full PIDADS obtained during the IST's September 2016 visit to LANL (see above). The TA-55 security structure has recently undergone a significant and extensive upgrade that was completed in 2014 at a cost of $245 million for 5,000 linear feet of triple barrier perimeter fencing, upgrades to the personnel access facility, and a perimeter road, which works out at $49.0 thousand per linear foot. This is clearly much more expensive than SRS' proposed PIDAS around MFFF. This difference is partly due to the difference between a PIDAS and a

PIDADS. In addition, MFFF has a gabion wall and SRS may be taking credit for by planning a relatively less substantial PIDAS.

Review Process:

The review was carried out as follows:

1. The IST provided an infrastructure questionnaire that was filled out by Dick (JR) Murphy of SRNS-NNP.
2. The entire visiting AoA team went on tour of K-Area on the morning of Wednesday, April 24, 2017, and observed elements of the PIDADS protecting the K-reactor building.
3. SRS provided the following relevant documents and presentations for the IST to review:
   - 15 Security Manual 7Q (various sections apply)
   - 15 Category SNM Policy 7Q-101*,*
   - 001 *Advanced Disposition Reactor Study* (current configuration with notional expansion of capability for a single new mission within PIDADS envelope), and
   - Copy of an email titled *PIDAS cost* from Ron Curtis (CB&I Project Services Group) to Dennis W. Godbee, 4/25/2017.

Those SRS people who provided most of the information summarized in this section of the IST's report, in addition to Jeff Allender and Brian Pool, were:

Name	Organization	Phone
J.R. Murphy	SRNS/NNP	803-952-5513
Rich Koening	SRNL/NNP	803-952-5513

Discussion

The K-reactor building at SRS is a Security Category I facility that has enough space for an 80 ppy manufacturing line. Thus, it would be possible to install that capability there. Whether to do so or not would be based on considerations other than security.

Assuming the MFFF is not eventually fully devoted to its original purpose of converting 34 metric tons of weapons grade plutonium into reactor fuel, there is ample space for an 80 ppy manufacturing line. As noted above, this would require the construction of 5,700 linear feet of fencing, along with any other items necessary to implement a fully functioning PIDADS. To what extent these items would need to be paid for by the pit manufacturing mission remains to be seen.

The AoA team also discussed adapting the currently unused new Waste Solidification Building (WSB) – for example, to take the plutonium-238 mission from LANL. The building is currently a Hazard Category II structure. Such an adaptation would require implementation of a state-of-the-art PIDADS, in addition to considerable, potentially expensive internal modifications, such as removing installed equipment and reorganizing spaces.

Preliminary Risk Considerations:

Two pertinent risks could have a significant effect on plutonium operations.

1. If the design basis threat changes, this could require potentially large expenditures to reconfigure the physical security infrastructure, with unknown delays to and cost for the pit production program. This would also affect other facilities and operations at SRS. Based on experience, there is a high probability that security requirements could change as a result of newly identified threats

during development and qualification or other phases of the pit production process. The costs could vary from small to very large, so the risk level remains indeterminate, but could well be high or very high. This is not a site-specific risk.

2. There is always the possibility that SRS will have to be shut down for an unknown duration in response to some future threat. This would lead to delays in pit production of unknown length and likewise unknown cost. Any other site would face the same risk, so this is not a discriminator between sites.

A.3.1.4 Standards and Calibration

Objective:

The objective of the review of standards and calibration was to determine if SRS has the capability and capacity needed to support the production of 80 ppy. There is a need for a hot calibration laboratory to provide a post check of contaminated instruments after the calibration interval has expired, as required by the NNSA Quality Assurance Program to verify that expired contaminated instrument(s) are still accurate to specification and assure all product tested has been accepted using instruments that are still accurate.

Facility Description:

SRS' standards and calibrations activities are carried out in multiple locations, but SRS is consolidating them into a central standards and calibrations laboratory. SRS is accredited to the National Institute of Standards and Technology via NAVLAB. It is in compliance with ISO-ASME-17205. SRS has a self-described "good" dimensional lab and is accredited to echelon 1 for mass measurement. SRS is not currently equipped to perform calibration work on hot instruments.

Review Process:

The review was carried out as follows:

1. The IST provided an infrastructure questionnaire that was filled out by Ed Polz and Alexcia Delley of Savannah River Nuclear Solutions, LLC.
2. SRS provided the following relevant documents for the IST to review:
   - 13 Calibration Services BBMP Report (draft)
   - 24 Measurement Control Manual 14Q

In addition, Ed Polz (SRS: 803-725-0955) attended a brief discussion session with the IST on Tuesday April 25, 2017.

Discussion:

SRS would have to establish a hot calibration capability if an 80 ppy manufacturing facility is established there. This capability will need to be provided within the pit manufacturing facility.

An estimate of what it would cost was obtained during the IST's September 2016 visit to LANL (see above). The increase in the work to accommodate the W87 build rate of 80 ppy and to support the requirement for a hot calibration area calls for an estimated 1000 ft^2 area of non-radiological space and 500 ft^2 of radiological laboratory space to perform the hot calibration checks. New instruments required for the workload increase as well as the Hot Calibration Laboratory were estimated by the LANL calibration team to cost $4.5 million. An equipment list was provided. This should be sufficient as a rough order of magnitude estimate for establishing the needed standards and calibration capability and capacity at SRS.

Preliminary risk considerations:

No risks were identified other than low.

A.3.1.5 Waste Treatment and Management

Objective:

The objective of the review of the various waste treatment and management systems at SRS was to determine if sufficient capability and capacity exists to accommodate the treatment, management, and disposition of liquid and solid waste generated by the production of 80 ppy by the year 2030. This chapter begins with the description of waste treatment and management facilities at SRS and then discusses whether they are adequate should an 80 ppy manufacturing facility be built there.

Facility Descriptions:

Waste Solidification Building: SRS has constructed a waste solidification building intended to handle both low-level and high-level liquid waste from MFFF. The building is constructed to seismic performance category 3+ (to follow Nuclear Regulatory Commission requirements) with walls of 12-inch reinforced concrete. It is a Hazard Category II building, but is currently not Security Category I. It has no PIDAS.

WSB was constructed with the intention of accepting and treating approximately 10,100 gallons per year of highly active liquid waste from MFFF and approximately 55,500 gallons per year of low-level liquid waste made up of approximately 43,800 gallons per year from MFFF, and 11,700 gallons per year from the now-abandoned Pit Disassembly and Conversion Facility. This would be done in batches (*i.e.*, the projected rate of waste generation is not necessarily equal to the total capacity of the WSB). The WSB has been placed in a layup configuration and is managed with the intention that it will be reactivated when MFFF comes on line or after a period such as 10 years.

SRS personnel recommended that WSB be used as the liquid waste treatment facility for a pit manufacturing facility, regardless of whether that facility is in MFFF, in the K-reactor building, or in a new building. A study of potential waste generation rates from a postulated 125 ppy manufacturing facility (the Modern Pit Facility [MPF] – DOE 2005b) projected that such a facility would generate 3 m^3 per year (approximately 800 gallons per year) of high activity liquid waste. For comparison, LANL estimates that an 80 ppy manufacturing facility would generate approximately 30 m^3 (approximately 8,000 gallons) of liquid TRU waste per year (see above). The discrepancy between these two estimates remains to be explained, but either is within the capacity of WSB.

The above-referenced MPF study predicts approximately 257 m^3 per year (approximately 67,000 gallons per year) of low-level liquid waste from a 125 ppy facility. This predicted low-level liquid waste stream on its face exceeds the capacity of WSB. Pro-rating to 80 ppy is not valid because the generation of low-level liquid waste is not proportional to the number of pits manufactured[2]. However, as noted above, the WSB will be operated in a batch processing mode. SRS personnel stated that they are confident that WSB could handle the low-level liquid waste liquid generated from the manufacture of 80 ppy. However, see below for other options for waste disposal at SRS.

Liquid TRU Radioactive Waste Facility: Independent of the WSB, SRS operates a robust liquid waste management infrastructure primarily configured for the treatment of legacy wastes currently held in the tank farms. The waste, currently totaling about 36 million gallons, is stored in 44 underground carbon-

[2] Note that LANL did not provide an estimate of the low-level liquid waste generated by the manufacture of 80 ppy, but merely noted that the incremental increase would only add 1-2 percent to the amount of low-level liquid waste that is generated from all on-site sources.

steel waste tanks grouped into two "tank farms" at SRS. The liquid waste in tank storage exists in essentially two forms: sludge and salt. Liquid radioactive waste is also generated at SRS as by-products from the processing of nuclear materials for national defense, research and medical programs.

The Defense Waste Processing Facility is designed to treat the high-activity radionuclides from both forms of this waste. The sludge form, while comprising only about 10 percent of the volume in the tanks, contains about half of the radioactivity. All of it goes to Defense Waste Processing Facility, which incorporates it into glass logs for safe storage and ultimate disposal in a deep geological repository.

The salt form comprises about 90 percent of the volume and contains the balance of the radioactivity. The salt waste is treated at the Modular Caustic Side Solvent Extraction Unit and the Actinide Removal Process. The higher activity portion of the salt waste—a very small stream—is sent to the Defense Waste Processing Facility. The rest is a decontaminated salt solution sent to the Saltstone facilities. There it is mixed with a cement-like grout and poured into Saltstone Disposal Units. These above-ground units, which hold approximately three million gallons of grout each, are designed to keep the waste immobilized until long after the residual radioactivity decays away.

These two waste treatment capabilities, WSB and Defense Waste Processing Facility, are more than adequate to treat legacy wastes and the ongoing generation of liquid waste, with an intended completion date in the 2030s, subject to change because of fluctuations in funding and the potential implementation of other missions at SRS. In principle, should the use of the WSB to process liquid waste from pit manufacturing not prove to be feasible, such wastes could be sent to the liquid TRU waste processing facility – i.e., this is a potential back-up.

SRS E Area Solid Waste Management Facility: This is in the central region of SRS and manages the following waste types:

1. Sanitary waste, which is collected and transported to a sanitary landfill
2. LLW, most which is disposed of onsite in various disposal units. The disposal unit and method are dependent on curie content and waste form
3. TRU, hazardous, and mixed wastes. Commercial vendors are primarily used for hazardous waste and mixed waste treatment and disposal. TRU waste is packaged as appropriate and sent to the WIPP in New Mexico

Any low-level and TRU solid waste generated by the WSB would be sent to E-Area for disposal. Similarly, any solid low-level waste or TRU waste generated in MFFF, or in K-Area should a pit manufacturing facility be installed there, or in a new pit manufacturing building would also be sent to E-Area.

E-area currently manages and disposes of 50 m^3 of solid TRU waste per year, equivalent to approximately 250 55-gallon drums. According to studies performed for the Modern Pit Facility (DOE 2005b), a 125 ppy facility is expected to generate approximately 130 m^3 per year or 650 55-gallon drums per year. This can be regarded as an upper bound for a rate of 80 ppy. For perspective, the IST learned that LANL estimates that an 80 ppy manufacturing facility is expected to generate 1100-1500 55-gallon drums containing TRU waste per year. Whichever of these estimates is correct, E-Area would have to process TRU-waste at a considerably increased rate. SRS personnel expressed confidence that they could handle these rates. E-Area at SRS can store 2,000 – 2,500 55-gallon drums on each of five pads. This would provide many years of storage capacity and allow flexibility in coping with potential fluctuations in shipments to WIPP.

E-area also manages and disposes of 5,000 m^3 per year of solid LLW and could easily double that. According to the MPF study, a 125 ppy facility would be expected to generate approximately 1,630 m^3 per year of low-level solid waste. During its September 2016 visit to LANL, the IST was informed that experience has demonstrated that the volume of low-level waste generated from TA-55 is not particularly tied to pit production rate; but, rather the frequency of performing maintenance operations (e.g., routine glove and filter replacements). The average volume of low-level solid waste generated by TA-55 is approximately 330 m^3 per month, or approximately 4,000 m^3 per year. This higher estimate of low-level solid waste generation is within E-area's capacity.

Review Process:

The review was carried out as follows:

1. The IST provided infrastructure questionnaires about the following areas and they were filled out by various SRS personnel:
   - Low-level liquid waste treatment – SRS EM operations
   - TRU liquid waste treatment – SRS EM operations
   - TRU liquid waste treatment – NNSA WSB operations
   - Solid low-level waste storage and shipping – SRS EM operations
   - Solid TRU waste management – SRS EM operations
2. The team listened to presentations on WSB (given by Tom Cantey) and E-area (given by Don Turno).
3. The entire visiting AoA team went on a tour of WSB on the morning of Tuesday April 24 and went to E-Area on the morning of Wednesday April 25, 2017
4. SRS provided the following relevant documents:
   - Liquid Waste System Plan
   - Rad Waste Requirements 1S Manual
   - Liquid Waste Info Pod
   - Liquid Waste Fact Sheet
   - Solid Waste Management Info Pod
   - Transuranic Waste Fact Sheet

Those SRS people who provided most of the information summarized in this section of the IST's report, in addition to Jeff Allender and Brian Pool, were:

Name	Organization	Phone
Don Turno	Solid Waste Operations	803-208-8716
Jimmy Winkler	SRNS EM Programs	803-208-8182
Lee Fox	SRNS – Solid Waste	803-208-0778
Matt Haelcney	SRNS-NNP	803-952-1291

Discussion:

SRS has the capability and capacity to treat the low-level and TRU waste, both liquid and solid, that will be generated by the manufacture of 80 ppy, subject to the caveats expressed below as risks.

Preliminary Risk Considerations:

1. MFFF is eventually completed and used for its originally intended purpose of converting 34 metric tons of surplus-to-requirements weapons-grade plutonium to fuel for reactors. The low activity and high activity streams that it generates are treated in the WSB. If 80 ppy are also manufactured

at SRS, the WSB may not have enough capacity to deal with both processes. Additional liquid waste treatment capacity would have to be built, at potentially considerable expense. Because it is not known how likely it is that MFFF will eventually be used for its originally-intended purpose, it is not possible to make an estimate of the level of risk. However, as noted above, the Liquid TRU Radioactive Waste Facility has ample capacity and could potentially receive waste from pit manufacturing. Thus, this risk could potentially be mitigated to a low-level.

2. If MFFF is not used for its originally intended purpose, and instead the 34 metric tons of weapons-grade plutonium is managed through the proposed dilute and dispose effort, the amount of TRU waste to be handled by E-Area and sent to WIPP for final disposal will increase to about 100,000 55-gallon drums over the lifetime of the project. In that case, major (but unspecified) upgrades to E-Area will be needed. This will be costly and, in the opinion of the IST, it appears quite probable. This risk looks to be in the medium range, although it may not be a risk to the pit manufacturing program, since upgrades to E-Area will presumably be paid for by the dilute and dispose program, which will be by far the largest generator of TRU waste.

3. WIPP experiences an event that causes it to be shut down for a sufficiently long time that TRU waste storage at SRS becomes full. Pit production shuts down for a period of months to years. At the time of writing, WIPP has been closed for 3 years and has only recently reopened. Another such shutdown cannot be ruled out. As noted above, storage in E-Area is sufficient to accommodate TRU waste generation from pit production for many years, so this risk is probably low. However, should the dilute and dispose program ramp up to accommodate 34 metric tons of moxable plutonium, the storage capacity in E-Area could fill up relatively quickly. The likelihood of this event is quite high. However, given the already large storage capacity for TRU at SRS, and the availability of space in E-Area for construction of further storage capacity, this risk should be mitigatable to a low-level.

5. WIPP experiences another event that causes it to be shut down. After it comes back on line, additional safety and regulatory constraints mean that it accepts and processes shipments at a much slower rate than before the event. This processing rate may be insufficient to accept TRU waste generated by 80 ppy, especially if increased by enhanced TRU waste production by the dilute and dispose activity, so that after some years TRU waste storage at SRS becomes full and pit production ceases. This scenario is also realistic because, now that WIPP has come back on line after its current shutdown, it is accepting and processing shipments for final disposal at a lower rate than before. Similar or perhaps even more onerous restrictions are likely in the event of a future shutdown. This risk is medium to high.

6. WIPP becomes full and is no longer able to accept solid TRU waste. Solid TRU capacity at SRS also becomes full and pit production shuts down. Additional TRU waste disposal capacity at WIPP or elsewhere may be required to support the 80 ppy capacity and, if implemented, to support the extra TRU waste generated if 34 metric tons of plutonium is treated via dilute and dispose instead of the MOX process. The IST's initial assessment of this risk was high, but, as is discussed in Appendix E, on further consideration it was assessed to be low. This in part is because it is assumed that, in the event of WIPP becoming full, further storage capacity will be developed there.

Note that none of the WIPP-related risks described above (3-5) are unique to SRS and will likely not be discriminators between sites.

A.3.1.6 Miscellaneous

This section contains information on several activities that are needed to support pit production, but which would not be expensive to implement (relative to the total cost of a pit production facility) should they not already be available at SRS. Alternatively, most of them could be readily outsourced.

A.3.1.6.1 Classified Beryllium (Be) Machining

SRS currently has no classified Be machining capability. This information was conveyed to the IST via Jeff Allender, SRNL (803-208-1291). It is expected that, if needed, classified Be parts can be obtained through a classified procurement or from another DOE site

Preliminary Risk Considerations:

No risks were identified other than those that are very low because it seems very unlikely that SRS would not be able to obtain classified Be parts from off-site sources if needed.

A.3.1.6.2 Classified Stainless Steel Machining

Objective:

The objective of the review of SRS' classified stainless steel capability and capacity was to determine if sufficient capacity exists to accommodate the machining of stainless steel parts that will be required to support the production of 80 ppy by the year 2030.

Facility Description:

Classified stainless steel machining is carried out in SRNL's Research and Development Machine Shop, which is in Building 749-A. This building has a production area of 10,000 ft^2, of which only 600 ft^2 is designated for classified machining. Administration, support, and other areas take up about 1,300 ft^2. The facility contains eight conventional mills, six CNC mills, eight conventional lathes, and four CNC lathes, but there is only one of each of these four items of equipment in the classified area. The facility also contains a grinder, an electrical discharge machine, fabrication equipment and a welder, but none of these are in the classified area. The maximum classified machining capacity, based on four machines and four machinists working 40-hour weeks for four months is 2,560 hours.

Review Process:

The review was principally conducted by using the questionnaire, which was filled in by Monica Phillips (803-725-3622) and Tom Nance (803-725-5842). This was supplemented by a brief tour of the shop on April 26, 2017, and by conversations with Jeff Allender.

Discussion:

SRS clearly has limited capacity for classified stainless steel machining. There may be capability associated with other facilities at SRS, including the NNSA Tritium Enterprise, but these likely have limited capacity and are dedicated to specific missions. In addition, building 749-A is a research and development shop and mixing manufacturing and research capabilities may be undesirable.

Should NNSA establish a pit manufacturing capability at SRS, the required classified stainless-steel capacity should be established at that time and plans to set it up should be made at an early date. Alternatively, the site might consider outsourcing its need for classified shapes to a site such as KCNSC.

Preliminary Risk Considerations:

No risks were identified other than those that are very low, because it seems very unlikely that SRS would not be able to obtain classified stainless-steel parts from off-site sources if needed.

A.3.1.6.3 Classified Graphite Machining

Overview:

SRS currently has a limited classified graphite machining capability in the same SRNL Machining Shop. SRNL, through Monica Phillips, pointed out that classified graphite machining has been done on the same machines that are used for classified stainless steel machining, but as noted above that capability is very limited as it would share the 600-ft^2 of classified machining space. No similar capacity was identified elsewhere at SRS.

Discussion:

It would be entirely feasible for SRS to outsource graphite machining requirements to LANL or to other off-site entities. Should SRS decide to set up its own capability it would require classified space and equipment like that for stainless steel, but with enhanced ventilation and a collection system to control dust.

During its visit to LANL in September 2016 the IST determined that the area currently dedicated to graphite fabrication in support of pit manufacturing is 2,500 ft^2 to administration, 2,000 ft^2 to production, and 2,500 ft^2 to support. The production area is in a standard industrial building but, as noted above, has a specialized ventilation process to capture the considerable amount of graphite dust particles that is released during the machining process.

LANL informed the IST that, to accommodate a production rate of 80 ppy on a one shift basis, the current production area would have to be enlarged from 2,000 ft^2 to 8,000 ft^2 including additional equipment and extended ventilation. The current administrative and support functions do not require additional area. The current production area contains eight lathes, five mills, and several electrical discharge machines. To accommodate 80 ppy will require the following new equipment items: three coordinate measuring machines, six lathes, and two mills.

Thus, to install graphite machining at SRS to support 80 ppy, based on the LANL information, about 13,000 ft^2 would be required in a standard industrial building. Of that 13,000- ft^2, 8,000 ft^2 would need to be in a specially ventilated area. Equipment needed would be fourteen lathes, seven mills, several electrical discharge machines, and three co-ordinates measuring machines.

Preliminary Risk Considerations:

No risks were identified other than those that are very low. SRS should be able to build the graphite machining capability in time or to outsource the machining.

A.3.1.6.4 Classified Uranium Machining

SRS currently has no classified uranium machining capability. This information was conveyed to the IST by Jeff Allender. The IST recommends that it should either be assumed that this capability will be outsourced (*e.g.,* to Y-12) or that equipment should be built into the pit manufacturing process.

Preliminary Risk Considerations:

No risks were identified other than those that are very low.

A.3.1.6.5 Graphite Coating

Overview:

SRS currently has no graphite coating capability. This information was conveyed to the IST via Jeff Allender, SRNL (803-208-1291).

The IST considers that a conventional manufacturing structure that could accommodate an enclosed area of 3,000 ft^2 would be sufficient to handle the coating operation for an 80 ppy manufacturing facility. The area would encompass 2,000 ft^2 of manufacturing space containing two 10 feet x 20 feet paint booths and other operations for preparation and cleaning, along with a 1,000-ft^2 complex of offices, storage, restrooms, etc. This operation should be close to the mold casting machining operation. There are no shelf-life issues, so if molding and coating is not carried out at SRS, it could equally well be done at a site such as LANL.

Preliminary Risk Considerations:

No risks were identified other than those that are very low.

A.3.2 Plant Core Infrastructure

This section addresses those items of plant core infrastructure that are needed by the 80 ppy manufacturing process.

A.3.2.1 Security Category 1 Facility Support

Objective:

The objective of the review was to determine if SRS has in place a Security Category I process to support the requirements of a pit manufacturing facility. SRS has been operational since the early 1950s and has performed several vital roles in support of nuclear weapons production. Security has been a significant and very important element for the successful performance of their mission since they are required to protect all types of nuclear materials, including SNM, government property, weapon products, and personnel.

Review Process:

The Security Category I system review consisted of discussions with qualified members of SRS security team and review of documentation (i.e., DOE Order 473.3, Protection Program Operations, and SRS policies and procedures). Those participating in the discussions, which took place on April 25, 2017, were:

Name	Organization	Phone
Rich Koenig	SRNL	803-645-5608
J. R. Murphy	SRNS	803-952-5513
Jeff Allender	SRNL	803-208-1291
Brian Pool	SRNS	803-208-0396
Chris Bader	TechSource	480-782-0415
Phil Forsberg	NA-143	202-586-2108
Geoff Kaiser	Leidos	301-340-9015

The following documents were provided:

1. SRNL, Safeguards and Security Programs Manual - 7Q
2. DOE: O 473.3, Protection Programs Operations

Discussion:

- SRS is required to follow and be compliant with the DOE Order 473.3, *Protection Program Operation*s. This Order establishes requirements for the management and operation of the Protection Program Forces, Contractor Protective Forces, and the Physical Security of property and personnel under the cognizance of DOE.

- SRS has prepared a security manual with supporting implementation procedures, governing the security for the entire site. It covers all requirements within DOE Order 473.3, including physical protection of facilities, buildings, government property, and employees, and it addresses national security interests such as classified information, SNM and other elements of the nuclear weapon programs.

Based on the determination that satisfactory safeguards and security policy and facility measures are in place, the DOE will grant SRS facility approval to receive, process, use, or store classified material, nuclear materials or DOE property of significant monetary value. A Facility Data and Approval Record (FDAR) is the process used to record approvals, facility importance ratings, facility upgrades or downgrades, and changes or deletions.

The DOE Office of Safeguards, Security and Emergency Services approves the FDAR and in conjunction with the prime contractor Savannah River Nuclear Solutions Department, and the Protective Force contractor Centerra ensures that policies, programs, and systems and all operations comply with appropriate implementation of the DOE Order and specifics of the FDAR. As missions and conditions change, the FDAR is reviewed and revised if necessary.

The contractors perform periodic self-assessments to verify compliance in addition to DOE audits and assessment of the programs.

No issues were identified within the security system that would prohibit the assignment of the pit manufacturing mission to SRS.

A.3.2.2 Normal/off normal Electrical Power

Objective:

The objective of SRS Electrical Power review is to determine if sufficient power is currently available or planned to support a pit manufacturing facility capable of producing 80 ppy by the year 2030.

Review Process:

SRS Site Services organization responded to the IST questionnaire by providing existing utility capacity data versus current and planned usage. Both Jeff Allender and Brian Pool coordinated the data with the Savanah River Site Services organization

It should be noted as of the present date the size of the pit manufacturing facility has not been established and therefore the amount of power or other utility requirements have not been determined.

It has been assumed that utility usage would be half of that being considered for the MOX facility. It is understood that this assumption is conservative since the MOX facility is designed as a greater than 500 thousand ft^2 facility. Current pit facilities space estimates are considerably less than half of the MOX estimate.

Description:

SRS has robust electrical power capabilities and capacities. The system is supplied by several independent electrical power generation plants located in South Carolina and Georgia. SRS has provided transmission capacities for nine separate substations including estimated usage projections for both current and future missions.

Based on the data provided the estimated electrical power demands for a pit manufacturing facility could be adequately supported within most of the areas if needed.

Table A–1 reflects current usage and current capacities for the existing nine substations.

Table A–1. Savannah River electrical transmission capacities

Item	Savannah River Area	Demand MVA	Capacity MVA	Remarks
1	A	12.0	40.0	
2	B	4.5	16.0	
3	C	6.5	30.0	
4	F	11.0	40.0	
5	MOX	23.0	37.3	Assumption - Pit facility 50 percent of MOX approximately 12.0 MVA
6	H	26.0	40.0	
7	K	6.0	30.0	
8	L	2.5	30.0	
9	681-3G	1.5	20.0	

Key: MOX = mixed oxide; MVA = mega volt ampere

While there is sufficient power at the Site to support a pit manufacturing facility, to ensure redundancy and to provide a comfortable safety margin, power redistribution from lower demand areas to any proposed pit manufacturing area should be considered.

A.3.2.3 Other utilities

Objective:

The objective of a review of SRS' other utility areas is to determine if capacities are available or planned to support a pit manufacturing facility capable of producing 80 ppy by the year 2030.

Review Process:

SRS Site Services organization responded to the IST questionnaire by providing utility capacity data versus current and planned usage. Brian Pool (803-208-0396) coordinated the data with the Savannah River Site Services organization.

Other site utilities were reviewed to determine their ability to support the 80 ppy mission and determine if some modifications or enhancement to capacity was needed. The results of that review are as follows:

1. <u>Chilled water</u> – SRS has two chilled water plants with a combined design capacity of 5,800 tons with current and planned utilization at 3,450 tons. Absent changes to the current and planned missions that would require more chilled water there should be amble supply for a pit manufacturing building producing 80 ppy.
2. <u>Domestic water</u> – SRS has one active water treatment plant located within Area A. The capacity for domestic water treatment provided by the Area A facility is 1,500-gallons per minute versus a total combined daytime demand of 900 gallons per minute. A smaller water treatment plant is located at Area D with a 200-gallons per minute output and a 10-gallons per minute average demand. Pending change to the current planned missions there is ample capacity available to support a pit manufacturing facility.

3. Fire Protection – It is assumed that the new pit facility will have a dedicated fire protection water tank and pumping capacity of suitable size for the facility. Pumping capabilities for SRS critical buildings are supported with 2,000 – 2,500 gallons per minute pumps and tank capacities of several hundred thousand gallons. Two water tanks currently are in Area E/F where the MFFF is located with capacities greater than 500 thousand gallons. They are serviced by a 2.5-thousand gallon per minute pump that would be available if the pit manufacturing mission used the MFFF. Similarly, if K-reactor was converted to a pit manufacturing facility it has a single tank of 500 thousand gallons with a 2.5-thousand gallon per minute pump. It is assumed that the fire protection tank and pumping system would be part of the pit facility cost if built in a green field.
4. Process water – SRS process water is supported by three different process treatment plants located in Areas A, F, and H, producing at a combined peak capacity of 3,000 gallons per minute with an anticipated demand of approximately 1,125 gallons per minute. There is sufficient process water capacity to support a pit manufacturing facility.
5. River Water Capacities – SRS river water provides water for the entire site. The water is pumped from the Savannah River for use in multiple areas and multiple applications for domestic consumption, fire protection, chilled water for cooling towers, etc. The design capacity of the system is 250,000 gallons per minute but only a fraction of the capacity is being used. Most of the system is in a stand ready state but is not used or needed. Based on the foregoing there is ample capacity of river water to support a pit manufacturing facility.
6. Steam Production – SRS steam production consists of four active power plants with combined average capacity flow of approximately 290 thousand pounds per hour and an average daily flow requirement of 104 thousand pounds per hour. Pending change to the current planned missions there is currently sufficient steam capacity to support a pit manufacturing facility.

As noted above the pit manufacturing facility has not been sized so an estimate of half of the MOX facility usage was used to ensure the analysis of utilities is sufficient to support the pit initiative when applicable.

A.3.2.4 Medical Facility

An onsite medical facility with capability to treat alpha contaminated personnel has been available to SRS for many years. The facility, centrally located within Area N, has a core of trained staff capable of performing decontamination processes and methods as well as performing first aid for minor injuries. The facility is equipped and personnel trained for performing emergency service and stabilization of personnel for transport in emergency situations.

A.3.2.5 Environmental Monitoring

SRS has a comprehensive Environmental Management System in place that ensures the protection of air, water, land, biota, and other natural, archaeological, and cultural resources. The DOE Savannah River Site Policy Manual, SRSPM 250.1.1E, provides the policy guidance to the site for environmental direction. The operating contractor has prepared supporting documentation to implement the environmental program through policies, programs, procedures, and training.

The on-site contractor has established improvement goals and targets; and routinely measures performance. When issues are identified, corrective actions are identified and action is taken to improve processes and protect the environment.

A.3.2.6 Sanitary Waste Facility

SRS has a central sanitary waste water treatment facility and three satellite facilities. The central facility services the entire site and has a treatment capacity of 1.05 million gallons a day and a peak flow of 0.6 million gallons a day. The satellite treatment facilities service areas D, K, and L. Area D is being deactivated, Area K is at maximum capacity, and Area L has 10 GPD excess capacity. The pit manufacturing facility would most likely be serviced by the central system which has sufficient capacity to support that mission.

A.3.2.7 Operating Infrastructure

This section addresses the various items of operating infrastructure that are needed to operate the proposed 80 ppy manufacturing facility.

A.3.2.8 Production Control System

Production control process are applied to the weapon product currently produced at SRS. The nature of the system will most probably be modified to accommodate the product differences between the current mission and the fabrication and assembly operations of parts required to produce a plutonium pit. If SRS is selected as the pit manufacturing site there is sufficient time to make the necessary changes as required

A.3.2.9 Manufacturing policy document

Manufacturing policy documents include conduct of operations and quality requirements specified in the 1Q Quality Assurance Manual. These documents provide the basis for the operation and conduct of business, as well as how to produce quality product, in a nuclear environment.

A.3.2.10 Material Control System

Material control systems are required and specified within the 1Q Quality Assurance Manual. As established by the manual, material control requires supplier evaluations, receiving or supplier source inspections, and certificate of conformance (1Q procedure 18-7, Quality Assurance Supplier Surveillance and 1Q procedure 7-2, Control of Purchased Items and Services). In addition, the 1Q manual specifies the requirement for parts Identification during processing to ensure controls are maintained (1Q procedure 8-1, Identification and Control of Items).

A.3.2.11 Safeguards and Accountability

SRS has responsibility for storing and maintaining SNM. To manage and administer the SNM program the Site has developed an SNM policy and procedures manual consistent with DOE Order 473.3, *Protection and Program Operations*. A policy document, 14Q, *Material Control and Accountability Manual,* contains procedures to administer and control a compliant SNM program. These SNM procedures and processes are routinely assessed by the operating and management contractor as well as audited annually by the DOE.

A.3.2.12 Qualified Operators and Technicians

Requirements for qualification of personnel are addressed in NQA-1-2008/2009, Sec. 200, and NAP-24A, section 3.2, Indoctrination and Training, and specified within the Site Management and Operations Quality Assurance and Management Plan, SRNS-RP-2008-00020. The objective of the training program is to provide and ensure initial proficiency, maintain proficiency, and adapt to changes in technology, methods, or job responsibilities.

A.3.2.13 Weapons Quality Program

SRS is responsible for manufacturing and supporting the nuclear weapons production program by producing and delivering tritium products. The DOE quality policy document for weapon products is NAP-24A, Weapon Quality Policy, published in 2015. SRS has adopted this policy and published a quality manual for the site that rolls the requirements of NAP-24A and NQA-1 2008/2009 together. Each section of the manual is independently controlled and updated as the quality policies evolve. DOE has approved this process and based upon periodic reviews and assessments monitors compliance. It is noted that a revision to NAP-24 has recently been released and SRS is in process of incorporating the changes. Forecast for completion and implementation of the revision is June 2017.

A.4 Idaho National Laboratory

The IST concluded that INL has most of the necessary infrastructure in place to support the manufacture of 80 ppy. That infrastructure includes strong capabilities in solid and liquid waste management, standards and calibration, plant core elements (such as processes and facilities to support a category I secured facility), adequate electrical power, medical support, and all operating infrastructure processes and systems (such as safeguards of nuclear materials, production and quality assurance).

The IST determined that the INL has excellent equipment and facility capabilities currently performing AC and MC. The primary issue encountered is that the laboratory buildings performing AC are Hazard Category 3 and only authorized to process 200 grams of plutonium-239 at one time, which cannot support production requirements. This issue also impacts LANL and SRS and underscores the need for either a review and favorable decision to increase this limiting requirement, or support of the activity by providing additional Hazard Category 2 facilities for laboratory work dealing with nuclear materials.

As identified during prior IST reviews (*i.e.,* of LANL and SRS), the W87 DA, LLNL, is planning to perform some portion of the AC and MC work required for process development and qualification for the 80 ppy production capability. LLNL's assistance will be very helpful and can offer an alternative to INL should they need additional AC and MC capacity. LANL potentially could serve as a backup for this capability.

The IST is also concerned about the uncertainty expressed by the INL team regarding their ability to support the 80 ppy requirement for many of the infrastructure items due to the lack of information about their projected needs for INL's primary core work. While the pit manufacturing effort starts in 2026 the amount work for the basic INL core activities is unknown at this time.

While the intellectual, technical, facility, and equipment capabilities clearly exist for most items, INL is reluctant to commit to having capacity to support the pit manufacturing project based on the uncertainty of their core work requirement needs.

INL was able to evaluate and estimate the pit manufacturing laboratory and waste management requirements based on the MPF studies performed in 2004. In many areas INL concluded that the pit project could be supported by adding a second shift, off-loading non-nuclear items to other sites, or procuring from qualified suppliers.

Some infrastructure elements necessary for establishing a capacity to produce 80 ppy were not included in the scope of this evaluation after having been judged to be unlikely to impact any of the potential alternatives. KCNSC is NNSA's center of excellence for providing non-nuclear product components to supplement or support all other NNSA sites. In addition, KCNSC provides many of the supplies and materials used in pit fabrication. Most of these items are off-the-shelf controlled commodity items obtained from qualified sources but are not included in this evaluation.

During the orientation meeting several questions regarding acquisition of a skilled labor force to operate the pit manufacturing plant were discussed. INL management responded that the site is an attractive placed to work with competitive wages and benefits, and they are confident in their ability to acquire 600-1000 glovebox machinists, production operators, and other supporting personnel to support the pit mission.

As was done on the other site reviews, the IST provided questionnaires requesting specific data on the major infrastructure items. The IST then reviewed the documents to determine if capability and capacity would be available to support the mission of 80 ppy.

Unlike prior infrastructure reviews the full IST was unable to visit the INL site due to other project priorities. The process to prepare this section included an IST review of the questionnaires and communicating with INL management via teleconference as required.

This chapter is divided into three sections: a) capital items and functions; b) plant core infrastructure, and c) operating infrastructure. The information compiled below was assembled from some or all of three sources: a) questionnaires that the IST sent beforehand; b) orientation briefings: and c) telephone follow up. The work was led by Chris Bader, assisted by Ian Andrews, Geoff Kaiser, and Vann Bynum. They, as well as INL individuals who were particularly helpful in organizing and providing information for the INL infrastructure review are as follows:

Name	Organization	Phone
Ian Andrews	NNSA	202-287-5123
Chris Bader	TechSource Inc.	480-650-2099
Vann Bynum	TechSource Inc.	505-603-9018
Geoff Kaiser	Leidos	301-340-9015
Carla Dwight	Space Nuclear Power & Isotope Technologies (INL)	208-533-7651
Stephen Johnson	Space Nuclear Power & Isotope Technologies (INL)	208-533-7496
Misty Benjamin	Homeland & National Security (INL)	208-526-5940

A.4.1 Capital Items and Functions

This section describes the information gathered on the following capital items and functions: analytical chemistry, material characterization, PIDADS, standards and calibration, waste treatment and management (low level and TRU liquid waste, low level and TRU solid waste), and miscellaneous (classified beryllium machining, classified stainless steel machining, classified graphite machining, classified uranium machining, and graphite coating).

A.4.1.1 Analytical Chemistry

Objective:

The objective of the review of AC laboratories is to determine if sufficient capability and capacity is available to perform required chemical testing, analysis, and verification of chemistry parameters necessary to produce a compliant and quality pit at a production rate of 80 ppy by the year 2030. AC supports the development, qualification, and production phases of the pit manufacturing project by performing tests and analysis to determine and evaluate compliance with material specifications and verify consistency of the manufacturing processes.

Facility Description:

INL provided the following description of the facilities available for performing AC:

The Materials and Fuels Complex (MFC) Analytical Laboratory is a Hazard Category 3 nuclear facility which specializes in characterization, post-irradiation examination, and fuel fabrication.

The current mission of the AC laboratory is:

- Chemical, radiochemical and physical measurements
- Nondestructive analysis measurements
- Applied research and engineering development activities in support of advanced nuclear fuel design, waste management, environmental, and other programs conducted at the MFC
- Analysis and characterization of as-built and post-irradiated nuclear fuels and reactor components
- Analysis of hazardous, mixed, or highly radioactive waste
- Analytical chemistry support for nuclear forensics
- Radioisotope separation
- Characterization of engineered materials

Significant equipment items within the AC laboratory include:

- Six interconnected hot cells, general chemistry laboratories, gloveboxes and fume hoods
- Gas mass spectrometers
- Characterization of as-built and post—irradiated nuclear fuels and reactor components
- Segmented Barrel Gamma Scanner for non-destructive analysis
- Conventional/off-the-shelf equipment and techniques for analyzing all types of radioactive materials

Review Process:

The review process consisted of INL completing a questionnaire provided by the IST for items considered important to the success of a pit manufacturing operation. For the AC Area, this form is identified as MPA-AoA-INL-11.

INL has excellent facilities, equipment, and trained and qualified personnel to perform the AC process for the pit manufacturing mission. However, several issues need to be addressed.

The first issue is that INL's AC laboratory is operating in a Hazard Category 3 facility with a MAR limit of 200 grams of plutonium-239-equivalent (gPu) for the building. The MAR limit severely restricts the rate at which tests can be performed for product development and qualification testing and will constrain the pit manufacturing operation's ability to sustain the required production rate. This issue is also applicable to LANL and SRS. Requests to increase the MAR have been made by both sites for well over a year without a response from the appropriate nuclear safety authorities. For purposes of the AoA the IST assumes favorable passage of the MAR increase.

The second issue is that several current INL projects are expected to extend into the future and it is difficult to forecast the amount of AC support they will require. Currently these programs occupy most of the existing AC facility and capacity. It is not known how much AC capacity will be available in 2026 and beyond when the pit processes are expected to be needed.

Discussion:

Current estimated dates for starting pit manufacturing process development is 2026. It is therefore likely that the pit manufacturing workload will be operating simultaneously with other INL projects. If there is conflicting activity one possibility is to deploy a second shift. INL has reviewed the AC needs of pit manufacturing based on the modern pit facility study and concluded that, provided the INL core work does not increase from current levels, the addition of a second shift could accommodate both major work activities.

Another consideration and potential solution would be for LLNL and LANL to assist with their AC laboratory resources. This strategy could be very helpful particularly during the early process development and qualification phase.

Another possibility is to explore the placement of the AC laboratory within the Fuel Processing Facility or the green field construction if either of these is the selected option. This would eliminate the MAR issue as well as provide uninterrupted support to pit operations.

Several options appear to be available to resolve or at least assist in the resolution of the capacity issue. Pit operations are not planned to start until 2026 which should be sufficient time to come up with an acceptable solution.

Preliminary Risk Considerations:

The principal risk is that if an 80 ppy manufacturing facility is established at INL, MAR limits in the buildings housing AC equipment will be insufficient to allow INL to process samples at the required rate. If this were to continue indefinitely, it would become impossible to deliver 80 WR ppy to Pantex. To mitigate or remove this risk, careful planning will be necessary to ensure that the necessary amount of Hazard Category 2 space is made available for AC equipment. The lead time is such that this should be possible, and the risk is assessed to be low.

The IST learned at LANL that research efforts are underway to increase the sensitivity of analytical techniques so that much smaller sample sizes are required. This would increase the number of sampling analyses that are possible at any one time while remaining within a MAR limit such as 200 gPu. This is another avenue that INL could explore should there be a need to further mitigate the risk described above.

Another way in which this risk could be further mitigated could be to reduce the number of samples that are required per pit. Based on experience at LANL, 18-20 five-gram plutonium metal samples were analyzed for every WR pit that was produced. However, potentially, if the initial metal could be delivered within certain well-defined specifications, this possibly could be reduced to 6-6.5 five-gram samples per delivered pit, making a total of about 500 samples per year for an 80 ppy program. With careful scheduling and improving the quality of incoming plutonium, this strategy potentially could be managed in a building with a 200g MAR ceiling.

In addition, as mentioned above, the risk could be mitigated by calling on AC resources at LANL or LLNL.

Considering the many potential ways of mitigating this risk, the IST's preliminary determination is that it is low.

A.4.1.2 Material Characterization

Objective:

The objective of the review of MC at INL is to determine if there is sufficient capability and capacity to perform testing, analysis, and verification of the manufacturing process parameters to produce a compliant and quality pit at a rate of 80 ppy by the year 2030. MC supports manufacturing operations in the development, qualification, and production phases of the program by performing material testing and analysis to evaluate compliance with specifications and verify consistency of the manufacturing processes.

In addition to the development and qualification phase, during the production campaign W-87 pits will be randomly selected from the production line and tested to ensure the processes are stable and yielding consistent and compliant results.

Facility Description:

The Material Characterization Laboratory (MCL) is currently performed in three different facilities and consists of an 11,000-ft^2 Hazard Category 2 building, and two combined buildings containing a combined 8,000 ft^2 of Hazard Category 3 space.

Significant equipment items include:

- a JEOL 7600 scanning electron microscope that has wavelength and energy dispersive x-ray detectors, along with electron backscattering capabilities to fully characterize samples to 1nm resolution at 15kv
- PHENOM, a table-top scanning electron microscope for basic capabilities
- an electron microscopy laboratory that can handle actinides and low to moderate radiological samples (300 R beta)
- Class I radiological hoods and gloveboxes to prepare actinide bearing samples
- a JEOL 7000 scanning electron microscope, that has the most modern and versatile detectors (wave length and energy dispersive) x-ray detectors and electron backscattering diffraction detectors
- a Quantas focused ion beam instrument and a transmission electron microscope
- an electron probe microanalyzer manufactured by CAMECA
- a thermal conductivity microscope, which is planned for FY 2019

The MC laboratory has an impressive list of facilities and equipment and appears to be entirely capable of performing the tests needed to support the technical MC requirements for pit manufacturing.

Review Process:

The review process consisted of INL completing a questionnaire provided by the IST for items considered important to the success of a pit manufacturing operation. For the MC section, this form is identified as MPA-AoA-INL-12.

The MC unit can support the pit manufacturing project with process development and qualification by verifying the manufacturing parameters meet or exceed the requirements as defined by the design agency. Further, once the parameters are established the manufacturing processes are continuously monitored by sampling the product throughout the build cycle to ensure process consistency is maintained.

The facility area needed for MC has been estimated to be 7,750 ft^2, consisting of 5,875 ft^2 of Hazard Category II space and 1,875 ft^2 of Hazard Category III space. Provisions for Hazard Category II space and equipment have been included within the manufacturing process area and the Hazard Category III space could be accommodated in existing INL facilities.

If the option selected is the modification of the Fuel Processing Facility, in addition to the installation of the pit production area, there would be ample space within that facility to accommodate the entire MC and AC requirements.

Discussion:

The largest concern identified by the INL management for MC is the projected workload required for INL's core work during the time period when pit manufacturing process development would start. As currently forecast pit production type work is unlikely to start prior to 2026, and as previously stated should allow ample time to identify, plan, and execute actions to mitigate interferences.

Preliminary Risk considerations:

1. There will be a "spike" in needed material characterization during development and qualification of the pit production process. Currently, it is not known what length of time will be available to cope with such a spike, nor whether INL has the necessary instruments and personnel. The worst case would be that the ability to produce 80 ppy is delayed by an unspecified number of months or years. This risk could be mitigated by enhancing INL's MC capability or by using offsite (e.g., LLNL) capability. The risk is judged to be low.

2. INL may have insufficient capability to perform the MC work necessary during steady state production of 80 ppy. As a result, INL will be unable to meet its target of 80 ppy or extensive deviations, which may or may not be acceptable, will have to be approved by the design agency. Per the discussion above, this risk is judged to be low.
3. In the future (*e.g.,* after 2030) there will be a need to produce some pits of a different type(s). This will require further development and qualification of the pit production process that will challenge INL's MC capabilities, and may cause a delay of an unknown number of years in the ability to produce the different pit type(s). However, this is so far in the future that there will be ample time for INL to manage the introduction of the different type of pit. This ought to be a low risk because of the long period available for planning.

A.4.1.3 Perimeter Intrusion, Detection, Assessment, and Delay System

Objective:

The objective of the IST's review is to determine INL's capabilities in the areas of perimeter intrusion, detection, assessment, and delay with respect to the potential installation of an 80 ppy pit manufacturing capability by the year 2030.

Facility Description:

INL currently has an active PIDAS surrounding a MFC secured structure that is undergoing an upgrade and scheduled for completion in 2017. This MFC PIDAS installation has been operational and in place for several years.

Estimates provided by the IST indicate that for the two options being considered at INL (*i.e.,* modification of the Fuel Processing Facility, constructed in the early 90s, and a new green field constructed facility), both alternatives require support building(s) for non-nuclear activities inside the protected area. Both alternatives also require that approximately 2,600 linear feet of PIDAS or PIDADS will be required, including pedestrian and vehicular access points.

Review Process:

The review process consisted of INL completing a questionnaire provided by the IST for items considered important to the success of a pit manufacturing operation. For the PIDADS section this form is identified as MPA-AoA-INL-03.

Discussion:

Based on the experience and continuing operation of the PIDAS surrounding the MFC secured structure INL has clearly demonstrated that they are capable of operating a security perimeter protection system required to protect a pit manufacturing facility.

Preliminary Risk Considerations:

Two pertinent risks could have a significant effect on plutonium operations.

1. If the design basis threat changes, this could require potentially large expenditures to reconfigure the physical security infrastructure, with unknown delays to and cost for the pit production program. This would also affect other facilities and operations at INL. Based on experience, there is a high probability that security requirements could change during development and qualification for the pit production process. The costs could vary from small to very large, so the risk level remains indeterminate but could well be high or very high. This is not a site-specific risk.
2. There is always the possibility that INL will have to be shut down for an unknown duration in response to some future threat. This would lead to delays in pit production of unknown length and likewise unknown cost. Any other site would face the same risk, so this is not a discriminator between sites.

A.4.1.4 Standards and Calibration

Objective:

The objective of the review of the Standards and Calibration Laboratory is to determine if INL has the capability and capacity needed to support the production of 80 ppy by the year 2030.

Facility Description:

INL's Standards and Calibration Laboratory functions are performed in a facility built in 1969. This facility has undergone multiple additions and renovations and is approximately 10,500 ft^2. In addition, heating, ventilation, and air conditioning upgrades have occurred to provide the proper controlled environment as required to support an accredited calibration laboratory. INL's management has described the facility has having adequate temperature, and vibration controls.

The Standards and Calibration Laboratory is accredited to ISO/IEC 17025:2005, and ANSI/NCSL Z540-1-1994 standards in several categories of instruments including dimensional; mechanical; electromagnetics; time and frequency; and thermodynamics.

Review Process:

The review process consisted of INL completing a questionnaire provided by the IST for items considered important to the success of a pit manufacturing operation. For the Standards and Calibration section this form is identified as MPA-AoA-INL-13.

Discussion:

As reported the Standards and Calibration Laboratory has capability, experience, and is accredited in many disciplines. The calibration laboratory will be allocated 500 ft^2 of laboratory space within the pit manufacturing processing area to perform a verification, after calibration intervals have expired, that the contaminated instruments still meet the accuracy requirements. This verification provides confirmation that prior completed product was tested with accurate instruments, and is a requirement of the Weapon Quality Program NAP-24.

Based on the information provided it is concluded that the laboratory has the capability to support a pit manufacturing production program at a rate of 80 ppy. Whether the Standards and Calibration Laboratory has the capacity to support pit manufacturing is unknown. There are several possible solutions that could be applied if capacity becomes an issue. First, there are many qualified and accredited commercial calibration laboratories available to assist with the added volume of instruments; and second, another shift could be added.

Preliminary Risk Considerations:

No risks were identified other than those that are very low.

A.4.1.5 Waste Treatment and Management

Objective:

The objective of the review of the various waste treatment and management systems at INL is to determine if sufficient capability and capacity exists to accommodate the treatment, management, and disposition of liquid and solid waste generated as a result of the production of 80 ppy by the year 2030. INL used the MPF study for estimating waste generation volume, SRS-SLD-G-FRD-X-00010, dated May 5, 2004.

A.4.1.5.1 Solid Low Level Radioactive Waste

Facility Description:

INL has five solid LLW operational locations within the MFC and INTEC complexes. INL has stated that LLW is currently stored in cargo containers pending processing and shipment to authorized offsite disposal sites.

Review Process:

The review process consisted of INL completing a questionnaire provided by the IST for items considered important to the success of a pit manufacturing operation. For the Solid Low-Level Waste area, this form is identified as MPA-AoA-INL-09.

Discussion:

In 2016 approximately 80 semi-loads of solid low-level waste were shipped from INL to authorized disposal and treatment facilities. INL identified that, except for needing additional cargo containers, no additional facilities or equipment will be required to accommodate 80 ppy.

A.4.1.5.2 Solid Transuranic Radioactive Waste

Facility Description:

The solid TRU waste is processed at INL in a dedicated waste processing facility capable of processing 250 cubic meters of solid TRU waste per month. Due to programs in place this capacity is expected to be fully utilized up through year 2021.

Review Process:

The review process consisted of INL completing a questionnaire provided by the IST for items considered important to the success of a pit manufacturing operation. For the Solid TRU Waste section this form is identified as PMA-AoA-INL-10.

INL's estimated generation rate for the 80 ppy mission is approximately 28 cubic meters per month and is estimated to start waste generation in 2026 at the earliest.

Discussion:

INL stated that after year 2021 some of the existing INL workload is expected to taper off, and that adequate facility, equipment, and processing capacity should be available to support the pit manufacturing mission of 80 ppy.

A.4.1.5.3 Liquid Low-Level Radioactive Waste

Facility Description:

The INL's Liquid Low-Level Radioactive Waste Facility located within the MFC area is a 5,400-ft^2 structure capable of processing 3,000 gallons per month. The facility was constructed in 1983 and is estimated to have approximately 50 years of operating life remaining. The facility also has capability to accept tanker trucks should that be required for emergency storage.

Review Process:

The review process consisted of INL completing a questionnaire provided by the IST for items considered important to the success of a pit manufacturing operation. For the Liquid LLW treatment plant this form is identified as MPA-AoA-INL-01. INL used the MPF study to determine that the estimated waste generation rate to support an 80 ppy capability. When added to the other site requirements the capacity is exceeded requiring modification to the facility to increase output.

Discussion:

INL identified that when the facility was initially designed and built it was intended that its capacity could be doubled with relative ease. Floor space and tankage were doubled to permit expected increases in demand. Modifications are minor thru the installation of additional filter banks, shielded hot air drum evaporators, and a modified control system.

INL anticipated that the demand for liquid low waste would be increasing and provided a facility that can be easily modified to accommodate a pit manufacturing operation.

A.4.1.5.4 Liquid Transuranic Waste

Facility Description:

The INL site does not currently have a dedicated Facility to process liquid TRU waste since the site no longer generates that waste form. In the past when INL generated liquid TRU waste it was treated and stabilized in several permitted locations within the site.

Review Process

The review process consisted of INL completing a questionnaire provided by the IST for items considered important to the success of a pit manufacturing operation. For the Liquid TRU Radioactive Waste Facility this form is identified as MPA-AoA-INL-02.

Discussion:

INL's waste management organization reviewed the 2005 MPF waste study to determine the generation rate for the aqueous option adjusted for 80 ppy. INL concluded that liquid TRU waste would be generated and will require processing and solidification.

INL stated that based on the MPF study the estimated volume generated could be accommodated within existing permitted facilities. While INL projected no additional facilities, they did state that additional equipment would be needed to perform the solidification process.

Preliminary Risk Considerations:

1. WIPP experiences an event that causes it to be shut down for a sufficiently long time that TRU waste storage at INL becomes full. Pit production shuts down for a period of months to years. At the time of writing, WIPP has been closed for 3 years and has only recently reopened. Another such shutdown cannot be ruled out. This scenario could be mitigated by using and/or building extra TRU-waste storage capability at INL and so should be low.

2. WIPP experiences another event that causes it to be shut down. After it comes back on line, additional safety and regulatory constraints mean that it accepts and processes shipments at a much slower rate than before the event. This processing rate may be insufficient to accept TRU waste generated by 80 ppy, especially if increased by enhanced TRU waste production by the dilute and dispose activity, so that after some years TRU waste storage at INL becomes full and pit production ceases. This scenario is also realistic because, now that WIPP has come back on line after its current shutdown it is accepting and processing shipments for final disposal at a lower rate than before. Similar or perhaps even more onerous restrictions are likely in the event of a future shutdown. This risk is medium to high.

3. WIPP becomes full and is no longer able to accept solid TRU waste. Solid TRU capacity at INL also becomes full and pit production shuts down. Additional TRU waste disposal capacity at WIPP or elsewhere may be required to support the 80 ppy capacity and, if implemented, the extra TRU waste generated if 34 metric tons of moxable plutonium is treated via dilute and dispose. The IST's initial assessment of this risk was high, but, as is discussed in Appendix E, on further consideration it was assessed to be low. This is in part because it is assumed that, in the event of WIPP becoming full, further storage capacity will be developed there.

A.4.1.6 Miscellaneous

This section contains information on several activities that are needed to support pit production, but would not be expensive to implement (relative to the total cost of a pit production facility). If they are not already be available at INL they could readily be outsourced.

A.4.1.6.1 Classified Beryllium (Be) Machining

INL currently has no classified Be machining capability. This information was previously conveyed to the IST in January 2017. It is expected that, if needed, classified Be parts can be obtained through procurement from qualified suppliers or from LANL.

Preliminary Risk Considerations:

No risks were identified other than those that are very low.

A.4.1.6.2 Classified Stainless Steel Machining

Objective:

The objective of the review of INL's classified stainless steel capability is to determine if sufficient capacity exists to accommodate the machining of stainless steel component parts required to support the production of 80 ppy by the year 2030.

Facility Description:

Stainless steel machining is carried out in several locations throughout the INL site. It appears that there are several small machine shops distributed throughout the site supporting various projects with test articles, fixtures, and maintenance items. There does not appear to be a centralized secure location to provide the machining needs for the pit manufacturing project.

Review Process:

INL responded that collectively they have about 50 machinists and operators in the total site population.

Discussion:

Based on INL's response there are several small machine shops scattered throughout the site. While there appear to be no central shop a facility for stainless-steel machining, capability can easily be established if needed. The facility requirements would include a secured conventional manufacturing building with overhead crane, process air, CNC mills and lathes and jig bore, CNC tube bender, and a coordinate measuring machine.

Preliminary Risk Considerations:

No risks were identified other than those that are very low.

A.4.1.6.3 Classified Graphite Machining

Review Process:

INL currently has no classified graphite machining capability. This information was previously conveyed to the IST in January 2017. It is expected that, if needed, classified graphite parts can be obtained through procurement from qualified suppliers or from another DOE site.

Discussion:

Development of a graphite machining center to support pit manufacturing would require a conventional manufacturing building within a secured area. The building would require a robust ventilation and graphite dust collection system equipped with conventional CNC lathes and CNC mills as well as inspection equipment such as a coordinate measuring machine to measure multi-axis shapes.

Other alternatives to consider include procuring from a qualified supplier with a secure facility or have the Kansas City Plant provide the non-nuclear items.

Preliminary Risk Considerations:

No risks were identified other than those that are very low.

A.4.1.6.4 Classified Uranium Machining

Objective:

The objective of the review of classified uranium machining is to determine INL's capability to process and machine uranium to support a pit manufacturing operation.

Review Process:

The review process consisted of INL completing a questionnaire provided by the IST for items considered important to the success of a pit manufacturing operation. For the classified uranium machining section, this form is identified as MPA-AoA-INL-06.

Discussion

INL has extensive experience with machining uranium and uranium alloys. INL is currently performing work on a production basis at their Test Area North Special Manufacturing Capability facilities. INL's experience also includes machining enriched uranium but it is currently limited in quantity.

If uranium products are required to support the pit mission and are produced at INL, then proper facilities will be required to process the required quantities. Currently the assumption for the prospective pit mission is that uranium products will be supported by Y-12.

Preliminary Risk Considerations:

No risks were identified other than those that are very low.

A.4.1.6.5 Graphite Coating

Overview:

INL currently has no graphite coating capability. This information was conveyed to the IST in January 2017 by Misty Benjamin, INL.

Discussion:

Development of a graphite coating center to support 80 ppy would require a secure conventional manufacturing building and a conventional paint spray booth. Conventional paint spraying equipment is also required along with coating preparation and mixing areas and chemical storage.

Preliminary Risk Considerations:

No risks were identified other than those that are very low.

A.4.2 Plant Core Infrastructure

This section addresses those items of plant core infrastructure that are needed by the 80 ppy manufacturing process.

A.4.2.1 Security Category 1 Facility Support

Objective:

The objective of the review is to determine if the INL has in place a Security Category 1 process to support the requirements of a pit manufacturing facility. INL has been operational since 1949 and has performed several vital roles in support of nuclear reactor research, nuclear weapons production and the Naval reactor research programs. Security has been a significant and important element of the successful performance of their mission since INL is required to protect all types of nuclear materials, including SNM, government property, weapon products, and personnel.

Review Process:

The review process consisted of INL completing a questionnaire provided by the IST. For the Security Category 1 facility support section this form is identified as MPA-AoA-INL-15. Additionally, the analysis was assisted by briefing materials presented to the AoA orientation team by security management during the week of April 25, 2017.

Discussion:

INL is required to follow and be compliant with DOE Order 473.3, Protection Program Operations. This Order establishes requirements for the management and operation of the protection program forces and contractor protective forces, and for physical security under the cognizance of DOE.

INL has implemented policies and procedures governing the security for all requirements as specified within DOE Order 473.3. These requirements include protective forces, physical protection of facilities, buildings, Government property, and employees, as well as national security interests such as classified information, SNM and other elements of the nuclear weapon programs.

To ensure the requirements are in place and being properly executed several levels at DOE routinely perform independent assessments. These include the INL Field Office and other jurisdictions, such as the Office of Inspector General. Based on the determination that satisfactory safeguards and security policy and facility measures are in place, DOE permits the site to operate accordingly. Contractors perform periodic self-assessments to verify compliance, in addition to DOE.

No issues were identified within the security system that would prohibit the assignment of the pit manufacturing mission to INL.

A.4.2.2 Electrical Power

Objective:

The objective of the INL normal/off-normal electrical power review is to determine if sufficient power is currently available or planned to support a pit manufacturing facility capable of producing 80 ppy by the year 2030.

Review Process:

The review process consisted of INL completing a questionnaire provided by the IST for items considered important to the success of a pit manufacturing operation. For the normal/off normal electrical power section this form is identified as MPA-AoA-INL-16. In addition, the INL Site Wide Utilities organization prepared a briefing describing the overall electrical capabilities, including power generation sources and distribution system.

Discussion:

The INL Site Services organization responded to the IST questionnaire by providing data on electrical power capacity and describing upgrades currently taking place and planned for the site. The site currently has three commercial feeds providing a capacity of 63 megawatts distributed to nine major substations. Currently several upgrades to major elements of the system are underway to provide an additional 50-megawatt capacity and to extend the systems life expectancy for an additional 40-50 years.

It should be noted that currently the power or other utility requirements needed for the pit manufacturing facility have not been fully determined. INL's utilities management is confident that with the upgrades currently planned there would not be any power supply issues.

While there is sufficient power at the site to support a pit manufacturing facility, to ensure redundancy and to provide a comfortable safety margin, power redistribution from lower demand areas to any proposed pit manufacturing area should be considered.

A.4.2.3 Other Utilities

The IST did not review the other utilities at INL.

A.4.2.4 Medical Facility

INL does not have a centralized medical facility on site but does have distributed emergency first aid capabilities in major locations, such as MFC and Central. Emergency Medical Technicians are assigned throughout the site and are capable of providing medical assistance and patient stabilization along with emergency vehicles to provide transport. INL primarily relies on the local community hospital in Idaho Falls. These groups providing medical assistance are trained and qualified to address alpha contamination.

A.4.2.5 Environmental Monitoring

INL is committed to environmental protection, environmental compliance, pollution prevention, and continual improvement. To implement this policy INL has developed a comprehensive environmental management program to ensure the protection of air, water, land, biota, and other natural, archaeological, and cultural resources

INL's environmental policy is implemented throughout the site by DOE's primary contractors (Fluor and the Battelle Energy Alliance). These contractors are provided the resources and are responsible to monitor, prevent, and report environmental conditions throughout the site. In addition to the normal DOE oversight the State of Idaho provides independent monitoring of the Laboratory through their Department of Environmental Quality.

A.4.2.6 Sanitary Waste Facility

The IST did not review the sanitary waste facilities at INL.

A.4.3 Operating Infrastructure

This section addresses the various items of operating infrastructure that are needed to operate the proposed 80 ppy manufacturing facility through the year 2030.

A.4.3.1 Production Control System

Production control processes are currently being applied to weapon products manufactured at INL. The system has produced over 8,000 units but is likely to need modification to accommodate the differences in the products between the current mission and the fabrication operations and assembly processes of parts required to produce a plutonium pit. If INL is selected as the pit manufacturing site there will be sufficient time to make the necessary changes as required.

A.4.3.2 Manufacturing policy document

Manufacturing policy documents are required by the NQA-1, 2000, standard adopted by INL and include conduct of operations, quality assurance processes, specific procedures to conduct manufacturing operations (i.e., material requirements planning, procurement, and material control). These documented processes provide the basis for conducting business and producing quality products in a nuclear environment.

A.4.3.3 Material Control System

Material control systems are essential and required to ensure manufactured items meet design requirements. Control of the procurement process and procured items and services are intended to prevent unqualified suppliers and nonconforming parts and materials from entering the manufacturing process. INL has implemented ASME NQA-1-2000 as their product quality standard. The necessity for strict control of items is clearly specified in Requirements 7 and 8 of the quality standard. INL has stated that their quality record is demonstrated by a high level of customer satisfaction. INL would have to adapt their current quality system to accommodate NAP-24.

A.4.3.4 Safeguards and Accountability

INL has responsibility for processing, storing, and maintaining nuclear materials and SNM. To manage and administer the SNM program the site has developed process and procedures consistent with DOE Order 473.3, *Protection Program Operations*. INL's Safeguards & Security Nuclear Materials Control and Accountability system contains processes to administer and control a compliant SNM management program.

These SNM processes are routinely assessed by the site contractor and are routinely audited and assessed by the DOE Field Office, Headquarters, and the Office of Inspector General.

A.4.3.5 Qualified Operators and Technicians

Requirements for operational training and qualification of personnel for manufacturing product are addressed in NQA-1-2000, Requirement 2, Indoctrination and Training. Nuclear safety training for site workers is specified within the INL Standardized Nuclear Safety Basis Manual, TOC-682, Section SAR-400-12, Chapter 12. The objective of INL's training program is to provide and ensure initial proficiency, maintain proficiency and adapt to changes in technology, methods, or job responsibility. As previously mentioned, INL's management believes that a qualified workforce can readily be obtained from the local area to support a proposed pit production effort.

A.4.3.6 Weapons Quality Program

The INL is responsible for manufacturing and supporting the military with quality products and has done so for over 20 years. The quality standard adopted by INL is ASME NQA-1-2000, which is comprehensive and comparable to DOE Weapon Quality Policy, NAP-24A, published in 2015. This American Society of Mechanical Engineers standard is thorough and INL will have no difficulty adapting its systems and processes to a nuclear weapon mission.

Appendix B. Infrastructure Siting Analysis

B.1 Introduction

A number of potential sites at which the 80 pits per year (ppy) manufacturing capability, or portions thereof, might be placed were analyzed. The sites were analyzed to determine available infrastructure, siting risk, and political risk, with a view to choosing the most promising candidates for further study.

The Analysis of Alternatives (AoA) team began by considering a list of 13 Department of Energy (DOE) sites at which it might be possible to place some or all of the facilities that are needed to meet the requirement to manufacture 80 War Reserve pits per year, while also preserving all other necessary activities that are essential for the plutonium sustainment mission. Based on the evaluation as described in this chapter, the team settled on an initial short list of the three most promising candidates: Los Alamos National Laboratory (LANL), the Savannah River Site (SRS), and Idaho National Laboratory (INL). In addition, the team identified two other backup sites that potentially could be considered for the plutonium pit mission: Pantex Plant (Pantex) and the Nevada National Security Site (NNSS). In order to separate the most promising sites from the initial list, the team gathered data from site representatives to determine which of relevant capabilities each site had. The categories listed below are discussed in more detail in Section B.2.1.

- **Capital items and functions:** such as waste treatment and disposal, Perimeter Intrusion, Detection, Assessment, and Delay System (PIDADS)/access control, and analytical chemistry
- **Operating infrastructure:** such as the availability of manufacturing and quality assurance processes, qualified operators and technicians, and a safeguards and accountability system
- **Plant core infrastructure:** such as the availability of Security Category 1 facility support, and power supplies

In addition, the AoA team evaluated siting risks, such as proximity to nearby populations and predominant wind directions, and conducted a preliminary and subjective assessment of political risk. This included the presence of political tensions between DOE/National Nuclear Security Administration objectives and elected officials, in addition to local opposition groups and ongoing litigation.

The remainder of this chapter describes how data were collected and qualitative analyses were performed to finalize a short list of sites to be analyzed in detail for the pit production mission.

B.2 Support Infrastructure Capability Analysis

The AoA team evaluated a comprehensive list of DOE sites, even though some of them could probably have been eliminated by cursory review (e.g., Brookhaven National Laboratory [BNL] and the Kansas City National Security Campus [KCNSC]). This might seem excessive, but it was done to ensure a comprehensive defensible, thorough, and systematic approach to the siting analysis. The sites selected for evaluation were:

- LANL
- SRS
- Pantex
- NNSS
- Lawrence Livermore National Laboratory (LLNL)

- Y-12 National Security Site (Y-12)
- Oak Ridge National Laboratory (ORNL)
- Waste Isolation Pilot Plant (WIPP)
- Hanford Site
- INL
- BNL
- KCNSC
- Sandia National Laboratories (SNL) – Albuquerque

A greenfield site (an undeveloped or agricultural track of land) was included for completeness, but was not defined as a specific location. By definition, a greenfield site would not have any of the supporting infrastructure present to support a new pit production capability, so its infrastructure was not investigated. Likewise, with no specific location defined many risk elements (*e.g.,* nearby populations) could not be evaluated, so risk was not assessed for the greenfield site.

B.2.1 Assembly of Site Infrastructure Data

This sub-section describes the data that were collected by the Infrastructure Sub-Team (IST) to determine support infrastructure needs, namely (1) capital items and functions, (2) operating infrastructure, and (3) plant core infrastructure. This collection effort began when the AoA team visited LANL in September 2016. For a week the team held discussions with the management and operators of the significant infrastructure items and functions, with follow-up teleconferences and visits as required. Appendix A.2 includes a report of that visit.

In April 2017 the IST met again at SRS, after which the team prepared a report on SRS infrastructure (see Appendix A.3). In May, the AoA team visited INL. The report on INL infrastructure is in Appendix A.4. In addition, the sub-team sent out a questionnaire asking each site to self-report on which items of infrastructure are located there and which are not. **Table B–1** lists site representatives and sources of data for each site. These questionnaires provided the basis for the final short list of sites – LANL, SRS, and INL – as well as NNSS and Pantex.

Table B–1. Site representatives and references

Site	Site Representative	References
LANL	Bob Putnam	Appendix A-2
SRS	Jennifer Rice	Picha (2017a) and Appendix A-3
Pantex	Larry Backus	Andrews (2016a)
NNSS	Joel Leeman	Leeman (2017)
LLNL	Mark Bronson	Bronson (2017)
Y12/ORNL	Tom Insalaco	Picha (2017b) and Andrews (2016b)
WIPP[a]	Kenneth Picha/IST	Picha (2017c)
Hanford/PNNL	Kenneth Picha	Picha (2017d)
INL	Misty Benjamin	Benjamin (2017) and Appendix A-4
BNL[b]	Todd Lapointe/IST	Verbal
KCNSC	Greg Enserro	Picha (2017e)
SNL-Albuquerque	Phil Chamberlain	Andrews (2017)
Greenfield	None	None

[a] DOE Office of Environmental Management (Picha 2017e) submitted that WIPP has no capabilities in this area. However, the IST has independent knowledge that there are some relevant infrastructure capabilities.

[b] The IST did not receive a written response from BNL.

B.2.1.1 Capital Items and Functions

Capital items and functions refer to the necessary infrastructure that, if missing or inadequate to support the manufacture of 80 ppy, would require potentially significant capital expenditures. They include the following:

- Low-level liquid radioactive waste treatment
- Transuranic (TRU) liquid waste treatment
- Low-level solid waste packaging, storage, and shipping
- TRU solid waste packaging, storage, and shipping
- PIDADS/Access control
- Classified machining (beryllium, uranium, stainless steel, graphite)
- Graphite coating
- Analytical chemistry
- Materials characterization
- Standards and calibration
- Cold machine and tooling shop

Table B–2 provides the results of the data collection effort in this area.