Los Alamos Study Group
Nuclear Disarmament • Environmental Protection • Social Justice • Economic Sustainability

U.S. Plutonium "Pit" Production: Additional Facilities, Production Restart are Unnecessary, Costly, and Provocative

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Results in brief

A strategy that conserves production capability in existing and nearly-completed Los Alamos facilities for the foreseeable future with neither stockpile production nor expansion of capacity, neither of which are needed, is the one that best minimizes risks, maximizes opportunities, harmonizes goals, and avoids waste of all kinds. Planning for potential stockpile contingencies due to pit failure, known to be extremely unlikely, could be adequately, easily, and cheaply addressed in any of several ways, including by providing for potential pit reuse and, as a very last resort, contingency production in existing facilities. Current infrastructure expansion plans, which include more than $3 billion (B) in additional new pit production facilities beyond the ones already under construction, are unnecessary, ill-timed, and incur substantial program risks. Gratuitous infrastructure investments and gratuitous pit manufacturing, should they continue or even increase, will squander the present opportunity to bring the National Nuclear Security Administration's (NNSA's) pit infrastructure and management strategies into greater harmony with its nuclear nonproliferation mission and today's fiscal realities. Even gratuitous pit **re-use** ***is wasteful, provocative, and may lower certification confidence. For all practical purposes stockpile pit production will never be needed again and is therefore a poor basis on which to plan for stable, effective pit program management.***

1. There are two main groups of decisions that must be made about pit production. The first concerns *operations* – "program" in budgeting parlance. For example, how many pits should be made for the stockpile, if any, and if so of what type?

   The second group of questions concern investments in *infrastructure*, both existing and proposed.

   In principle, program decisions probably can be changed more easily than commitments to major new infrastructure. The latter are politically difficult to abandon once large sunk costs are physically visible.

2. There is no significant dispute regarding the need to operate a fully-capable plutonium facility for the foreseeable future, with supporting infrastructure, to make pits for testing purposes, to conduct surveillance on existing pits, to support disarmament and nonproliferation activities, to retain expertise for all these and related purposes, and to provide for its safe operation, assuming programs are well-designed, well-managed, and appropriately modest in scale and intent.

   In other words, as long as there are nuclear weapons there will be nuclear weapon pits. Both a place and people capable of working on them are required.

3. The significant program questions pertain to pit-related operations *which exceed this basic level in scale, novelty, or tempo.* NNSA does not acknowledge the existence of this fundamental level of operation, and represents that massive investment in both infrastructure and program is necessary to retain even the capacity to make a single plutonium pit. This is an absurd proposition.

4. During the present administration's first year there were no major programmatic decisions, or decisions pending, regarding pit production operations.

   Near the end of 2009 the trade press reported a Department of Defense (DoD) proposal for what could become a new joint Air Force/Navy ballistic missile warhead, possibly involving pit production. On February 1 of this year, an initial $26 million was requested for a life extension study of the W78 warhead, explicit involving possible changes to the physics package. These W78 efforts, which might in time include pit production, would grow under this request to $347 million (M) by 2014, from an annual baseline of about $40 M. This same budget request mentions a goal of starting pit production by "2018-2020."

5. Unless new-build pits are required within the next few years, there will be no colorable reason for stockpile pit production until a *second* round of life extension programs (LEPs) begins. At that time, proposals for new-design warheads may be advanced again. It would be conspicuously wasteful to build new-design replacements for warheads that have just been rebuilt, with 20-30 years of added shelf life.

   Nearly all U.S. warheads will have been rebuilt in life extension programs (LEPs) prior to the earliest completion date of the proposed large annex to the pit production facilities at LANL, the Chemistry and Metallurgy Research Replacement Nuclear Facility (CMRR NF).

6. There is no current or foreseeable military or congressional requirement to produce additional copies of deployed stockpile pits beyond the short-term exception of about two dozen W88 pits. Even this small requirement has been contested by House appropriators, who in 2008 suggested stopping W88 production entirely and in 2009 suggested slowing this limited production and extending it over more years to keep production staff busy longer. NNSA now anticipates completing or terminating W88 production in FY2011.

7. Published estimates suggest that 90% of stockpile pits were made between 1979 and 1989 and thus are between 21 and 31 years old.

8. There is a robust scientific consensus, observed and articulated by the JASON advisory group in 2006 and supported by decades of continuing stockpile surveillance, long-term aging samples, accelerated aging experiments, and all available evidence from over 60 years of research in a number of countries, that "most" deployed U.S. pits could be kept without replacement for at least a century.

   This means most pits could be kept until 2079 if not longer. This is far more distant than any program or infrastructure planning or decision horizon.

   For those pit types with a working life judged to be less than a century, "clear" age mitigation strategies either have been proposed, or are already being implemented.

   Thus for all practical purposes today, pits do not age.

9. The U.S. nuclear deterrent, so-called, includes extensive redundancies and "diversity," both overall and as regards pits.

There is redundancy a) in targeting, b) in delivery modes (a triad), c) in delivery vehicles (two ballistic missiles, multiple aircraft, air- and sea-launched cruise missiles), and d) in warhead and bomb types. There are 16 modifications of 10 basic nuclear warhead designs in the arsenal, of which 4 basic designs are closely-related members of the B61 "family" of warheads and bombs.

Within each of the 16 warhead and bomb types there are deployed warheads, spares, and active and *inactive reserve* units. There are now almost as many intact warheads and bombs not deployed, i.e. "de-alerted" to one degree or another, as there are deployed.

Active reserve warheads are maintained to allow deployment on short notice. *Inactive* warheads would require an overhaul prior to deployment, if such a decision were ever made.

After planned stockpile reductions under the Strategic Offensive Reductions Treaty (SORT), the size of the undeployed or "shadow" arsenal will likely exceed that of the deployed arsenal. There are rumors that the forthcoming Nuclear Posture Review (NPR) will finally retire some, possibly thousands, of these undeployed warheads.

As far as pits are concerned there are also re-usable pits of some deployed warhead and bomb types either in storage or in the dismantlement queue, in quantities unknown to us. Approximately 3,500 additional re-usable pits of deployed stockpile types are expected to be liberated from warheads dismantled over the coming dozen or so years, if not more, which pits can be added to the stockpile of reserve pits if desired.

After SORT implementation but prior to any Obama stand-downs or full retirements, we estimate there will be about 2.4 reserve warheads and re-usable pits for every deployed warhead, overall. Retirements from the reserve arsenal will not change this ratio. For B61s, W80s, B83s, W78s, and W76s, the combined warhead and pit reserve exceeds, in some cases greatly exceeds, twice the number of deployed warheads using those pit types.

In addition to all these reserves, there are already thousands of pits in storage – it is not publicly known how many – for potential re-use across type. These include (but are not likely to be limited to) W68 pits, of which over 5,000 were made.

Some pit re-use designs, including one for the numerous and strategically-central W76 and W76-1 warheads, have a nuclear testing pedigree. In 1999 DOE described its W76 pit re-use design as "mature," readily certifiable in the absence of nuclear testing.

In addition to all these redundancies, there has been an evolution in the accuracy of some delivery systems, and this could continue. There have also been militarily-significant changes in fuzing systems, allowing new target classes for some warheads – notably, for the numerous W76-1. Accuracy and fuzing "improvements" may allow smaller nuclear yields for a given target, further increasing targeting, warhead choice, and design options, possibly including pit reuse options as well as other changes which increase performance margins.

10. These are the reasons there is no need whatsoever for stockpile pit production to maintain a large, diverse, and heavily-redundant nuclear arsenal for an indefinite period of time.

    There are also disarmament requirements to consider, as we do below, but the argument against pit production is overwhelming without considering the disarmament imperative.

11. Since there is no need for stockpile pit production for the foreseeable future, there is no technical or managerial need to provide an *option* of future stockpile pit production

("contingency production") for the foreseeable future. A *de minimus* level of pit production, for stockpile maintenance and related testing purposes only, is adequate.

12. Variations of the following five justifications for investments in new pit infrastructure, and in active pit production, are commonly heard.

    a. It is necessary to create and exercise pit production capacity in case it is needed for a stockpile emergency.

    Given the absence of pit aging and multifaceted redundancy described above, a stockpile emergency that requiring pit production is not credible. This argument for pit production is really a euphemism for a creating a qualitative stockpile "breakout" option, d) below.

    b. It is desirable to inspire awe and fear abroad by the capability and capacity thus created and exercised ("capability-based deterrence").

    The concept of "capability-based deterrence" is beyond the scope of this paper – and perhaps beyond evidence-based discourse generally. We find it contrary to the historical record, illogical, lacking a sense of proportion, and self-serving. The history of every empire in its latter days includes military overstretch and overspending, a potent cause of decline. Why is it that creating otherwise-unjustified capabilities would not produce the *opposite* of awe and fear in foreign eyes is a question that advocates of capability-based deterrence have failed to answer.

    Capability-based deterrence *does* make sense from the perspective of domestic pork-barrel and corporate interest politics – as a supporting public relations theme. *Domestic opposition* is what is to be deterred. Unlike the claim that investments in nuclear weapons capability contribute to international tranquility, their influence on domestic politics is beyond dispute.

    There is also a kind of logic to laying prior claim to resources which may become scarce in the future. If budgets are expected to be tight, it makes sense to deter questioning of long-term investments by making near-term irrevocable choices.

    c. It is desirable to deploy upgraded warheads which are purportedly safer or more secure against theft (i.e. have greater "surety") throughout the stockpile-to-target sequence (STS).

    The quest for increased surety is discussed below. In brief: that quest will not be successful when evaluated over the nuclear enterprise as a whole. At the same time, all proposed technical surety improvements for gravity bombs and cruise missiles, and some proposed for ballistic missiles warheads, can be achieved without pit production to the extent they can be achieved at all.

    d. It is desirable to create and exercise greater pit production capacity in case it is needed for qualitatively different warheads.

    This justification, if allowed by policy, is sound, provided the new warhead types which are to be enabled by pit production are wanted within about the next two decades.

    It would be difficult if not impossible to *create* and *maintain* greater production capacity without *using* that capacity.

    e. It is necessary to create and use new pit production capacity to retain skills, motivate workers across the warhead complex, and retain and restore institutional knowledge.

Since retaining skills could be accomplished elegantly at a small physical scale, and without investments in new capacity or actual stockpile production, and since a larger physical scale isn't needed unless many new-design pits are desired, the hue and cry over skills boils down to a desire for new-design warheads. That's what the skills are for, if they are needed at that larger scale.

Much of the concern about skills retention and institutional knowledge is actually concern about *ideological* transmission, not transmission of skills, to a new generation.

13. As will be discussed below, pit re-use may be an alternative to the production of pits for some *new* warhead designs.

    The Obama Administration has proposed pit re-use in an extensive upgrade of the B61-3, -4, -7, and -10, apparently similar to the Bush Administration's second Reliable Replacement Warhead (RRW-2). With or without pit-re-use and associated nuclear redesign, if carried to fruition this LEP product, the "B61-12," would replace three non-strategic and one strategic B61 variants and be adapted to the F-35 fighter-bomber, a new delivery platform.

    A decision regarding whether or not to request funding for B61-12 pit re-use and certification is pending as of this writing and may be included in the Nuclear Posture Review (NPR).

    As of early 2008, the Bush Administration was not planning any but minor refurbishment for the B61-3, 4, 7, and 10 until 2030. It is not clear why the perception of need for a highly-intrusive LEP or replacement for these bombs has arisen.

14. There are major decisions urgently pending regarding pit production infrastructure. These infrastructure decisions turn out to be *de facto* decisions about the nature of future pit production programs. Facilities require programs and vice versa.

15. The U.S. maintains the capability to produce plutonium pits of existing and new designs at Los Alamos National Laboratory (LANL) and is poised to expand that capability within existing facilities, with or without CMRR NF construction.

16. Neither NNSA nor any external government reviewers have conducted any thorough or objective survey of plutonium facilities and missions, and their interrelationship, either at LANL or across the U.S. nuclear weapons complex.

17. All existing NNSA analyses, and all of NNSA's current infrastructure plans, explicitly or cryptically assume there will be large-scale production of new-design plutonium pits at the earliest possible time, possibly in the 2018-2020 timeframe.

    The current administration has not provided other policy options.

18. Pit production infrastructure questions are currently centered on the proposed LANL CMRR NF, which is estimated to cost more, possibly quite a bit more, than $3 billion (B).

    This facility is discussed in much greater detail in a companion analysis.

    The circa $400 million (M) CMRR Radiological Laboratory, Utility, and Office Building (RLUOB) is under construction and may be ready for use by the end of fiscal year (FY) 2013. In what follows we assume this building will be completed more or less as scheduled, together with near-term planned upgrades to LANL solid and liquid waste facilities and with the planned refurbishment of LANL's main plutonium facility, Building PF-4 in Technical Area (TA) -55.

19. LANL plutonium programs, as housed in these and related existing and nearly-completed new facilities, subject to planned refurbishments, but *without* additional nuclear facilities such as the CMRR NF, could preserve and enhance pit production capability for some decades within current funding levels, at increased safety relative to today's operations.

20. This outcome cannot be achieved by drift, distraction, or with managerial and fiscal overreach. It would require more clarity of purpose, better program focus, and a more proactive safety posture than exists today. It would require rejecting the sometimes-unconscious notion that greater spending equals more capabilities and a better program, and hence more nuclear deterrence, and hence better national security. If more spending is the measure of program success, management's role devolves to one of finding more ways to spend money and more ways to get it. We assume this is not the case.

21. Infrastructure choices are not at all exhausted by the "build/no build" dichotomy. Thoughtful delay is also an option. For example, NNSA has not examined the life-cycle costs and benefits of pausing CMRR NF procurement at the present preliminary stage, before detailed design and construction (which are to be somewhat concurrent).

    A decade's delay in construction, even allowing for an extra $100 million (M) in design costs, would save at least several hundred million dollars in present value. LANL estimates CMRR maintenance will cost 2.5% of its replacement value (currently roughly $3.5 B), which means CMRR maintenance will be an order of magnitude more expensive than the existing Chemistry and Metallurgy Research (CMR) building (cost: $6 million/year, according to LANL). Considerable additional program and administrative staff will also be needed in the new buildings. Additional nuclear waste must be handled, and additional security provided. CMRR operating costs are likely to exceed $100 M/year.

    Construction cost inflation is likely to occur over the coming decade, but if so operating costs can be expected to increase also, making the case for delay robust.

22. A decade-long delay in CMRR NF would not negatively impact the safety, security, or reliability of the present arsenal either now or later. It would allow greater focus on increasing the safety and stability of current LANL operations, as well as provide greater budgeting freedom in the meantime, with attendant benefits across NNSA.

23. Neither the nuclear expertise needed to finalize the CMRR NF design, nor the construction skills necessary to build it, nor yet the "special facility equipment" (SFE) providers, will disappear in the next decade. Other, better-justified NNSA nuclear construction, and more so the civilian nuclear power industry, will maintain the necessary nuclear-certified skills and providers for the coming decade.

24. Final appropriations for the plutonium sustainment mission, including pit production, fell by about a third over the most recent two-year period, from $214 million (M) in fiscal year (FY) 2008 to $142 M in FY2010, reflecting a tacit agreement in government that there is no need for more than *de minimus* stockpile pit production. This year's budget request would raise this figure to $190 M for FY2011.

25. LANL's current pit production capacity is not a fixed number of "X pits/year" but rather depends heavily on management choices, commitments, and skill, the specified startup time and production campaign duration, the pit design in question, the degree of prior planning,

26. Under a variety of assumptions regarding these matters, and at various times over the last 15 years, NNSA, its predecessor the Department of Energy (DOE) Defense Programs, and the Secretary of Energy Advisory Board (SEAB), have described LANL's current capacity as being as small as 20 pits/year and as great as 200 pits/year. This latter level explicitly required significant management reforms and also, as reported to us by briefed insiders, manufacturing-friendly pit design, equipment additions and production rationalizations.

27. NNSA and DOE currently operate, at considerable cost, five (5) large Hazard Category II nuclear facilities with significant plutonium missions. Two are at LANL, one at Lawrence Livermore National Laboratory (LLNL), and two at the Savannah River Site (SRS). NNSA (and possibly also DOE in one case) are currently proposing to build, or upgrade, a total of four (4) large facilities (two at each of LANL and SRS) at cost of at least $11 B, while downgrading one (at LLNL) and demolishing one (at LANL).

    After all this construction, the agency would still have, as before, five (5) large plutonium facilities, at two instead of three geographic sites.

    NNSA could save itself the cost of one of these facilities – the CMRR NF – without compromising any mission.

    Each of these facilities requires considerable related infrastructure, including vault(s), facilities for processing and disposing of nuclear wastes, program-related analytical and testing facilities, administration, security, and transportation. Many of these ancillary facilities must be built new, or rebuilt. Once built, all these facilities will have very significant operating costs. Eventually, they will have large decommissioning and disposal costs.

    Under current plans, plutonium-related expenses will consume an unnecessarily-large part of NNSA's budget for the foreseeable future.

28. If, despite today's consensus by the weapons laboratories and the JASONs, unforeseen technical problems involving pits did arise in a future stockpile, there would be many potential solutions, depending on the circumstances.

    These solutions include:

    a) retiring the warhead type(s) involved, possibly gaining arms control or nonproliferation benefits or simply accepting fewer redundancies in warheads, delivery systems, and/or targets;

    b) replacing the entire warhead or bomb where possible or the nuclear explosive package (NEP), in other cases, again where possible;

    c) recalling active or inactive warheads from the reserve arsenal as replacements;

    d) replacement of the affected pits by surplus pits of the *same type* in new-built primaries;

    e) building warheads based on pit re-use *across type* where supported by the nuclear testing record;

    f) slow, small-scale stockpile pit production in existing facilities; and finally

g) a true pit production campaign.

29. The last option above will likely cost the most. These costs are hidden if *the option* of providing for future large-scale pit production is built, operated, and maintained "just in case" it is wanted – if the intent to produce and the intent to build in order to produce are cryptically separated.

30. Given the current robust technical confidence in U.S. pits and primaries, and these many alternatives to production, and the costs and risks discussed below, further pit production for the stockpile would be ill-advised *under any circumstances*. This conclusion is robust even without further stockpile declines, which would provide even more backups, redundancies, and alternatives to pit production.

31. There is an additional backup solution available, namely the possibility of creating *a plan* for emergency or contingent pit production, which would not be materially implemented unless it was needed.

    It is important to reemphasize that the NNSA weapons laboratories and JASONs do not recognize the possibility of such an emergency.

    Preference for immediate large infrastructure investment over contingency planning signals intent to produce new-design warheads more or less as soon as possible.

    A plan for emergency pit production is also a plan for the production of new-design pits for prompt stockpile changes on short notice – an arms race or "breakout" scenario, in so many words. Of the two interpretations, stockpile breakout is by far the more likely and contingency production plans will be described in that way.

32. Pit production need not and often has not taken place at a single geographic site or location. This fact can allow higher levels of contingent production with less new infrastructure. For example, pit-ready plutonium metal can be prepared at a different site than the one where plutonium machining and pit assembly take place. Only two or three pit parts (out of roughly 25) are actually made of plutonium and must be fashioned or joined in a plutonium glovebox environment. Most production steps need not take place in a plutonium fabrication facility.

33. A pit production campaign could be conducted, choosing one in a spectrum of pre-planned contingency production options, in a hypothetical breakout scenario using NNSA's existing and soon-to-be-completed plutonium facilities at LANL, LLNL, and SRS, provided these facilities are adequately and safely maintained. Many components could be provided by industry. The proposed CMRR NF would not be needed even in this rapid campaign production scenario unless larger-scale production was to continue on a permanent basis and at LANL alone.

34. The adequacy of NNSA's plutonium facilities, both current and planned, to create breakout capacity for pit production depends more on the quality of NNSA and facility management than many other factors.

35. Plutonium operations not directly related to pit production at LANL, elsewhere in the NNSA complex, can assist in providing contingent pit production capacity if made subject to contingent reprogramming and modification as needed. By definition, exigencies change program priorities. Capacity could be increased in a matrix of pre-planned, well-defined steps which could be taken sequentially, in parallel, or both. The first increase in pit

production could be implemented within approximately 6 months and the largest increase within very approximately 6 years from a stockpile finding or other initiating event and decision.

36. The CMRR NF, expected to cost well in excess of $3 billion (B), is not required either to maintain production capability or to provide for at least some contingent expanded production, although the CMRR NF would enable a higher level of contingent capacity and would reduce the response time across the capacity spectrum.

37. Proceeding with CMRR NF in the absence of a compelling, large-scale nuclear stockpile emergency would squander NNSA's present once-in-a-lifetime opportunity to bring its nuclear sustainment, nonproliferation, and fiscal responsibility goals into greater harmony.

38. Since there is no rational reason to make additional pits of existing types for the stockpile or to add to the existing glut of extra pits, pit production policy, and especially the momentous choice of whether or not to expand production infrastructure and capacity, depends on choices regarding *innovation* in nuclear primaries, *not* on choices as to how to indefinitely maintain any subset of the existing stockpile. The only reason to expand pit production infrastructure, by building the CMRR NF or any similar nuclear facility, would be either a) to produce, or to create the option to produce, *new-design* ("replacement") pits and primaries *in large quantities, on relatively short notice*, or b) to maintain continuous large-scale pit production, and to do so with all plutonium-related pit activities occurring at LANL alone.

39. New-design ("replacement") pits could be produced at LANL today, and in large quantities over time – but not *both* quickly *and* in large quantities, and not without postponing or curtailing other LANL programs.

40. Preparing for even *possible* certification and production of new-design primaries is a markedly distinct and more expensive policy than indefinitely maintaining the presently-deployed suite of nuclear primaries and the large, diverse stockpile they enable. Setting aside serious questions concerning the confidence which could be accorded to untested primaries, creating the *option* of producing them on relatively short notice has great policy and fiscal implications, the beginning of which we are seeing today. *Actual* production would have *additional* fiscal and policy implications.

41. It is not clear that certification of new-design primaries could ever be unambiguous, objective, confident, or permanent in the absence of nuclear testing. In addition to technical questions regarding certifying and deploying untested primaries in what would then be, by definition, new-design warheads, confidence in such primaries and the weapons containing them would also cryptically depend on institutional, social, and political factors *which could change*, and change unpredictably, even after deployment, potentially impacting perceived deterrent value (and future budgets) in unpredictable ways. Confidence in untested physics packages could be become undermined or even lost entirely by post-deployment doubts and concerns, *whether well-founded or not*.

42. In 2008 the JASONs reviewed the success to date of, and prognosis for, the NNSA's Life Extension Programs (LEPs). Supplementing their earlier findings on pit lifetimes, they found that the reliability of existing warheads could be extended for "decades, with no anticipated loss of confidence, by using approaches similar to those employed in LEPs to date," i.e. without pit manufacture.

43. Further, the JASONs found that all the currently-proposed (controversial) additional surety features for air-carried warheads and bombs (B61-3, -4, -7, -10, and -11, W80-0 and -1, and B83-0 and -1) could be implemented by component re-use, i.e. without pit production. *Some* of the intrinsic surety features proposed for re-entry weapon systems (W78, W87, W76-0/1, and W88) could be implemented without pit production, while others would require new components, presumably including new-design pits.

    As the JASONs noted, the supposed benefits of these surety technologies remain to be evaluated "in the context of the nuclear weapons enterprise as a system." Innovations meant to provide more warhead surety will also have surety *costs* to the enterprise as a whole. Both costs and benefits must be examined to see whether there would be a net gain in surety from the proposed innovation. The prospect of real, net surety gains overall appears highly dubious.

    It is very far from clear why even entirely new gravity bombs, new reentry vehicles, or new delivery systems generally (as might be contemplated in some hypothetical future nuclear posture), would require either new-made or new-design pits. A wide spectrum of long-lived options within present nuclear "design space" already exists.

    There are bounding physical limits to future geometries and masses, not even considering issues of design confidence. The physical parameters of new-design primaries will be constrained just like the present ones are.

44. The U.S. nuclear arsenal can be most reliably, safely, and securely maintained in the form of a declining subset of existing warhead types maintained by LEPs without physics package innovations, including innovations in primaries or pits. The quest to confidently and permanently certify new-design primaries may fail unexpectedly, *after deployment*. This quest is perilous, expensive, and unnecessary, provides no security value, and should not be joined. New-design ("replacement") primaries should never be placed in the stockpile.

45. Pit production at more than pilot scale may be difficult to achieve or may even be infeasible, without a more widely-accepted mission need, broader community and internal institutional support, and greater freedom from fiscal constraints than are likely to be available over the next decade.

    Success might ultimately also require formal or informal suspension of some worker safety and environmental regulations. This would be described as removing excessive, redundant, or punitive regulations, streamlining compliance, and so on.

46. The large, decade-or-more-long, capital investments required to significantly increase present pit production capacity may not be sustainable in the face of other societal needs and anticipated future budget shortfalls. These capital investments require significant sacrifices in other DOE and Energy and Water Appropriations line items. Operating costs will also increase if stockpile pit production is begun in earnest.

47. For these reasons and others, attempts to increase production capacity via major new infrastructure, or attempts to meet higher pit production goals (with or without new capacity), carry significant management risks.

    Attempts to either create, or to exercise, *too great* a capacity may damage *any* capacity as funds, social tolerance, management attention, skilled staff, and political support for NNSA missions (and mistakes) are limited. Further, each of these is limited to an unknown – and changing – degree. Hubris is dangerous.

48. We believe the present decade will be one of great historical change, including a decline in U.S. influence in part due to this country's declining economic position, in which the cost of our grossly outsized military commitments have played, and continue to play, an important causal role. This decade, even more than the last, poses significant fiscal and management risk for complex nuclear endeavors with poor justifications and limited political support, as is the case for pit production and expansion of its infrastructure.

49. For the above reasons and others to follow *it is difficult to believe that the U.S. would ever produce and deploy new-design pits in any quantity for the foreseeable future*, i.e. until beyond today's planning horizons, *regardless of any preliminary decision that might be made to do so this year or next*. *<u>Reality will intrude</u>*.

50. Stockpile reductions (both those ordered by the Bush Administration and those which may be ordered in the future) will provide additional backup warheads and pits, as well as other spare components within a given warhead type.

51. Stockpile reductions may also increase pit re-use options by increasing the number of extra pits available from dismantlement for pit reuse and by decreasing the number of warheads which might need them.

52. Stockpile reductions also decrease the maximum scale of any contingency production plans and decrease the potential variety of pits that might need replacement. If an entire warhead type is retired there is obviously no need for backups, life extensions, or any contingent production planning for that type.

53. "Making" fully-tested and fully-certified (or easily re-certifiable) pits via dismantlement has almost no marginal cost above the expense of dismantlement itself. Unlike pit production, making pits by dismantlement has no lead time, requires little or no new infrastructure or additional staff, and has no (marginal) environmental impact at all.

54. The diplomatic demand for mutual nuclear disarmament waxes and wanes but never fully disappears, if for no other reason than because the present distribution of nuclear weapons among states is objectively unstable. That distribution must and will give way either to further nuclear proliferation, to further disarmament, or some combination of both.

    Widespread nuclear proliferation is universally feared, in part because it would be very unstable and even possibly incompatible with human survival, given the expected short-term climate impacts of even a "small" nuclear exchange.

55. It is often forgotten in U.S. nuclear planning circles that nuclear deterrence is a far less sure defensive posture than mutual disarmament. Nuclear deterrence only exists in certain situations if it can be truly said to exist at all; it is not stable with respect to many factors beyond national control. In the final analysis deterrence really only lies in the fickle eye of the beholder. It is not *our* nuclear weapons which make us safe from nuclear attack, but rather the *absence* of the other guy's nuclear weapons.

    More-or-less universal recognition of these facts and critical uncertainties creates significant perennial diplomatic pressure for nuclear disarmament. It never goes away because it arises from immutable, transcendent realities affecting the self-interest of states and peoples. These realities are independent of any law or treaty, all national policy, any leader's political persuasion or opinion, any particular country's security situation, any particular diplomatic or public relations initiative, all public opinion, and all media coverage or its lack.

For these reasons permanent maintenance of large nuclear arsenals is fundamentally incompatible with long-term nonproliferation success.

This is a fact, not a policy. It has received legal expression in Article VI of the Nuclear Nonproliferation Treaty (NPT), where it is usually described as the result of a diplomat "bargain." It is more than that, for the reasons above.

56. The U.S. has a widely-recognized legal obligation, already adjudicated in a unanimous decision within the 1996 advisory opinion of the International Court of Justice (ICJ), to complete a process of mutual nuclear disarmament, and in the meantime to proceed in "good faith," as Article VI of the NPT says, toward mutual nuclear abolition.

57. Those states which maintain large nuclear arsenals without conspicuous and unambiguous disarmament progress will find nonproliferation leadership very difficult. They will have a credibility problem which no diplomatic effort can overcome.

58. The political need and legal requirement for nuclear disarmament "brackets" all long-term stockpile maintenance considerations, including pit management strategies, making them hypothetical when applied to distant years. There is nothing deterministic or predictable about the so-called "need" in future years for any particular pit type or number of pits. To repeat, this is not a matter of policy but of fact.

59. Hypothetical, "far-future" technical issues are irrelevant for present planning and policy to the extent there is surveillance in place capable of providing enough lead time to fully respond to the hypothetical future emergency. More information pertinent to the necessary response – to its nature, scale, and urgency – will be available at that time than is available now.

60. It would be irrational to even think about fixing hypothetical problems which might, at the earliest, arise farther in the future than the time needed for all the preparations required to respond to them.

61. We believe, based on the best information available to us, that a *completed* campaign of *large-scale* pit production, enough to replace any pit type in the quantity currently deployed, could be conducted within a decade from first warning, using only existing and soon-to-be-completed facilities *if there were a widely-perceived serious need*. Smaller campaigns could be completed more quickly, easily, and cheaply, but again only *if there were a widely-perceived need*.

    The U.S. has not seen such a mobilization since the 1980s, when it was part of a conscious policy to rapidly increase the nuclear stockpile in both number and kind. Present NNSA culture does not reflect such a mobilization because there is no need for it, and neither Congress nor voters would be likely to accept one in any case.

    Given the many options available for pit management short of new production, and given present and future pit reserves, such mobilization will never be needed, barring a policy to dramatically increase the nuclear arsenal beyond that available from present reserves.

62. Approximately half of all U.S. nuclear warheads have completed a LEP in this decade (W87, B61-7 and -11), or else have a LEP underway (W76). By 2022, when the W76 LEP is slated to be complete, approximately three-fourths of the total U.S. stockpile (including reserves) is likely to have been through the LEP "major overhaul and upgrade" process. The fraction LEPed by 2022 would be greater, all things being equal, if the stockpile were reduced. Each warhead LEPed will not need to another LEP for at least two decades.

63. The Obama Administration has said it will not seek to certify or produce "replacement" warheads involving new pits – leaving, however, the door to novel replacement warheads open for later. Should this "no new pits" policy be reversed, for reasons presently unforeseen, the earliest date at which NNSA could realistically begin producing such pits is probably at least 2016, given that internal and congressional debate, authorization, and funding, and then warhead design and certification, and only after these, pit production trials, must precede actual stockpile production. Even then stockpile production could not proceed at a large scale quickly without displacing other LANL programs. Initial production could precede CMRR NF operation (currently estimated for 2022), but long-term rapid production would require CMRR NF unless other current tenant programs in the existing plutonium facility were moved or terminated.

    Under current plans, most of stockpile will have been LEPed by the end of this decade and given 20-30 years of additional shelf life without the new-design pits CMRR NF would help produce.

    As discussed in the companion paper on CMRR NF, NNSA will not receive, and Congress will not be presented, a cost and schedule "performance baseline" for CMRR NF this year. Decision-critical data may not be available next year either.

    It therefore appears that any decision to proceed with CMRR NF implies a decision to create an option to produce relatively large numbers of new primaries for the *second round* of warhead LEPs.

64. NNSA, its contractors, and their predecessors have learned a great deal about plutonium and plutonium pits since 1940, and the use of plutonium in nuclear explosives is a mature subject in the U.S. There are relatively few practical questions which remain unanswered; most if not all of these questions have been enumerated by the JASONs.

    Pit surveillance is very important and should be carefully continued and enhanced. Aging studies should continue, but these and other lines of technical research should be narrowly focused and goal-oriented. Research should address key practical concerns in order to a) retain high confidence, b) lower costs where possible, and c) increase overall technical quality in the program, morale, and safety.

65. Building additional production capacity has a diplomatic cost. Even "paper" contingency plans to create higher production levels would have some diplomatic cost. Diplomatic costs are real national security costs. The *net marginal national security benefit* of even *creating the option* to make new-design primaries quickly and in large quantities cannot be evaluated independently of the diplomatic costs of such a decision. There will also be fiscal impacts, in national security programs and elsewhere.

66. At present, pit management policy discussions are cryptically interwoven with purely political issues related to potential Senate ratification of the still-pending START

replacement treaty (START-R) as well as a possible attempt in this administration to ratify the Comprehensive Test Ban Treaty (CTBT), both of which would require the support of nearly one-fourth of all Senate Republicans.

Conflating pure political deal-making with technical and management issues will almost surely result in poor management outcomes and poor political outcomes, *both*.

Prominent among stated Republican demands is "[f]ull funding for the timely replacement of the Los Alamos plutonium research and development and analytical chemistry facility…and a modern pit facility." Since NNSA is currently well-along toward completing the CMRR Radiological Laboratory, Utility, and Office Building (RLUOB), *which will significantly exceed the size and capabilities of the present LANL analytical chemistry infrastructure*, and since NNSA has also begun a multi-hundred-million-dollar modernization project at LANL's main pit production facility (the TA-55 Reinvestment Project, or TRP), it could be argued that Republican demands are being met without the $3+ billion CMRR NF. Only Republicans can clarify their demands, however.

Republican demands could be "clarified" (upward) to include the CMRR NF. Significantly, the size and capabilities of the CMRR NF are not yet firmly fixed. Preliminary design has not been completed. Until a performance baseline is published the CMRR NF is a "pig in a poke."

The Republican demand for a "modern pit facility" could be clarified upward even further to include additional plutonium facilities beyond CMRR NF as that project is understood today, some provision for which has already been made in site planning and CMRR design (both).

67. Pit management policy discussions are also interwoven with concerns about the long-term stability of institutional knowledge and the plutonium skill base at LANL, as well as issues of recruitment and morale. These are real issues. In our view, make-work projects, such as making a few more W88 pits for the stockpile, have limited long-term value in attracting, motivating, focusing, and retaining skilled, safe plutonium workers.

    A narrowly-focused plutonium and pit curatorship mission, suggested by the JASONs in 1994, as applied to a declining stockpile, and also contributing to disarmament, nonproliferation, waste management, and the safety of all the above, would appropriately sharpen skills and allow for "right-sizing" the overall scale of the program for the longer run. Failing to right-size the program will (continue to) damage morale.

68. U.S. nuclear warheads are more than adequately reliable and barring gross management failure will remain that way indefinitely.

69. In the final analysis stockpile "confidence," given adequate custodial care, is not primarily limited by technical issues related to either warheads or weapon systems overall. "Confidence" is rather, at root, a more integrative concern that requires confidence in the wisdom and sustainability of nuclear weapons policies generally. Such confidence is and will remain elusive, because nuclear weapons have never acquired, nor will they acquire, more than provisional domestic and international legitimacy. Stockpile "confidence" is now conflated with the credibility of nuclear deterrence itself, which is uncertain for reasons far beyond NNSA's control. Technical assurance will not be improved by any confusion between it and the ongoing quest for credibility and relevance in nuclear deterrence.

"Confidence" can be maximized (and lack of confidence minimized) through NNSA management by placing nuclear sustainment within a broader context of mutual disarmament and nonproliferation. The latter goals enjoy far greater societal confidence here and abroad than nuclear sustainment, let alone nuclear modernization.

Following this logic, stockpile confidence and ease of management in all its aspects can and should be maximized by policies that *prudently minimize* expenditures to support a *declining arsenal* with *declining roles*. Apart from planning and underlying maintenance, potential far-future policy reversals and stockpile contingencies should be treated as what they are – distant and remote possibilities. Only real needs should incur real expenses. The country has plenty of them.

70. Routine stockpile pit production would have diplomatic, safety, and fiscal impacts, would serve no rational purpose in the absence of a decision to produce new-design primaries, and should not be done.

71. Modest production capability can and should be maintained in existing and soon-to-be-completed facilities by the production of a small number of undeployed test pits of existing designs, by enhanced pit surveillance and testing, and by other plutonium programs, especially in nonproliferation and waste management.

72. With sound direction and management, a small cadre of dedicated production and curatorship experts amidst a somewhat larger cohort of plutonium workers involved in a suite of co-located programs at LANL, Lawrence Livermore National Laboratory (LLNL), and the Savannah River Site (SRS) could comprise a stable and if necessary expansible workforce. They must be appropriately selected, motivated and supported within a revised nuclear security mission.

73. Efforts should be redoubled to make the LANL pit facility and its support facilities safer, abandoning the major fiscal and managerial distraction of attempting to build a major new nuclear facility for plutonium. Safe operations are the only sustainable ones and are the only firm basis for realistic contingency plans of any kind. Greater and more prompt attention should be paid to the advice of the Defense Nuclear Facilities Safety Board (DNFSB) than is presently the case.

74. Pit re-use options within and across warhead types should be recognized, protected, and if desired enhanced as the stockpile declines, but pit re-use options should only be exercised as a last resort – especially pit re-use across type. It is certainly far cheaper to store pits than to make new ones or build the facilities to do so.

75. If breakout capacity is desired, contingency plans could be developed. These plans would involve the contingent reprioritization of available funding and infrastructure space, and could be revised annually in the light of new information and evolving policies, including stockpile declines and infrastructure status across the NNSA complex.

76. The capable, large, and relatively problem-free LLNL "Superblock" and its supporting facilities and workforce can and should be retained. It should not be irreversibly transitioned from a Hazard Category II status until and unless it is clear that the (smaller, more expensive) CMRR NF will not be built. It makes no sense to close a modern, operational facility while attempting to build a smaller, but far more expensive one slated to come on line a full decade hence.

Short background and key definitions

The aim of this short study is to provide policy and management recommendations. It is normative, not merely descriptive, and it is focused only on the United States. It will be brief and without a wealth of detail, although we strive not to be conclusory. We invite questions and further discussion.

A "pit," in nuclear vernacular, is the core of an implosion-based nuclear explosive. In the multi-stage explosives used in all U.S. nuclear warheads and bombs, the pit is the core of the initial fission stage (the "primary"), which nominally consists of the pit, an explosive system consisting of high explosive (HE), sometimes called conventional high explosive (CHE), or insensitive high explosive (IHE), and includes detonators, for symmetrically imploding the pit into a spherically-symmetric mass of concentric layers, a boost gas system that injects a mixture of tritium and deuterium into the innermost hollow core of the pit, and one or more neutron generators to irradiate the imploded fissile material with neutrons, which provide control and predictability to the timing and rate of the initial fission reactions.

Warheads are fitted to missiles for delivery and (gravity) bombs are dropped. In this paper both are sometimes collectively called "warheads," for convenience.

Plutonium-238 is the usual main fissile material in a pit because of its relatively low critical mass and consequent small pit size, which implies less high explosive and a smaller and less massive primary overall. Lighter primaries are heated to greater temperatures with a given energy yield and thus supply much greater X-ray flux per unit yield, and so have a much greater ability, again per unit yield, to compress and ignite a second nuclear explosive stage (the "secondary").

Secondaries yield energy by both fission and much more powerful fusion reactions, and also produce large amounts of neutrons that cause fission in the warhead's radiation case, if desired. So the secondary stage, if used, provides by far the greater part of a warhead's energy. Other things being equal, higher yields (and higher yield-to-weight ratios) require larger secondaries. Small-diameter primaries allow placement forward rather than aft in conical reentry vehicles, maximizing space for the secondary and thus maximizing yield.

The portion of primary yield over and above that necessary to compress and ignite the secondary is the performance margin (or simply margin) of the warhead. Often loosely spoken of as a property of the primary alone, performance margin is really a function of the relationship between the implosion requirements of the secondary, the yield of the primary, and the efficiency with which the energy of the primary is provided to the secondary. Performance margins can be increased by increasing primary yield, e.g. by more frequently replacing the tritium, which decays, in the boost gas, or at least in principle if not in practice, by decreasing the primary yield needed.

All aspects of nuclear weapons design are classified, but design details are generally unimportant for policy discussions. Not just a few but many different and divergent pit designs are possible.[1] Pits are highly-symmetric objects of simple, concentric design with exacting dimensional tolerances and material properties. Small-diameter pits have been made since the mid-1950s

[1] Conversation with Theodore Taylor, 1998.

with ellipsoidal, rather than spherical symmetry, facilitating forward placement in conical reentry vehicles.[2]

Boosting greatly enhances primary yield by supplying a large neutron flux (produced by fusion reactions in the boost gas) to the fission reactions in the imploded pit. All U.S. primaries are boosted and all have a pit tube by which the boost gas is conveyed to the central pit cavity.

Since boosting requires minimum conditions of temperature and pressure, created by the initial fission reactions, all boosted primaries also have at least one inherent unboosted yield, which could be produced by disabling the boost gas system.

Despite its higher critical mass, highly-enriched uranium (HEU) has also been used as the primary fissile material in implosive primaries, and other fissile materials could also be used as well. All deployed U.S. nuclear primaries employ plutonium.[3] HEU components may also be present[4] as well as other isotopic mixtures and alloys. Beryllium, other metals, and ceramics may be present. The outermost pit layer is probably stainless steel in most if not all cases; the innermost shell must be the fissile material.

Nuclear warheads and bombs consist of not just a nuclear explosive (device, physics package or nuclear explosive package) but also specific weaponization features and components, which together account for the majority of warhead or bomb parts and systems. The B83 bomb contains some 6,519 parts, of which only 219 (3%) are found in the physics package.[5]

Warhead surety is an important if imprecise term that refers to either the safety or security features of a warhead or both. Intrinsic surety refers to that increment of surety enabled by the physics package itself, as opposed to devices external to it.

A warhead or bomb, integrated with a delivery vehicle such as a missile or airplane, becomes a nuclear weapon. A nuclear weapon with an associated launch platform (e.g. a submarine, or B-52 bomber for cruise missiles) and supported by command, control, targeting, and other supportive functions becomes a functional nuclear weapon system.

Changes in any part of a nuclear weapon system, e.g. technical or institutional innovations, improvements, or degradations, will change how that weapon system might be used, i.e. change perceptions of that system's military utility or "capability," which doesn't really have a precise

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[2] Sybil Francis, "Warhead Politics: Livermore and the Competitive System of Nuclear Weapons Design," 1995 doctoral dissertation, cited in Andre Gsponer and Jean-Pierre Hurni, *Fourth Generation Nuclear Weapons*, sixth ed. 1999, International Network of Engineers and Scientists Against Proliferation (INESAP).

[3] Jon Medalia, Congressional Research Service "Nuclear Warhead 'Pit' Production: Background and Issues for Congress," RL31993, updated March 29, 2004, p. 1.

[4] LANL, "Nuclear Facilities Master Plan for Stockpile Stewardship and Management Support," July 1996, prepared by Lockwood Greene Technologies and Los Alamos Technical Associates, at p. 5-5, under "Disassemble pit:" Oralloy [i.e. HEU] [pit] components may be reduced to oxide before packaging for transport [to another site]." Los Alamos Study Group files. See also *Draft Supplemental Programmatic Environmental Impact Statement on Stockpile Stewardship and Management for a Modern Pit Facility*, DOE/EIS-236-S2, p. A-5: "[Plutonium] castings would then be machined to proper dimensions, combined with other non-plutonium parts including beryllium and *enriched uranium components* and would be assembled into pits." Study Group files, emphasis added.

[5] Sandia National Laboratories, photograph and data October 1996 and April 1997; cited by Jon Medalia, ………….. Congressional Research Service, p. 62.

meaning. The required performance specifications of a particular warhead or bomb are its military characteristics.

Prior to deployment by the Department of Defense (DoD), warheads are designed and built at the eight sites in the nuclear warhead complex administered by the National Nuclear Security Administration (NNSA), a semi-autonomous part of the Department of Energy (DOE). Three of these sites, Los Alamos National Laboratory (LANL), the Savannah River Site (SRS), and Lawrence Livermore National Laboratory (LLNL), currently have various plutonium processing capabilities. At all three sites these capabilities are currently in flux to one degree or another. LANL is the sole designated site for stockpile pit manufacture and therefore is the primary geographic focus of this paper.

A fourth site, Pantex, has extensive pit storage facilities as well as facilities for the requalification of pits taken from dismantled warheads and bombs, but no capability for plutonium processing or intrusive pit modification.

Pits may typically contain roughly twenty-five (25) parts, of which just three are made of plutonium.[6] Manufacture of non-plutonium pit parts and final pit assembly need not occur in a plutonium facility and at least in the latter years did not occur in such a facility at Rocky Flats.[7] This is because the plutonium hemi-shells, once they are welded together and plated with a relatively inert metal (originally nickel and now more likely gold [ref]) and joined with the pit tube, can be handled with relative safety as the rest of pit is assembled.

Pit manufacture has been described by LANL as having ten component processes:[8]

1. Receive, inspect, assay, and store old pits
2. Disassemble old pits
3. Recover, process, and prepare metal
4. Cast and machine new plutonium pit
5. Fabricate other pit components
6. Measure and certify components
7. Assemble new pit
8. Ship or store new pit
9. Recover scrap and residues
10. Manage wastes and effluents

Not all these activities need take place at the same physical location or geographic site. For example activities 1-3 could take place at one site, 4 and part of 6 at another, 5 and the other part of 6 at many potential sites, and 7 and 8 at another location within the same geographic site as 4.

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[6] May 2, 1996 interview with Richard Mah, cited in "Nuclear Facilities Master Plan for Stockpile Stewardship and Management Support," op. cit., at p. 98.

[7] Ibid., same interview, and author's interview with a former Rocky Flats production supervisor in 2004.

[8] Ibid, Figure 2-3.

		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	N&K Estimated 2009 Stockpile: Estimated Deployed Active Stockpile in 2009, not including spares	N&K 2007 Estimate for 2012 Stockpile Showing Estimated SORT Reductions, Prior to any further Obama Reductions: Estimated Active Deployed in 2012 [10]	Spares, Active Non-deployed, & Inactive (w/o boost gas) [7]	Estimated Total in 2012	Life Extension Program dates	Warheads N&K estimate will be dismantled from 2007 under SORT, not including W84 and W62. Equals pits liberated. [11]	N&K estimate of reserve warheads, plus reserve pits under SORT, as % of Active Deployed, by warhead, delivery system, and overall. [4]		
Gravity bombs and cruise missiles	"Non-strategic" bombs	B61-3	"Non-strategic"	200	186	386	400	200	50	250	? [2]	136	98%	342%	246%
		B61-4		200	204	404		200	50	250	? [2]	154			
		B61-10		0	206	206	0	0	0	0	? [2]	206			
	Cruise missile Ws	W80-0		100	189	289	100	0	0	0	2013-2017	289	598%		
		W80-1	"Strategic"	1,452	354	1,806	350	300	228	528		1,278			
	"Strategic" gravity bombs	B61-7		215	224	439	150 w/ B83-1	120	300	420	2006-2009	19	243%	360%	
		B61-11		20	21	41		20	15	35		6			
		B83-0		0	298	298	0	0	293	293	2010-2017	5	524%		
		B83-1		323	3	326	See B61-7/11	100	220	320		6			
Re-entry systems	ICBM warheads	W78		550	244	794	350	200	200	400	? [3]	394	297%	169%	
		W87		50	502	552	200	300	247	547	1999-2005	5	84%		
	SLBM warheads	W76		1,344	1,686	3,030	0	122	1,252	1,374	2009-2021	1,010	295%	198%	
		W76-1		0	0	0	768	646	0	646		0			
		W88		384	20	404	384	384	20	404	? [3][5]	0	5%		
		Totals		**4,838**	**4,137**	**8,975**	**2,702**	**2,592**	**2,875**	**5,467**		**3,508**			
		"Strategic"		4,338	3,352	7,690	2,202	2,192	2,775	4,967					
		"Non-strategic"		500	785	1,285	500	400	100	500					
		W62		325	255	580	0					580			
		W84		0	383	383	0					383			
		Total Stockpile		**5,163**	**4,775**	**9,938**									
				Total added to dismantlement queue since 2007								**4,471**			

Notes to Table

1. Stan Norris and Hans Kristensen, "The U.S. nuclear stockpile, today and tomorrow," and "U.S. Nuclear Forces, 2009," *Bulletin of the Atomic Scientists* Sept./Oct. 2007 and Mar./Apr. 2009.
2. Pit re-use is being considered for a new warhead to replace the B61-3, 4, 7, and 10, the proposed B61-12. See for example Todd Jacobsen, "Administration ramps up pressure for zeroed out B61 funding," *Nuclear Weapons and Materials Monitor*, August 31, 2009, p. 2.
3. A possible highly-intrusive joint LEP, or new warhead, to wholly or partially replace the W78 and W88 is reportedly being considered. Elaine Grossman, "Pentagon Eyes Shared Modernization package for Navy, Air Force Warheads," December 24, 2009, Global Security Newswire,
4. Does not include pits in current surplus inventory, about 15,000. Less pits destroyed in surveillance.
5. House appropriators suggested retiring this warhead in their FY2008 report.
6. Jim McBride, Amarillo Globe News, Jan 29, 2009, "Pantex may hit storage limit in 2014," http://www.amarillo.com/stories/012909/new_12389377.shtml.
7. Neither SORT nor START formally distinguish between two kinds of non-deployed warheads and bombs: active (i.e. quickly deployable) and inactive (requiring tritium). Neither treaty addresses tactical warheads and bombs. Neither treaty requires dismantlement.
8. W62 retirement should be complete during FY2010. See http://www.fas.org/blog/ssp/2009/10/w62.php. Also, see FY2010 CBR Vol. 1 p. 81: "In FY 2010, a final annual assessment report and dismantlement activities will be accomplished under the Weapon Dismantlement and Disposition Program." W62 Stockpile Systems FY2008: $2,122; FY2009: $1,596; FY2010: $0.
9. No funding for maintaining W84s is included in the FY2010 Stockpile Systems funding line; all FY2010 W84 funding is for dismantlement. In FY2009 there were still W84s in the inactive stockpile receiving at least some Directed Stockpile funding.
10. In 2009, N&K changed their 2012 assumptions to retain 100 W80-0 SLCM warheads.
11. Resulting pit inventories will decline about 1 pit per year per type, as destroyed during surveillance.

Stockpile life extension programs (LEPs) and resulting longevity Greg Mello, Los Alamos Study Group, 1/21/10, 505-265-1200

Warhead (W) or Bomb (B) Type		Explosive yield(s), kilotons[1]	Estimated Active Deployed in 2012, prior to any Obama reductions[2]	Spares, Active Non-deployed, Inactive (w/o boost gas)[3]	Estimate d Total in 2012	Life Extension Program dates where known	Earliest possible second LEP dates. Could be later. Assumes not retired.	Notes
B61-3	"Non-strategic"	0.3 - 170	200	50	250	?[4]	?	Controversial proposed B61-12; nature and schedule of LEP unknown. Said to be tied to F-35 design schedule. Despite official disclaimers, new military capabilities (bomb, delivery system) are evidently sought. See and compare references provided.
B61-4		0.3 - 45	200	50	250			
B61-10		0.3 - 80	0	0	0			
W80-0		5, 170-200	0	0	0	2013-2017	2033-2,037	If LEP goes forward, second LEP appears beyond current planning horizon. Forthcoming Nuclear Posture Review may retire W80-0.
W80-1	"Strategic"	5, 15-170	300	228	528			
B61-7		0.3 - 340	120	300	420	2006-2009	2026-2,029	Second LEP appears beyond current planning horizon.
B61-11		0.3 - 340	20	15	35			
B83-0		Low - 1,200	0	293	293	2010-2017	2030-2,037	If LEP goes forward, second LEP appears beyond current planning horizon.
B83-1		Low - 1,200	100	220	320			
W78		335-350	200	200	400	?[5]	?	No rush, given plenty of refurbished W87s of nominally equal yield.
W87		300, 475 if upgraded	300	247	547	1999-2005	2019-2025	
W76		100	122	1,252	1,374	2009-2021	2,039[6] 2,051	Sandia National Laboratories (SNL) says LEP could last 60 years.[7]
W76-1		100	646	0	646			
W88		475	384	20	404	?[8]	?	Newest warhead in stockpile; scheduled last among LEPs in 1998.
Totals			**2,592**	**2,875**	**5,467**			

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[1] Estimates from Carey Sublette, derivative from Chuck Hansen, NRDC, others. At http://www.nuclearweaponarchive.org/Usa/Weapons/Allbombs.html. Not all yields shown.

[2] All three stockpile columns are estimates by Stan Norris and Hans Kristensen, "The U.S. nuclear stockpile, today and tomorrow," *Bulletin of the Atomic Scientists* Sept./Oct. 2007, http://thebulletin.metapress.com/content/3605g0m20h18877w/fulltext.pdf.

[3] The disparate categories mentioned are lumped together for lack of open-source data.

[4] Some key references include Todd Jacobsen, "Administration ramps up pressure for zeroed out B61 funding," *Nuclear Weapons and Materials Monitor* (NWMM), August 31, 2009, p. 2, and other NWMM; DOE FY2010 Congressional Budget Request, Vol. 1 (NNSA), p. 74; Elaine Grossman, “U.S. Air Force Might Modify Nuclear Bomb,” *Global Security Newswire*, 9/26/08, at http://www.nti.org/d_newswire/issues/2008_9_26.html#B8705677; Jeffrey Lewis, “B61 Mod 12 LEP,” October 13, 2008, at http://www.armscontrolwonk.com/2060/b61-mod-12-lep; and Marko Beljac, “B61-12 LEP or WR-2,” Nuke Strategy Wonk (blog), October 15, 2008, at http://scisec.net/?p=62.

[5] Elaine Grossman, "Pentagon Eyes Shared Modernization package for Navy, Air Force Warheads," December 24, 2009, Global Security Newswire, http://www.globalsecuritynewswire.org/gsn/nw_20091224_5161.php.

[6] Thirty years: http://nnsa.energy.gov/defense_programs/life_extension_programs.htm.

[7] Bill Murphy, *Sandia Lab News*, December 4, 2009, http://www.sandia.gov/LabNews/091204.html, p. 4.

[8] House appropriators suggested retiring this warhead in their FY2008 report. See also note 4. See DOE, *Stockpile Stewardship and Management Plan: Second Annual Update*, April 1998, p. 1-7, for proposed W88 LEP details and scheduling. Details and scheduling for other LEPs as of that date are also provided.

Heuristic pit management options

<table>
<tr><th colspan="2">Current pit disposition</th><th>Overall management category or class of action</th><th>Certifica-tion risk</th><th colspan="2">Active management options, subjectively ranked by approximate added certification risk</th></tr>
<tr><td rowspan="15">In active warheads</td><td rowspan="7">Deployed and spares</td><td rowspan="15">Active management and pit surveillance as part of active management of warhead or bomb.

All non-retirement options have significant overhead cost per type and per warhead.

Unit costs vary widely with action taken.

Intrusive, higher-risk management options have dramatically higher investment thresholds and unit costs.

Even creating the option for these higher-risk actions is very costly in the case of pits and primaries, in both design and production.

Higher-risk management actions are associated with more dramatic warhead adaptations and changes, which are in turn associated with new military capabilities and enhanced perceived military utility (PMU).</td><td rowspan="4">Very low</td><td colspan="2">Retire warhead</td></tr>
<tr><td colspan="2">LEP, change non-nuclear components</td></tr>
<tr><td colspan="2">LEP, primary and secondary hydrodynamics unchanged (e.g. adapt existing warhead to new delivery system, according to LANL)</td></tr>
<tr><td colspan="2">[Placeholder for possible classified option(s), LANL]</td></tr>
<tr><td rowspan="3">Low</td><td colspan="2">LEP, integral primary components, e.g. HE, unchanged.</td></tr>
<tr><td colspan="2">LEP, pit unchanged. Includes pit re-use within type. According to LANL, reducing yield of secondary and “modest” engineering changes also have low risk.</td></tr>
<tr><td colspan="2">[Placeholder for possible classified option(s), LANL]</td></tr>
<tr><td rowspan="8">Non-deployed</td><td rowspan="6">Medium</td><td colspan="2">Pit re-use with intrusive modification, within type</td></tr>
<tr><td rowspan="2">Pit re-use across type</td><td>w/o modification</td></tr>
<tr><td>w/ modification</td></tr>
<tr><td colspan="2">Reactivating inactive warhead, with a variety of upgrades and certifications required (hard to categorize risk; could be low, medium, or even high)</td></tr>
<tr><td colspan="2">New build of existing type, including new nuclear components, including pits, with process certifications</td></tr>
<tr><td colspan="2">[Placeholder for possible classified options, LANL]</td></tr>
<tr><td rowspan="2">High</td><td colspan="2">New build of existing components, including pits, for use in new combinations, i.e. new design</td></tr>
<tr><td colspan="2">Build new-design, untested, unproduced warhead</td></tr>
</table>

<table>
<tr><td colspan="3">In inactive non-deployed warheads</td><td colspan="2">Passive storage, surveillance, conservation until warhead enters dismantlement queue or is reactivated; little cost</td></tr>
<tr><td colspan="3">In warheads in dismantlement queue</td><td colspan="2">Passive storage, pit surveillance, conservation until dismantled; little marginal cost/pit, as for inactive</td></tr>
<tr><td rowspan="6">Stored</td><td rowspan="2">Re-usable if desired</td><td>With no PMU decrement</td><td colspan="2" rowspan="2">Passive storage, pit surveillance, conservation as needed at little or no marginal cost/pit</td></tr>
<tr><td>With possible PMU decrement</td></tr>
<tr><td colspan="2" rowspan="4">Unusable or unwanted pits, no quality surveillance needed. Denature if desired.</td><td rowspan="3">Dispose (or “use” in MOX)</td><td>Direct disposal of denatured pits (least cost)</td></tr>
<tr><td>Vitrify (higher cost)</td></tr>
<tr><td>MOX (highest cost)</td></tr>
<tr><td>Recycle within weapons program</td><td>Research, test pits, or new production</td></tr>
</table>

Chart by Greg Mello, Los Alamos Study Group, January 21, 2010. 505-265-1200, gmello@lasg.org

Abbreviations and references: PMU, perceived military utility; LEP, life extension program; LANL, Los Alamos National Laboratory; MOX, mixed-oxide (nuclear) fuel; HE, high explosive. The LANL views are from “The U.S. Nuclear Stockpile: Looking Ahead: Drivers of, and Limits to, Change in a Test-Constrained Nuclear Stockpile,” March 1999, SRD redacted in FOIA response to Los Alamos Study Group, p. 20, http://www.lasg.org/Change_in_a_test-constrained_stockpile.pdf. LEP risks are known to be controllable; see JASON, “Lifetime Extension Program (LEP) Executive Summary” JSR-09-334E, 9/9/09, www.armscontrolwonk.com/file_download/213/JASON_LEP.pdf. Other interpretations are author’s. The phrase “added certification risk” means in addition to changes in performance margin. Using such a ranking by itself in effect assumes margins are adequate, as they have been declared to be. Achieving greater margins can risk certification confidence.