U.S. Nuclear Weapons Research and Development under the Comprehensive Test Ban Treaty

by

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INTRODUCTION

U.S. nuclear weapons policy, as currently implemented by the Department of Energy (DOE) Stockpile Stewardship and Management Program (SSMP), seeks to retain Cold War capabilities and develop new ones. In this paper we focus on the emerging technical capabilities of the United States to design and certify nuclear weapons absent underground testing with super-critical assemblies of fissile material. Recently-available government documents depict a strategy for acquiring advanced research facilities which moves in this direction. Details are also now emerging about the Submarine Launched Ballistic Missile Warhead Protection Program, a joint DOE/Department of Defense (DoD) initiative to design and certify "replacement" warheads for the currently deployed Trident strategic weapon systems. A discussion of x-ray laser research in the SSMP is given, both as an example of the scientific work supporting warhead certification under the CTBT and as an example of continuing advanced nuclear weapon design activities.

SSMP CERTIFICATION OF WEAPONS

The DOE defines certification as to "render judgment on the ability of weapons or their components to perform their functions as defined by military requirements."[1] Two reports play a significant role in the certification process: the *Major Assembly Release* and the *Final Warhead Development Report.* "[Certification] is initially reported in the weapons *Major Assembly Release* (MAR). The MAR is updated as necessary when there are changes in the military requirements or changes in the weapon's ability to meet military requirements."[2] The *Final Warhead Development Report* is signed by the design laboratory director—either Los Alamos National Laboratory (LANL) or Lawrence Livermore National Laboratory (LLNL) when a weapon is introduced into the stockpile,

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[1] "Stockpile Stewardship and Management Plan: First Annual Update (DELETED VERSION, CLASSIFICATION MARKINGS REMOVED, Derivative Classifier: Dr. Ruben Sanchez, DP-22)," DOE Office of Defense Programs, Approved for Release to Congress October, 1997, pg. 4-3.

[2] Ibid. And further on pg. 4-10: "This document, prepared by SNL, approved by the two applicable design laboratories and then DOE, states that specific war-reserve material is satisfactory for release to the DoD on a designated effective date for specified uses qualified by exceptions and limitations."

and Department of Defense (DoD) uses this document in its own certification process, which is carried out by the Design Review and Analysis Group (DRAAG).

DOE performs both "Nonrecurring Certifications" and "Recurring Certifications." While technical issues are presumably common to both activities, Nonrecurring Certifications are of interest with respect to changes to the U.S. stockpile and new nuclear weapon design work. Five planned Nonrecurring Certifications are shown in Table 1. Three (W87, W88, and SWPP) represent a certification following modifications affecting the nuclear explosive package.[3] Since the nuclear explosive package, unlike most components of a modern U.S. nuclear weapon, cannot be fully tested under the CTBT, modifications to it represent a more significant departure from current experience than changing out other components. NRDC has publicly argued that modifications to the nuclear explosive package should serve as a demarcation between weapons activities consistent and inconsistent with the intent of a test ban. The controversial B61-11 modification is being performed to enable an earth-penetrating mission (i.e., penetration of 3-6 meters of concrete or hard rock before detonation in order to destroy targets buried hundreds of meters deep). While this is not a modification to the nuclear explosive package, the B61-11 does represent a change in the warhead which provides the U.S. with a new military capability.[4]

There are two principal Recurring Certifications: "Annual Certification" and "Yield Certification." Annual Stockpile Certification was initiated by President Clinton in 1995 and is scheduled for completion in August of every year:

> The goal of this process is to certify the safety and reliability of each type of weapon in the active stockpile, or identify significant issues that may need to be addressed by a nuclear test. The certifications are provided to the Secretaries of Defense and Energy, who are advised by the NWC [i.e., Nuclear Weapons Council], the Directors of the DOE nuclear weapons laboratories, and the Commander in Chief of the U.S. Strategic Command (CINCSTRAT).[5]

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[3] The "nuclear explosive package," or alternately "physics package" or "nuclear assembly," is a collective term for the primary, secondary, and radiation case.

[4] See for example Kristensen, Hans, "Targets of Opportunity: How Nuclear Planners Found New Targets for Old Weapons," *Bulletin of the Atomic Scientists,* No. 5, Vol. 53 (September 1997), pg. 22.

[5] "Stockpile Stewardship and Management Plan: First Annual Update," pg. 4-12.

The Senate has just passed an amendment to pending legislation setting up what is in effect a parallel annual certification process.[6] The future of the other Recurring Certification—Yield Certification—is currently undergoing review:

> In the past, DOE has provided the DoD with certifications for the yields of stockpiled nuclear weapons on a more or less periodic basis. The most recent certification was transmitted in March 1995. That certification was based on a reexamination, by the laboratory technical staff that designed and tested the stockpiled weapon, of all the new data that might impact the weapon's yield. With the cessation of underground nuclear testing, DOE is currently reviewing the methodology that has been used in the past to revalidate all aspects of stockpile nuclear weapon performance, including the yield. The results of this review, in part, will determine if future certifications will be issued periodically or only when circumstances warrant. [7]

Nonrecurring Certification	Schedule	Description
B61-3,4,10 Surety Upgrades	To be determined	Weapon modification includes improvements to the trajectory sensing signal generator, an encryption modification to the permissive action link (PAL), use-control life extension, and other possible safety and security modifications.
B61-11	FY 1997	Modifications of the B61-7 to meet the mission of the B53 (destruction of deeply buried structures).
W87 Life Extension Program	FY 1998	Structural modifications for both retention on the Peacekeeper and to support single reentry vehicle deployment on Minuteman III. Modifications will affect the nuclear explosive package.
W88 Surveillance Rebuilds	Not given	Pits manufactured at LANL to replace pits destroyed in the surveillance program require certification.
Submarine Launched Ballistic Missile Warhead Protection Program (SWPP)	To be determined	"An assessment of each design and a proposed process for their certification will be conducted..."[8]

Table 1: Nonrecurring Certifications of U.S. nuclear weapons. From the "Stockpile Stewardship and Management Plan: First Annual Update," pp. 4-10 to 4-11.

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[6] An amendment offered by Senator Jon Kyl (Republican-Arizona) was adopted by voice vote in the Senate as an amendment to the Fiscal Year 1999 Defense Authorization Act (S2057). "(a) ESTABLISHMENT. There is hereby established a commission to be known as the "Commission for Assessment of the Reliability, Safety, and Security of the United States Nuclear Deterrent". (b) COMPOSITION.-(1) The Commission shall be composed of six members who shall be appointed from among private citizens of the United States with knowledge and expertise in the technical aspects of design, maintenance, and deployment of nuclear weapons..."

[7] "Stockpile Stewardship and Management Plan: First Annual Update," pg. 4-11.

[8] Ibid., pg. 4-11.

Given the above discussion of the form that warhead certification processes now take, it is of interest to also consider the technical content.

> Certification is guided by extensive experimental tests, rigorous control of critical manufacturing processes, extensive calculations with validated three-dimensional codes, and independent peer review.[9]

Calculations with validated three-dimensional codes are the focus of the long-term (i.e., to 2010) SSMP certification strategy.[10] Here the computer simulation of a nuclear explosive is being advanced in pieces which are then to be integrated. For example, the Dual-Axis Radiographic Hydrodynamic Test Facility (DAHRT), under construction at LANL, represents an advance in the experimental capability to collect data on some aspects of primary performance for comparison to new calculations. While some stages of a nuclear explosion or some bomb components can be experimentally studied and modeled in isolation, key processes such as boosting cannot:

> ...the entire implosion and explosion history affects the boost process... Non-nuclear experimental capabilities do not adequately address the boosted explosion phase of a primary. The complexity of the coupled physical processes and the catastrophic consequences to warhead performance would result from primary boost failure and require significant advances in theoretical and calculational capabilities.[11]

Clearly the integration of sub-models into a comprehensive model of weapon behavior also cannot receive experimental validation under a testing moratorium, thus "...the existing surveillance strategy of testing at the highest attainable level of systems integration remains a cornerstone of the certification strategy."[12] It is possible, however, to compare new calculations with past test data (a process referred to as "post-diction"). This work is being performed under the SSMP, for which test data is being reviewed and archived.

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[9] Ibid., pg. 7-29.
[10] This overarching Stockpile Stewardship strategy is analyzed in the NRDC reports: *End Run* (August 1997) and *Explosive Alliances* (January 1998).
[11] "Stockpile Stewardship and Management Plan: First Annual Update," pg. 7-13.
[12] Ibid., pg. 7-28.

MODIFICATIONS TO NUCLEAR WEAPONS IN THE U.S. STOCKPILE: "REFURBISHMENTS"

Currently there is no requirement for DOE to design and build new nuclear explosive packages to replace those in today's stockpile weapons. On the other hand, a broad range of weapon design activities are ongoing and are referred to as "refurbishments" of existing warheads. "Refurbishment" of the nuclear weapon stockpile includes periodic maintenance activities, as well as modifications to nuclear weapon components through design, development and production. In 1997 DOE stated: "refurbishment will be derived from a need to:

- perform modifications or alterations in response to a change in military requirements;
- redress performance or surety[13] concerns developed through the surveillance and certification functions; and
- replace components whose performance can no longer be certified."[14]

The on-going B61-11 conversion is characterized as "a change in military requirements." Furthermore, DOE states that to "[p]rovide and demonstrate the capability to design and develop new nuclear weapons and associated components" is a stockpile refurbishment program need.[15] And, of course, certain components of nuclear weapons such as boost-gas generators, boost-gas transfer systems, boost-gas reservoirs, neutron generators, and powers supplies are replaced on a periodic schedule, sometimes with components of improved design.[16]

All components replaced in refurbishment will be certified, individually and in the subsystem or system, to meet Military Characteristics (MCs)[17] and Stockpile-to-Target-Sequence (STS)[18] normal, abnormal, and hostile environment criteria. DOE states that if

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[13] The DOE defines "surety" as an umbrella term for safety, security, and use control of nuclear explosives.
[14] "Stockpile Stewardship and Management Plan: First Annual Update," pg. 1-8.
[15] Ibid., pg. 5-3.
[16] Ibid., pg. 1-3. This process is referred to as Limited Life Component Exchange (LLCE).
[17] An example of a Military Characteristic of a weapon is its yield.
[18] DOE defines the Stockpile-to-Target Sequence as the range of environmental conditions, including temperature, moisture, acceleration, and vibration, which a weapon must be able to withstand and still function properly.

this cannot be accomplished, a joint reexamination of the Military Characteristics may be initiated and/or a request for a nuclear test may be initiated.[19]

SLBM WARHEAD PROTECTION PROGRAM

In 1995 the U.S. Navy requested DOE to begin a joint design and certification process for potential replacement warheads for the two Trident strategic weapon systems. The subsequent development of this program, called the Submarine Launched Ballistic Missile Warhead Protection Program (SWPP) is described in detail in the Appendix. In the SWPP, two warhead designs were selected for Phase III[20] development: one that employs the technique of pit reuse and one that incorporates a newly designed pit. Unlike for the B61-11, these designs include changes to a tested nuclear explosive package and the development of a new one, although no decision to produce and deploy these warheads has yet been made.

Both replacement warhead designs were intended to improve upon the W76 and W88 in several areas—ease of surveillance, resistance to aging, safety (i.e., use of Insensitive High Explosives (IHE) and Fire Resistant Pits (FRP)), and possibly use-control improvements—while possessing nearly identical Military Characteristics and a Stockpile-to-Target-Sequence as the W88. Both designs are intended to be compatible with the Mark 5 (Mk5) reentry vehicle.

Currently-available documents do not describe the SWPP certification strategy in detail. LLNL has made clear that the certification process itself will not occur during the SWPP for the reused pit design, but is relegated to a follow-on program. It should be noted that budgetary, not technical issues, are cited in this decision. An indication of the certification activities for the reused pit design was made in 1997:

> Calculational modeling of pit reuse primary performance will incorporate all improvements in models of IHE behavior, plutonium equation of state,

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[19] "Stockpile Stewardship and Management Plan: First Annual Update," pg. 7-27.

[20] Phase III development of a nuclear weapon is the start of warhead development at a National Laboratory, culminating in a proposed warhead design. Phase I is the definition of a new warhead or component concept and Phase II addresses technical feasibility, cost, and production schedule. See Appendix, pg. 13.

> mix, and other parameters discussed in Chapter 7 [i.e., Chapter 7 of the First Annual Update to the Green Book], as they become validated and available. Significant improvements in computational platform speed and in the application codes capabilities are anticipated during this time frame and will be a critical part of the final establishment of certification performance.[21]

This quotation reaffirms that new weapons models supported by new data will serve to certify a modified nuclear explosive package without underground testing. Note the specific reference to IHE behavior: IHE was not used for the W76 or W88 but is envisioned for the SWPP designs.

The new design pit option for the SWPP is being pursed at LANL. Here the goal is explicitly to design a primary which could be certified without underground testing:

> The replacement warhead for the Mk5 RB [i.e., reentry body] is currently in a conceptual design stage. A major certification issue being addressed includes a review of the design envelope for robust or high margin primary designs based on past nuclear test data. The design envelope for nonnuclear and nuclear weapons components has been historically determined by constraints of the delivery system and its STS and MCs. The replacement warhead option for the Mk5 will be further constrained by certification issues without additional nuclear testing and by future manufacturing and production capabilities.[22]

One goal of the SWPP is to pursue design and certification to the point where complete full-scale engineering development may be completed three years from the time that the replacement option is authorized. Currently, warhead flight tests for the pit reuse design are scheduled for fiscal years 1999 and 2000, and flight tests for the new pit design for 2000 and 2002.[23]

X-RAY LASERS IN THE SSMP

The National Ignition Facility (NIF) is intended to provide experimental data for the SSMP at conditions similar to those created in a nuclear explosion. The principle categories of weapons-physics experiments planned for the NIF are: opacity experiments;

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[21] "Stockpile Stewardship and Management Plan: First Annual Update," pg. 10-19.
[22] Ibid., pg. 10-20.

radiation-flow experiments; equation-of-state experiments; non-LTE (Local Thermodynamic Equilibrium) and x-ray laser experiments; hydrodynamic experiments; and capsule implosion experiments.[24] Research in x-ray lasers is currently pursued in the U.S. nuclear weapons program because of their demonstrated potential as plasma diagnostic instruments (i.e., to produce calibration data for nuclear weapons and inertial confinement fusion codes) and in dual-use applications, as well as for their relevance to advanced nuclear weapons concepts.

Recall that laser is an acronym for "Light Amplification from Stimulated Emission of Radiation." In the lasing process, atoms or molecules are stimulated by ambient photons to make a quantum transition to a lower energy state and emit photons of similar frequency. For this to occur, more atoms or molecules must be in a higher-energy state than would normally be the case in thermodynamic equilibrium (e.g., as given by a Boltzman distribution). This condition necessary for lasing is called a "population inversion," and is an example of non-LTE physics.

A 1995 LLNL report discusses a three-year experimental plan for non-LTE x-ray laser experiments on the NIF, totaling 200 shots.

> These are needed to maintain our core competency in non-LTE design and to develop short-wavelength x-ray lasers for dual-benefit applications. ... Our plan includes developing a testbed for non-LTE physics, exploring new regimes and schemes in x-ray laser research, and using x-ray lasers for plasma-imaging diagnostics. These lasers are used for plasma imaging because they provide absolute plasma-density measurements. This information is needed to validate codes and benchmark data for both the ICF [i.e., Inertial Confinement Fusion] and weapons-physics communities.[25]

LLNL posits three categories of non-LTE and x-ray laser experiments: plasma imaging experiments; ionization balance experiments; and "new regimes and schemes for x-ray lasers."[26] Plasma imaging is the application of short-wavelength x-ray lasers as a tool to

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[23] Ibid., pg. 5-9.
[24] "NIF System-Design Requirements for Nuclear-Weapons Physics Experiments," Lawrence Livermore National Laboratory, April 1995, UCRL-ID-120738. "The NIF will be an ideal facility for studying much of the physics involved in nuclear weapons both as isolated processes and as compound events. (pg. iii)"
[25] Ibid., pg. 15.
[26] Ibid., pp. 15-17.

diagnose rapidly evolving (at time scales less than one nanosecond) high electron density plasmas (10^{21} cm^{-3} < plasma electron density < 10^{24} cm^{-3}) in two dimensions.[27] X-ray lasers have yet to be fully developed as reliable diagnostic instruments. Ionization balance experiments involve the study of photo-ionization and (electron-ion) recombination kinetics and radiation transfer in non-LTE plasmas. Nuclear weapon code calibration is emphasized for these kinds of experiments ("a test-bed for non-LTE physics").

Research is planned for the NIF both on the physics of x-ray lasers and on new x-ray laser architectures. "The large energy available on NIF will allow us to extend existing x-ray laser schemes into new regimes and to test new schemes for producing short-wavelength x-ray lasers."[28] Furthermore:

> To maintain core competency in advanced nuclear design while developing laboratory x-ray lasers for dual-benefit applications, Defense Sciences is planning non-LTE and x-ray-laser physics experiments for the new National Ignition Facility (NIF). In the first two sections [i.e., of this LLNL Report] we review some of the important physics experiments that were done underground at the Nevada Test Site (NTS) and describe NIF experiments that can help improve our physics understanding of these issues. ... [deleted lines] The goal [presumably the goal of the nuclear tests] was to assess the technical feasibility of an x-ray laser weapon to avoid technological surprises from an enemy. [deleted lines] The basic idea was to create a bright x-ray beam that could destroy a target, such as an ICBM [i.e., and Intercontinental Ballistic Missile] or satellite, at a great distance.[29]

Such work continued on the NIF is referred to as "enhancement of the technology infrastructure."[30] Finally, prefacing a discussion of the "Fast Ignitor"[31] concept for ICF,

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[27] A soft-x-ray laser interferometer operating at 155 Angstroms was developed at Nova around 1995. Ibid., pg. 15.

[28] Ibid., pg. 16.

[29] "Nuclear Weapons Physics on the NIF: Experimental Opportunities to Improve Predictive Modeling Capabilities of Nuclear Weapons Phenomena (Stephen B. Libby, Conference Chair; Mark J. Eckart, Co-Chair; John E. Heidrich, Scientific Editor; Shirley R. Jennings and Jane C. Olivera, Technical Editors, January 1995, UCRL-MI-119994, pg. 57.

[30] Ibid., pg. 65.

[31] The technique now most actively pursued towards achieving fusion ignition in the laboratory is to symmetrically implode a small but complex capsule target containing a mixture of tritium and deuterium. The capsule implosion is performed either by direct illumination by—for example—a laser, or x-ray illumination of the capsule by laser-heating a high-Z (usually gold) shell or hohlraum which contains it. In the "Fast Ignitor" concept a capsule implosion is initiated, a channel is then bored through the surrounding

LLNL notes: "...we describe a number of advanced concepts that could help maintain the design skills of weapons physicists in areas ranging from secondary physics to nuclear directed-energy weapons concepts."[32]

NRDC has learned anecdotally that in the 1980's a capability like ignition with gain on the NIF was viewed by some at the National Laboratories as important for progress in the Strategic Defense Initiative. It is clear from recently-declassified documents that there is a technical connection between the NIF and such weapon concepts, and that development work will continue in the SSMP.

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plasma to the capsule center by a laser, and a second laser beam travels down that channel to ignite the fusion fuel.

[32] "Nuclear Weapons Physics on the NIF: Experimental Opportunities to Improve Predictive Modeling Capabilities of Nuclear Weapons Phenomena," pg. 69.

CONCLUSIONS

The U.S. certification process for nuclear weapons historically involved nuclear explosions. Under the CTBT, the SSMP strategy for certification stresses advances in computer modeling validated by data from new research facilities. Five Non-Recurring certifications, performed for example when a modified or new warhead is introduced into the stockpile, are now planned. Three of the warhead certifications are required due to modifications of the nuclear explosive packages. Two certifications are planned because of significant modifications to components outside the nuclear package. One of these, the B61-11 retrofit, provides the United States with a new nuclear military capability.

Certification issues for new-design warheads under a test ban are being addressed in the SWPP. While entailing modifications to the nuclear explosive package, the SWPP designs do not appear to be qualitatively far removed from tested designs now deployed in the U.S. stockpile. By contrast, x-ray laser research is planned for the NIF which is technically linked to nuclear directed-energy weapon concepts that were pursued unsuccessfully as part of the Strategic Defense Initiative.

DOE is putting in place the necessary tools to permit certification of changes to non-nuclear components as well as to the nuclear explosive package under the CTBT. A significant future threshold will be the design and certification without testing of an entirely new weapon in order to increase U.S. military capabilities. Achieving this capability will ultimately depend on the robustness of the Stockpile Stewardship and Management Program, now funded at about $4.5 billion annually.

Two international security impacts of this course of development are plausible. First, when explosive testing which typically produces remotely-detectable seismic waves is a requirement for militarizing nuclear capability, a well-monitored test ban serves as an effective means of arms control and non-proliferation. However, if the United States pursues the capability to design and certify nuclear weapons without such testing, the perceived security benefits of the CTBT for rival nuclear powers diminishes. Second, the capabilities to be generated by the U.S. SSMP enable continued effort towards advanced weapons concepts which were not realized during the Cold War.

APPENDIX

DETAILED CHRONOLOGY OF THE U.S. SUBMARINE LAUNCHED BALLISTIC MISSILE WARHEAD PROTECTION PROGRAM APRIL 1995 TO JANUARY 1998

The following chronology of the Submarine Launched Ballistic Missile (SLBM) Warhead Protection Program (SWPP) is derived from 41 documents released to NRDC pursuant to the Freedom of Information Act (FOIA), spanning the time period April 1995 to January 1998.

In a 14 April 1995 memo to Harold P. Smith, Chairman of the Nuclear Weapons Council Standing and Safety Committee (NWCSSC), the Director of Navy Strategic Systems Programs stated:

> As a result of the continuing need for a reliable strategic deterrent and the results of the recent Phase II Study, it is requested that the DOE join with Navy Strategic Systems Programs in a cooperative effort to ensure the availability of alternate warhead designs for the MK4 and MK5 SLBM reentry systems. It is envisioned that this effort, coordinated through the existing Project Officers Group (POG), will address the analysis and above ground testing of a limited number of design options.[33]

Here the Navy requested (jointly with the DOE) permission from the NWC to draw up a "detailed plan and schedule" for completing design work on a few warheads for the submarine leg of the U.S. strategic triad, potentially "to a point where [they] could be productionized."[34] In the past, nuclear weapon design, production and retirement was structured into seven phases as shown in Table 2. The Phase II or "Joint Feasibility" study referred to in this memo implies a prior Phase I or "Concept Definition" study, possibly derivative of the original W76 and W88 Phase I studies. As Phase III—"Development Engineering" —in the past culminated in a nuclear warhead design and Phase IV—"Production Engineering" —adapted the design into a manufacturing system, the Navy in April 1995 effectively solicited preliminary approval for both Phase III and

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[33] G.P. Nanos, Jr., Memo, Subj: SLBM WARHEAD PROTECTION PROGRAM, 14 April 1995.

[34] Some background on the Navy's strategic forces may be useful in understanding the SLBM Warhead Protection Program. Under the second Strategic Arms Reduction Treaty (START II), the submarine leg of the U.S. strategic triad will account for about half of all accountable, deployed warheads. Most of the Navy's strategic warheads are of the W76 design, about 3500 of which were produced between 1978 and 1987. About 400 W88 warheads were produced from 1988 to 1991; W88 pit production was terminated prematurely due to the closure of the Rocky Flats plant near Denver, Colorado. Both the W88 and the W76 warheads were designed at Los Alamos National Laboratory. The W88 is heavier and has a much higher yield (475 kilotons) than the W76 (100 kilotons).

Phase IV work, while not explicitly using these terms. Prior to its termination, the Military Liaison Committee (MLC) had responsibility to approve or deny a Phase III request, which is now the responsibility of the NWC.

Phase	Name	Description
Phase I	Concept Definition Studies	Definition of a new nuclear warhead or component concept, including performance parameters, transportability, employment concepts, delivery techniques, yield and/or effect selection, fuzing options, typical targets, safety considerations and control requirements.
Phase II	Joint Feasibility Studies	Determination of the technical feasibility of developing a nuclear warhead to meet the Phase 1 requirement.
Phase IIA	Joint Design Definition and Cost Studies	Estimate of costs and production schedules. Analysis of tradeoffs involving the safety, security, survivability and control features of the weapon.
Phase III	Development Engineering Project	Start of warhead development at a DOE weapon laboratory, culminating in a proposed warhead design.
Phase IV	Production Engineering	Adaptation of the Phase 3 design into a manufacturing system that can mass produce the warhead.
Phase V	Initial Production	Delivery of the first warhead and limited production.
Phase VI	Quantity Production	Quantity production.
Phase VII	Retirement	Retirement.

Table 2: Summary of the seven phases of nuclear weapon research, development, production and retirement practiced by the United States during the Cold War.[35]

While the Cold War roles of DOD as nuclear weapons "customer" to DOE is reflected in the SWPP, program responsibility and organization within DOE required definition. A 28 June 1995 memo from the Deputy Assistant Secretary for Military Applications and Stockpile Support (DP-20) to the Deputy Assistant Secretary for Research and Development (DP-10) states:

> To ensure success in this endeavor [i.e., SWPP], DOE should clearly delineate areas of responsibility within Defense Programs. I envision a process in which DP-10 is responsible for funding and leading this effort during the program's development phase. While DP-10 has the lead, my office, DP-20, will serve as overall coordinator/observer. If production of one of the alternative warheads is required by the Navy, the funding and lead for production and stockpile support will transition to DP-20. ... This approach to the division of responsibility provides the necessary

[35] Cochran, Thomas B., Arkin, William M., Norris, Robert S., Hoenig, Milton M., *Nuclear Weapons Databook Volume II: U.S. Nuclear Warhead Production*, Ballinger, 1987, pp. 104-106.

framework for us to accomplish our required program functions while minimizing concerns over questions of "who is in charge." This effort will be an excellent foundation for delineation of responsibilities in any future stockpile warhead modification or replacement activity.[36]

This division of responsibility appears to have been implemented at about the same time.[37]

On 25 May 1995 Smith wrote to Vic Reis, DOE Assistant Secretary of Energy for Defense Programs, advising him that the SWPP "must be consistent with the findings of the Nuclear Posture Review and not preclude in any way similar efforts by other Services."

Subsequently on 22 June 1995, a joint planning meeting which involved Los Alamos National Laboratory (LANL), Lawrence Livermore National Laboratory (LLNL), and Sandia National Laboratory (SNL) was held at the DOE complex in Germantown, Maryland. Acting Director of DOE Defense Program's Office of Development and Testing (DP-12) Kenneth J. Adney called the meeting so that DP-12 could be briefed on the results of the Phase II study, be provided suggestions by the National Laboratories for follow-on activities, and generate debate on the budgetary competition between the SWPP and other DP-12 "new program activities." "The results of this meeting will be either a DOE coordinated and integrated development plan supported by each design laboratory or a path to achieve such a DOE plan."[38] Since all three labs briefed DP-12 on the Phase II study it can be assumed that it was a collaborative effort, as the SWPP continues to be. Both the W76 and W88, however, are LANL designs.[39]

The DOE planning session at Germantown was certainly in preparation for the SWPP "kickoff meeting" held one week later at Kaman Sciences Corporation in

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[36] Charles J. Beers, Jr., Rear Admiral, U.S. Navy, Deputy Assistant Secretary for Military Application and Stockpile Support (DP-20), DOE Defense Programs, 28 June 1995, to the Deputy Assistant Secretary for Research and Development, DOE DP-10, SUBJECT: SUBMARINE LAUNCHED BALLISTIC MISSILE WARHEAD PROTECTION PROGRAM.

[37] A memo written on the same day to DOE's Albuquerque Operations (DOE/AL) Office described the above organizational structure as in effect. "The Deputy Assistant Secretary for Research and Development, DP-10, is responsible for funding and leading this effort during the program's development. If production of one of the alternative warheads is required by the Navy, the funding and lead for production and stockpile support will transition to by office, DP-20." Charles J. Beers, Jr., to Manager, Albuquerque Operations Office, 28 June 1995, SUBJECT: SUBMARINE LAUNCHED BALLISTIC MISSILE WARHEAD PROTECTION PROGRAM.

[38] Kenneth J. Adney, Acting Director Office of Development and Testing, Defense Programs, Department of Energy, Memo, Subject: SEA-LAUNCHED BALLISTIC MISSILE (SLBM) WARHEAD PROTECTION PROGRAM PLANNING MEETING, May 22, 1995.

[39] A 28 June 1995 memo from the Deputy Assistant Secretary for Military Applications and Stockpile Support, DP-20 (Rear Admiral Charles J. Beers, Jr.) to the Deputy Assistant Secretary for Research and Development, DP-10, stated: "The SSPO [Strategic Systems Program Office] wants the alternate warhead effort handled via the MK4/W76 and MK5/W88 Project Officers Groups (POG). It is anticipated the POGs will establish a working group of POG members, a Lawrence Livermore National Laboratory member, and selected observers. This is similar to the approach used for the Navy Phase 2 Study."

Arlington, Virginia. The Kaman agenda lists four potential candidate nuclear warhead types to be discussed: SAFETY POD, PIT REUSE, NEW PIT, and REPLACEMENT. A memo accompanying the agenda notes: "The candidates that will be used for this initial planning effort will be those briefed at the recent STRATCOM sponsored Stockpile Confidence Symposium. Additional candidates may be proposed by the principals as appropriate."[40] This statement is noteworthy, since the Phase I and II studies should logically have served to provide the set of options for Phase III. The SAFETY POD is nowhere else mentioned in the documents released to NRDC, and the REPLACEMENT may refer to the W94 warhead (a new warhead type listed in one of Cuneo's viewgraphs in preparation for the 29 June 1995 SWPP "kickoff" meeting, discussed below). PIT REUSE and NEW PIT were subsequently developed in the SWPP, as discussed below.

Also on the agenda for the SWPP "kickoff meeting" were three topics to be presented by the National Laboratories:

- IDENTIFY AGING MECHANISMS FOR NUCLEAR AND NON NUCLEAR COMPONENTS
- YIELD CERTIFICATION PROCESS
- EXPANDED TEST AND ANALYSIS TECHNIQUES TO ELIMINATE NEED FOR UGT [UnderGround Tests]

These three issues are central the SWPP, and to a general discussion of the Stockpile Stewardship Program with US development of new nuclear designs under a CTBT. Predicated on the continuing US adherence to the test moratorium, the SWPP entails development of alternatives to underground nuclear testing in order to certify the yield and other military characteristics of future designs. One day prior to the kickoff meeting, Rear Admiral Beers, DOE Deputy Assistant Secretary for Military Application and Stockpile Support, directed the DOE Albuquerque Operations Office to: "allow for the integration of new science-based stockpile stewardship facilities [into the SWPP plan and schedule] as they become available. These new facilities should become integral elements for maintaining the reliability and safety of the MK4 and MK5 reentry systems and developing alternate warhead designs."

Language in Navy's earlier memo to the NWC was reiterated to participants at the SWPP "kickoff meeting:"

> A working group of the W76 and W88 POG is being formed to develop a detailed plan and schedule to support the SLBM Warhead Protection Program recently requested by Navy Strategic Systems Programs. The plan and schedule should focus the technical efforts on warhead candidates which protect the reliability and safety margins of the SLBM strategic deterrent while maintaining the design expertise needed to respond to operational system needs. This group will address the analysis and above ground testing of a limited number of design options. These

[40] Cliff DeJong, Kaman Sciences Corporation, Memo, SUBJECT: SLBM WARHEAD PROTECTION PROGRAM, 15 June 1995.

options would address candidates of increasing safety margins. The candidates would be time phased to provide alternatives in the near-term, mid-term, and far-term, should they be needed. If a candidate design is brought to a point where it could be productionized, but is not yet needed, due to the continuing longevity of the exi[s]ting W76 and W88 Warheads, it can be shelved and work continued on the longer time frame candidates.

This basic concept for the SWPP was subsequently developed and approved by the NWCSSC. A viewgraph from Lt. Col. Jeffrey Cuneo (DOE Office of Development and Testing, DP-12) distributed for comment prior to the kickoff meeting is shown in Figure 1. Importantly, the SWPP is characterized as an opportunity to apply Stockpile Stewardship concepts to a potential future weapons system, and is required to maintain weapon design expertise and capabilities.

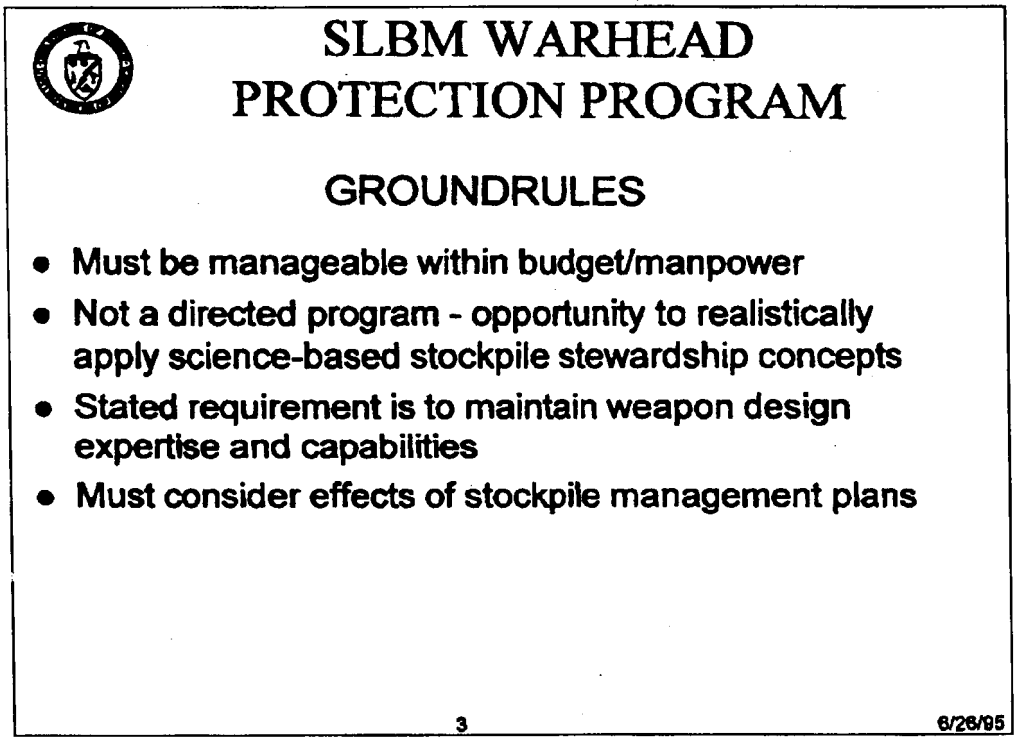

Figure 1: DP-12 vu-graph distributed for comment prior to the 29 June 1995 SWPP "kickoff" meeting held at Kaman Sciences Corporation, Arlington, Virginia.

On 3 July 1995, Victor Reis wrote to Harold Smith, indicating that DOE "is pleased to join the Department of Defense (DoD) in an effort to propose a plan and schedule for ensuring the availability of alternate warheads for Submarine Launched Ballistic Missile (SLBM) reentry systems." Reis noted: "... as science-based stockpile stewardship facilities become available, DOE can direct their use to support this

activity."[41] Thus prior to defining the SWPP plan and schedule for the NWC, Reis has indicated to the NWC that new Stewardship Facilities, such as the LANL's Dual-Axis Radiographic Hydrodynamic Test Facility (DARHT) and LLNL's National Ignition Facility (NIF), can play a role in alternate warhead development.

During the following six months, DOE and DoD organized the SWPP and briefed the NWCSCC. Meetings involving all three National Laboratories and DoD occurred at LANL on August 1. DOE management's concerns were that the SWPP should not be seen as distinct from the Stockpile Stewardship Program:

> The plan and schedule should emphasize the strategies depicted in our Stockpile Stewardship and Management Program. It should also allow for the integration of new science-based stockpile stewardship facilities as they become available. Finally, the plan should ensure that the alternative warhead designs considered will maintain design expertise and capabilities that are necessary to respond to the Navy's operational system needs.[42]

Was DOE management concerned that weapons scientists and engineers would approach the SWPP with strategies that would differ from Stewardship, and perhaps not include facilities such as the NIF? The SLBM warhead protection program, although described as a warhead design effort, is not here characterized as a response to Navy "operational system needs," as no decision to proceed to production is envisioned in the near term.

By 18 September 1995, LLNL had generated a "SWPP Pit Reuse Tier-0 Draft Plan," developed by James Tyler of LLNL and Doug Henson of Sandia National Laboratory's California site (SNL/CA). In a cover memo dated 15 September, Tyler describes the plan:

> It proposes a schedule, three different phases with deliverables and reviews at the end of each phase, and a final deliverable at the end of the project. It also describes generic activities and objectives within each phase. It is a "Tier-0" project plan, which is intended to provide an overall structure within in which to plan major project activities, such as ground and flight tests. This latter plan of major, specific activities will constitute the Tier-1 plan for the project.[43]

Moving cautiously, Tyler remarks: "Once the DOE community has arrived at a mutually agreeable Tier-0 plan, we would propose to forward it to the Navy SP [Strategic Programs] Office. We solicit comments from DOE/HQ [DOE Headquarters] regarding how to do that."[44]

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[41] Victor H. Reis, Assistant Secretary for Defense Programs, DOE, letter to Harold P. Smith, Jr., Chairman, Nuclear Weapons Council Standing and Safety Committee, Department of Defense, July 3, 1995.
[42] Roger E. Fisher, Deputy Assistant Secretary for Research and Development, DOE, memorandum to Siegfried S. Hecker, Director, LLNL; Bruce C. Tarter, Directer, Sandia; and Al Narath, President, Sandia; July 27, 1995.
[43] James V. Tyler, memorandum to "Distribution," Subject: Proposed Project Structure for the SLBM WPP Pit Reuse Project," September 15, 1995.
[44] Ibid.

The Pit Reuse Project within the SWPP aims to achieve a warhead design consistent with the Trident II/MK5 re-entry body (RB) delivery system with a reused pit. The final product of this Phase III effort will be a Data Package, which Tyler defines as:

> ... a collection of information that defines the SLBM WPP pit reuse warhead design option and its integration into the MK5 RB and that provides the rationale, from both the experiments and calculations, that this design option would meet requirements and could be fabricated rapidly and entered into the stockpile with high confidence.[45]

It is unclear whether a Data Package was generated for past warhead designs, for which underground test results would have contributed to confidence assessments. Tyler and Henson anticipate a tight budget for the Pit Reuse Project:

> The project will be constrained by limited funding, significantly less than was traditionally expended on Phase 3 projects, and some expensive tests will be deferred to the hypothetical, future period when the project might be restarted in response to a future stockpile need. This could especially be true for large demonstration tests. The strategy will be to best utilize our limited funds to address the maximum number of vital (or "showstopper") issues.

A few months later, Tyler would liken the SWPP to the comic strip character "Fearless Fosdick" who gets shot full of holes but nevertheless pushes on.[46] In their Tier-0 plan, a five-year schedule for the Pit Reuse project was suggested, and is shown in Table 3.

In November 1995 the Nuclear Weapons Council Standing and Safety Committee was briefed on the SWPP, and approved it on 15 November. A 6 December meeting at Kaman Sciences Corporation included a discussion of what Navy told the Committee:

> Mr. Maglich, SSP [Strategic Systems Program], who will be the Navy's principal Manager for this program then went over the ground rules for the program and outlined the proposed subgroups of the POG/Executive Working Group. This basically reiterated the principals outlined in earlier discussions. His description of the purposes of the different subgroups (Design certification, Design Integration, Safety and Joint Test) elicited some general discussion on the role and philosophy of certification in particular. *All parties view this program as a forcing function for the DOE to define certification for a new weapon and apply it to the products in SWPP as a trial run* (italics added).[47]

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[45] Jime Tyler (LLNL) and Doug Henson (Sandia), "SLBM Warhead Protection Program Pit Reuse Project Proposed Tier-0 Project Overview," September 15, 1995, pg. 1.

[46] Jeffrey A. Cuneo, Lt Col, USAF, Program Manager, Office of Development and Testing, Defense Programs, DOE, memorandum to "Distribution," Subject: Meeting Minutes, SLBM Warhead Protection Executive Working Group, Dec 6, 1995, December 18, 1995.

[47] Jeffrey A. Cuneo, Lt Col, USAF, Program Manager, Office of Development and Testing, Defense Programs, DOE, memorandum to "Distribution," Subject: Meeting Minutes, SLBM Warhead Protection Executive Working Group, Dec 6, 1995, December 18, 1995.

This description of the SWPP as a "forcing function" for the DOE is significant. It is a recognition that sizable facilities in the Stockpile Stewardship Program will not become operational for years, yet their purpose is predicated in part on an as yet untested strategy for designing and certifying weapons without underground testing.

Project Phase (duration)	**Preliminary** (15 months)	**Interim** (24 months)	**Final** (21 months)
Fiscal Year(s)	1996-1997	1997-1999	1999-2000
Activities	Develop "documents similar to MCs, STS, and ICDs"	Finalize design and program requirements	
	Develop the preliminary design concept	Develop complete set of detailed drawings	Produce final set of design drawings (CER-like)
	Conduct early calculations and tests to examine crucial issues, especially potential "showstoppers"	Conduct majority of calculations and tests	Complete tests and calculations, emphasize use of test units
	Develop warhead certification criteria and strategy		Conduct certification study
	Develop the methodology for robustness analysis	Begin the robustness analysis	Complete robustness analysis
	Develop the surety theme		
	Determine the future fabrication complex and technologies to assume for the project	Develop plans to validate fabricability; make components for test units	Demonstrate fabricability
		Establish methodologies to quantitatively estimate longevity.	Provide quantitative estimates of longevity

Table 3: LLNL/SNL proposed schedule for the SWPP Pit Reuse Project. Each phase concludes with a design report and a review of the project and design (review panel similar to a DRAAG [Design Review and Analysis Group]). The Final Phase design report is intended to be a major component of the Data Package. The Tier-0 plan suggests: "The LLNL and Sandia Directors formally certify the design, as appropriate for this level of development (policy still to be devloped)."

In late December 1995 a Memorandum of Understanding (MOU) was drafted delineating DOE and DoD responsibilities for the SWPP. Both Departments are tasked with ground and flight tests of the replacement warheads, and separate responsibilities are listed in Table 4. Here the Data Package was identified as the "Deliverable" from this effort, which in addition called for the "Identification of any additional activities required for Full Scale Engineering and Development (FSED) and certification..." The MOU derived its authority on the 21 March 1953 Agreement between the Atomic Energy

Commission (now DOE) and the Department of Defense for the development, production, and standardization of weapons, AT(29-2)-230, as amended.

On 20 February 1996 the SWPP Design Integration Subgroup (DISG) met at Lockheed Martin Missiles & Space in Sunnyvale, CA. The DISG was tasked with the following responsibilities:

> The Design Integration Subgroup (DISG) is responsible to the SWPP Study Group for performing Mechanical and Electrical integration of DOE Hardware into DoD produced MK4 and MK5 hardware to meet SWPP Requirements. The Subgroup will conduct design integration studies and activities, and document findings as required. In conjunction with these activities the Subgroup will recommend appropriate ground and flight tests.[48]

At this meeting, the flight test requirements were discussed, along with issues relating to the development of replacement components. In a second meeting of the DISG at Kaman Sciences Corporation, Colorado Springs, CO, the agenda included a presentation on quantifying the advantages of "using proposed advanced technologies for advanced AF&F [Arming, Fuzing, and Firing] systems by Sandia, and "Shipboard Vibration Data Analysis" by Kaman.[49]

DoD SWPP Responsibilities	DOE SWPP Responsibilities
Provide reentry body (RB)/missile physical and functional interfaces definitions and DOD requirements (such as the MCs)	Provide component, subsystems, and systems alternative design options including the Advance Fuzing and Firing
Assess the reentry body with the replacement options	Provide a warhead certification methodology which does not rely on future Underground Nuclear Testing (UGT) and is consistent with the forecasted capabilities for both above and under ground non-nuclear testing and computational techniques of Science Based Stockpile Stewardship (SBSS)
Assess the acceptability of changes required to the DoD hardware and facilities	Fabricate and evaluate components and subsystem hardware to demonstrate the feasibility of the designs as replacement options

Table 4: Delineation of DOE and DoD responsibilities for the SWPP, as described in the December 1995 draft MOU. Note the explicit requirement for the DOE to develop alternatives to underground testing in the certification of new warhead designs.

Other SWPP subgroups formed and met in the first half of 1996: the Producibility Subgroup on 13 March (at DOE Albuquerque, Albuquerque, NM) and the Design

[48] David Gibson, Kaman Sciences Corporation, memorandum to SWPP DISG Members, Subject: Action Items, 5 March 1996.

[49] Ron Brunsvold, Kaman Sciences Corporation, memorandum to "Distribution," Subject: 2ND MEETING OF THE SWPP DESIGN INTEGRATION SUBGROUP, 25 March 1996.

Certification Subgroup on 17 April (at Kaman Sciences, Colorado Springs, CO). The Producibility Subgroup (or Process Realization Team) was tasked to "facilitate coordination between the laboratories and production facilities to ensure that warheads are designed that can be produced within the reconfigured nuclear weapons complex." The agenda for the Design Certification Subgroup meeting was held "to review the issues involved for certification within this program and in the larger context of DoD and DOE policy; and to discuss joint testing requirements planned to support the certification portion of the design data report at the end of the program."[50]

Jim Tyler and Doug Henson, authors of the Pit Reuse Project Tier-0 plan, reacted to the March 13 Producibility Subgroup meeting with a "white paper" discussing the apparent lack of DOE/Albuquerque support for the goal of demonstrating that this design option can be fabricated: "...it became clear that there is not a common understanding between the laboratories and DOE/AL regarding the level of support the project should expect from DOE/AL."[51] Tyler and Henson stated that they expect the SWPP to include a demonstration that a design option can be fabricated (and should archive a Product Realization Plan stating how that could be done in the future). But at the 13 March Subgroup meeting "...it appeared that at present DOE/AL has no significant funding to apply to the SWPP, it has no planning to supply such funding in the future, and the probability of a change in priority to supply such funding is questionable." They go on to warn: "If this is indeed the DOE/AL position regarding the SWPP, then the program will have to be drastically downscoped from what we have understood up until now. In particular, the demonstration of fabricability will have to be deleted."[52]

With respect to the Pit Reuse Project, Tyler and Henson reiterate the major program technical objectives of design and fabricability:

> There are two overall technical objectives for the SWPP/PRP. The first is to certify a replacement design option without further nuclear testing. We plan to use the existing and developing techniques and capabilities of Science Based Stockpile Stewardship (SBSS) to accomplish this end. Indeed, the SWPP/PRP is intended to provide a demonstration of the practical utility of the SBSS approach. The laboratories will take the lead in this part of the effort.
>
> The second objective is to demonstrate the capability to fabricate the design option within the context of the changing production complex. The organization and locations of fabrication capability are presently undergoing change, and various fabrication technologies may change. As design agencies, the laboratories expect to work closely with DOE/AL

[50] Jeffrey A. Cuneo, memorandum to "Distribution," Subject: SLBM Warhead Protection Program (WPP) Design Certification Working Group, March 29, 1996.
[51] Jim Tyler, memorandum to "Distribution," Subject: LLNL/SNL Perspectives on DOE/AL Support Needed for the SWPP, April 2, 1996.
[52] Jim Tyler (LLNL) and Doug Henson (SNL/CA), "Support Needed from DOE/AL and the DOE Production Agencies for the SLBM Warhead Protection Program Pit Reuse Project," April 2, 1996, pg. 1.

and the production agencies with concurrent engineering throughout the design and demonstration cycle.[53]

Tyler and Henson proposed that the first year of effort on Pit Reuse fabrication should consist of study and planning, particularly to identify *expected future* nuclear weapon fabrication technologies. Subsequently, "a substantial amount of funding through DOE/AL (presumable of the SM [Stockpile Maintenance] variety) for the production agencies will also be required, if fabricability is to be demonstrated."[54]

In what was sure to be an important issue for the Navy, Tyler and Henson state that if the SWPP Pit Reuse Project was truncated such that demonstration of fabricability was not attempted: "There would be no Product Realization Plan and no reliable estimate of a future, hypothetical schedule to FPU [First Production Unit], should the program ever be restarted for entry into the stockpile."[55] DOE funding for fabrication demonstration of Pit Reuse was estimated as modest until fiscal year 1998. As shown below, the SWPP schedule placed the Pit Reuse option several years ahead of New Pit, therefore fabrication issues arose earlier. However the fabrication issues with respect to Pit Reuse and New Pit are clearly very different, and LANL has only recently fabricated a W88 pit (but not a War Reserve pit).[56]

In parallel with the Spring 1996 efforts of the Producibility Subgroup, the Certification Subgroup was also defining its tasks. Jeffrey Cuneo prepared a draft "SWPP Design Certification Subgroup Charter," shown in Figure 2. The Charter calls for the development of a set of criteria for design certification. Notably, Cuneo referred to "emerging DOE certification guidelines." One inference from this statement is that DOE was developing broad or generic guidelines for warhead certification under a test moratorium.

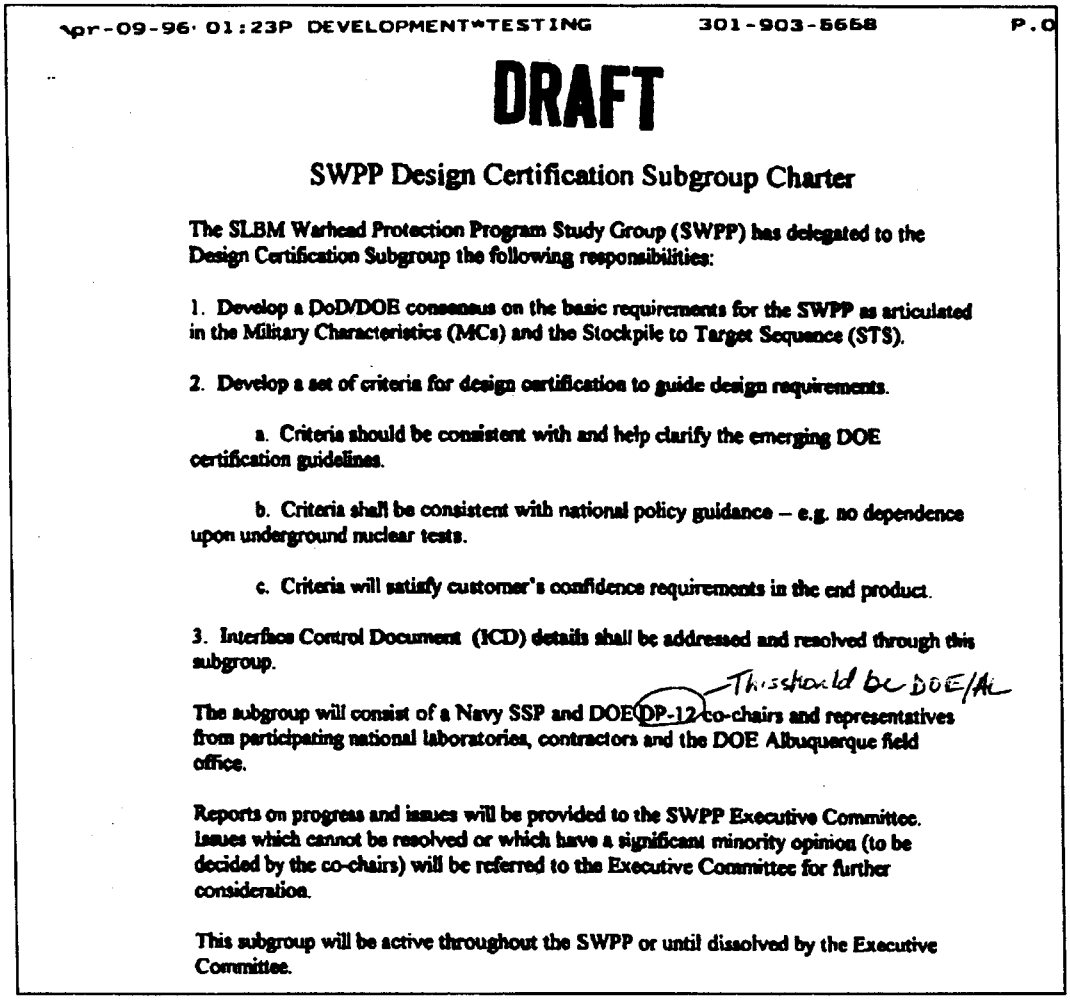
A second general meeting for the SWPP was held on 5 June 1996 at Kaman Sciences Corporation in Arlington, Virginia. One day later a DOE meeting was held in Germantown, Maryland, to "discuss the DOE perspective of the program."[57] The meeting minutes contain the following passage:

> Karen Lombardo DOE HQ (DP-17) explained for the benefit of the Labs and AL the political climate that is evolving in Washington concerning the development of new nuclear weapons. Questions of whether WPP constituted a new weapon have been raised, in the wake of the comm[ents] on WPP in the "Inside the Pentagon" and the Secretaries request for information. The Office of Development has responded to several inquiries whether the DOE was developing any new weapons. Karen further explained the importance of the WPP as not only the means to exercise our expertise, but also to exercise the tools being developed in

[53] Ibid., pg. 2.
[54] Ibid., pg. 3
[55] Ibid.
[56] reference to be provided
[57] "Meeting Minutes;" DATE: June 12, 1996; RECORDED BY: DP-17, R. Glenn Bell (SNL); MEETING: DOE Team meeting for the SLBM WPP; LOCATION: Germantown, June 6.1996, pg. 1.

> Science-Based Stockpile Stewardship. The WPP will set a preceden[t] for future design activities as well as influence the future relationship with the Navy. Therefore, it is paramount that the program develops and maintains a direction that emphasizes Stockpile Stewardship and de-emphasizes new warhead development.

While emphasizing the political dangers DOE HQ saw in a perception that SWPP represents the development of a new nuclear weapon, the message to the National Laboratories was to prepare the way for future design work by incorporating Stewardship Program capabilities within the SWPP.



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DRAFT

SWPP Design Certification Subgroup Charter

The SLBM Warhead Protection Program Study Group (SWPP) has delegated to the Design Certification Subgroup the following responsibilities:

1. Develop a DoD/DOE consensus on the basic requirements for the SWPP as articulated in the Military Characteristics (MCs) and the Stockpile to Target Sequence (STS).

2. Develop a set of criteria for design certification to guide design requirements.

   a. Criteria should be consistent with and help clarify the emerging DOE certification guidelines.

   b. Criteria shall be consistent with national policy guidance – e.g. no dependence upon underground nuclear tests.

   c. Criteria will satisfy customer's confidence requirements in the end product.

3. Interface Control Document (ICD) details shall be addressed and resolved through this subgroup.

The subgroup will consist of a Navy SSP and DOE DP-12 co-chairs and representatives from participating national laboratories, contractors and the DOE Albuquerque field office. This should be DOE/Al

Reports on progress and issues will be provided to the SWPP Executive Committee. Issues which cannot be resolved or which have a significant minority opinion (to be decided by the co-chairs) will be referred to the Executive Committee for further consideration.

This subgroup will be active throughout the SWPP or until dissolved by the Executive Committee.

Figure 2: Fax from Jeffrey Cuneo (DOE DP-12) to personnel at LANL, SNL/NM, SNL/CA, LLNL, Kaman Sciences Corporation, LMMS, and DOE/Al. Cuneo wrote on the cover: "Attached is a DRAFT Charter for our subgroup. It is my no means carved or even written in stone or anything firmer than pencil + paper. I hope it provides us with a starting point to discuss what we are going to address in the meeting next week. Call me if you see a burning issue that won't wait till the 17th. See you in C-Springs."

In addition the issue of nuclear weapon Use Control was raised at the DOE meeting:

> Another important topic that was discussed was Use Control. It was discussed that the policy may not be completely clear (see Attachments) as was the case for the HPRF [High Power Radio Frequency Warhead] program. The DOE and DoD interpretation were slightly different. Likewise, the NPR [Nuclear Posture Review] indicates that the policy is for improved Use Control. It was pointed out by the Labs that the DOE has an obligation to Use Control and to improve it. It was discussed that the WPP was an excellent opportunity to establish a better working relationship with the Navy on the appl[ication of] Use Control, recognizing that the Navy's first response is no. This discussion lead to a plan that called for the labs to brief the Use Control Effectiveness Committee (UCEC) on possible Use Control options. It was expressed that the minimum Use Control option should not be zero. The UCEC will evaluate the effectiveness of each option. The UCEC positions will be evaluated against safety and cost benefit analysis by a subgroup within the DOE team of WPP. This group has not been organized and the details about the group were not discussed. This group with the UCEC would then make recommendation to DP-20 for a DOE position. DP-10 will then present and negotiate the DOE Use Control position for WPP with the Navy. These options would of course recognize the Navy original requirements. The question was raised as to LLNL drop dead date for implementing Use Control and response was soon if not already past. LLNL was therefore to present their option at the next UCEC the week of June 10th.[58]

An attachment to the meeting minutes describes DOE Use Control Policy, revised guidelines for which were apparently issued on 16 April 1990. This attachment is reproduced in Figure 3.

Apparently the DOE meeting and the prior SWPP general meeting on 5 June 1996 clarified the issue of fabricability raised by Tyler and Henson: "Dr. Hannah at the program review stated that demonstrating the production process was not a requirement. The Navy did expect the program to work on real hardware, but this could be test hardware."[59] Furthermore: "A plan that defined how the components would be produced was required. Therefore, the only unfunded assistance from the plants and AL would be to provide support in the design phase as part of concurrent engineering and in the development of the production plan."[60] This is in some contrast to Tyler and Henson's "White Paper," where the concluded that without substantial plant funding, production

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[58] "Meeting Minutes;" DATE: June 12, 1996; RECORDED BY: DP-17, R. Glenn Bell (SNL); MEETING: DOE Team meeting for the SLBM WPP; LOCATION: Germantown, June 6.1996, pg. 2.
[59] Ibid., pg. 2.
[60] Ibid..

uncertainties would be significant. A 13 December 1996 Sandia memorandum notes that Jim Tyler was replaced as LLNL Program Manager, however this occurred prior to mid-June, 1996.

"Department of Energy (DOE) USE Control Policy -- Protection of Nuclear Weapons and Nuclear Explosive Against Deliberate Unauthorized Use," issued April 16, 1990

- An integrated system of positive measures shall be developed, implemented, and maintained to protect all nuclear weapons and NEDs in the custody of the DOE against deliberate unauthorized use.
- To the maximum extent possible, UC measures shall include positive design features.
- DOE will assist and coordinate with the DoD and other federal agencies to provide protection against deliberate unauthorized use for all U.S. nuclear weapons throughout their life cycle.
- Applies to all DP nuclear weapons development or modifications unless there are compelling reasons to the contrary which are approved by the Assistant Secretary for Defense Programs.

Figure 3: Attachment to a DOE memorandum, describing recent policy on Use Control for nuclear weapons.

As noted above, DOE management indicated that the SWPP should incorporate Stewardship tools, however in the 1996 the vulnerability expensive components of the Stewardship Program—notably the Advanced Design and Production Technology (ADaPT) program and the Accelerated Strategic Computing Initiative (ASCI) —where in question:

> This issue of connections and dependence on other programs was briefly discussed. The labs did not see a concern over the inter-connections. As part of new business practice, the use of tools being developed in other programs was seen as an effective and necessary means to achieving the objective of the program. The concern from HQ was that the heavy dependency on program such as ADaPT, Enhanced Surveillance, and ASCI in the out years could cause some difficulties or delays if those programs were cut back or redirected. It was therefore crucial that the Labs keep HQ informed on the dependencies on these programs in the out years, so HQ could help work to resolve any issues. The support from other programs will vary within the Labs. LLNL stated that they were not very dependent on other programs at this time. The concern from HQ was more directed at the elements of the program that are much farther out in time and not as well defined at this time. For instance, the Certification

Plan may plan to use facilities or codes that are being developed under other programs and what happen[s] if the programs are cut or redirected. [61]

The Certification Plan for the SWPP necessarily involves a substitution for nuclear testing in the process whereby nuclear weapon designs are determined to satisfy military (user) requirements for performance, reliability and safety. To the extent that the SWPP designs deviate from tested designs, the Certification Plan will likely entail Stewardship experimental data and computer calculations intended to extrapolate from or supplement past underground testing results. It is these programmatic ties between SWPP and elements of Stewardship that are of concern with respect to DOE obligations to the Navy. However, the meeting minutes note that both the Certification Process and "links to other projects (ASCI, ADaPT, Dual-Revalidation, etc.)" were not discussed.

On 26 June 1996, the Design Certification Sub Group met at Sandia National Laboratory to discuss:

- Draft SWPP Military Characteristics (Comparison with Phase 2 Military Characteristics);
- Vulnerability Certification without underground tests; and
- Yield Certification without underground tests.

Also at Sandia, the Design Integration Subgroup met on 18 September 1996. "Action Items" included:

- Prepare qualitative description of advantages for advanced Arming, Fuzing, and Firing systems; and
- Review Lockheed Martin Missile Systems proposal for change to Military Characteristics regarding the reentry body/warhead allowable dynamics.

On 27 November 1996, a draft paper entitled "SLBM Warhead Protection Program Requirements and Constraints Document" was issued. It was noted at the 6 June 1996 meeting that SWPP requirements seemed loosely defined orally and in viewgraphs. The Requirements and Constraints document notes: "This document provides requirements in addition to the Military Characteristics (MC's) and Stockpile-to-Target Sequence (STS) documents to define the deliverables, goals, and constraints of the Submarine Launched Ballistic Missile (SLBM) Warhead Protection Program. "[62] In particular it spells out the constraints that may arise from future Stewardship Program activities:

> 6.1.1 SWPP will be relying on the enhanced Surveillance Program to provide tools and information needed to determine the longevity of the replacement designs. Delays in the Enhanced Surveillance Program may impact the ability to accurately predict the longevity of the design.

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[61] Ibid.

[62] "Draft SLBM Warhead Protection Program Requirements and Constraints Document," Dated November 27, 1996, pg. 1.

6.1.2 The ability to provide evidence for both the confidence in the design of some components and the certification of the design in the future will require computational tools that will be provided by [the] Accelerated Strategic Computing Initiative (ASCI). These tools will have to be developed and validated in a timely manner in order to support certain aspects of SWPP. Delays in ASCI may adversely affect confidence in the SWPP designs as well as the future certification process as applied to the deployed stockpile.[63]

In addition to DOE's effort to design potential replacement warheads for Trident which possess well defined, even extended service lifetimes, the SWPP will incorporate changes to the W76 and W88 warheads intended to increase safety:

4.5 The replacement design option will provide increased safety margin.

Deliverable: The replacement options will include safety features defined in Section I of the Design Data Package and the supporting evidence will be documented in Section II that the design features will increase the present W76/Mk4 and W88/Mk5 safety margins.

As will be shown below, DOE plans to incorporate Fire Resistant Pit (FRP) technology, as well as Insensitive High Explosives (IHE), into both Trident replacement warhead designs.

Production, or fabricability issues and the extent to which the SWPP served to break ground both in the new Stockpile Stewardship certification processes, and in the Stockpile Management Production processes, was apparent again in a 6 December 1996 memo from Thomas P. Seitz (Deputy Assistant Secretary for Military Application and Stockpile Management, DOE DP). Seitz set up a meeting at DOE HQ to address the "zero defects issue" and SWPP:

...I recently hosted a meeting where we discussed approaches to achieving zero defects in the remanufacture process. Among the methods discussed were concurrent engineering, product realization teams, integrated product and process design (IPPD), "virtual" prototyping and model based manufacturing. In the past 10 years industry has successfully applied these techniques to improve quality and reliability, reduce time to market and even reduce cost. During that period the nuclear weapons complex has spent significant R&D effort in developing technologies supporting these methods but, in general, reduction to practice has not followed. It is time to change that trend.

...Over the last year the SLBM Warhead Protection Program (SWPP) has become a prominent activity in the complex where new ways of meeting

[63] Ibid. pp. 5-6.

our product realization mission are being examined. I think it is very important that the zero defects issue be addressed in the SWPP program. [64]

On 16 January 1997 the SWPP Design Certification Subgroup met for the fourth time. The agenda for the meeting included:

- Current Mass Properties for LLNL Warhead Designs
- Participants' MCs [Military Characteristics] Changes Recommendations
- Laboratory End-to-End Certification Plan
- Core Punch Results for SWPP.

Action Items at the meeting included: "provide current mass properties for LLNL warhead designs," and "Promulgate 4% weight limit due to vulnerability considerations to other concerned SWPP subgroups, e.g., Design Integration Subgroup."[65] On 15 January 1997 the Design Integration Subgroup also met for the fourth time, at Lockheed Martin Missiles & Space in Sunnyvale, CA.

A document dated 4 December 1997 and bearing the Kaman Sciences Corporation letterhead is entitled: "SLBM Warhead Protection Program (SWPP) Program Plan." In the first (Background) section of the Plan, it states:

> ... the SLBM Warhead Protection Program (SWPP) was conceived as a multi-year effort that concentrates on replacement point designs rather than development of a new or increased capability. The program focuses on devising replacement alternatives to non-reproducible technologies in the stockpiled W76/MK4 and W88/MK5 weapons. It also focuses on development of certification methods which are not based on future Nuclear Underground Tests (UGTs), but rather on non-nuclear Above Ground Tests (AGTs) and evolving science-based computer modeling and simulation technologies. This is a cooperative Department of Defense (DoD) and Department of Energy (DOE) program, being managed by a Study Group of the W76/MK4 and W88/MK5 Project Officer Groups (POGs). The program does not include fabrication of hardware for the stockpile.[66]

Futhermore, the Plan states that the SWPP warheads will be designed so that they can be integrated into the existing aeroshells without modification. The designs will be time-phased to provide a mid-term option in the next few years (i.e., the Pit Reuse), followed by a longer term option (i.e., New Pit). Note that this is a change from earlier planning, in which three alternate designs (also time-phased) were envisioned for the SWPP.

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[64] Thomas P. Seitz, Deputy Assistant Secretary for Military Applications and Stockpile Management, DOE DP, memorandum to "Distribution," 6 December 1996, Subject: "SLBM Warhead Protection Program (SWPP) Focus on Zero Defects."

[65] Bob Nuttleman, Kaman Sciences Corporation, memorandum to "Distribution," 12/16/96, SUBJECT: 4th SWPP Design Certification Subgroup Meeting.

[66] "SLBM WARHEAD PROTECTION PROGRAM (SWPP): PROGRAM PLAN, K97-84U(R), 4 December 1997, Kaman Sciences Corporation, pg. 1.

The SWPP Plan states two objectives of the program:

A. To maintain and exercise the DOE expertise, facilities and capability to design, fabricate and certify replacement weapon components, subsystems and systems.

B. To provide for a continuum of replacement options for the W76/MK4 and W88/MK5 reentry systems. These replacement options should have decreased sensitivity to aging, enhanced safety features and maintain current capability to the maximum extent possible.[67]

The plan also enumerates Departmental requirements for the SWPP, and Program goals, listed in Table 5.

Related to the issue of maintaining design capabilities, the SWPP Plan states: "At appropriate milestones of each project on the SWPP master schedule, a SWPP Design Data Package (DDP) review will be conducted. This SWPP DDP review will be modeled after the Design Review and Acceptance Group (DRAAG) review process defined in DOD Instruction 5030.55 of 21 January 1974."[68]

The SWPP products will not be warheads for the U.S. stockpile, but a set of documents called the Design Data Package, which includes the Certification Plan and Concurrent Engineering Report. A description of each document is presented in Table 6.

From the SWPP Master Schedule given in the Plan, the Technical Strategy for Certification was intended to be complete by 1 November 1997, however it is not marked as complete as of December. The two most documents which NRDC received under FOIA are from early and mid-January, 1998. The "PRP Response to [SNL/NM] Comments on Technical Strategy for Certification"[69] dated 2 February 1998 probably indicate why. (Note that SNL/CA—not SNL/NM—are involved in PRP.) A viewgraph entitled "PRP response to SNL/NM comments on Technical Strategy for Certification" states: "The SWPP/PRP will not certify the design:

— Building a technical base for certification

— Basis will be incomplete in the data package

— Certification plan will provide a guide to complete the technical basis

— Budget an priority decisions will determine how far we get."

It is probably a correct supposition that the PRP team was responding to criticisms about the sufficiency of their proposed certification strategy. Despite Navy's original description of the project, the LLNL-SNL/CA team states now that the end product will not be a certified design. However, the PRP team cites management/budgetary hurdles, not ones of a technical nature.

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[67] Ibid., pg. 2.

[68] Ibid., pg. 7.

[69] John Heidrich and Dana Rowley (LLNL), Larry Weingarten, Steve Vasey, and Doug Henson (SNL/CA), "PRP Response to Comments on Technical Strategy for Certification," January 14, 1998, "Presented to Design Certification Subgroup."

DoD and DOE SWPP Requirements	SLBM Warhead Protection Program Goals
1. MCs for the Warheads for the TRIDENT II (D-5) MK4A and MK5A Reentry Bodies dated 3 June 1993. 2. Trident II (D-t) - WYY-0/MK5A Reentry Body Assembly (RBA) Preliminary Stockpile to Target Sequence (STS) dated 15 December 1993. 3. WXX-0/MK4A Reentry Body Assembly (RBA) Preliminary Stockpile to Target Sequence (STS) dated 15 December 1993. 4. DOE Order O 452.4 - Security and Control Nuclear Explosives and Nuclear Weapons issued 4 June 1997. 5. Affordability shall be primary consideration in all program aspects. 6. Be consistent with the strategies depicted in the Stockpile Stewardship and Management Plan and apply the principles of Science-Based Stockpile Stewardship, as applicable. 7. Maintain current safety margin. 8. No new Underground Tests (UGTs) are permitted.	1. No changes to the TRIDENT II (D-5) missile. 2. No changes to the MK4 or MK5 reentry body aeroshells. 3. Maintain the size, shape and to the extent possible the mass properties of the present reentry system. Mass properties changes to be within Navy-provided limits. 4. No changes to the missile physical and functional interfaces for the MK5 RBA. 5. Minimize changes to the functional interface of the MK4 to allow for MK5 fuzing functionality and MK5 nuclear safety implementations. Changes will be coordinated with the Navy. 6. No changes to the MK4 physical interfaces. 7. Minimize dependence on new flight tests. Flight test configurations must not invalidate the MK4 and MK5 flight test data. 8. Proposed replacement design unit cost should be ¼ of the W88/MK5 production cost. 9. Proposed replacement design should achieve first Production Unit (FPU) within 3 years of start of E&MD. 10. Use control features will be incorporated in such a manner as to minimize changes to DoD hardware and minimize impacts while in DoD custody. 11. Minimize changes to operational capability. 12. Minimize changes to the missile fire control software. 13. Maintain the existing V-Gamma map. 14. Provide increased safety margin, where practical.

Table 5: Departmental requirements for the SWPP, and Program goals.

SWPP Product:	**Design Data Package**	**Certification Plan**	**Concurrent Engineering Report**
Description:	design information; evidence to support feasibility; description of required follow-on developments, certification and production activities; "The DDP also provides the rationale, from both experiments and calculations, that the design options can meet the requirements, reduce development time, be fabricated, be certified and enter the stockpile with high confidence."	"provides the experiments and calculations conducted during SWPP, the experiments and calculations needed to be performed during E&MD in order to formally certify the designs, and the rationale for these tests. It also defines the risks associated with not performing certain experiments until E&MD and not performing certain experiments due to restrictions."	"summary of the processes needed to produce the components. It describes the issues and risks that need to be addressed during E&MD. It also provides information on the process used to manufacture the test hardware."

Table 6: Description of the SWPP products.

To emphasize their point, the PRP team presented a further viewgraph entitled: "Certification will not be done in the Pit Reuse Project (PRP)," shown in Figure 4. Here the design validation process is depicted as less than half complete by the end of PRP, and certification would occur only afterwards.

While the PRP team's final viewgraph is entitled "Peer review is expected before certification," paradoxically it goes on to note:

- [peer review] Probably required for certification
- Peer review is a fiscal issue
- Independent analysis peer review could increase confidence in data package
- Peer review is not necessary for PRP data package.

This position must be contrasted with the fundamental rationale for maintaining two nuclear weapon design laboratories—providing for adequate peer review for classified national defense research and engineering.

Finally on the manufacturing issues for SWPP, Daniel Rose of DOE/AL presented a viewgraph entitled: "SWPP Issues." In this he reiterates the issues stressed by the former LLNL Program Manager for Pit Reuse (James V. Tyler):

Minimal Production Complex funding/involvement

- No concurrent engineering
- No process development
- No Test Hardware

Manufacturing is not being addressed

Rose's recommendations are to "Fully Fund Production Plant Support of SWPP." Cost estimates—shown in Figure 5—are given, but it is unclear whether they refer to SWPP as a whole, PRP, or New Pit. Note that LLNL and SNL/CA are not listed.

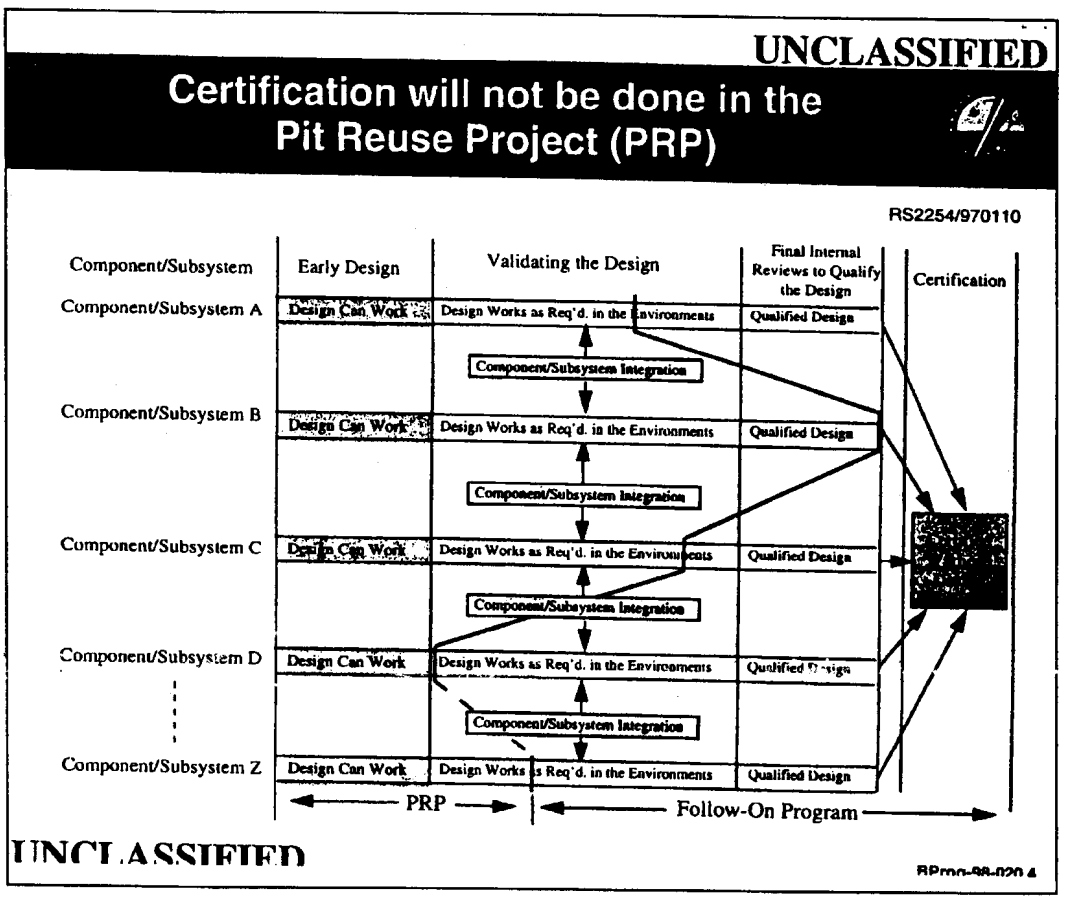

Figure 4: Viewgraph from "PRP Response to Comments on Technical Strategy for Certification;" a presentation by LLNL and SNL/CA on the SWPP.

The indications from the available documentation is that SWPP is an uncertain program—in both the tasks of certifying the designs and of establishing the ability of the downsized DOE production complex to fabricate the designs. Perhaps in response, a Program Realization Team (PRT) was established for the SWPP, and initially met on

January 22 and 23, 1998. Daniel Rose (Program Manager for Navy Strategic Programs, Weapons Divisions Program, Albuquerque Operations Office, DOE) wrote that the purpose of the meeting was to:

1. Discuss the SWPP path forward based on the decisions from the DP-10 and DP-20 Meeting of December 5, 1998: **No additional funding was provided** (emphasis in original).
2. Develop and Integrated Laboratory and Production Plant Program Plan.
3. Determine resource requirements and budget planning for SWPP.
4. Identification of Sub-PRTs, taskings and identify team members. Specifically proposed Sub-PRTs are for the advanced AF&F, Pit Reuse Option and New Pit Option.[70]

To summarize, the Navy conceived of the SWPP as a means to force DOE to apply Stewardship strategies/capabilities in the development of designs for existing strategic delivery systems (Navy called it a "forcing function"), in part to probe the DOE Stewardship Program and in part to keep SLBM warhead skills in parctice. The Navy wanted DOE to complete Phase III and what would have been part of Phase IV for two designs: a reused pit and a new pit. DoD emphasized that the MCs, STS, etc. would remain the same as for the Trident systems, and characteristics like the warhead mass distribution would be constrained to very close to the W88.

However, National Laboratory personnel indicate that they do not have sufficient funds either to a) get very far in the certification- without-underground-testing process or b) demonstrate that the Trident replacement warhead designs can be manufactured in the downsized DOE complex. LLNL claims that peer review is "probably required for certification," but "not necessary" for this project. That is an incredible statement, as LLNL lobbied for their continued existence largely on the issue of classified peer review.

One can postulate several reasons for the SWPP programmatic uncertainty:

1) NRDC's report "End Run" and other press reports diminished upper management or administration support for SWPP;
2) DOE is reluctant to fund SWPP because certification without underground testing is politically risky: if the National Laboratories can achieve this capability now, why invest billions more in the SSMP; if the National Laboratories run up against general "showstoppers," this may cast doubt on the over-arching Stewardship strategy even with new future planned capabilities;

[70] Daniel Rose, Memorandum, Subject: "SLBM Warhead Protection Program (SWPP) Program Realization Team (PRT) Meeting, December 22, 1997.

3) DOE simply views the money as better spent on other parts of Stewardship, so the Navy will get something, but additions to the stockpile in the near term are not planned as part of the SWPP.

(Dollars in 000)	FY97	FY98	FY99
Kansas City Plant			
Required	$ 788	$ 2,220	$ 434
Funded	$ 788	$ 1,578	
LANL			
Required		$ 300	$ 300
Funded			
Pantex Plant			
Required		$ 300	$ 300
Funded			
Savannah River Plant			
Required		$ 200	$ 200
Funded			
SNL/NM			
Required	$1,600	$ 1,980	$ 325
Funded	$1,600	$ 1,775	
Y-12			
Required		$ 1,860	$ 1,535
Funded			
Total Needed		$ 3,507	$ 825

Figure 5: SWPP cost estimates, from a presentation by Daniel Rose (DOE/AL). It is unclear whether these cost estimates refer to the SWPP as a whole, to the Pit Reuse option, or to the New Pit option