Thinking Inside the Boxes: Can Existing Buildings Meet DoD's Pit Needs?

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[slide 1: title] This panel is on Opportunities to Reduce the Cost of the U.S. Nuclear Deterrent. I'll focus on potential opportunities to reduce the cost of the nuclear weapons complex, specifically pit production, and while I'm at it, ways to move forward on that issue.

As most of you know, a pit is a hollow plutonium shell. When imploded by conventional explosives, the energy from the resulting nuclear explosion detonates the rest of the weapon. During the Cold War, the Rocky Flats Plant made pits on an industrial scale, sometimes over 1,000 per year. Rocky Flats ceased production in 1989. Since then, the US has been unable to make more than about 10 pits per year (ppy), and post-1989 attempts to produce pits at a higher rate have failed. Yet DOD says it needs 50 to 80 ppy by 2030 in order to extend the life of certain types of nuclear weapons.

There's a debate on the need for 80 ppy. But my focus is on a topic that hasn't been debated: how could the US produce pits at the maximum rate DOD says it needs, 80 per year?

The takeaway is that some options may permit reaching that capacity by using existing buildings, at relatively modest cost and schedule, with minimal environmental impact, or by using new, smaller, less costly buildings.

To explain these options, I must present several terms. While preparing a report on this topic, I found that these terms were the magic key that unlocked the gates to understanding pit production issues. Please bear with me! These terms figure prominently in the rest of my talk. [slide 2; terms]

First is **MAR**, which stands for Material At Risk. This is the aggregate amount of radioactive material of all types permitted in a building. Since there are many radioactive materials, all have to be converted to a common unit, plutonium-239 equivalent (Pu-239E); as you know, Pu-239 is the fissile isotope in pits.

Next is **Hazard Category (HC)**. The standard to which a plutonium building must be designed depends on the amount of Pu-239E it is intended to hold. For example, a Hazard Category 3 building can hold between 38.6 and 2,610 g of Pu-239E. Higher standards are intended to reduce the risk of material leaking out in the event of an earthquake, accident, etc.

Closely related is **Radiological Facility**. Some buildings, such as some labs, are expected to hold only a small amount of radioactive material, 38.6 g of Pu-239E or less. They do not need to be designed as robustly as HC-3 buildings because an accident would release so little material.

Buildings are also rated by **Security Category** (SC) based on the attractiveness of the material, especially to terrorists. Buildings with weapons, or with more than 2 kg of weapons-grade plutonium, are in SC-I and require elaborate security measures. At the other end of the spectrum, SC-IV buildings hold low-grade material, which is less attractive to terrorists. As a result, less stringent security measures suffice.

Analytical Chemistry (AC) supports pit production. It determines the isotopic composition, and amount and type of impurities, in plutonium samples from pits. Many samples are taken for each pit at various points in its production. The samples analyzed are often milligrams of plutonium dissolved in a few drops of acid. Since AC uses a certain number of samples per pit, the number of samples and the floor space used increase as pit production increases. Thus AC is low-MAR and low-SC but space-intensive.

[slide 3, Pu-238] Finally, **Plutonium-238** (Pu-238) is an isotope of plutonium. It is 275 times more radioactive than Pu-239 and glows red hot. It is used to power space probes. It is not suitable for pits. Pu-238 in quantities less than 16 kg is high-MAR but low-SC.

[slide 4, PF-4 and CMR] Pit production is done at Los Alamos National Laboratory (LANL), using 2 buildings. PF-4, which opened in 1978, is the main plutonium building at LANL. It has a foundry and other equipment for making pits. It also houses other plutonium projects, such as a Pu-238 line, the ARIES line for turning pits into plutonium oxide, a line for recovering plutonium from nitric acid solution, plutonium R&D, and some AC. Most AC is done in the Chemistry and Metallurgy Research Building, CMR, operational since 1952. One report called it "genuinely decrepit"; another called it "structurally unsound." It is seismically fragile. The National Nuclear Security Administration (NNSA) wants to exit CMR by 2019.

With that as background, I'll discuss two pit production options. One would use new buildings called modules; the other would use existing buildings. I'll address the module option briefly, as it has been set forth elsewhere. There are no unclassified sketches of a module.

Modules would be reinforced-concrete structures for such high-MAR tasks as pit fabrication and Pu-238 work. They offer several potential advantages. Large buildings have been rejected repeatedly; modules would be smaller, less costly, and more likely to receive support. Indeed, Congress authorized NNSA to pursue this strategy in the FY2014 National Defense Authorization Act. Each module would be designed for a single task, so would not have to meet regulatory requirements imposed by other tasks. On the other hand, there are questions about the need for modules, given other options; whether they are needed now; and how much they would cost. Note that even if a pit foundry and Pu-238 work were moved into modules, space would still be needed outside of PF-4 for AC because it would be very difficult to reconfigure PF-4 to perform most types of AC efficiently, especially for a capacity of 80 ppy. Nor would modules be cost-effective for AC, which is low-MAR, since they would be designed for high-MAR work.

[slide 5, matrix] Let me now turn to options using existing buildings. As a framework for analyzing these options, here's a matrix showing high and low SC vs. high and low HC. Each cell has a different task; each task can be done in different buildings. The secret sauce is matching tasks to buildings.

[slide 6, matrix, high SC/high HC] The high-SC/high-HC cell is for tasks that use a lot of weapons-grade plutonium (WGPu), notably casting hemishells, or half-pits, which are welded together to form a pit. This can only be done in PF-4, the only building with high SC, high HC, and the necessary pit processing equipment. It appears that PF-4 does not have the MAR allowance and space to fabricate 80 ppy and do the supporting AC, as well as continue other plutonium missions that can only be done in PF-4. So one way to produce 80 ppy in PF-4 is to move out some MAR and keep out most AC, which would otherwise encroach on floor space as capacity rose. How might this be done with existing buildings?

[slide 7, matrix, low SC/high HC] Pu-238 accounts for 40% of PF-4's MAR allowance, yet is not used in pits. Pu-238 also occupies 8,000 square feet of PF-4, out of 60,000 square feet. [slide 8, CPP-1634 and H Canyon/B+HB-Line] Savannah River Site and Idaho National Laboratory have buildings that could be refurbished or expanded to handle Pu-238, CPP-1634 at Idaho and H Canyon and HB-Line at Savannah. Each has done Pu-238 work. A DOE study last year estimated the cost of moving Pu-238 to Idaho or Savannah at around $200M, taking about 8 years. Others believe the cost would be higher.

[slide 9, matrix, low SC/low HC] Turning now to AC, at least 2 facilities outside LANL could do the AC for 80 ppy. [slide 10, B-332 and F/H Lab] Building 332 at Lawrence Livermore National Laboratory used to be HC-2/SC-I, like PF-4, but has been downgraded to SC-III. It has ample space and ventilation capacity, so could handle a large number of small samples. Savannah River Site is another possibility. Built in the early days of the Cold War, it was sized to produce plutonium for hundreds of pits per year. All that plutonium required AC. The buildings, F/H Laboratory and Building 337-A, would require refurbishment and some new equipment, but they are available, and have ample space. However, LANL needs some AC capability to maintain expertise and for analyses requiring quick turnaround. A possibility would be to use Livermore or Savannah for some AC. There is no cost estimate for the AC to support 80 ppy at these sites.

[slide 11, RLUOB] There's another option for AC. NNSA built the Radiological Laboratory-Utility-Office Building, or RLUOB, at LANL. It was completed in FY2010, and has 19,500 square feet of lab space, plus office space. But as a Radiological Facility, it is permitted to hold 38.6 g Pu-239E. WGPu contains Pu isotopes more radioactive than Pu-239, so it is more radioactive than pure Pu-239. 38.6 g Pu-239E works out to 26 g WGPu. How much is that? [slide 12, photo of 2 nickels] It's the volume of 2 nickels. Now as it happens, RLUOB was built to a much higher standard than was needed for a Radiological Facility. In fact, the laboratory part was built to HC-3 standards to obtain lessons on how to build nuclear facilities. I said RLUOB was built to HC-3 standards, but it was not *certified* to those standards. As a result, it remains a Radiological Facility. However, it is ideally set up for AC. [slide 13, RLUOB ventilation] It has a huge ventilation capacity, which is important for AC. The utility basement and the laboratory floor above it are made of heavily-reinforced concrete, while the office floors are built to the standards of an emergency response building like a fire station, so RLUOB is much more seismically robust than CMR. LANL estimates the cost of moving AC and related work from CMR to RLUOB and PF-4 to be $800M.

There are at least 3 options for RLUOB. One is to use it as is for AC. The catch is that, as a Radiological Facility, 26 g of WGPu is nowhere near the 500 to 1,000 g needed for the AC to support 80 ppy.

A second option is to convert RLUOB to HC-3. This would involve lots of studies. Los Alamos listed about 100 of them, as seen here. [slides 14-16, study of studies report] Some of these studies could lead to physical modifications of RLUOB. This option may be feasible, though it is unclear if conducting studies and retrofitting modifications would be less expensive than building a new RLUOB, minus the office floors.

A third option is RLUOB with regulatory relief. The reason for high building standards and limits on radioactive material is to keep the radiation dose to workers and the public in an accident below DOE guidelines. [slide 17, dose calculation] LANL calculated the dose if RLUOB, with 1,000 g of WGPu, collapsed in an earthquake and a fire dispersed the plutonium. This slide shows that the dose would be far below the guideline. On the other hand, relaxing standards for one building could set a precedent for doing so for other projects.

In sum, several potential paths might reach 80 ppy. Modules could contain a pit foundry and a Pu-238 line at less cost than a large building, leaving space in PF-4 and RLUOB for AC. Other options hold the possibility of producing 80 ppy while avoiding new buildings, minimizing environmental impact, and holding down schedule and cost. Detailed study would be needed to evaluate feasibility and cost.