Pit Production Workshop

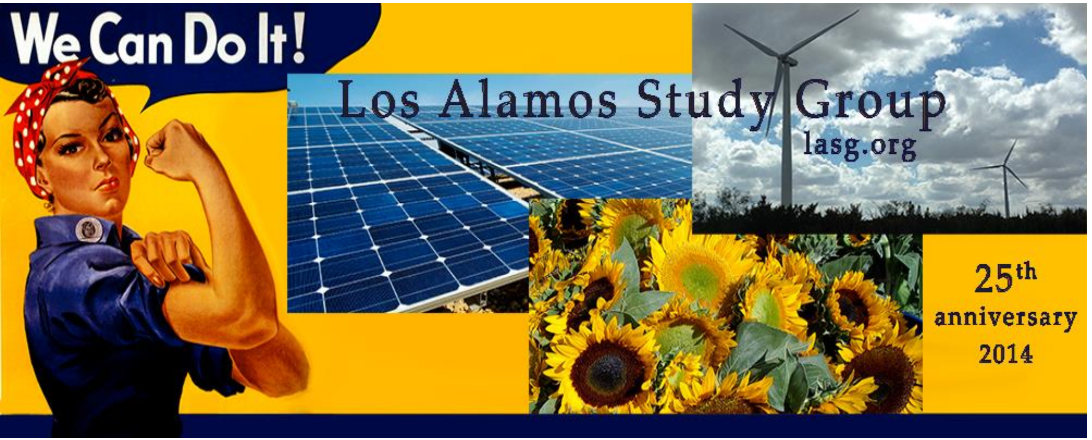
Why, how many, when, how, where, with what risks?

Greg Mello, Los Alamos Study Group, July 12, 2018

Theme A: pit production purposes, evolving requirements, and related observations

Theme B: Understanding the NNSA 2017 Analysis of Alternatives (AoA) and 2018 Engineering Analysis (EA)

Theme C: Program risks and extra costs hiding in plain sight



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Why this workshop?

Pit production choices entail **tens of billions of dollars** and involve the partial repurposing of one or more National Nuclear Security Administration (NNSA) sites.

Management risks are very high. At least half a dozen prior pit production capitalization plans and projects have "failed" over the past three decades due to unexamined assumptions, excessive optimism in various forms, exaggerated mission need, poor safety performance, and other factors.

Despite these "failures," **confidence in the large, diverse US nuclear stockpile – in its longevity in particular – is apparently higher than ever.**

Legal challenges from South Carolina, administrative challenges in New Mexico relating to the proposed dilute and dispose (D&D) program for surplus plutonium, and new requirements in pending legislation, have halted the South Carolina component of the Administration's pit strategy for an unknown period of time.

At the same time there is no consensus that LANL can successfully acquire and carry out an enduring industrial pit mission on any scale.

Theme A: Pit production purposes and evolving requirements

- **Why produce new pits?**

- **What production capacities are needed for which purposes, and by when?**

In public discussions, there are several purposes of pit production, which resolve into two broad categories of mission need:

- basic capability and pilot or "batch" production, and
- significant, reliable ("industrial") capacity.

These differ markedly in cost, management risk, political support, lead time, institutional implications, and immediate apparent necessity. A strong case can be made -- and has been by NNSA in its 2017 Analysis of Alternatives (AoA) -- that basic capabilities should not be placed at risk by industrial program requirements.

		Warhead (W) or Bomb (B) Type		Norris and Kristensen (N&K) Estimated 2007 stockpile [1], less all W62s [8] and W84s [9]: Estimated Active Deployed in 2007	Spares, Active Non-deployed, & Inactive (w/o boost gas) [7]	Estimated Total in 2007, less W62 and W84s
Gravity bombs and cruise missiles	"Non-strategic" bombs	B61-3	"Non-strategic"	200	186	386
		B61-4		200	204	404
		B61-10		0	206	206
	Cruise missile Ws	W80-0		100	189	289
		W80-1	"Strategic"	1,452	354	1,806
	"Strategic" gravity bombs	B61-7		215	224	439
		B61-11		20	21	41
		B83-0		0	298	298
		B83-1		323	3	326
Re-entry systems	ICBM warheads	W78		550	244	794
		W87		50	502	552
	SLBM warheads	W76		1,344	1,686	3,030
		W76-1		0	0	0
		W88		384	20	404
		Totals		4,838	4,137	8,975
		"Strategic"		4,338	3,352	7,690
		"Non-strategic"		500	785	1,285
		W62		325	255	580
		W84		0	383	383
		Total Stockpile		5,163	4,775	9,938

How many pits are there? We think:

- ~4,018 in the stockpile, mostly in the reserve stockpile (various locations)
- ~2,600 in intact but recently retired warheads
- Thus, ~6,618 in warheads
- Note that if there were 9,938 warheads in 2012 including the older W62s, ~3,320 pits have been liberated (including W62s).
- We think there are 17,000 + or – 2,000 pits outside warheads at Pantex, of which 3,000 to 6,000 are usable in modern warheads and bombs. Those kept for this purpose are "National Security" or "National Security Asset" pits. Most of these were made in the 1980s.

What are the possible purposes of pit production?

a. To repair non-plutonium defects in existing pits (pit rebuild); Hazard Category 2 facilities are not needed for these (Security Category 1) operations;

b. To retain pit production skills and transmit them to new employees as needed;

c. To retain pit production technologies and foster their prudent development;

d. To produce stockpile quantities of new pits of existing types (i.e. hundreds per type, an industrial mission) in anticipation of eventual failure of the plutonium portions of existing pits, or in response to incipient failures of this type detected by surveillance;

e. To produce new types of pits in stockpile quantities (an industrial mission; prototyping of new pits is by definition R&D); the facilities and personnel for this mission are the same as for d;

f. To provide "confidence" to support arms control negotiations, or as an aspect of nuclear deterrence ("capability-based deterrence"); "confidence" is presumably an outcome of purposes a. through e. – indisputably of the first three and disputably of the last two.

These pit production purposes fall into two clear groups

Essential plutonium missions undergird and complement the first group

- These basic missions have unambiguous value within overall program objectives, low to moderate cost, low to moderate management risk, and engender little controversy:

  a. Pit surveillance

  b. Pit aging studies

  c. Targeted plutonium science

  d. Retain production skills via pilot or demonstration production; transmit skills

  e. Retain production technologies and develop them as needed

  f. Inspect, reuse, and if needed repair (rebuild) pits

- These industrial missions have contested value, very high cost and risk, a track record of failure, and are controversial in themselves and in their implementation:

  g. produce stockpile quantities of existing types of pits

  h. produce stockpile quantities of new types of pits

Observations (1 of 3)

- Short gaps in basic plutonium operations (a. through f.) may be tolerated but longer gaps (more than 1 year) may be self-perpetuating and could have longer-term impacts (e.g. via loss of key personnel).
- In stark contrast, new pits need not be supplied until 3 or even 4 decades from now with no effect on the stockpile until >2060. Pits not retired need replacement, but not soon!
- NNSA's pit disassembly and conversion (PDC) pilot program (ARIES) is currently housed in LANL's PF-4. It is slated for a 10x increase in production rate (to 1,117 kg/yr) in 2022/3.
- **Prudent management dictates that preparation for industrial missions (pit production and PDC) must not jeopardize or interfere with basic stockpile missions a. through f., the true foundation of stockpile confidence for primaries. The AoA is careful about this. The EA is not.**
- Continuity in basic missions requires an enduring, capable, well-maintained and -operated plutonium facility, with appropriate safety systems. At LANL this is, at best, a "work in progress" – at worst, a process of gradual collapse and "run-to-failure."

Observations (2 of 3)

- NNSA's basic pit plutonium missions are largely housed in PF-4, which was completed in 1978 to then-current codes. The adequacy of PF-4's safety systems is contested. PF-4's ability to withstand a design-basis earthquake is ambiguous. Neither ventilation nor fire protection are safety-class.
- Despite continual investment, NNSA has stated PF-4 will "age out" by 2039. NNSA opinions differ on the date (or decade) but agree that replacement will be required during the productive lifetime of planned pit production facilities. *Ceteris paribus*, outages are likely to increase over time and with increases in overall mission burden, if undertaken.
- Replacement of PF-4 would be a deeply-fraught prospect at best; at worst – impossible.
- PF-4 replacement will require most or all of the remaining real estate within TA-55 for building footprint, access, and laydown. No planning for this is visible. Current proposals for expansion of pit capacity use up the real estate in which this could be done.
- Removal and replacement of PF-4 gloveboxes is a slow, disruptive, dangerous, and expensive process. Too much internal re-tooling is likely to halt much or all work at PF-4.

Observations (3 of 3)

- Construction of the LANL industrial pit production options under consideration in the EA will make it difficult (options 2a, 2b) if not impossible (2c) to maintain continuity of operations in PF-4, and would prevent PF-4's replacement at TA-55.
- We sometimes hear the argument that off-loading some MAR-intensive missions would allow PF-4 a longer life. Decreasing MAR would lower the expected off-site dose in a design-basis accident but would not necessarily make the facility safer for workers under either normal or accident conditions, or more reliable. E.g., off-loading MAR will not create a supply chain for obsolete fixed equipment, or halt any chronic degradation processes in structural or mechanical systems.
- Thus at LANL, there is a high risk of mission interference of **two** kinds: attempted expansion of the pit mission makes big gaps in basic plutonium missions, or else cuts short their future (with the proposed surplus plutonium disposition mission a *second* body-blow to the integrity and operation of PF-4) – and, on a broader level,
- We also believe the contracts, overall culture, and environment of LANL will make it impossible to reliably conduct industrial missions ***at all***, as we will discuss.

Existing pit production requirements – what are they?

- (Placeholder for pit inspection and reuse: so far, as needed at Pantex)*
- Pit rebuild: 90 ppy capacity at LANL by 2024 (FY16 SSMP, p. 2-34) (whose mandate?)
- New-pit manufacturing: legislative requirements (50 U.S. Code § 2538a)
  - During 2021, begin production of qualification pits;
  - During 2024, produce not less than 10 war reserve (WR) pits;
  - During 2025, produce not less than 20 WR pits;
  - During 2026, produce not less than 30 WR pits; and
  - During a pilot period of not less than 90 days during 2027-2029, demonstrates the capability to produce WR pits at a rate sufficient to produce 80 pits per year.
- New-pit manufacturing: executive branch requirements; ≥80 WR pits, 9 out of 10 years
  - Unclear as to origin of recent apparent changes, and if this interpretation is legally required; current interpretation is explained well in AoA, pp. 5-13.

* See CoLOSSIS, cf https://www.sciencedaily.com/releases/2010/01/100126084740.htm.

Where did the "50-80" ppy requirement come from?

MR. HARVEY: We established that requirement back in 2008 for a capability to produce in the range of 50 to 80 per year. That evolved from a decision to basically not take the path that we originally were taking with the Modern Pit Facility, but to go and be able to exploit the existing infrastructure at Los Alamos to meet our pit operational requirements. The capability at Los Alamos was assessed to be somewhere in the range of 50 to 80 per year that they could get with the modernization program they anticipated. The Nuclear Weapons Council looked at that number. It's a capacity-based number, and said it's probably good enough. We'll have to accept some risk, but it's probably good enough.

MR. BROOKS: So you can't tie it to a specific – you can't tie it to a specific deployment schedule or something. It's a judgment that is a combined judgment on yeah, you can probably do this, and yeah in the most reasonable world this will be enough.

(from Jon Medalia, "U.S. Nuclear Weapon "Pit" Production Options for Congress," February 21, 2014, R43406.

Why 50-80 ppy? (continued)

"In 2008, the [NWC] agreed on a strategy to balance cost, risk,, and stockpile needs and established the requirement for 50-80 pits per year. A factor considered in this decision included the anticipated capacity using existing infrastructure at [LANL PF-4] and [RLUOB] (pending completed construction). Additionally, constructing a new "big box" facility to replace the 60-year-old [CMR] facility was required to support this decision.

…

"…the production capability located in PF-4 at LANL…will require reconfiguration for higher pit production rates and major recapitalization in 10-20 years. These facilities are very costly to maintain and/or replace…[and require] long timelines (20+ years) for moving from initial design to completion of these facilities. These costs informed the 2008 selection of 50-80 pits per year.

…

"Given the delays to date on replacing the CMR facility capability, further evaluations of the plutonium processing facility are now considering the age of the PF-4 facility."

Assessment of Nuclear Weapon Pit Production Requirements, SecDef Hagel to HASC 1/16/14

High confidence: NNSA modeling of new-pit production requirement, complex W87-like WR pits (most demanding), single shift (AoA, p. 13)

Table 2–4. Model results

	30 Pits Per Year	50 Pits Per Year	80 Pits Per Year
Confidence level %	96%	97%	93%
Lowest throughput, units	8	20	30
Average throughput, units	41	84	103
Highest throughput, units	75	143	158
Sample Size, years	7,500	7,500	7,500

“30” + “50” → average 125 ppy; simpler pits → higher ppy; double shift → ~ 2x single

How and why have pit production requirements changed?

Current proposed legislation to clarify:

1. FY2019 NDAA (H.R. 5515), **House** Report 115-676, p. 239.

"…the committee directs the Secretary of Defense, in coordination with the Secretary of Energy and the Commander of U.S. Strategic Command, to submit a report to the Committees on Armed Services of the Senate and the House of Representatives by November 30, 2018, on the annual pit production requirement, including any associated timelines. Such report should include a detailed rationale and justification for any changes to the requirement, the drivers behind the requirement, and associated costs. Such report should also include a detailed assessment of the potential to reuse plutonium pits that are currently in the inventory of the United States."

How and why have pit production requirements changed? (continued)

Current proposed legislation to clarify:

2. FY2019 EWD Appropriations, **Senate** Report 115-258, p. 104.

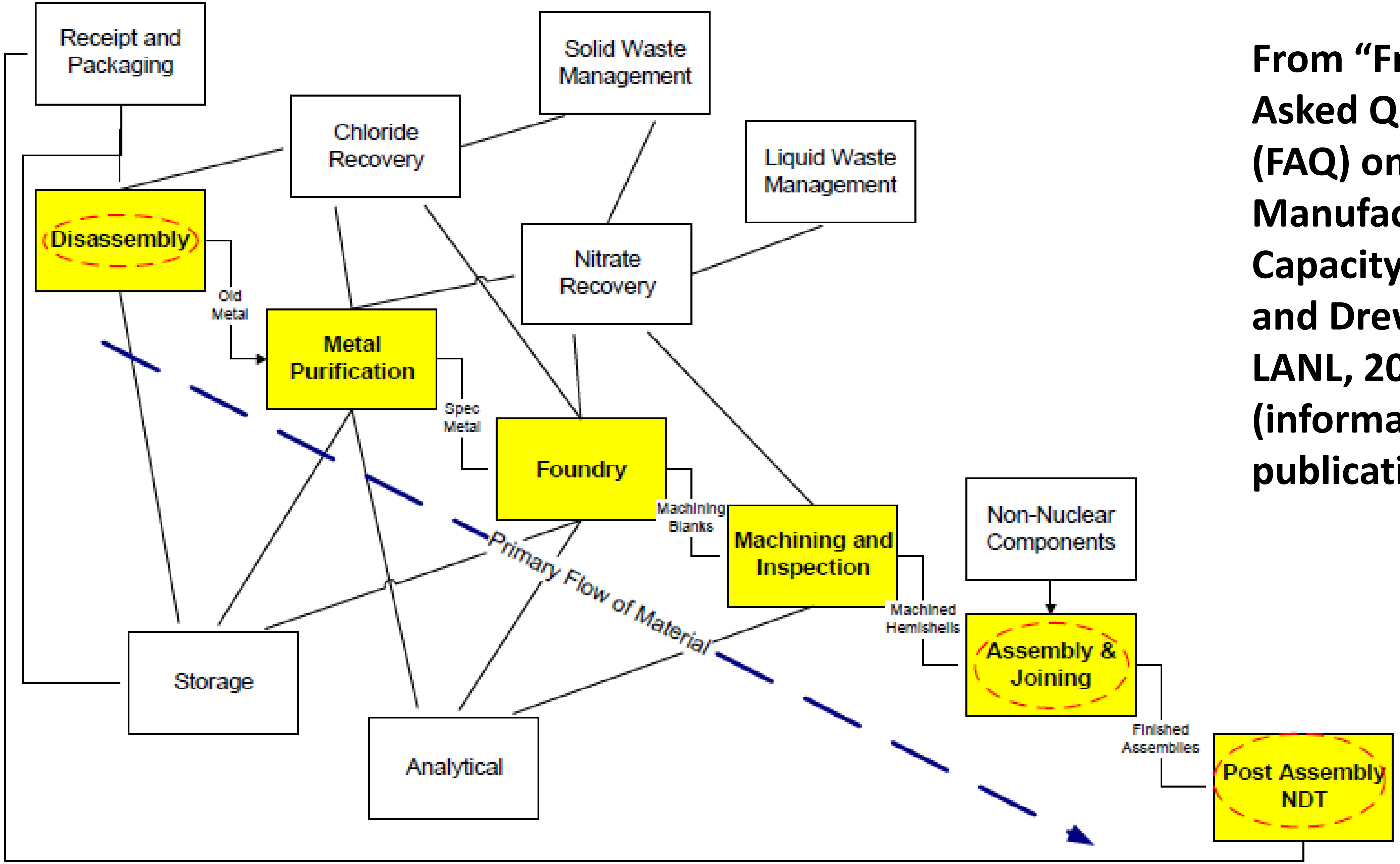
"The Committee directs the Administrator to enter into a contract with the group known as JASON for a study to assess the efforts of the NNSA to understand plutonium aging and the lifetime of plutonium pits in nuclear weapons. The Administrator shall make available all information that is necessary to successfully complete a meaningful study on a timely basis. Not later than 18 months after the date of enactment of this act, the Administrator shall submit to Congress a report on the findings of the study. The report shall include recommendations of the study for improving the knowledge, understanding, and application of the fundamental and applied sciences related to the study of plutonium aging and pit lifetimes, an estimate of minimum and likely lifetimes for pits in current warheads, and the feasibility of reusing pits in modified nuclear weapons. The report shall be submitted in unclassified form but may include a classified annex."

Pit production requirements (continued)

Current proposed legislation to clarify:

3. FY2019 EWD Appropriations, **House** Report 115-697, p. 109.

“The Committee is concerned that the NNSA is proceeding with a premature decision to replace the W78 with an interoperable warhead based on a stockpile strategy that was not endorsed in the Administration's Nuclear Posture Review and that was not funded by the Congress when first proposed under the previous Administration…the NNSA never demonstrated [pit] production at full capacity and lost the limited capacity it had built due to safety missteps that shut down plutonium operations in the PF-4 facility for several years.…any nuclear modernization program that relies on the successful establishment of a near-term pit production capacity should be considered by the Administration to be a high-risk endeavor…In lieu of the request to begin phase 6.2 activities for an [IW] to replace the W78, the recommendation provides funding to begin a phase 6.1 study to fully analyze all available alternatives for the W78…[including costs of pit production].



From "Frequently Asked Questions (FAQ) on Pit Manufacturing Capacity, Brett Kniss and Drew Kornreich, LANL, 2009 (informal publication)

Figure 1: The generic pit manufacturing flowsheet starting with raw materials (aged

The Pit Production Matrix

	Pit R&D, prototyping	Pit rebuild: pilot production	Pit rebuild: industrial production	Pilot production of new pits	Industrial production of new pits of existing (or new) types
In the 2020s	LANL	LANL	LANL; possibly nowhere	LANL, unless disturbed by expansion attempts or shutdowns	Not possible anywhere
2030 & after	LANL	LANL, possibly plus SRS, other?	SRS, conceivably LANL, or other?	?	SRS, other? *Virtually impossible at LANL. Unlikely by 2030.*

Other sources of pits for LEPs:

- **Pit inspection and reuse during LEPs (routine)**
- **Pits from inventory, within type**
- **Pit reuse across type, with nuclear explosive testing pedigree (MAST, PRESS) or not**

LEP requirements can also be a) downsized or b) eliminated

END OF THEME A

Theme B: Understanding the NNSA 2017 Analysis of Alternatives (AoA) and 2018 Engineering Analysis (EA) on pit production: what these studies found, how they differ, and possible alternatives.

Guidance, assumptions, and conclusions of these two analyses differ radically. All the alternatives examined in the EA are based on a split production model that was rejected in the AoA because of its redundancy and high cost. Three of the four EA alternatives use a split manufacturing flowsheet, which likewise was rejected in the AoA for reasons of feasibility, longevity, and risk. One alternative in the EA is included even though it does not meet many of the EA's own feasibility and safety criteria.

What other alternatives might merit analysis?

"Lessons learned" are conspicuously absent on this topic in official discourse, markedly so in the EA.

The 2017 Pit Production Analysis of Alternatives (AoA): key results & comments

- (No need to repeat congressional briefing or nameplate findings)
- High-confidence (HC) 80 WR ppy was "validated prior to the start of the AoA," based on "pit aging" and military requirements. This is being questioned in the FY2019 NDAA.
  - There is a three-way tradeoff between stockpile size (and composition), the date steady pit production starts, and the steady production capacity needed. Present value analysis, and strong economies of scale, suggest there is case for a larger capacity, or operation at two shifts, later, IF a large (4,000 warhead) stockpile must be supported. But the stockpile might be smaller than that, again favoring later investment. Premature investment is costly.
- The AoA is careful to emphasize that a "HC" capacity of 80 WR ppy (= 103 ppy average, hardest pit) is not commensurable with the (30 ppy) plutonium sustainment (PS) "goal" or "average" at LANL. This is correct – and also not commensurable in stability, flexibility, or surge capacity.

Gamma Ray
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MFFF, Jan 2018
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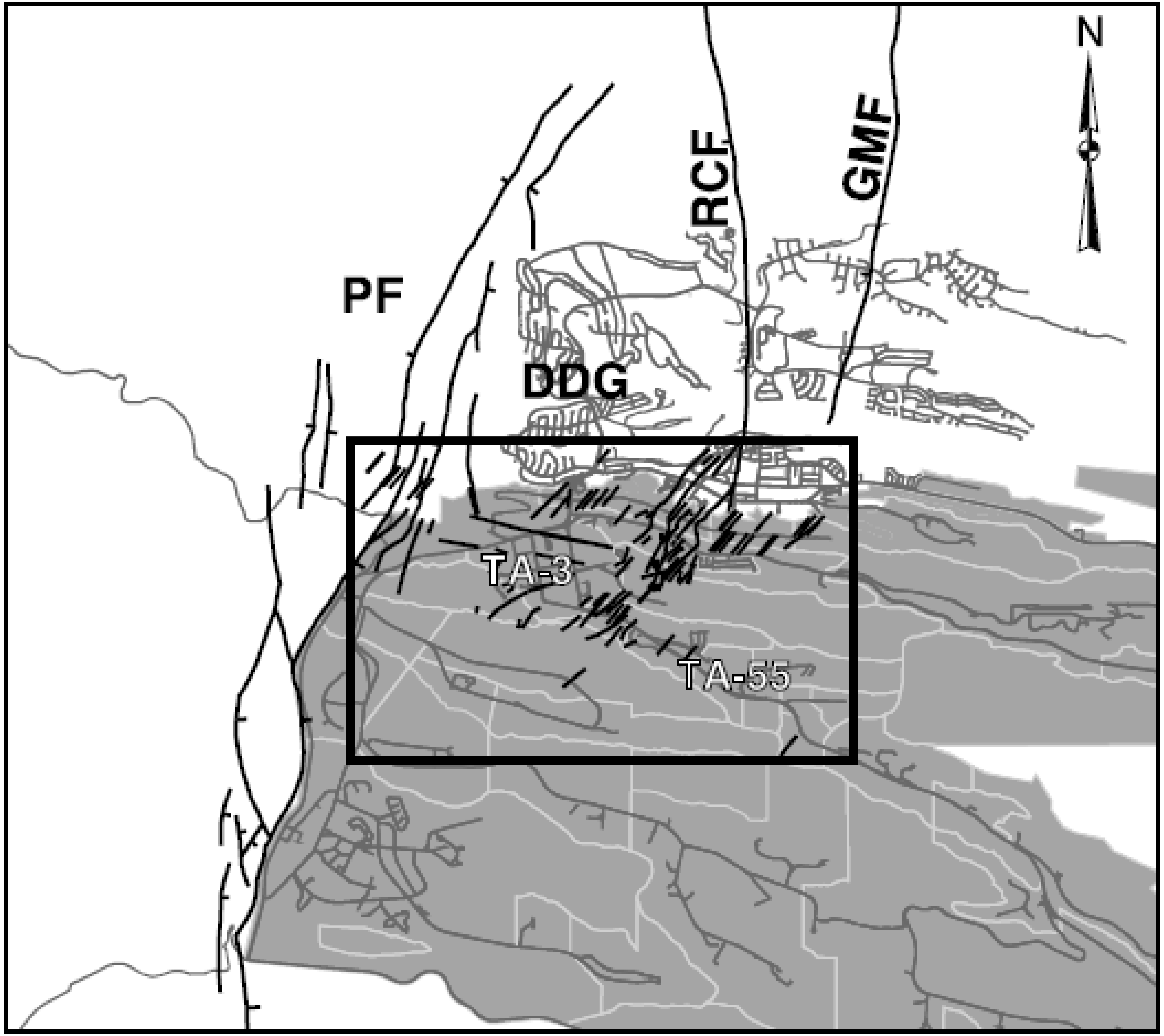
Table 1. LANL Pit Manufacturing through FY11.

Fiscal Year	Total Pits Built against a 29 unit requirement	Pits delivered to the WR Stockpile	Pits delivered to Destructive Testing	Pits delivered to Shelf Life Surveillance
2007	11*	3	1	6
2008	6	5	0	1
2009	4*	4*	0	0
2010	6*	5	0	0
2011	2	3*	1*	0
2012	1	1	0	0
Total	30*	21*	2*	7

* One pit built in FY07 was accepted in FY09, One pit built in FY09 was accepted in FY10, and two pits built in FY10 were accepted in FY11

(From LA-UR-12-25400, "Pit Manufacturing Fiscal Year 2012 Program Report to the University of California, Bradford G. Story)



Gardner et al
1999

AoA results and comments, continued

- The difference in equipment and space for HC 80 vs. 50 ppy is smaller than the margin of estimation error. The AoA says it makes little sense to have a pit production facility smaller than 80 ppy. The AoA rejects "split production" as grossly inefficient (next slide) yet split production is the basis of the follow-up Engineering Assessment (EA).
- Renovation of the PF-4 processing area to increase production capacity will make the 30 ppy PS goal unachievable, and interfere with basic plutonium missions as well. Yet EA alternatives 2b and 2c do this.
- The HC 80 ppy equipment would require seven 5,000 sq. ft. "modules," if "modules" are to be the basis of capacity expansion. These wouldn't fit in TA-55.*
- The AoA rejects all production based or dependent on PF-4, including "split flowsheet" production. Three EA alternatives (2a, 2b, and 2c) are dependent to varying degrees on PF-4. The AoA would have PF-4 "return to the [R&D] mission for which it was built. It will last longer that way. It may be essentially irreplaceable.

* During the workshop it was asserted these (and more) WOULD fit. Perhaps, in raw physical terms, but I still assert they would not be FUNCTIONAL in that configuration. On all such matters, LANL's self-assessment cannot be trusted.

Economies of scale in pit production (AoA)

30 ppy (HC)	50 ppy (HC)	80 ppy (HC)	80 vs. 50: 60% more pits
90 (83 for PS) pcs	111 pcs	133 pcs	Pieces of equipment (18% more for 80)
13,300 sq. ft.	18,000 sq. ft.	21,200 sq. ft.	Space for equipment (18% more)
26,600	36,000	42,400	(Double to include working space)
	73,700	87,600	Support functions, building services
	110,000	**130,000**	**Total HazCat 2 space (18% more)**
	46,800	**67,500**	**Additional Sec. Cat. 1 space**
	95,000	**122,700**	**Additional space outside PIDAS**

Split production is rejected (AoA) – but added back in EA

30/50 ppy (HC)	80 ppy (HC)	Difference	
90+111 = 201 pcs	133 pcs	68 pcs (51% more equipment, space, people to operate, supporting space and costs)	
Requires 7 pcs more equipment and 2,000 sq. ft. more reconfiguration in PF-4 than 30 ppy PS level production			
Adds (doubles?) surveillance costs due to two separate pit provenances			
PF-4 adds production risk and short longevity			

DPAG

Plutonium-Pit Production in the 21st Century

Salient features of DPAG study - prepared for LSPF workshop on

March 21, 2000

Linda Branstetter, SNL

- Study performed 2/98 - 11/98
  - sponsored by DOE/AL (Earl Whiteman)
  - concluded that a LSPF is needed
    - limited capacity at LANL not adequate over long-term
- Top-Level Requirements
  - DEVELOPED OUR OWN - DPAG's task was to look at a continuum of possible futures. Within that continuum, the study team chose a realistic "base case" for purposes of illustration:
    - baseline production nominally 150 WR-pits/yr, but up to 225 WR-pits/yr (single shift); total capacity (baseline + contingency) up to 450 WR-pits/yr (2 shifts)
      - total capacity selected based on realistic stockpile future, realistic contingency and augmentation requirements, practical operational constraints for pit fabrication facility, current stockpile age, and potential pit lifetimes
    - 40 hr. work week / 8 hrs. per shift / 5 shifts per week / 40 weeks per year
      - balance of year used for major maintenance, inventory, & vacation shutdown
    - sprint (3rd shift) production not considered realistic
      - unsustainable

Pit Fabrication Facility*

DPAG

- Base Case
  - big enough to allow elimination of inactive stockpile
  - 450 WR-pits/yr 2-shift capacity
    - single shift capacity falls at ~225 WR-pits/yr
  - ~81,000 sq. ft. hardened (Cat I) space
    - ~19,000 sq. ft. of this is actual manufacturing space
      - foundry
      - machining
      - welding & assembly
      - final assembly (including radiography)
  - ~62,000 sq. ft. soft space
- Single shift capacity of 150 WR-pits/yr
  - only ~10% smaller than base case overall
    - ~71,000 sq. ft. hardened (Cat I) space
      - ~16,000 sq. ft. for actual manufacturing
    - ~58,000 sq. ft. soft space

*No balance of plant activities included

50% greater capacity obtains from 10% greater facility size. This theme repeats in the AoA analysis. It is characteristic of this mission.

AoA results and comments, continued

- All alternatives have high schedule risk. The achievement of HC 80 WR ppy is unlikely before 2033 for any alternative, beginning in FY19. This is the same "14 years" estimated by DPAG in 2000. [Replacing PF-4, a large operating facility on a narrow mesa, would take significant longer than this, we believe – a germane consideration in this discussion.]
- Note inclusion of pit reuse, surge capacity, synergy of functions, flexibility to accommodate mission changes, and useful lifetime in evaluation criteria.
- Moving ARIES and Pu-238 missions out of PF-4 would not generate enough space to matter. Also, the Pu-238 mission "cannot be gapped."
- Moving metal preparation out of PF-4 does not provide enough space to matter, would take too long to establish elsewhere, and would disrupt the 30 ppy operation in PF-4.
- PF-4 was built in 1978 with a planned useful lifetime of 50 years. Relying on PF-4 for pit production would jeopardize the program of record, present unacceptably high risks, and PF-4 would still be 22,000 sq. ft. too small. MAR doesn't matter or enter in to this.

AoA results and comments, continued

- Parametric cost estimates, while comparable across alternatives, may be low-balled, especially so at LANL. CMRR-NF HazCat 2 space costs were staggering (equipment plus working space: $150,000/sq. ft.) due to site-specific seismic, geotechnical, congestion, and haulage requirements.
- The ~$2 B advantage for an existing facility may be a minimum.
- Transportation of pits is not expected to be a discriminator (p. 73).
- Refurbishment alternatives save about 4 years in schedule over new construction.
- The MFFF has about three times the processing space required. Additional space in MFFF, should it be needed, is thus inexpensive. The INL FPF – older, smaller, built to less exacting codes, and therefore riskier and with less longevity – has 30% more space than required.
- **The MFFF is the "most favorable" choice for pit production (p. 81). This choice is however dependent on congressional and judicial concurrence in terminating the MOX program.**
- The AoA did not provide a location for a proposed new facility at LANL. Tellingly, the AoA found "little cost or schedule distinction" between new facilities at LANL, SRS, and INL.

AoA results and comments, continued

- All higher-capacity LANL pit production plans involve converting RLUOB into NLUOB for analytical chemistry (AC) – that is, acquiring nuclear facility space without having constructed it to nuclear facility standards. This may or may not be possible. If it is, it may come with operational constraints.
- NLUOB may very well not be adequate for 80 ppy. (pp. A-3,4). The same marginality applies to material characterization (MC) resources.
- Building a Security Category I facility outside TA-55 will cost $1 B just in security infrastructure (p. A-7). This is not included in cost estimates. Unless a large enough new version of PF-4 is planned now for TA-55, a second Pu site may be required at LANL.
- There are a number of problems with inadequate LANL support facilities (waste handling, instrument calibration, non-nuclear parts. There may be electric power supply issues.
- SRS may have significant issues with support facilities as well.
- There may be significant political and possibly tribal opposition to pit production at LANL.

41 Options Evaluated Resulting in Detailed Analysis of 5 Alternatives

Production Approach	Capabilities in PF-4	Capabilities Outside PF-4	41 Alternatives Evaluated 5 Options (*shaded green*) Received Detailed Cost, Schedule and Risk Analysis			
0 - Status Quo	Pu Science and Cert + Metal Prep and 30 ppy		LANL0			
1 - Split Production	Pu Science and Cert + Metal Prep and 30 ppy	Production 50 ppy at LANL	LANL1-A (New)			
		Production 50 ppy at SRS	SRS1-A (MFFF)	SRS1-B (K-Area)	SRS1-C (WSB)	SRS1-D (New)
		Production 50 ppy at INL	INL1-A (FPF)	INL1-B (New)		
		Production 50 ppy at Pantex/NNSS	PX1 (New)	NNSS1 (New)		
	Pu Science and Cert + Metal Prep and other missions out	Production various ppy at new construction at LANL	LANL1-B (Aries and Pu238 stay)	LANL1-C (Aries stays, Pu238 goes)	LANL1-D (Aries goes, Pu238 stays)	LANL1-E (Aries and Pu238 go)
2 - Move Production and Metal Prep	Pu Science and Cert	Metal Prep and 80 ppy at LANL	LANL2 (New)			
		Metal Prep and 80 ppy at SRS	SRS2-A (MFFF)	SRS2-B (K-Area)	SRS2-C (WSB)	SRS2-D (New)
		Metal Prep and 80 ppy at INL	INL2-A (FPF)	INL2-B (New)		
		Metal Prep and 80 ppy at Pantex/NNSS	PX2 (New)	NNSS2 (New)		
3 - Move Production	Pu Science and Cert + Metal Prep	80 ppy at LANL	LANL3 (New)			
		80 ppy at SRS	SRS3-A (MFFF)	SRS3-B (K-Area)	SRS3-C (WSB)	SRS3-D (New)
		80 ppy at INL	INL3-A (FPF)	INL3-B (New)		
		80 ppy at Pantex/NNSS	PX3 (New)	NNSS3 (New)		
4 - Move Metal Prep	Pu Science and Cert + 80 ppy	Metal Prep at LANL	LANL4 (New)			
		Metal Prep at SRS	SRS4-A (MFFF)	SRS4-B (K-Area)	SRS4-C (WSB)	SRS4-D (New)
		Metal Prep at INL	INL4-A (FPF)	INL4-B (New)		
		Metal Prep at Pantex/NNSS	PX4 (New)	NNSS4 (New)		

- 36 of 41 options were eliminated from further consideration after the team developed floor space estimates and initial cost, schedule, and risk assessments
  - Insufficient space
  - High cost for support facilities
  - Late to need
  - Facility condition
  - Mission disruption

Detailed Analysis of 5 Alternativ

Capabilities in PF-4	Capabilities Outside PF-4	41 Alternatives Evaluated 5 Options (*shaded green*) Received Detailed Cost, Schedule and Risk Analy			
Pu Science and Cert + Metal Prep and 30 ppy		LANL0			
Pu Science and Cert + Metal Prep and 30 ppy	Production 50 ppy at LANL	LANL1-A (New)			
	Production 50 ppy at SRS	SRS1-A (MFFF)	SRS1-B (K-Area)	SRS1-C (WSB)	SRS1-D (Ne
	Production 50 ppy at INL	INL1-A (FPF)	INL1-B (New)		
	Production 50 ppy at Pantex/NNSS	PX1 (New)	NNSS1 (New)		
Pu Science and Cert + Metal Prep and other missions out	Production various ppy at new construction at LANL	LANL1-B (Aries and Pu238 stay)	LANL1-C (Aries stays, Pu238 goes)	LANL1-D (Aries goes, Pu238 stays)	LANL1-E (Aries and Pu23
Pu Science and Cert	Metal Prep and 80 ppy at LANL	LANL2 (New)			
	Metal Prep and 80 ppy at SRS	SRS2-A (MFFF)	SRS2-B (K-Area)	SRS2-C (WSB)	SRS2-D (Ne
	Metal Prep and 80 ppy at INL	INL2-A (FPF)	INL2-B (New)		
	Metal Prep and 80 ppy at Pantex/NNSS	PX2 (New)	NNSS2 (New)		
Pu Science and Cert + Metal Prep	80 ppy at LANL	LANL3 (New)			
	80 ppy at SRS	SRS3-A (MFFF)	SRS3-B (K-Area)	SRS3-C (WSB)	SRS3-D (Ne
	80 ppy at INL	INL3-A (FPF)	INL3-B (New)		
	80 ppy at Pantex/NNSS	PX3 (New)	NNSS3 (New)		
Pu Science and Cert + 80 ppy	Metal Prep at LANL	LANL4 (New)			
	Metal Prep at SRS	SRS4-A (MFFF)	SRS4-B (K-Area)	SRS4-C (WSB)	SRS4-D (Ne
	Metal Prep at INL	INL4-A (FPF)	INL4-B (New)		
	Metal Prep at Pantex/NNSS	PX4 (New)	NNSS4 (New)		

f 41 options were eliminated from further consideration after the tea

Summary of Results

Approach	Refurbishment		New Facility Construction		
Alternative	**SRS MFFF**	**INL FPF**	**INL**	**SRS**	**LANL**
CD-4 Cost Range (FY18$B)	1.4 - 5.4	1.5 – 5.0	1.9 - 6.9	1.8 - 6.7	1.9 - 7.5
CD-4 Schedule Range	FY24 – 31		FY27 – 33		
80 ppy Schedule Range	FY29 – 36		FY33 – 38		
Risks	Potentially contentious state government				
	No experience with pit production				
	Delays in facility availability cause schedule delays				
	Potential structural issues with refurbishment				
	Change in safety basis from NRC to DOE				
		Organizational Interface - Not an NNSA Site (DOE-NE site)			
Opportunities	Ample space for future flexibility				Experienced pit production techs
	Current NNSA production agency			Current NNSA production agency	
	NNSA Site Office			NNSA Site Office	

The 2018 Pit Production Engineering Analysis (EA): key results and comments

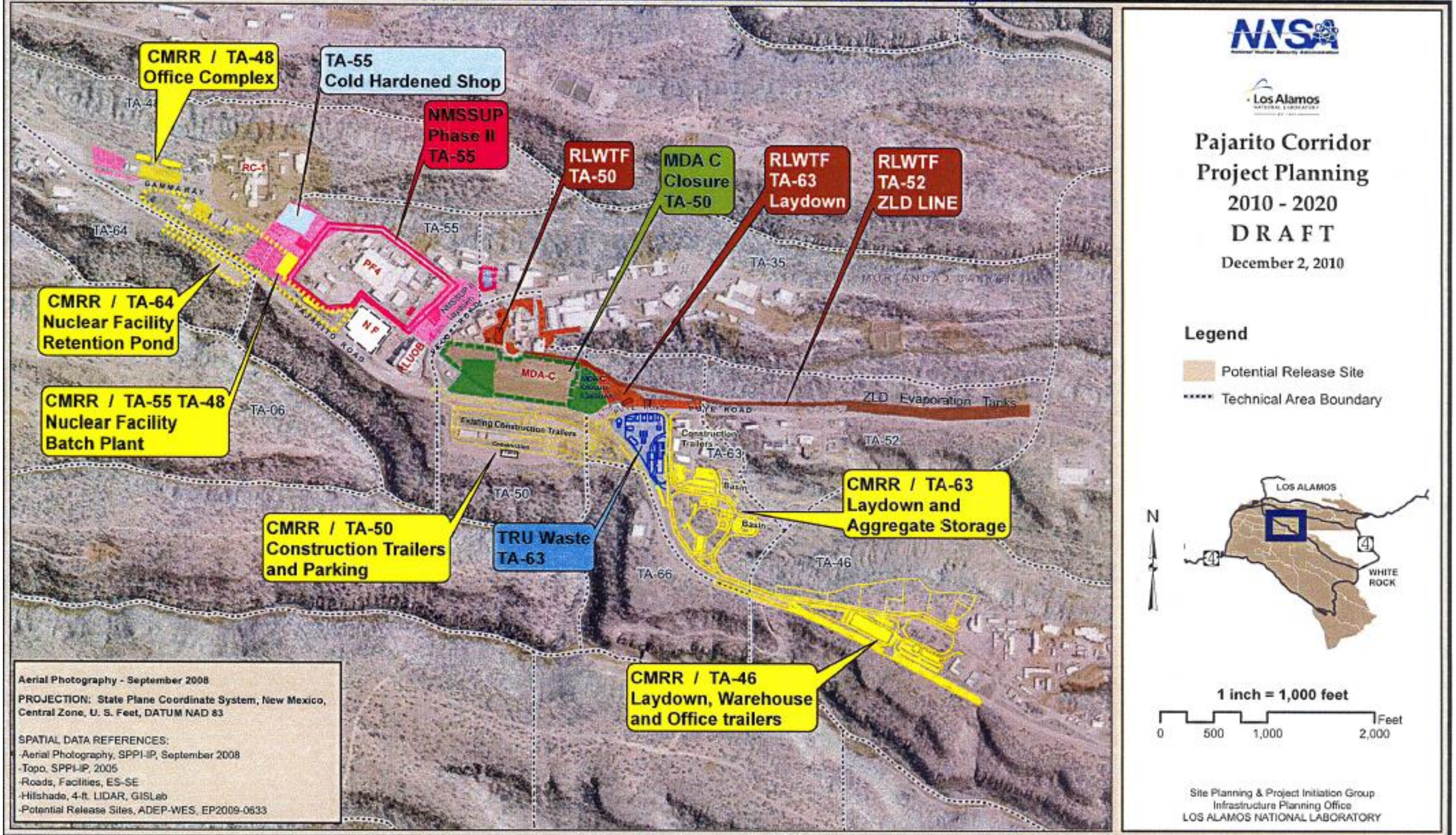
- I find it difficult to take the EA very seriously as an engineering document. It has many flaws and tricks. Disclaimers cover asses, e.g.: "costs and schedules are "rough-order-of-magnitude estimates." Unpleasant conclusions are soft-pedaled, hidden, or redacted.
- The EA is largely a *de novo* analysis that does not depend on, use – or rebut – the AoA's analysis.
- The EA alternatives all involve split production. The qualitative and quantitative differences between 30 ppy (HC) and 30 ppy (PS) at LANL are suppressed. The greater mission disruption and much (~50%) capital costs, operating, and surveillance costs of split production are not mentioned; they do not discriminate between the options offered. They are "baked in." Split Pu shell production ended in 1965 in the US.
- All EA alternatives explicitly depend on an enduring, reliable 50 + 50 = 100 year PF-4 lifetime for ≥30 HC ppy. All EA alternatives depend on NLUOB for 30 or for 80 ppy AC. All LANL alts depend on PF-4 to varying degrees, at a minimum aqueous Pu recovery, i.e. are split flowsheet production. Alt 2a, "partial reliance;" Alt 2b, "complete interdependency;" Alt 2c, even more dependence, requiring 2 shifts in PF-4 to meet the 80 ppy requirement.

Los Alamos Study Group, artist's conception of proposed plutonium modules

Los Alamos Study Group, artist's conception of plutonium modules

LANL TA-55:

1. PF-4, 60K ft^2 labs, HC2
2. RLUOB, 20K ft^2 labs, HC3
3. Proposed underground modules and tunnels, each 5K ft^2 labs, HC2
4. Brand-new fixture assembly bldg, not shown
5. Former proposed CMRR-NF footprint
6. Temporary sheds
7. PF-3 (cold shops)
8. Pajarito Canyon
9. Mortandad Canyon
10. Area C nuclear, chemical dump
11. TA-50 WCRR
12. TA-50 liquid waste



CMRR / TA-48
Office Complex
TA-55
Cold Hardened Shop
NMSSUP
Phase II
TA-55
RLWTF
TA-50
MDA C
Closure
TA-50
RLWTF
TA-63
Laydown
RLWTF
TA-52
ZLD LINE
RC-1
GAMMA RAY
TA-64
TA-55
PF4
TA-35
CMRR / TA-64
Nuclear Facility
Retention Pond
NF
MDA-C
ZLD Evaporation Tanks
CMRR / TA-55 TA-48
Nuclear Facility
Batch Plant
TA-06
Existing Construction Trailers
Construction Trailers
TA-63
TA-52
TA-50
CMRR / TA-63
Laydown and
Aggregate Storage
Basin
Basin
CMRR / TA-50
Construction Trailers
and Parking
TRU Waste
TA-63
TA-66
TA-46
CMRR / TA-46
Laydown, Warehouse
and Office trailers
Aerial Photography - September 2008
PROJECTION: State Plane Coordinate System, New Mexico, Central Zone, U. S. Feet, DATUM NAD 83
SPATIAL DATA REFERENCES:
-Aerial Photography, SPPI-IP, September 2008
-Topo, SPPI-IP, 2005
-Roads, Facilities, ES-SE
-Hillshade, 4-ft. LIDAR, GISLab
-Potential Release Sites, ADEP-WES, EP2009-0633
NNSA
Los Alamos
Pajarito Corridor
Project Planning
2010 - 2020
DRAFT
December 2, 2010
Legend
Potential Release Site
Technical Area Boundary
LOS ALAMOS
N
4
4
WHITE ROCK
1 inch = 1,000 feet
0 500 1,000 2,000 Feet
Site Planning & Project Initiation Group
Infrastructure Planning Office
LOS ALAMOS NATIONAL LABORATORY

The 2018 EA: key results and comments, continued

- All LANL alts would block PF-4 replacement.
- No serious alt comes close to meeting the 2030 requirement. From pp. xvii ff:
  - Alt 1 (PF-4 + MFFF): ≥ 2034-2038 (CD-4 + "7" yrs to production + (≥1 year) ramp-up to 50 ppy, still having an assumed enduring 30 ppy at LANL.
  - Alt 2a: ≥ 2034-2037 (CD-4 + "5" yrs to production + (≥1 year) ramp-up to 80 ppy
  - Alt 2b: ≥ 2033-2036 (CD-4 + "5" yrs to production + (≥1 year) ramp-up to 80 ppy
  - Alt 2c, phase1: ≥ 2025-2029 (reconfigure PF-4 for 80 ppy in two shifts until modules are ready). "The EA Team identified serious risks associated with this alternative."
  - Alt 2c, phase 2: ≥ 2038-2041 (CD-4 + "5" yrs to production + (≥1 year) ramp-up to 80 ppy, go back to single shift in PF-4 after decade).
  - The discrepancy between "5" and "7" years startup in new facilities is not explained.
  - All alternatives "could" meet requirements using (uncosted) shift work, etc.

The 2018 EA: key results and comments, continued

- 1: 30 ppy in PF-4, all functions, 50 ppy in MFFF.
- 2a: All PDC & metal prep + 30 ppy in PF-4, 50 ppy in two-story TA-55 HC2 building + personnel support module
- 2b: All PDC & metal prep, plus foundry, + 30 ppy in PF-4; 50 ppy in slightly smaller new building + personnel support module
- 2c: phase 1: All functions for 80 ppy (two shifts) are built in PF-4, until the late 2030s when underground TA-55 modules with high equipment density are built and brought into full production. Some radiography at Pantex probably, for phase 1. In phase 2, 50 ppy in modules, 30 ppy in PF-4 plus PDC & metal prep (plus foundry?) + 30 ppy in PF-4. Possible personal support module.
- Size of process areas for 50 ppy: Alt 1: **66,000 sq. ft.**; 2a: 26,000; 2b: 18,000; 2c: 15,000. The total space allocation in the EA is less -- vastly less for the LANL alternatives -- in relation to the AoA. The discrepancy with AoA is not fully explained. The factor of ≥2.5 greater process space for Alt. 1 vs. the LANL alts (3.4x to 4.0x total space) is not credible. NB: CMRR-NF was 38.5K usable sq. ft./270,000 gross sq. ft. = 14% usable; here it's 20-30%.

The 2018 EA: key results and comments, continued

- It strongly appears that the LANL-preferred module option (2c) was retained for political reasons despite not meeting requirements and various operational, schedule, and safety challenges, some severe. The design was provided by LANL, not driven by architectural standards, nuclear codes, or operational needs. At least that much is clear from any fair reading of the EA. The AoA rates 2c as providing less than half the required space and capacity. The details of corners cut, some of which are provided by the EA, are shocking. Without stating the obvious, readers are invited to come to their own conclusions.
- In the EA, Alts 2a and 2b (but not Alt 1, MFFF) are said to require *one half to one third less process space* for 50 ppy than in the AoA analysis. Only some of this is explainable by keeping aqueous processing (2a) and aqueous processing and foundry work (2b) in PF-4.
- Germane in this case as it was for the CMRR-NF: "Delusion and Deception in Large Infrastructure Projects: Two models for explaining and Preventing Executive Disaster," Bent Flyvbjerg, Massimo Garbuio, Dan Lovallo, California Management Review Vol. 51, No. 2 Winter 2009.)

Is 30 ppy (PS) at LANL worth it? Is it worth the risks to PF-4?

Assuming LANL succeeds in meeting the 30 ppy by 2026 requirement -- a big question -- and can keep it up at 30 ppy through 2030, LANL's total production will add up to 181 WR pits by the end of 2030.

If an 80 ppy (HC) production facility is brought on line in the early 2030s, LANL production quickly fades to insignificance, and the long-term of costs of two pit provenances begin.

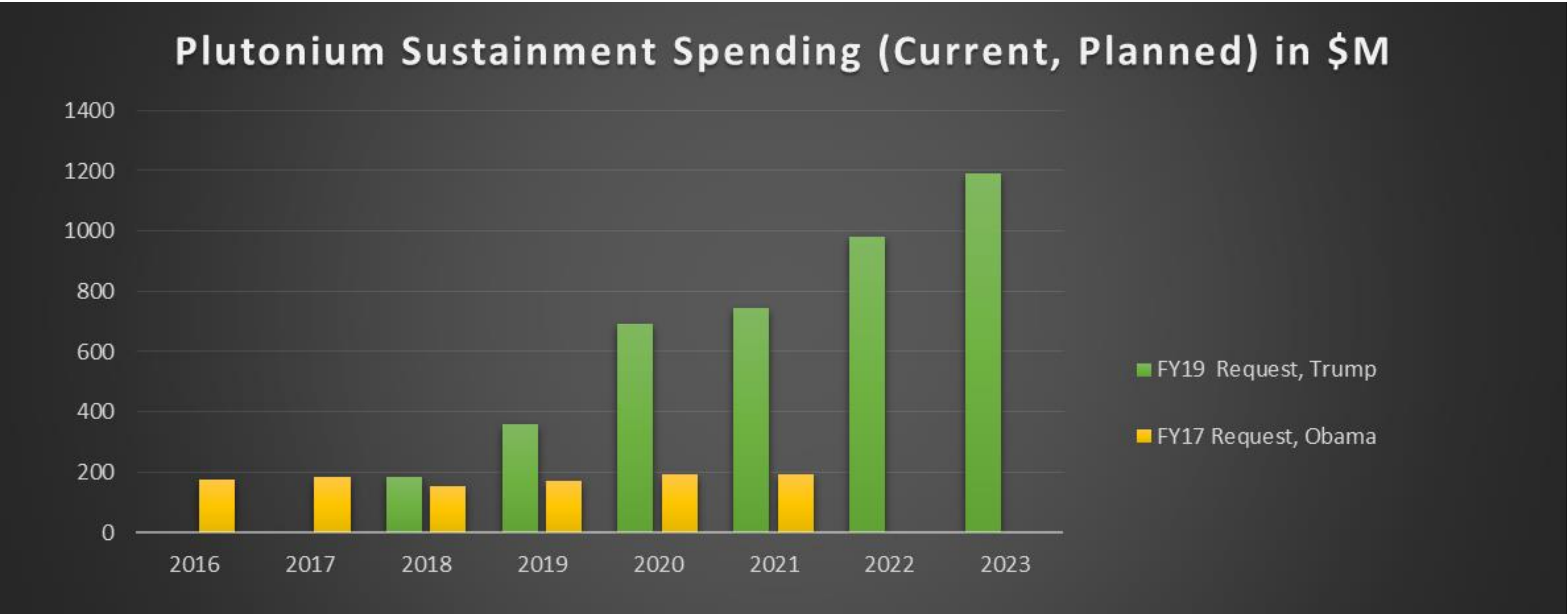
Then production eventually shuts downs as PF-4 comes near end of life and the long transition to a new facility begins.

NNSA (in the AoA briefing for Congress) says 30 ppy (PS) will be a $3 B investment ($2 B capital, $1 B operating). $3 B/181 = $16.6 M/pit, or ~ 100 times weight in gold.

Current proposed legislation to clarify NNSA pit production plans

3. FY2019 EWD Appropriations, **House** Report 115-697, pp. 107-108.

“The NNSA's five year budget plans include approximately [$4 B] for unspecified activities within Plutonium Sustainment to achieve long-term pit production capacity targets. The specific activities and total costs needed to achieve these targets are not described, and a management plan with near-term milestones for carrying out this significant multi-year effort are not presented. The NNSA's continued inability to produce a transparent plan to establish a pit production capability that includes a resource-loaded schedule that can be independently verified for reasonableness creates significant concerns. The recommendation establishes a new construction project [19-D-650] that shall be utilized to carry out any capital improvements and equipment installations that are needed at [LANL] to meet plutonium mission needs.



For the entire Future Year Nuclear Security Plan (FYNSP) (five years), the proposed increase in Plutonium Sustainment is 43% of the proposed increase in Weapons Activities (WA). For FYs 2022 and 2023, Pu Sustainment composes 69% and 77% of the proposed WA increase.

Current proposed legislation to clarify NNSA pit production plans

4. FY2019 EWD Appropriations, **Senate** Report 115-258, p. 103.

“Within available funds, NNSA is directed to contract with a third-party [FFRDC] to conduct an independent assessment of the NNSA's decision to conduct pit production operations at two sites. NNSA shall identify and execute a contract with an independent FFRDC, not directly involved in plutonium pit production, not later than 60 days after enactment of this a act. NNSA shall not proceed with conceptual design activities for the recently announced preferred alternative until an FFRDC is under contract. The assessment shall include an analysis of the four options evaluated in the recent [EA], all identified risks, engineering requirements, workforce development requirements, and other factors considered. The FFRDC shall submit its report to the Committees on Appropriations of both the Houses of Congress not later than 210 days after enactment of this act.”

5. **FY2019 NDAA, Senate** Report 115-262, pp.415-416: Same but with impossible deadlines (contract July 1; final report October 1, 2018!)

Why do some of us say that industrial pit production is virtually impossible at LANL?

- Isolation
- Dissected topography, e.g. at TA-55
- R&D culture
- Institutional arrogance
- Unconsolidated sediments
- Seismicity
- Aging facilities (PF-4); decrepit, unsafe facilities (Main Shops); unknown status (Sigma)
- RLUOB
- Negative social attributes of New Mexico
- Lack of qualified workforce, low educational attainment of population
- Local opposition

END OF THEME B

Theme C: Program risks and extra costs hiding in plain sight: institutional, safety, workforce, infrastructure, and geographic factors.

There are cultural factors native to the pit production mission that apply at all sites, and there are site-specific factors of all the above kinds -- hard data, with major effects on outcome -- which are not at all captured in the AoA and EA. We will discuss some of these.

I (Greg Mello) know a fair bit about LANL but little about SRS. I hope others will step up as regards the latter site.

Cultural factors which apply to any site

- Will it prove possible to produce pits on an industrial scale in tnhe absence of a clear, present need?

- Can pit production occur without the “heroic mode of production”?

- If so, what might be some of the institutional and cultural requirements?

Speed is the problem, not the solution.

Patience is a virtue.

A US special forces motto is: “Slow is smooth; smooth is fast.”

The Mello family backpacking mantra is: “Slow, steady, safe, strong.”

ENDS