PANEL ON PUBLIC AFFAIRS

April 2004

THE MODERN PIT FACILITY (MPF)

No urgency for a MPF.
Address key technical issues before proceeding.

Issue

Congress is considering whether to authorize construction of a Modern Pit Facility capable of manufacturing plutonium pits for nuclear weapons, at an estimated cost of $2 to $4 billion.

Conclusions

There are several technical issues to address before proceeding with site selection or committing to an MPF design. These decisions should be deferred until Congress can more thoroughly assess the MPF and various alternatives while supporting an enhanced research program on plutonium aging. In particular, in 2006, a milestone will be reached in an experiment to estimate the minimum pit lifetime, the result of which will help inform production needs. Further, pit production assessments must be informed by clearer evaluations of future nuclear force structure.

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The APS

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Executive Summary

Plutonium "pits" are the cores of modern nuclear weapons. In order to ensure that the U.S. nuclear arsenal is safe and reliable, plutonium pits are closely monitored for any deterioration due to aging.

The average age of plutonium pits in the U.S. arsenal is 20 years with the oldest being about 26 years old. The *minimum* pit lifetime is currently estimated to be 45 to 60 years, based largely on the modest changes observed in key properties of plutonium samples that are 40 years old.

The pits in the current nuclear weapons stockpile were manufactured at a facility that was shut down in 1989. The National Nuclear Security Administration (NNSA) recently reestablished a limited capability to produce pits at the Los Alamos National Laboratory. The NNSA has proposed an additional Modern Pit Facility (MPF) that could produce, depending on the final design, either 125, 250 or 450 pits per year in single-shift operation, beginning in 2020.

Recent Congressional hearings and associated testimony have indicated that a MPF could be a major budget item for the NNSA. The APS Panel examined the technical issues associated with the MPF because such a large investment in permanent infrastructure is a demanding commitment of resources in the stewardship program.

The APS Panel concluded that there is insufficient technical reason to commit to a site or design for a MPF at this time. Deferring such decisions until at least 2006, the date that the NNSA initially proposed in evaluating the facility's environmental impact, would allow Congress to more thoroughly consider key issues that could significantly affect overall decisions regarding an MPF:

- Pit facility design and site selection should not proceed until there are more precise estimates of future nuclear force structure.

- Site and design decisions should be deferred while the NNSA enhances the research program on plutonium aging. In particular, an experiment is underway which by 2006 will help determine whether pits can be expected to have a minimum lifetime of 60 years. With a 60-year minimum lifetime, the earliest that a pit might need to be replaced is 2038, and there may be no need to commit to a MPF for 15 more years.

- The various production options should be more thoroughly assessed. In particular, the cost and benefits should be evaluated for a small-scale production facility – capable of producing 50 to 80 pits a year in single-shift operation - that has the capability of a modular enhancement to larger production if necessary.

While a pit manufacturing capability is required to maintain the nuclear arsenal, delaying MPF site and design decisions by a few years would provide the time to address key technical issues and ensure that future pit production will be based on good science, good policy, and prudent management of tight federal budgets.

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Contents

I. Background

All nuclear weapons in the U.S. arsenal use chemical explosives to compress a hollow shell of plutonium in order to trigger the nuclear explosion. This shell of plutonium at the core of a nuclear warhead is called the "pit."

The integrity of the pit is critical to the performance of the nuclear weapon. To ensure that the nuclear arsenal is safe and reliable, the National Nuclear Security Administration (NNSA) established an Enhanced Surveillance Campaign (ESC). The ESC closely monitors the pits for any deterioration due to aging.

Two leading causes of potential aging effects are (1) the radioactive decay of the various plutonium isotopes and (2) corrosion. The maintenance of well-sealed pits and the exclusion of foreign contaminants during pit production have virtually eliminated the corrosion problem.[1] Consequently, the ESC's primary activity is to look for potential aging effects due to radioactive decay.

According to nongovernmental estimates, there are currently about 8,000 warheads in the deployed or active stockpile and 3,000 warheads in the inactive stockpile.[2] The average age of the plutonium pits in these weapons is 20 years with the oldest being about 26 years old. The *minimum* pit lifetime is currently estimated at 45 to 60 years.

All the pits in the current U.S. nuclear weapons stockpile were manufactured at the Rocky Flats Plant in Colorado. That facility was shut down in 1989 because of environmental violations.[3] Since that time, Los Alamos National Laboratory has been developing an improved pit production process and in April 2003 succeeded in producing a "stockpile certifiable" pit in its TA-55 plutonium facility.[4] The current NNSA plan is for the TA-55 facility to produce pits for the stockpile at a rate of 10 to 20 pits per year by 2007.[5]

NNSA has determined that the United States requires a pit manufacturing capacity greater than the 20 pits per year that TA-55 is currently scheduled to be able to produce. Specifically, NNSA has proposed building a Modern Pit Facility (MPF) with a single-shift production capacity of 125, 250, or 450 pits per year, beginning operation in about 2020.[6] The NNSA has also specified that the facility be designed to be "agile" with an "ability to simultaneously produce multiple pit types" and "the flexibility to produce pits of a new design in a timely manner."[7]

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[1] "Plutonium: Aging Mechanisms and Weapon Pit Lifetime Assessment" by Joseph C. Martz and Adam J. Schwartz *JOM*, September 2003, http://www.tms.org/pubs/journals/JOM/0309/Martz-0309.html, p5.
[2] Inactive warheads are warheads with their tritium canisters and other "limite-life" components removed. Tritium has a half-life of about 12 years and therefore has to be replenished at invervals of several years.
[3] *Modern Pit Facility Draft Environmental Impact Statement* (hereafter MPF DEIS, National Nuclear Security Administration, June 4, 2003), http://www.mpfeis.com, Summary, S-1.
[4] Los Alamos National Lab, April 22, 2003, http://www.lanl.gov/worldview/news/releases/archive/03-054.shtml
[5] *Nuclear Warhead "Pit" Production: Background and Issues for Congress* by Jonathan Medalia, Congressional Research Service, updated, March 29, 2004, p. 6. Medalia reports that, as of March 2004, a total of 5 certifiable W88 pits had been produced
[6] MPF DEIS, Chapter 2, "Purpose and Need," p. 2-6.
[7] MPF DEIS, Summary, p. S-11.

Production at the TA-55 facility has the potential to be expanded beyond the scheduled 20 pits per year and could in principle be increased to between 80 and 150 pits per year in a single-shift operation. NNSA has given a number of reasons for not pursuing this option. The most important are that a single-shift production capacity of 80 pits per year "does not meet the minimum capacity requirement of 125 pits per year" and that the option to expand TA-55 capacity to 150 pits per year "approaches the cost and schedule of a small newly-constructed modern pit facility, but does not provide the agility or contingent [higher] capacity needed for the long term."[8] Finally, there is concern that maintaining a large production capability at TA-55 would conflict with the necessary science missions of Los Alamos Laboratory.

The House Appropriations Committee challenged the justification for a Modern Pit Facility in July 2003:

> "The fiscal year 2004 budget request is the second budget request delivered to the Committee that is loosely justified on the requirements of the Nuclear Posture Review (NPR) policy document but lacking a formal plan that specifies the changes to the stockpile reflecting the President's decision. The Committee was hopeful that the outcome of the Administration's review would provide a definitive inventory objective for each weapons system to allow the NNSA to plan and execute a program to support defense requirements based on what is needed rather than the continuation of a nuclear stockpile and weapons complex built to fight the now defunct Soviet Union…
>
> "The Committee supports the budget request in fiscal year 2004 for continued conceptual design work on a Modern Pit Facility, but urges the NNSA to look diligently at ways to more effectively utilize TA-55 at Los Alamos National Laboratory to address Stockpile Stewardship Program pit manufacturing requirements in the near term and take a less aggressive planning approach for a new multi-billion dollar facility. The Committee feels the Department's rush to commit to an MPF design and siting decision is premature without the development of a detailed analysis of outyear pit production capacity requirements tied to the 2012 stockpile."[9]

The NNSA's proposal to commit to a Modern Pit Facility has also been questioned by arms control organizations. In particular, these organizations are concerned about the upper end of the proposed size range for the MPF. An MPF with a capacity of 450 pits per year would be able to maintain a stockpile of over 10,000 warheads. Critics argue that this would be inconsistent with U.S. commitments to nuclear disarmament under Article VI of the Nonproliferation

[8] MPF DEIS, Chapter 3, "Alternatives," p. 3-17.
[9] House Appropriations Committee, "Report on the Energy and Water Development Appropriations Bill, 2004 (H.R. 2754)," Report # 108-212, July 16, 2003, http://thomas.loc.gov/cgi-bin/cpquery/T?&report=hr212&dbname=cp108&, pp. 141 ff.

Treaty. Further, they are concerned that NNSA's expressed interest in new pit designs would quite possibly lead to resumed nuclear testing.

The cost estimates of between $2 – $4 billion for the proposed MPF are also of concern, given current Federal budget constraints. Specifically, there is a concern that a multi-billion dollar MPF could potentially jeopardize adequate funding for some elements of the Stockpile Stewardship Program.

In response to these various concerns, the NNSA recently postponed issuing a final Environmental Impact Statement and site-selection decision on the MPF, that was originally scheduled for 2006,[10] while it reconsiders the "scope and timing" of the decision.[11] At the same time, however, it proposes to almost triple its budget for the MPF to $29.8 million in fiscal year 2005 with a planned steady ramp up to $105.2 million in fiscal year 2009.[12]

Regardless of the arms control and economic issues, the plutonium in nuclear weapons cannot be expected to last forever and maintaining the nation's nuclear arsenal will eventually require a pit production capability.

The APS Panel examined the technical issues associated with the MPF because such a large investment in permanent infrastructure is a demanding commitment of resources in the stewardship program. The APS Panel considered the three technical questions that need to be addressed in evaluating the size and urgency of such a pit production capability:

How large a stockpile will the United States have in the future?

How soon and how fast will the existing pits have to be replaced?

Are there alternatives to an MPF that deserve more consideration?

The following sections consider each of these questions in order.

[10] MPF DEIS, p. S-14.
[11] "NNSA Delays Modern Pit Facility Environmental Impact Statement and Selection of a Preferred Location" (National Nuclear Security Administration press release, Jan. 28, 2004, http://www.nnsa.doe.gov/
[12] *Nuclear Warhead "Pit" Production: Background and Issues for Congress*, Table 1.

II. The Size of the Nuclear Stockpile

The size of the U.S. nuclear stockpile is classified. According to nongovernmental estimates, there were approximately 10,000 warheads in the U.S. stockpile at the beginning of 2004. In addition, according to the same sources, 5,000 of the 12,000 pits stored at NNSA's Pantex warhead assembly/disassembly plant near Amarillo, Texas have been designated as a strategic reserve.[13]

The Strategic Offensive Reduction Treaty (SORT) requires that the number of U.S. "operationally deployed" strategic warheads be reduced to the range of 1,700 to 2,200 by 2012. Most likely, the active stockpile will also decline – perhaps to roughly 5,000 warheads. If no further pits are declared excess, however, the U.S. will still have 15,000 pits in 2012, including 10,000 divided between the inactive stockpile of warheads and the stockpile of reserve pits.

The size of the future stockpile is a critical factor in determining the required pit production capacity. Unfortunately, as indicated in the quote from the House Appropriations Committee report above, the Bush Administration has still not fixed a planning figure for the future size of the U.S. nuclear-weapon stockpile. According to the NNSA:

> "The size and composition of the enduring stockpile are…uncertain. In classified analyses, the NNSA has considered possible futures in which the stockpile size could be reduced to 1,000 total weapons or in which it could be as large as required to meet [the 2001] Nuclear Posture Review requirements."[14]

If pits were produced and retired at a constant rate, then the relationship between stockpile size, production capacity, and pit lifetime would be given by

$$S = C\tau$$

where S is the stockpile size, C is the pit production capacity, and τ is the average pit lifetime. The currently estimated minimum pit lifetime is 45 to 60 years.[15] Thus, a production capacity of 80 pits per year would support a stockpile of between 3,600 to 4,800 warheads, and a capacity of 450 pits per year could theoretically support a stockpile of more than 20,000 warheads.

Pits have not been produced at a constant rate, however. As indicated in Table 1, the pits in nearly all of the warheads in the current stockpile were produced over a period of only 12 years, from 1978 to 1989.[16] If each pit was replaced when it reached a particular age, then the rebuilding period would be approximately 12 years and, even at a rate of 450 pits per year, only 5,400 pits could be replaced.

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[13] "NRDC Nuclear Notebook: Dismantling U.S. nuclear warheads," *Bulletin of the Atomic Scientists*, Vol. 60, No.1 (January/February 2004), pp. 72–74, http://www.thebulletin.org/issues/nukenotes/jf04nukenote.html.
[14] MPF DEIS, Summary, p. S-13.
[15] MPF DEIS, Summary, p. S-12.
[16] The only exception is the W62 warhead for the Minuteman ICBM, which was produced from 1970 to 1976, but is to be retired by the end of Fiscal Year 2009.

Table 1	Approximate production period and total inventory (active + inactive) of warheads in the current stockpile.

Warhead Type	System	Laboratory[a]	Production Period[b]	Number in Stockpile[c]
B61-3/4	Tactical bomb	LANL	1979-89	1,100
B61-7	Strategic bomb	LANL	1985-90[d]	470
B61-10	Tactical bomb	LANL	1983-86; 1990-91[e]	200
B61-11	Strategic bomb	LANL	1997[f]	50
W62	Minuteman	LLNL	1970-76	610
W76	Trident	LANL	1978-87	3,200
W78	Minuteman	LANL	1979-82	920
W80-0	SLCM	LANL	1983-90	320
W80-1	ALCM/ACM	LANL	1981-90	1,800
B83-0/1	Strategic bomb	LLNL	1983-91	620
W84	GLCM	LLNL	1983-88	400
W87	MX/Minuteman	LLNL	1986-88	550
W88	Trident	LANL	1988-89	400
Total				10,640

[a]LANL = Los Alamos National Laboratory; LLNL = Lawrence Livermore National Laboratory
[b]Dates of warhead assembly. It is unlikely that the pits were produced much earlier than the first warhead.
[c]Natural Resources Defense Council, http://www.nrdc.org/media/docs/020213a1.pdf.
[d]The B61-7, produced from 1985-90, is a modified B61-1 and may contain a somewhat older pit.
[e]The B61-10 was produced using the physics package from the W85, which was produced from 1983-86.
[f]The B61-11, produced in 1997, is a modified version of the B61-7.

It is not necessary to replace every pit when it reaches a particular age, however. For example, if pits produced in 1978 were replaced when they were 40 years old and those produced in 1989 were replaced when they were 60 years old, the rebuilding period would be increased from 12 to 32 years. At a rate of 80 to 450 pits per year, 2,500 to 14,000 pits could be replaced over this 32-year period.

Figure 1 illustrates the relationship between stockpile size, production capacity, and pit lifetime, assuming an interim production capacity is established at TA-55 in 2007 and that TA-55 is expanded or an MPF begins operation some years later. The maximum stockpile size, S, when the youngest pits (which were built in 1989) reach the maximum pit lifetime, τ, is given by

$$S = C_{int}\, t_s + C(\tau - t_s - 17)$$

where C_{int} is the interim capacity of TA-55 (assumed here to be 20 pits per year) and t_s is the number of years that elapse between establishing the interim capacity and the start of production at an MPF or an expanded TA-55 with capacity C. Thus, assuming an expanded TA-55 with a capacity of 80 pits per year begins operation in 2015 and a pit lifetime of 60 years, a total stockpile of about 3,000 pits could be replaced by 2050 - sufficient to maintain a SORT-sized arsenal of deployed strategic warheads plus several hundred spares.

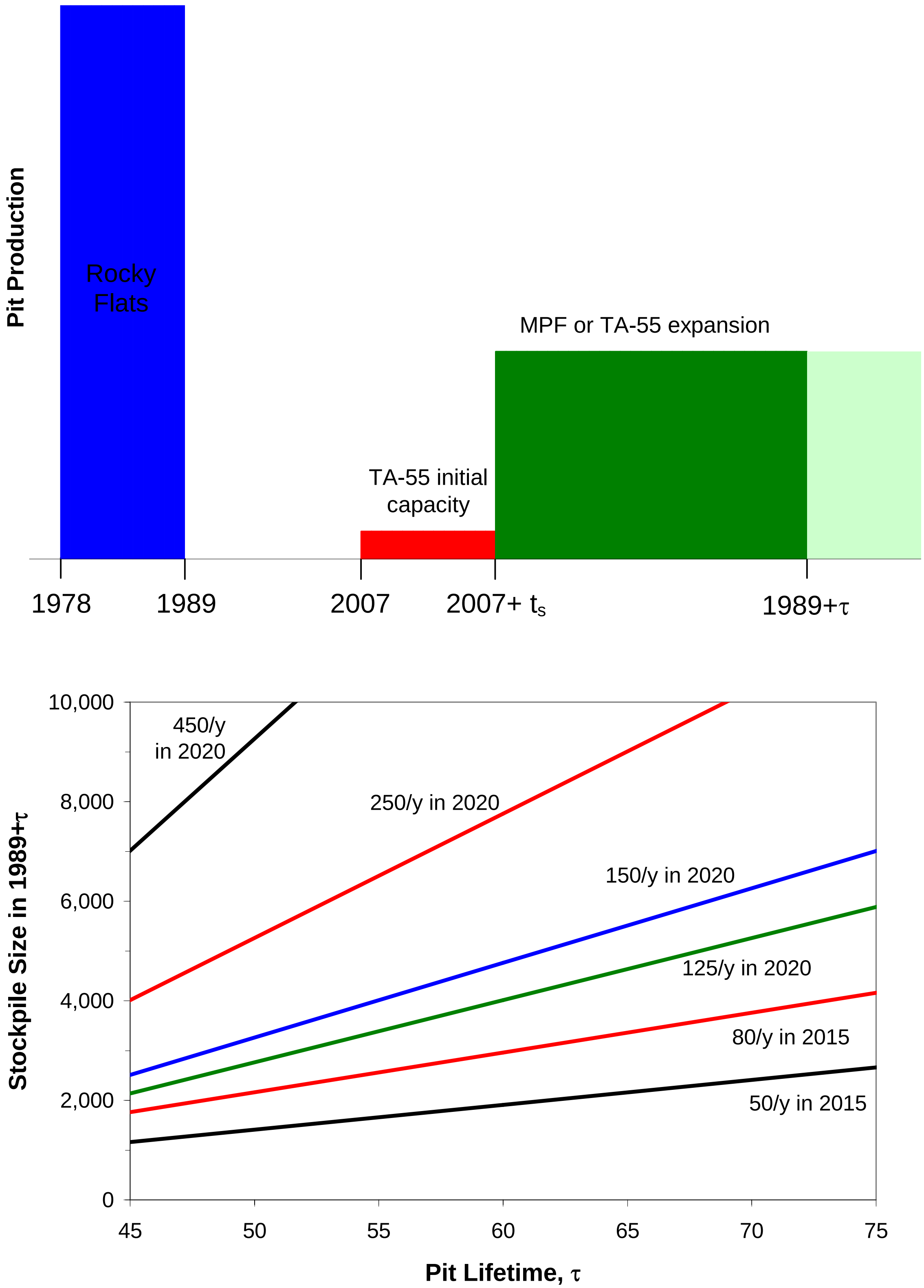

Figure 1	Stockpile sizes for various pit production capacities, assuming an interim production capacity of 20 pits per year at TA-55 beginning in 2007.

The NNSA lists a number of additional considerations that bear on the sizing of the MPF:

> "The capacity of a MPF needs to support both scheduled stockpile pit replacement at end of life and any 'unexpected' short-term production…to address, for example, a design, production, or unexpected aging flaw identified in surveillance, or for stockpile augmentation (such as the production of new weapons, if required by national security needs)." [17]

Surge capacity to deal with unexpected problems could be provided without building a larger facility, simply by training more workers and using multiple shifts. Capacity could be doubled or tripled relatively quickly in an emergency.

The need for additional production capacity to deal with unexpected problems is, however, substantially reduced by the fact that the United States plans to maintain a diversity of warhead types and a considerable stockpile of spare and inactive warheads.

Under SORT, the U.S. will have at most 2,200 warheads "operationally deployed" in 2012 (i.e., mounted on ballistic missiles or stored at air bases where strategic bombers are deployed).[18] These will be of seven warhead types: four for ballistic warheads, one air-launched cruise missile warhead, and two bombs. The W62 warhead is to be retired, leaving U.S. intercontinental ballistic missiles with two warhead types: the W78 and the W87. Similarly, U.S. submarine-launched ballistic missiles will have two warhead types: the W76 and the W88. Finally, strategic bombers will have the W80-1 for air-launched cruise missiles (backed up by the W-84 GLCM warhead in the inactive stockpile) and two types of bombs, the B61 and B83. Thus, if a warhead type develops a problem, there will in all cases be a substitute in the stockpile.

The possibility of a "common mode failure" is sometimes raised, in which a particular aging problem affects many warhead types and requires the replacement of all or a large fraction of the pits in the stockpile. This theoretical vulnerability of the current stockpile is aggravated by the relatively short period over which the pits were produced. The most effective way to ameliorate it will be to produce replacement pits at a lower rate over a longer period of time.

The only specific new warhead being examined is the "robust nuclear earth penetrator, for the study of which, the NNSA has requested \$27.6 million for fiscal year 2005."[19] Since the current idea is to use an existing pit inside a penetrating shell, this would not require new pit production.

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[17] MPF DEIS, Summary, p. S-15.

[18] Although the U.S. might also stockpile several hundred non-strategic warheads, and many thousands of reserve warheads and pits, there would be little or no need to replace these on an emergency basis should reliability problems be discovered.

[19] Statement of Spencer Abraham, Secretary, U.S. Department of Energy Senate Committee on Armed Services, March 23, 2004

However, a large-scale production facility could be used to manufacture new pits for new types of warheads. If the additional capacity is intended to provide this option of new warhead production, then DOD should justify the need for new warheads before NNSA builds the additional capacity to produce them.

Conclusions:

- Decisions regarding MPF design should not be made until there is a more precise estimate of the size of the future nuclear arsenal.
- If the minimum pit lifetime is found to be 60 years, then a production rate of 80 pits per year could support an arsenal of 1,700 to 2,200 deployed strategic warheads plus several hundred spares and non-strategic warheads. That is the reduced arsenal size to which the U.S. is pledged by the recently concluded Strategic Offensive Reductions Treaty (SORT) with Russia.
- In determining the size of a future production capability, the NNSA should not create unnecessary, excess capacity, particularly since multi-shift operation inherently provides back-up capacity. Yet, much of the capacity provided by an MPF with a production capability of 450 pits per year, would be unnecessary for maintaining a SORT-sized arsenal. If the additional capacity is intended as a "surge" capability that allows for more rapid warhead replacement, then, given warhead interchangeability, NNSA should clarify under what scenarios a surge capability would be necessary. If the additional capacity is intended to provide the option of new warhead production, then DOD should justify the need for new warheads before NNSA builds the additional capacity to produce them.

III. Pit Lifetime

NNSA currently estimates that the minimum pit lifetime is at least 45 to 60 years. This estimate is based on the fact that "measurements to date have not shown any significant degradation of pits over approximately 40 years." [20] Of course, many additional measurements are called for to make this a robust conclusion.

The NNSA has samples of weapon-grade plutonium that are 40 years old. These samples show insignificant degradation and virtually no corrosion. According to the NNSA-commissioned review of the subject:

> "Experience from stockpile surveillance programs reflects this point: pits have remained remarkably pristine and free of corrosion, especially since the adoption of modern cleaning and sealing methods... [21]
>
> "On the basis of careful evaluation of the [aging] effects described above through extensive characterization of old pits, modeling, and preliminary design sensitivity calculations…an initial assessment of minimum pit lifetimes has been derived. Evaluation of the oldest samples of plutonium metal, both metal of oldest absolute age (40 years) as well as the oldest samples most directly comparable to the enduring stockpile (25 years) have shown predictably stable behavior. The many properties that have been measured to date, such as density and mechanical properties have shown only small changes and detailed microstructural studies have been correlated to these changes in properties. The response of each system to potential changes is specific to each particular design. Based on this assessment, current estimates of the minimum age for replacement of pits is between 45 and 60 years."[22]

To improve these estimates, a number of theoretical calculations and experiments, including an "accelerated-aging" experiment, are currently underway that will be used as a basis for joint laboratory report due in 2006 that is to establish whether some or all pit types can be expected to have a minimum lifetime of 60 years. NNSA experts describe the "accelerated-aging" experiment as follows:

> "The process of alpha decay within plutonium can be accelerated by the addition of isotopes with shorter half-lives. An alloy of normal weapon-grade plutonium mixed with 7.5% of the Pu-238 isotope will accumulate radiation damage at a rate 16 times faster than weapon-grade material alone. This is a useful tool to evaluate

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[20] "Plutonium aging: Implications for pit lifetimes" by J. Martz (LANL) and A. Schwartz (LLNL), LA-UR-03-0259 in MPF DEIS, Appendix G, p. G-65. An article expanding on this report, "Plutonium: Aging mechanisms and weapon pit lifetime assessment" by Joseph Martz and Adam Schwartz, has been published in *JOM: The member journal of the Minerals, Metals & Materials Society,* September 2003, http://www.tms.org/pubs/journals/JOM/0309/Martz-0309.html.

[21] "Plutonium aging: Implications for pit lifetimes," MPF DEIS, Appendix G, pp. G-63.

[22] "Plutonium aging: Implications for pit lifetimes," p. G-64.

> extended-aged plutonium (up to 60-years equivalent and possibly beyond) within a few years. Critically, acceleration of the input or radiation damage must be matched by acceleration of the subsequent annealing and diffusion of that damage. We accomplish this subsequent acceleration by raising the temperature at which the samples are stored. These processes are thermal in nature, and the activation energy (a term which describes the energy required to activate a process) is different for each specific mechanism. Unfortunately, there is no single temperature at which the thermal diffusion of this damage will be equivalently and perfectly matched to the initial acceleration of the damage input. As a result, the accelerated aging experiments are carried out at three different temperatures…
>
> By early 2006, these samples will have reached an equivalent age of 60 years, and measurements of their properties (and comparison to aging models) [will] form a key milestone in our estimate of pit lifetimes."[23]

It is critical that NNSA provide adequate funding so that this full program of experiments and analysis can be carried through.

Conclusions:

- Decisions regarding MPF design or site should not be made before an experiment is completed in 2006 that will help determine whether pits can be expected to have a *minimum* lifetime of 60 years. With a 60-year minimum lifetime, the earliest that a pit might need to be replaced is 2038. In that case, there would be no need to commit to a large-scale production capability for at least 15 more years.

- If, in 2006, pits are estimated to have only a 45-year lifetime, then site selection and design commitment for MPF could begin. The oldest pits would reach their 45-year lifetime in 2023, still leaving 17 years to build an MPF. In the meantime, hundreds of replacement pits could be produced at the current TA-55 facility.

- Deferring site selection and design affords NNSA the time to develop a more vigorous program in plutonium aging, one that spans a greater range of materials and uses.

[23] "Plutonium aging: Implications for pit lifetimes," pp. G-62, G-65.

IV. Production Options

Deferring site selection and design decisions offers the opportunity to explore more creative solutions to the complex problem of pit production than the current proposals for an MPF. Specifically, it will provide the opportunity to better address issues of cost, science, and need.

Proposed alternatives to a large-scale MPF include: proceeding exclusively with TA-55 production; adding a wing to the existing TA-55 to provide additional production space; or, building a small-scale production facility at a new site that has the capability for modular expansion to large production. These options are considered briefly below.

A study done by Los Alamos for the U.S. National Nuclear Security Administration (NNSA) found that, for an expenditure of $0.5-0.7 billion, it would be possible by 2014-16 to have a production line in TA-55 that could produce all pit types in the U.S. "enduring stockpile" (except for that in the B83 bomb) at a rate of 50 to 80 pits per year, operating 40 hours a week. [24]

With a production rate of 80 pits per year starting in 2015, TA-55 could produce 2,800 replacement pits by 2049, when the youngest pits in the current stockpile would be 60 years old. An additional 100 to 200 replacement pits could be produced at TA-55 between now and 2015. Thus, the TA-55 facility could reasonably be expected to be able to maintain a stockpile of up to 3,000 warheads, assuming a capacity of 80 pits per year and a minimum pit lifetime of 60 years. If TA-55 fails to meet the 80 pit per year schedule in single shift operation, double-shift operation is still an option.

The study also explored the possibility of expanding the TA-55 facility. It found that, for a total expenditure of $1.2-1.6 billion, an additional wing could be added to TA-55 and its production capacity increased so that it could produce by 2020 all the pit types in the enduring stockpile at a rate of 150 pits per year, including the capability of simultaneously producing two different types of pits.

The original design of TA-55 was based on modularity – the capability of adding additional production lines to accommodate the option for increased capacity in the future. Indeed, the United Kingdom copied the TA-55 design and exploited this inherent modularity.

Production options that adopt modularity offer two clear advantages over a large-scale MPF. Modularity provides hedging options should stockpile requirements or unforeseen problems necessitate expanding capacity. And, modular production lines provide the greatest flexibility at a time of significant budget pressure.

[24] "Summary of TA-55/PF-4 upgrade evaluation for long-term pit manufacturing capacity" by S.T. Boertigter, D.E. Kornreich, and W. Barkmen (Los Alamos National Laboratory, LA-UR-03-2711 in MPF DEIS, Appendix G, p. G-54. More detail on the current use of space in TA-55 facility and an earlier analysis for the expansion of its single-shift production capacity to 50 pits per year (80 pits per year with multiple shifts) may be found in the *Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory, Vol. II, Part II,* "Enhancement of plutonium pit manufacturing" (U.S. Department of Energy, DOE/EIS-0238, 1999).

Another option that should be more thoroughly explored is the development of a small-scale modular production facility at a new site. This has been previously proposed as a scalable facility, with modules capable of 50-pit-year production being added on to the facility as necessary.[25] While there is a clear benefit to the design flexibility afforded by a new modular facility, it must be carefully weighed against existing TA-55 options. In particular, the TA-55 options should be assessed for the cases of plutonium lifetimes ranging up to 60 years and a SORT-sized arsenal.

There are several issues that must be addressed in assessing the TA-55 options. First, the TA-55 facility plays a critical role in the science and engineering associated with plutonium assemblies for weapons and it is also an important tool for maintaining stockpile reliability. While it offers the opportunity for enhanced pit production, care must be taken to preserve its essential role in plutonium stewardship and stockpile surveillance.

Further, the previous study of a TA-55 upgrade cautioned that the highest-capacity option was subject to "high execution risk…due to the possibility of an unforeseen event during the construction of new floor space that could disrupt both the upgrade and on-going TA-55 manufacturing and certification activities."[26] Finally, the fact that the production date for TA-55 to produce its first certifiable pit slipped from 1998 to 2003 created a credibility problem for its management which have not been completely eliminated by the ramp up in its production over the past year.[27]

All these production options should be reviewed by independent organizations.[28] The assessments should determine the causes of past delays at TA-55 and whether the production needs could be better addressed at another site.

Deferring irreversible decisions—such as site selection and MPF design—until after 2006 affords the time to more thoroughly examine the various production options proposed above. It also provides the time to include in the assessments the results of the pit-longevity experiment (described in the previous section) that will be completed in 2006. Finally, it will allow for more accurate estimates of future nuclear force structure to be included in sizing considerations.

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[25] John Foster, et. al.,"Panel to Assess the Reliability, Safety, and Security of the United States Nuclear Stockpile", April 11, 2003.
[26] Ibid.
[27] *Nuclear Warhead "Pit" Production: Background and Issues for Congress,* pp. 6-8.
[28] Such organizations include the National Academy of Science and JASON, a group of academic experts that do studies of this type for the Departments of Defense and Energy.

Conclusions:

- The numerous options for pit production must be more thoroughly explored before selecting an MPF site or design.
- A production capacity of 80 pits/year may be more than adequate to accommodate all foreseeable production needs. The capability of meeting this production need at TA-55 should be more thoroughly examined particularly regarding costs, timeline, impact on the Los Alamos science mission, and technical capabilities. At the same time, modular production at a new site should be more thoroughly explored.
- To strengthen the basis for a decision regarding a pit production facility, Congress should consider seeking such analysis through independent organization such as NAS or JASON. There is adequate time for these groups to report their findings. Suspending site and design decisions until 2006 will not jeopardize the reliability of the existing stockpile.

Appendix I: Purpose, Authors and Reviewers

While a pit manufacturing capability is required to maintain the nuclear arsenal, recent Congressional hearings and associated testimony have highlighted plans for a Modern Pit Facility that would eventually represent a major budget item for the National Nuclear Security Administration and the overall stewardship program.

The American Physical Society Panel on Public Affairs examined the technical issues associated with the MPF because such a large investment in permanent infrastructure is a demanding commitment of resources in the stewardship program. The authors concluded that delaying the decision for the MPF by a few years would provide the time to address key technical issues and ensure that a decision on future pit production will be based on good science, good policy, and prudent management of tight federal budgets.

This Discussion Paper was drafted by the National Security Subcommittee of the APS Panel on Public Affairs (POPA). It was then reviewed, edited, and unanimously supported by the entire POPA committee. POPA members include:

John Ahearne
Arthur Bienenstock, Chair
John Bahcall
Steven Block
Peter Bond
Brian Clark
Morrel Cohen
Daniel Cox
Peter Eisenberger
Martin Einhorn
Steve Fetter
Yogendra Gupta
Roger Hagengruber
Steven Koonin
Barbara Levi
Joel Primack
Ernest J. Moniz
Wayne Shotts
Frank von Hippel
Jennifer Zinck
Francis Slakey, Subcommittee Advisor

This Discussion Paper was also reviewed by numerous national laboratory scientists and leading independent researchers with expertise in the field of plutonium aging. All the reviewers' comments were addressed in the development of the final paper; however, the conclusions are the responsibility of the authors alone.