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Report 97-945

*NUCLEAR WEAPONS PRODUCTION CAPABILITY  
ISSUES: SUMMARY OF FINDINGS, AND CHOICES*

Jonathan Medalia, Foreign Affairs and National Defense Division

Updated June 24, 1998

**Abstract.** Congress and the President have made clear that the United States will retain nuclear weapons for the foreseeable future whether or not the Comprehensive Test Ban Treaty, or CTBT, enters into force. To this end, the Department of Energy has a program of R&D and production. The role of R&D in maintaining the nuclear stockpile has attracted much attention, unlike that of production. This report seeks to help Congress understand production issues.

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## Nuclear Weapons Production Capability Issues: Summary of Findings, and Choices

Updated June 24, 1998

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## ABSTRACT

This report summarizes a longer report, *Nuclear Weapons Production Capability Issues*, CRS report 98-519 F, June 8, 1998, by Jonathan Medalia. Both are intended to help Congress understand nuclear weapons production issues. The present report first provides background. It then summarizes 15 findings from the longer report that show the role of production and present investment, people, and technology problems facing production. Last, it examines alternatives for maintaining the stockpile, and discusses the relationship between the Comprehensive Test Ban Treaty (CTBT) and weapons research, development, and production. Related topics such as arms reduction agreements, environmental issues at the production plants, and laboratory issues *per se* fall largely outside the scope of this report. This report will help Congress in considering (1) annual funding for production in the national defense authorization bill and the energy and water development appropriations bill, and (2) U.S. ability to maintain nuclear weapons for the long term, a critical issue in hearings and debate on the CTBT that may occur in 1998 and 1999. This report is most appropriate for staff with an interest in nuclear weapons production, though parts of it will be of value to those with an interest in (for example) workplace demographics, the impact of new technologies on production, and the integration of design and manufacturing software. This report will not undergo a complete revision, though minor revisions and updates may be made from time to time. Related CRS products include issue brief 92099, *Nuclear Weapons: Comprehensive Test Ban Treaty*, updated regularly; report 96-11 F, *Nuclear Weapons Stockpile Stewardship: Alternatives for Congress*; and report 94-418 F, *Nuclear Weapons Stockpile Stewardship: The Role of Livermore and Los Alamos National Laboratories*, all by Jonathan Medalia.

# Nuclear Weapons Production Capability Issues: Summary of Findings, and Choices

## Summary

The United States shows every intention of retaining nuclear weapons for the foreseeable future, thus committing itself to maintaining their safety, reliability, and performance. Maintenance requires R&D and production. While the former requirement is well understood, the latter is not. This report provides information on production and associated investment, people, and technology issues.

Production is done for many reasons. Problems with existing warheads have historically emerged over time and seem likely to do so in the future. Warhead maintenance requires modifications, life extension programs, replacement of defective components, disassembly and reassembly for surveillance, and similar activities. Plants and labs make complementary contributions to production. It appears that all five nuclear weapon states perform maintenance, and that all but the United States produce weapons of new or existing design.

Production, as any industrial process, requires ongoing investment. In planning budgets for the plants, DOE attaches highest priority to production operations because they are fundamental to its ability to support the stockpile. This priority, though, has led DOE to defer some longer-term investment in such areas as maintenance, facility upgrades, infrastructure, and equipment; such deferral impedes work at the plants. At the same time, DOE is investing in some technology and other programs to aid the plants.

Production depends on people. There are adverse demographic trends among scientists and engineers at the plants. Trends for skilled trades personnel are potentially more serious; negligible hiring of new personnel and the initial hiring of most current personnel between 1977 and 1981 raise the prospect of mass retirements in a decade or so. While the plants' mission is weapons work, nonweapons work helps them retain staff members and maintain and develop their skills.

The labs and plants are developing vast amounts of weapons-related technologies. The plants' focus is on evolutionary advances in products and processes; that of the labs, on revolutionary advances. This technology has a profound impact. Two examples: software is changing how nuclear weapon components are designed, engineered, and produced, with computer models becoming the medium for conducting and linking these steps; and new technologies and declining work volume are changing the skill mix needed for production, often requiring trades workers to increase skills. New technology holds differing implications for different groups.

The United States has signed the Comprehensive Test Ban Treaty. Some who would abolish nuclear weapons support the treaty and reject all but an interim, low-level weapons maintenance effort. Others, believing that this nation can obtain the confidence it needs in weapons only through nuclear testing, would reject the treaty, support more effort on weapons maintenance, and resume testing. There appears to be a confluence of interest between many who favor the treaty and many who would increase effort on weapons maintenance, as the two are arguably complementary.

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# Nuclear Weapons Production Capability Issues: Summary of Findings, and Choices

## Introduction

Congress and the President have made clear that the United States will retain nuclear weapons for the foreseeable future whether or not the Comprehensive Test Ban Treaty (CTBT), which this Nation and 148 others have signed, enters into force.<sup>1</sup> As part of its effort to maintain these weapons, the Department of Energy (DOE) is conducting a two-part program called Stockpile Stewardship and Management, or SSM.<sup>2</sup> Its R&D element is Science-Based Stockpile Stewardship; the production element is Stockpile Management. The role of R&D in maintaining weapons has attracted much attention;<sup>3</sup> that of production has not. R&D may discover the need for, and guide, weapon modifications and such weapon maintenance activities as refurbishments, repairs, life extension programs, and replacement of components at the end of their service lives, but production is needed to implement them.

This report seeks to explain and clarify production issues that Congress may consider. This chapter first provides background. It then presents four main points: (1) Production is needed to maintain nuclear weapons, and is done in the United

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<sup>1</sup> A Presidential Decision Directive of November 1997 “affirms, for example, that the United States will continue to rely on nuclear arms as a cornerstone of its national security for the ‘indefinite future,’ ... according to Robert G. Bell, a special assistant to the president and senior director for defense policy at the National Security Council.” R. Jeffrey Smith, “Clinton Directive Changes Strategy on Nuclear Arms,” *Washington Post*, December 7, 1997: 8. The following web sites provide current information on the CTBT: Coalition to Reduce Nuclear Dangers, Comprehensive Test Ban Treaty Site, [<http://www.clark.net/pub/clw/coalition/ctbindex.htm>]; Center for Security Policy, [<http://www.security-policy.org>]; and Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization, [<http://www.ctbto.org>]. See also CRS Issue Brief 92099, *Nuclear Weapons: Comprehensive Test Ban Treaty*, by Jonathan Medalia.

<sup>2</sup> In the latter part of 1997, DOE changed the name of the Stockpile Stewardship and Management Program to the Stockpile Stewardship Program, reflecting both the common usage of “stewardship” to include R&D and production, and the integration of these two elements. As the focus of this report is production, it retains the older usage to help differentiate between production and R&D.

<sup>3</sup> See the following CRS reports on stockpile stewardship: U.S. Library of Congress. Congressional Research Service. *Nuclear Weapons Stockpile Stewardship: Alternatives for Congress*. Report 96-11 F. December 14, 1995, 30 p., by Jonathan Medalia; *Nuclear Weapons Stockpile Stewardship: The Role of Livermore and Los Alamos National Laboratories*. Report 94-418 F. May 12, 1994, 75 p., by Jonathan Medalia; and *The National Ignition Facility and Stockpile Stewardship*. Report 97-337 SPR. March 11, 1997, 61 p., by Richard Rowberg.

States and the other four declared nuclear weapon states. (2) The nuclear weapon production plants need investment if they are to help maintain the stockpile for the long term. (3) Demographic issues threaten production capability. (4) A vast array of new technologies being developed will affect production across the board. Several specific findings, summarized here, support each point. Finally, this report presents choices and a conclusion. This report is a slightly modified version of the first chapter of a longer CRS report.<sup>4</sup> DOE's Office of Declassification reviewed that document and found it to contain no DOE-classified information.

## Background

In 1992, Congress directed that the United States pursue a CTBT and temporarily halt nuclear tests.<sup>5</sup> President Clinton extended the moratorium three times, and vigorously sought a CTBT. Multilateral negotiations at the Conference on Disarmament (CD) in Geneva began in January 1994, and produced a draft treaty acceptable to all CD members except India in August 1996. The U.N. General Assembly adopted the treaty in September 1996 by a vote of 158 to 3. As of June 1998, 149 nations, including the United States, had signed it, and 13, including France and the United Kingdom, had ratified it. Its key obligation is "not to carry out any nuclear weapon test explosion or any other nuclear explosion."<sup>6</sup>

Although the United States observes a ban on nuclear testing, Congress and the President plan to retain U.S. nuclear weapons for the foreseeable future, and to maintain confidence in the safety, reliability, and performance of these weapons. In July 1993, the President stated, "To assure that our nuclear deterrent remains unquestioned under a test ban, we will explore other means of maintaining our confidence in the safety, the reliability, and the performance of our own weapons."<sup>7</sup> Also in 1993, Congress directed that "The Secretary of Energy shall establish a stewardship program to ensure the preservation of the core intellectual and technical compe-

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<sup>4</sup> U.S. Library of Congress. Congressional Research Service. *Nuclear Weapons Production Capability Issues*. Report 98-519 F, June 8, 1998, 135 p. By Jonathan Medalia.

<sup>5</sup> P. L. 102-377, sec. 507, FY1993 Energy and Water Development Appropriations Act. In 1996, the Senate rejected an attempt to withdraw this legislation.

<sup>6</sup> United Nations. General Assembly. Fiftieth Session. *Adoption of the Agenda and Organization of Work: Comprehensive Test-Ban Treaty*. "Annex: Draft Comprehensive Nuclear-Test-Ban Treaty," Article I. A/50/1027. August 26, 1996.

<sup>7</sup> Clinton, William. "The President's Radio Address," July 3, 1993. In U.S. National Archives and Records Administration. Office of the Federal Register. *Weekly Compilation of Presidential Documents*, July 12, 1993: 1246. The means of implementing this policy were codified in a Presidential Decision Directive, which is referenced in U.S. Department of Energy. "Stockpile Stewardship and Management Programmatic Environmental Impact Statement," Notice of Intent, *Federal Register*, June 14, 1995: 31292. National Security Council staff told the author on Nov. 17, 1995, that the directive is entitled "Fiscal Year 1994-1999 Nuclear Weapons Stockpile Stewardship Plan" and is classified.

tencies of the United States in nuclear weapons ....”<sup>8</sup> These statements set a requirement for “stockpile stewardship,” which the President reaffirmed in August 1995:

... I consider the maintenance of a safe and reliable nuclear stockpile to be a supreme national interest of the United States.

I am assured by the Secretary of Energy and the Directors of our nuclear weapons labs that we can meet the challenge of maintaining our nuclear deterrent under a CTBT through a Science Based Stockpile Stewardship program without nuclear testing.<sup>9</sup>

In announcing at that time his decision for a zero-yield CTBT, President Clinton set forth six “safeguards” — unilateral actions the United States would take to enhance its security consistent with the treaty — on which he conditioned the decision. All of them relate, directly or indirectly, to stewardship. In brief, they are: Safeguard A, conducting a Science Based Stockpile Stewardship program; B, maintaining modern nuclear laboratory facilities and programs; C, maintaining the basic capability to resume nuclear testing; D, continuing to improve U.S. treaty monitoring capabilities; E, continuing programs to ensure complete information on nuclear weapon and related programs worldwide; and F, “[t]he understanding that ... the President, in consultation with Congress, would be prepared to withdraw from the CTBT under the standard ‘supreme national interests’ clause in order to conduct whatever testing might be required” if a serious problem developed in a critical warhead type that could not be resolved without testing.<sup>10</sup>

Congress has consistently supported and funded programs to maintain nuclear weapons. A Senate resolution of January 1996 stated in part: “The United States is committed to proceeding with a robust stockpile stewardship program, and to maintaining nuclear weapons production capabilities and capacities, that will ensure the safety, reliability, and performance of the United States nuclear arsenal ....”<sup>11</sup> Conferees on the FY1997 National Defense Authorization Act added \$85 million for weapons R&D and production activities, and another \$90 million for the weapons manufacturing infrastructure.<sup>12</sup> Conferees on the FY1998 Energy and Water Development Appropriations Bill added \$130 million for stockpile stewardship and

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<sup>8</sup> *National Defense Authorization Act for FY1994*, P.L. 103-160, sec. 3138.

<sup>9</sup> Clinton, William, “Statement on a Comprehensive Nuclear Weapons Test Ban,” Aug. 11, 1995. U.S. Office of the Federal Register. National Archives and Records Administration. *Weekly Compilation of Presidential Documents*, Aug. 14, 1995. Washington, U.S. Govt. Print. Off., 1995: 1433.

<sup>10</sup> U.S. White House. Office of the Press Secretary. “Fact Sheet: Comprehensive Test Ban Treaty Safeguards,” August 11, 1995, 1 p.

<sup>11</sup> Treaty with the Russian Federation on Further Reduction and Limitation of Strategic Offensive Arms (The START II Treaty). [Resolution of Ratification] U.S. Congress. *Congressional Record* (daily ed.), January 26, 1996: S461.

<sup>12</sup> U.S. Congress. Committee of Conference. *National Defense Authorization Act for Fiscal Year 1997*. Conference report to accompany H.R. 3230. H. Rept. 104-724. 104th Congress, 2d Session. Washington, U.S. Govt. Print. Off., 1996, p. 900-901.

\$108 million for stockpile management, and reduced program direction, a DOE function, by \$53.5 million.<sup>13</sup>

The plan to retain weapons holds despite efforts to reduce their number. The United States had 9,200 strategic warheads in 1979 and approximately 13,000 such warheads in September 1990.<sup>14</sup> START I (the first Strategic Arms Reduction Treaty), which is now in force, sets for the United States and Russia a ceiling of 6,000 strategic warheads apiece accountable under the treaty; the START II Protocol, which the United States has approved and which is pending approval in the Russian Duma, would lower that ceiling to 3,500.<sup>15</sup> Presidents Clinton and Yeltsin reached an understanding on a START III framework at their summit in Helsinki in March 1997.<sup>16</sup> According to this framework, START III might reduce strategic warheads to 2,000 to 2,500 for each side by December 31, 2007, though Russia is reportedly interested in even lower limits. Many other details remain to be negotiated.

Warheads deteriorate with age, and other flaws may emerge, so methods must ultimately be found to maintain them. In the past, testing provided assurance, when needed, that a fix worked. Now, alternate means must be found as long as testing remains halted. Some advocate prompt worldwide nuclear disarmament, which would render weapons maintenance moot. Others would retain weapons. Of this

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<sup>13</sup> U.S. Congress. Committee on Conference. *Making Appropriations for Energy and Water Development for the Fiscal Year Ending September 30, 1998, and for Other Purposes*. Conference report to accompany H.R. 2203. H. Rept. 105-271. 105th Congress, 1st Session. Washington, U.S. Govt. Print. Off., 1997, p. 88-89.

<sup>14</sup> The 1979 figure is from the statement of Secretary of Defense Harold Brown, in U.S. Congress. Senate. Committee on Foreign Relations. *The SALT II Treaty*. Hearings, 96th Congress, 1st Session. Washington, U.S. Govt. Print. Off., 1979. Part 1, p. 99. The figure of 9,200, while presented simply as “total weapons” for strategic offensive forces, appears to be deliverable weapons, e.g., excluding spares. The 1990 figure is from a briefing by General Colin Powell, U.S. Army, Chairman of the Joint Chiefs of Staff, at the Pentagon to news media representatives, January 29, 1992, regarding the President’s initiative to reduce numbers of nuclear warheads in the U.S. stockpile.

<sup>15</sup> Actual numbers of warheads are greater because of spares and other nondeployed strategic warheads, as well as nonstrategic warheads. For further information on START, see U.S. Library of Congress. Congressional Research Service. *Nuclear Arms Control and Nuclear Threat Reduction: Issues and Agenda*. Issue brief IB94054, updated regularly, by Amy Woolf. According to Norris and Arkin, “The term ‘stockpile’ refers only to those nuclear warheads held in Defense Department custody. The stockpile contains three categories of warheads: those with active operational forces — usable in minutes or hours — along with spares kept at the bases where nuclear weapons are deployed; augmentation or ‘hedge’ warheads not necessarily associated with active nuclear delivery systems; and reliability replacements kept in storage.” There are also retired warheads and pits, and a strategic reserve of pits and secondaries. Robert Norris and William Arkin, “NRDC Nuclear Notebook: U.S. Nuclear Stockpile, July 1997,” *Bulletin of the Atomic Scientists*, July/August 1997: 62.

<sup>16</sup> “Russia-United States Joint Statement on Parameters on Future Reductions in Nuclear Forces,” March 21, 1997, in U.S. National Archives and Records Administration. Office of the Federal Register. *Weekly Compilation of Presidential Documents*. March 24, 1997, p. 389-390.

latter group, some believe that DOE's SSM program can maintain weapons, while others hold that no amount of resources for maintaining weapons without testing can provide the assurance that testing does, and would reject a CTBT. These alternatives, and others, were detailed in the 1995 CRS report cited above. The present report has a much narrower focus, nuclear weapons production within the current policy assumptions that the United States will (1) enter the CTBT, or continue its moratorium on nuclear testing if the treaty does not enter into force; and (2) retain and maintain its nuclear weapons for the long term without testing.

DOE is developing its SSM program to maintain weapons without testing. It defined the program in July 1995 as follows:

Stockpile Stewardship includes activities required to maintain a high level of confidence in the safety and reliability of nuclear weapons in the absence of underground nuclear testing, and to be prepared to resume nuclear testing if so directed by the President. Stockpile Management activities include dismantlement, maintenance, evaluation, and repair or replacement of weapons and their components in the existing stockpile.<sup>17</sup>

Any program to maintain weapons is sure to rest heavily on an extensive program of nuclear weapons science and technology because that is the only way to perform certain essential tasks without testing: monitoring warheads in the stockpile; conducting experiments to investigate nuclear weapons physics and supply data for computer models; evaluating problems that emerge with warheads over time; developing computer models to predict and help solve problems; modifying designs or developing new components, materials, and processes to solve problems; certifying that new or rebuilt weapons will function as intended; and more. Most in Congress and elsewhere accept this science-based approach as necessary if the stockpile is to be maintained without testing, though some doubt that any non-test-based method can work.

The role of production in maintaining the stockpile is far less well understood for several reasons: DOE has emphasized the role of R&D in maintaining the stockpile; policymakers arguably are more familiar with science than with manufacturing; and the practical meaning of "production" has changed. During the Cold War, the term referred mainly to the manufacture of large numbers of warheads of new design; now, it consists of activities that require facilities for such industrial processes as component manufacture, warhead refurbishment, dismantlement of warheads being retired, and others described beginning on page 10. DOE's views on production have also changed. In May 1995, its SSM proposal emphasized science

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<sup>17</sup> DOE, "Stockpile Stewardship and Management Programmatic Environmental Impact Statement," Notice of Intent: 31292. Other reports on stewardship include: (1) Sidney Drell et al., *Science Based Stockpile Stewardship*. McLean, VA, JASON Program Office, the MITRE Corporation, November 1994. Report JSR-94-345, 113 p. (2) U.S. Department of Energy. Secretary of Energy Advisory Board. Task Force on Alternative Futures for the Department of Energy National Laboratories. *Alternative Futures for the Department of Energy National Laboratories*. February 1995, 66 p. + app. (3) U.S. Congress. Congressional Budget Office. *Preserving the Nuclear Weapons Stockpile under a Comprehensive Test Ban*. May 1997, 77 p. by David Mosher.

and envisioned a very small production base,<sup>18</sup> while a DOE report released in November 1996 placed an increased emphasis on production.<sup>19</sup> DOE's current position on SSM is spelled out on page 8.

## Nuclear Weapon Description

This description introduces key terms and shows the relationship between weapon components. Modern nuclear weapons have two stages a short distance apart that a metal radiation case encloses. In the "primary" stage, a layer of chemical explosive surrounds a hollow "pit" containing fissile uranium-235, plutonium-239, or both, as well as non-fissile materials. Detonating the explosive creates an implosion wave that compresses the pit, making it go supercritical. A neutron generator injects neutrons into the compressed pit, initiating a nuclear fission explosion. Hydrogen isotopes (deuterium and tritium) are inside the pit. The heat of the fission reaction makes them undergo fusion, releasing more neutrons that enhance the fission reaction and "boost" explosive yield sharply. The "secondary" stage, containing lithium-6 deuteride and uranium, adds most of the yield.<sup>20</sup> X-rays from the primary explosion flow inside the volume enclosed by the radiation case to the secondary. They transfer energy to compress and ignite the secondary, causing fusion of tritium (generated from lithium-6) and deuterium. Fusion releases energy and produces high energy neutrons that fission more uranium.

## The Nuclear Weapons Complex

The Department of Energy owns eight sites for research, development, testing, production, and assembly/disassembly of nuclear weapons, their components, and their materials. Each is operated by a contractor. Four sites focus on R&D. Los Alamos National Laboratory (LANL), in New Mexico, and Lawrence Livermore National Laboratory (LLNL), in California, design the "physics package," or nuclear explosive component, of warheads; Sandia National Laboratories (SNL), headquartered in New Mexico, designs nonnuclear components such as radars, fuzes, and arming and safing systems. Los Alamos and Sandia have specialized production responsibilities as well, with the former producing detonators and preparing to produce pits, and the latter preparing to produce neutron generators. Nuclear tests were conducted at the Nevada Test Site; the last U.S. test was conducted there in 1992. Now the site is in standby mode. It is maintained in a way that it could conduct a nuclear test within two to three years of receiving notice to do so, but in the event of a high national priority it could conduct a few tests in 12 to 18 months

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<sup>18</sup> U.S. Department of Energy. Office of Defense Programs. *The Stockpile Stewardship and Management Program: Maintaining Confidence in the Safety and Reliability of the Enduring U.S. Nuclear Weapon Stockpile*. May 1995. p. 5-8.

<sup>19</sup> U.S. Department of Energy. *Final Programmatic Environmental Impact Statement for Stockpile Stewardship and Management*. DOE/EIS-D236, September 1996. Summary volume, p. S-32 through S-44, S-51.

<sup>20</sup> "The secondary is the stage that produces high yields for modern U.S. strategic weapons — typically hundreds of kilotons." U.S. Department of Energy. Office of Arms Control and Nonproliferation (NN-40). *The National Ignition Facility (NIF) and the Issue of Nonproliferation*. Final study, Dec. 19, 1995, p. 13.

with a reprioritization of funds.<sup>21</sup> DOE is conducting subcritical experiments at the site, in which high explosives are detonated near plutonium in configurations that cannot produce a self-sustaining nuclear chain reaction. DOE conducted one such experiment in July 1997, a second in September 1997, and a third in March 1998.

The other four sites focus on production. The Kansas City Plant (KCP), in Missouri, fabricates or contracts for nonnuclear components. The Y-12 Plant, in Tennessee, manufactures lithium, uranium, and other nuclear components. Savannah River Site (SRS), in South Carolina, used to produce plutonium and tritium; now, its main defense work is purifying tritium.<sup>22</sup> Should the United States build a new linear accelerator to produce tritium, it would be located at SRS. The main role of the Pantex Plant, in Texas, during the Cold War was final assembly of nuclear weapons; it mated high explosives to plutonium components and then combined the resulting element with other weapon components. It also disassembled and dismantled weapons. (Disassembly refers to taking a weapon apart for inspection, replacement of components, refurbishment, etc., with a view to subsequent reassembly; dismantlement refers to taking a weapon apart in the course of retiring it.) Now, most of its effort is spent on dismantlement of weapons, storage of plutonium components, and disposal or reshipment of other components and materials; it also monitors weapons in the stockpile.

The end of the Cold War resulted in sharp cuts in the nuclear weapons complex. The number of sites dropped from a high of about 14 to the current eight<sup>23</sup>. Nuclear weapons work halted at several large sites, notably Hanford (WA), Pinellas (FL), Mound (OH), and Rocky Flats (CO). The number of people working in the weapons complex rose from 53,859 in FY1986 to a peak of 57,935 in FY1990, then fell to 24,384 in FY1997 and 23,874 (projected) in FY1998.<sup>24</sup> As a specific illustration,

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<sup>21</sup> Information provided by Department of Energy, Office of Defense Programs, in a telephone conversation with the author, December 8, 1997.

<sup>22</sup> Tritium, a radioactive isotope of hydrogen, is an essential ingredient of modern nuclear weapons; without it, their yield would be much less than the design specification. The United States has not produced any tritium since 1988. It decays radioactively to helium-3 at a rate of 5.5 percent a year. Accordingly, there is a need to purify it (remove the helium-3 to maintain weapon performance) and to produce new tritium.

<sup>23</sup> The figure of 14 was provided by Department of Energy, Albuquerque Operations Office, November 3, 1995; the years in which the complex had this number of sites was not specified, but was probably in the 1960s.

<sup>24</sup> These figures are for staff employed by Management and Operating Contractors with DOE Office of Defense Programs funds at the nuclear weapons complex sites. Currently, these contractors and their sites are: AlliedSignal, Kansas City Plant; Bechtel Nevada, Nevada Test Site; Lockheed Martin, Sandia National Laboratories and Y-12 Plant; Mason and Hanger, Pantex Plant; University of California, Lawrence Livermore National Laboratory and Los Alamos National Laboratory; and Westinghouse, Savannah River Site. As such, these figures represent the direct employment at the nuclear weapons complex. They exclude subcontractors. Information provided by DOE's Office of Defense Programs, December 10, 1997.

total employment at KCP reached 7,845 in FY1985, and fell to 3,310 in FY1996.<sup>25</sup> Likewise, the budget for the complex has dropped; the budget (in FY1998 dollars) for weapons activities conducted by DOE's Office of Defense Programs, the office that directly funds nuclear weapons research, development, and production, rose from \$3.611 billion in FY1980 to a peak of \$6.275 billion in FY1986, then dropped to \$4.044 billion (requested) in FY1998.<sup>26</sup> (The adjusted FY1998 budget is \$4.147 billion.<sup>27</sup>) The Administration's request for FY1999 is \$4.500 billion; this same figure is the estimated annual request for FY2000-FY2003.<sup>28</sup>

The United States, having closed some plants, cannot now produce complete warheads for the active stockpile because it cannot make key components to so-called "war reserve" standards (i.e., certified acceptable for use in deployed warheads). Los Alamos is setting up a capability to make pits (including plutonium components). It is working on developmental pits for the W88 warhead. It is expected to make its first war reserve pit in FY1998.<sup>29</sup> Sandia is setting up a capability to make neutron generators; the first production unit is expected in October 1999.<sup>30</sup> Y-12 suspended five production processes for a safety stand-down in September 1994; all had been restarted by late 1997 except the process for making highly enriched uranium components. Y-12 expects to resume the latter process in June 1998.<sup>31</sup>

## DOE's Current Position on Stockpile Stewardship and Management

DOE's current position on SSM was spelled out in a record of decision of December 19, 1996, and an environmental impact statement of the previous month on the same topic.<sup>32</sup> DOE indicated that it would, among other things, build several

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<sup>25</sup> AlliedSignal, Inc. *FM&T/KC [Federal Manufacturing and Technologies/Kansas City] Demographics*, March 1996, p. 1.

<sup>26</sup> Data provided by Office of Program Analysis and Financial Management, Office of Defense Programs, Department of Energy, August 27, 1997.

<sup>27</sup> U.S. Department of Energy. Office of the Chief Financial Officer. *FY 1999 Congressional Budget Request*. Volume 1, Atomic Energy Defense Activities. DOE/CR-0051, February 1998, p. 39.

<sup>28</sup> Ibid.

<sup>29</sup> Ibid., p. 125-126. Paul Cunningham, Director, Nuclear Materials and Stockpile Management Program, Los Alamos National Laboratory, indicated that the first Los Alamos developmental pits will use plutonium parts made at Los Alamos and other components made at other nuclear weapons complex sites while they were "up and running," but that as Los Alamos moves into steady-state production, it will manufacture all of the pit components. Personal communication, December 7 and 12, 1997.

<sup>30</sup> Information provided by Sandia National Laboratories staff in a telephone conversation with the author, November 1997.

<sup>31</sup> Information provided by Y-12 staff in a telephone conversation with the author, June 4, 1998.

<sup>32</sup> U.S. Department of Energy. "Record of Decision: Programmatic Environmental Impact Statement for Stockpile Stewardship and Management," *Federal Register*, December 26, (continued...)

large experimental facilities at LLNL and LANL, reestablish a capability to build plutonium pit components at LANL, and retain but further downsize production capacity at KCP, Pantex, and Y-12. Regarding these three plants, DOE decided to downsize the capacity for weapons assembly and disassembly and high explosive component fabrication at Pantex, weapons secondary and case component fabrication at Y-12, and fabrication of nonnuclear components at KCP.

A DOE report of October 1997 updated the program, its strategies, and its accomplishments. It noted, “Today, the program is characterized by three integrated strategies or phases of stockpile stewardship.” They are: “Surveillance: predicting and detecting problems”; “Assessment and Certification: analyzing and evaluating effects of changes on warhead safety and performance”; and “Design and Manufacturing: refurbishing stockpile warheads and certifying new parts, materials, and processes.” It further stated, “The accelerated and greatly expanded use of strategic computing and simulation tools is the fundamental innovation of this [recent] evolution [of the program].”<sup>33</sup> It continued the approach of retaining but downsizing the plants. (As noted earlier, DOE changed terms in 1997: “stockpile stewardship and management” became “stockpile stewardship.” As this report focuses on production, it retains the earlier terminology to help differentiate between production and R&D.)

## **Organizational Aspects of Stockpile Stewardship and Management**

The Department of Defense (DoD) is responsible for developing the U.S. nuclear deterrent strategy and, if need be, for executing it. In this role, it is DOE’s “customer,” outlining the actions it needs DOE to perform in order to meet DoD needs. During the Cold War, DoD would specify Military Characteristics for DOE to meet in designing a warhead. These included weight, yield, safety requirements, etc., and, by reference to the Stockpile to Target Sequence (a document that specified temperature cycles, shock, vibration, and other conditions a warhead might encounter), defined the environments a warhead would have to survive and the abnormal conditions in which it would have to remain predictably safe.

Now, DoD has no requirements for new-design warheads for the foreseeable future, and the United States has signed the CTBT. This shifts the DoD-DOE relationship from developing and producing new warheads with nuclear testing to maintaining and modifying existing ones without such testing. For example, DoD has set requirements for an assured supply of tritium to support the stockpile, for the development of the B61-11 bomb to replace the B53 bomb (see page 12), and for a safety study for each warhead type every five years. The President has established a requirement for an annual certification for warheads, and has set conditions under which the United States might resume nuclear testing; both require a reporting

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<sup>32</sup>(...continued)

1996: 68014-68026; and Department of Energy, *Final Programmatic Environmental Impact Statement for Stockpile Stewardship and Management*, September 1996.

<sup>33</sup> U.S. Department of Energy. Office of Defense Programs. *Stockpile Stewardship Program: Overview and Progress*. October 1997, p. 4.

procedure. A dual revalidation procedure, in which currently a Los Alamos-Sandia team and a Livermore-Sandia team review each weapon type, has been established.

Various joint DoD-DOE groups coordinate inputs from the Joint Chiefs of Staff, the Strategic Command, the Assistant to the Secretary of Defense for Nuclear and Chemical and Biological Defense Programs, the Assistant Secretary of Energy for Defense Programs, the nuclear weapons laboratories, and others. The main one is the Nuclear Weapons Council, or NWC. It is composed of the Under Secretary of Defense for Acquisition, the Vice Chairman of the Joint Chiefs of Staff, and a senior DOE representative (most recently the Deputy Secretary of Energy) designated by the Secretary of Energy. It is responsible for preparing the annual Nuclear Weapons Stockpile Memorandum, a document for the President's signature that specifies how many warheads of each type shall be in the U.S. stockpile. It also, among other things, develops stockpile options and their costs, identifies options for scheduling of nuclear weapons production, and considers safety issues for existing and proposed weapons.<sup>34</sup> It can make decisions, such as scheduling tasks for weapon life extension programs, within the constraints of the Nuclear Weapons Stockpile Memorandum.<sup>35</sup>

Much of the council's work is done by its Standing and Safety Committee. Its main mission is to advise and assist the NWC and to coordinate and provide preliminary approval for most actions that go to the NWC for final approval. The committee is chaired by the Assistant to the Secretary of Defense for Nuclear and Chemical and Biological Defense Programs; its vice chair is the Principal Deputy Assistant Secretary of Energy for Military Application. Other members include representatives of the three services, the Joint Staff, the Strategic Command, DOE's Deputy Assistant Secretary for Military Application and Stockpile Management (at present), and the Deputy Assistant Secretary of Defense for Forces Policy. There are observers from other DoD components, and the three labs are technical advisers. In addition to the NWC and its Standing and Safety Committee, there are other joint, but lower-level, coordinating groups.

## Definitions

**“Production”** in this report is taken broadly to mean any industrial-type activities performed on a nuclear weapon from or destined for the stockpile, as well as on its components or materials. These activities include but are not limited to fabrication of components; modification of warheads; replacement of components or materials; the assembly of components into warheads as part of life extension

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<sup>34</sup> The Nuclear Weapons Council was established by P.L. 99-661, the National Defense Authorization Act for Fiscal Year 1987, sec. 3137, 100 Stat. 4065-4066.

<sup>35</sup> The Office of Program Analysis and Financial Management in DOE's Office of Defense Programs provided the following information to the author, April 1, 1998: “The Secretaries of Energy and Defense are required to submit a Nuclear Weapons Stockpile Memorandum (NWSM) to the President annually. The memorandum transmits a draft Presidential Decision Directive, containing the requested nuclear weapons stockpile quantities for the current year and five planning years, along with the Departments' strategy for maintaining and supporting the stockpile. The table of stockpile quantities in the Presidential Decision Directive is called the Nuclear Weapons Stockpile Plan.”

programs; dismantlement of warheads for subsequent disposition; disassembly of warheads for modification or for detailed examination and nonnuclear testing, and subsequent reassembly; remanufacture of copies of warheads to more or less the original specifications; and modification of warheads for flight tests. The hallmark here is physically changing a warhead or component from or destined for the stockpile, or changing materials into such warheads or components, as distinct from performing R&D, developing computer models, or building prototypes. Production activities would also include making complete warheads for deployment, but the United States cannot do this at present for reasons noted on page 8.

Production **“capability”** is taken here to mean the ability to produce one war reserve warhead or component. It is distinct from **capacity**, which refers to a rate, the number of units that can be produced in a given time.

Current usage of two terms is imprecise. **“Warhead”** refers to the complete nuclear explosive device (including its case, arming and firing system, and so on) delivered by missile or artillery. It sometimes includes nuclear gravity bombs as well. In current usage, **“weapon”** means a warhead or bomb (as in “nuclear weapons complex”), or an aircraft or missile for delivering them. This report uses “weapon” in all instances to mean warhead or bomb, and uses “warhead” to mean warhead or bomb except where the context makes clear that the reference is only to a missile warhead.

## **What Are “New Weapons” and “Weapons Maintenance” and What Difference Do the Terms Make?**

No definition is possible for two terms that appear throughout this report, **“new weapon”** and **“weapons maintenance,”** because the terms are themselves weapons in a struggle over the role and future of nuclear weapons. The debate over the definitions, which masquerades as a matter of semantics, cloaks this larger struggle. Opponents of new weapons and advocates of weapons maintenance are at opposite ends of the debate. All would view a weapon of brand-new design, with a new designation number (W97, B102), as a new weapon; all would view remanufacturing a component to identical specifications to replace aged units as weapons maintenance. In between, a spectrum of activities might or might not, depending on one’s point of view, produce a new weapon or maintain weapons.

Policy, treaties, interpretation, and criticism may frown upon “new weapons.” Accordingly, those who would de-legitimize the use of nuclear weapons, shrink the stockpile, and abolish these weapons as soon as possible, here called “Denuclearizers,” use “new weapon” inclusively in hopes that broadening the list of new weapon activities will narrow the scope of U.S. weapons activities. Those who see strategic value in the nuclear stockpile for the foreseeable future and would maintain weapons in a ready, reliable state, here called “Maintainers,” use “weapons maintenance” inclusively. If “new weapons” are only weapons of completely new design from top to bottom, then modifications, life extension programs, and so on may proceed. Because “new weapons” and “weapons maintenance” intersect many of these groups’ core issues, definitions of these terms are pivotal for both groups.

Denuclearizers would agree with the statement by DoD setting as a DoD requirement to DOE, “No new-design nuclear warhead production.”<sup>36</sup> They criticize some R&D and production activities on grounds that they are leading to “new weapons” despite this requirement. Maintainers counter that the same DoD statement also requires DOE to “Maintain *capability* to design, fabricate, and certify new warheads” and to “Demonstrate capability to refabricate and certify weapon types in enduring stockpile.”<sup>37</sup> Two DoD officials emphasized that the statement on production of new-design warheads is not a ban on production of such warheads and that DoD does not want to foreclose production of them. Rather, DoD has no military requirement for warheads of totally new design at present, so there is no need for DOE to produce them.<sup>38</sup> Denuclearizers respond there is currently no such military requirement partly because policy *de facto* opposes new warhead types on two seemingly contradictory grounds: such warheads would provoke criticism that the United States sought to evade the spirit of the CTBT and would probably be unacceptable to DoD without testing.

Denuclearizers favor no first use of nuclear weapons, yet see some new weapons, or modified ones able to perform new missions, as more usable. Maintainers believe that if weapons are not usable, they can scarcely be credible as deterrents. A case at issue is the B61-11 bomb. This project modified the case of an older B61 version to enable it to penetrate the earth, thus increasing the damage it can do to buried structures. It replaces the B53, an older bomb with a much higher yield that does not meet current standards on safety, use control, etc. Denuclearizers see the B61-11 as a new bomb designed to do a new mission.<sup>39</sup> Maintainers extend “weapon maintenance” to cover stockpile maintenance, and see the B61-11 as needed to permit retirement of the B53 by retaining in the stockpile the latter weapon’s capability even as the B61-11’s reduced yield makes it more usable.<sup>40</sup>

Denuclearizers want to extend the CTBT beyond its basic obligation of conducting no nuclear explosions to include what they see as its original purpose, stopping weapons development. They want to proscribe R&D and production activities leading to new weapons. They claim that advances in technology enable this

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<sup>36</sup> U.S. Department of Defense and Joint Chiefs of Staff. *Nuclear Posture Review*. Briefing slides, 1994. Slide entitled “Infrastructure Requirements (Cont).” Reprinted in U.S. Congress. House. Committee on Foreign Affairs. *U.S. Nuclear Policy*. Hearing, October 5, 1994, 103d Congress, 2d Session. Washington, U.S. Govt. Print. Off., 1995, p. 67.

<sup>37</sup> *Ibid.*; emphasis added.

<sup>38</sup> Telephone discussions between the author and Frank Dellerman, Director for Strategy, Forces, and Operations, Office of the Secretary of Defense, DoD, February 3, 1998, and between the author and William Kahn, Director of Nuclear Safety and Security, Office of the Secretary of Defense, DoD, February 26, 1998.

<sup>39</sup> See, for example, Greg Mello, “The Birth of a New Bomb,” *Washington Post*, June 1, 1997: C1, C6.

<sup>40</sup> See Harold Smith, Jr., Assistant to the Secretary of Defense (Nuclear and Chemical and Biological Defense Programs), prepared statement before the Energy and Water Development Subcommittee of the Senate Appropriations Committee, April 9, 1997, p. 4-5.

Nation to produce new weapons without testing, subverting the CTBT. They could not make this claim if “new weapons” covered only warheads of entirely new design; it is generally agreed that such warheads require testing because an all-new untested warhead entails too many uncertainties for the labs to certify, DoD to accept, or Congress to fund. Maintainers counter that the basic CTBT obligation cannot be stretched to mean more than what it says because the Denuclearizers’ interpretation is at odds with the nuclear weapon states’ intention to maintain their weapons, which requires R&D and production.

Maintainers see confidence in weapon reliability as essential to credibility, and believe that if weapons are to be maintained in reliable condition, changes to their design, materials, and production processes are inescapable. For example, the Warhead Protection Program aims to redesign warheads for submarine-launched ballistic missiles to make them less sensitive to aging, certifiable without nuclear testing, producible by current or future processes, and so on. Denuclearizers see this effort as design, leading to production, of new weapons; Maintainers see it as maintenance.

Denuclearizers attack work on new weapons, or even the maintenance of existing ones, as contrary to the obligation the United States assumed in signing the Nuclear Nonproliferation Treaty: “Each of the Parties to the Treaty undertakes to pursue negotiations in good faith on effective measures relating to cessation of the nuclear arms race at an early date and to nuclear disarmament, and on a treaty on general and complete disarmament under strict and effective international control.” (Article VI) If the United States cannot honor its own obligations in this area, they ask, how can it take the lead in asking others to desist from nuclear proliferation? Maintainers counter that the nuclear arms race has effectively ceased, the United States and Russia are rapidly reducing their nuclear stockpiles, and the world is not pursuing complete disarmament seriously if at all. They believe that U.S. nuclear forces help deter nuclear proliferation on grounds that abolition, or even deterioration, of these forces would magnify the advantage potential adversaries would gain from possessing a few weapons, and could lead U.S. allies to hedge against that risk by developing weapons of their own. They agree with U.S. policy viewing nuclear weapons as of value in deterring possession or use of chemical and biological, as well as nuclear, weapons.<sup>41</sup> This form of deterrence requires, in the

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<sup>41</sup> Three statements on this policy follow. (1) “... even if we could ignore the Russian nuclear arsenal entirely, there are unfortunately a range of other potential threats to which nuclear weapons are a deterrent. One cannot survey the list of rogue states with potential WMD [weapons of mass destruction] programs and conclude otherwise.” Walter Slocombe, Under Secretary of Defense for Policy, prepared statement. In U.S. Senate. Committee on Governmental Affairs. Subcommittee on International Security, Proliferation, and Federal Services. The Future of Nuclear Weapons. Hearing, 105<sup>th</sup> Congress, 1<sup>st</sup> Session, February 12, 1997. Washington, U.S. Govt. Print. Off., 1997, p. 22. (2) According to a press article, “[Robert] Bell [Special Assistant to the President and Senior Director for Defense Policy, National Security Council] said Clinton’s nuclear targeting directive reflects ‘much greater sensitivity to the threats’ posed by chemical and biological attacks since the previous directive was issued [in 1981]. But he added that it only reiterates what senior administration officials already have said about the issue during the past year — namely, (continued...) ”

Maintainers' view, that weapons be credible both in terms of readiness, which requires maintenance, and usability.

Different groups use the terms to their advantage. For antinuclear activists, condemning a "new weapon" is more fruitful for mobilizing protests, gaining media attention, and generating public interest than pointing out a minor modification. Similarly, nuclear weapons complex managers describe their work as "weapons maintenance" or "stockpile maintenance," terms that seem more benign than building a "new weapon."

The longer report presents in detail, with many references, the 15 findings that support the main points. These findings are summarized next.

## Findings on Production

**1. Problems with existing warheads have historically emerged over time and seem likely to do so in the future.** If current warheads were perfectly designed and built, and retained their initial physical condition indefinitely, then the United States would not need to make an effort to maintain them. However, age-related changes such as cracks in components and decay or corrosion in materials may impair warhead safety, reliability, and performance. Warheads sometimes have design or production flaws that are not discovered until many years after deployment, or vulnerabilities revealed by improved understanding of potential accidents. These problems ultimately can be expected to occur more often because warheads will be deployed far beyond the length of service for which they were designed. A drop in the number of warhead types in the post-Cold War stockpile can be expected to increase the fraction of that stockpile affected by a problem with one warhead type. Without production, the United States would have to choose between continuing to deploy unsafe, unreliable, or ineffective warheads, or retiring them.

**2. Warhead maintenance and modification require substantial production work, which is done on an ongoing basis.** Warhead production is limited in scope because DOE cannot produce complete warheads of

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<sup>41</sup>(...continued)

that if any nation uses weapons of mass destruction against the United States, it may 'forfeit' its protection from U.S. nuclear attack under the 1995 pledge." R. Jeffrey Smith, "Clinton Directive Changes Strategy on Nuclear Arms," *Washington Post*, December 7, 1997: 10. The pledge by the United States, Britain, China, France, and Russia, as paraphrased in the *Washington Post* article, was that those nations would not "use nuclear arms or threaten their use against countries that are not trying to develop or acquire nuclear arms." Ibid. (3) "If any nation were foolish enough to attack the U.S., its Allies, or friends with chemical or biological weapons, our response would be swift, devastating, and overwhelming. As Secretary Perry said in 1996, we are able to mount a devastating response without using nuclear weapons. Nevertheless, we do not rule out in advance any capability available to us." Edward Warner III, Assistant Secretary of Defense (Strategy and Threat Reduction), prepared statement before the Strategic Forces Subcommittee, Senate Armed Services Committee, Hearing on Nuclear Deterrence, March 31, 1998, p. 9.

new or existing design, as noted earlier; this is a source of concern to DoD.<sup>42</sup> Production is limited in quantity because the stockpile is smaller than it was a decade ago. Yet a large production effort is ongoing or scheduled in the near term for seven of the nine types of warheads in the enduring stockpile.<sup>43</sup> Several examples illustrate the scope of production. The **B61-11 bomb** is a new modification to some existing B61-7 bombs so they can penetrate the earth and detonate underground.<sup>44</sup> KCP and Y-12 are producing a new case, tail, ballast, aircraft attachment mounts, and similar components for this bomb. (Refer to pages 6-8 for a description of labs and plants in the nuclear weapons complex.) **Pantex** maintains some warheads by disassembling them, replacing old components with new ones, and reassembling them. It disassembles and reassembles other warheads to conduct surveillance. It dismantles warheads that are excess to U.S. needs. **Reservoirs** hold tritium and deuterium in nuclear warheads. They must be replaced from time to time. KCP is producing reservoirs of a new design; Savannah River Site is cleaning and filling them. A **life extension program** underway for the W87 warhead will rebuild the warheads to refurbish them and enhance structural integrity. Y-12 and KCP are producing parts; Pantex uses them to replace old parts in rebuilt W87s. **Joint test assemblies** transmit data on a warhead's performance during a flight test. KCP and Y-12 produce components, which Pantex assembles. Warheads to be flight tested are returned from the field to Pantex, which disassembles them, removes the nuclear explosive component, inserts the joint test assembly, and reassembles the warhead as a test unit. There are some **laboratory production** assignments, such as neutron generators (Sandia) and detonators and pits (Los Alamos). The labs are also responsible for the design and reliability of modified and existing weapons. Thus production involves the entire nuclear weapons complex and is done for many purposes.

**3. The other four nuclear weapon states seem certain to continue warhead production-related activity for as long as they have warheads.** *United Kingdom:* Once gravity bombs are withdrawn from deployment by the end of 1998, the only deployed U.K. warheads will be on Trident submarine-launched ballistic missiles. These warheads are currently being produced. To maintain its weapons and weapons complex once serial production of these warheads ends, Britain is focusing on: an expanded experimental program to address future weapons problems and attract top scientists; ongoing maintenance of Trident warheads and perhaps continuing production as needed to maintain stockpile levels;

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<sup>42</sup> “The Nuclear Posture Review contained a requirement that DOE be able to ‘demonstrate the capability to refabricate and certify weapon types in the enduring stockpile.’ The new weapons complex — regardless of its structure — must be able to perform this task. As yet, this capability has not been demonstrated.” Harold Smith, Jr., prepared statement, April 9, 1997, p. 8.

<sup>43</sup> “Statement of Dr. Victor Reis, Assistant Secretary for Defense Programs, Department of Energy, before House National Security Committee, Subcommittee on Military Procurement, March 12, 1996, prepared statement, p. 6; and “Statement of Charles B. Curtis, Deputy Secretary of Energy, U.S. Department of Energy, Before the House National Security Committee, Subcommittee on Military Procurement, September 19, 1996,” prepared statement, p. 5.

<sup>44</sup> See Larry Witt, “B61-11 Update,” *Weapons Insider* [published by the Nuclear Weapons Technology Program, Los Alamos National Laboratory], August 1996: 2-3.

and technology transfer work to support staff while developing weapons skills. **France** used its final nuclear test series in 1995-1996 to develop more robust weapon concepts and obtain fundamental weapons physics data in order to maintain a credible future nuclear force without testing. France is producing warheads now, and plans to replace warheads reaching the end of their service lives with newly-produced robust warheads. While they will resemble earlier ones, their performance would be less sensitive to minor changes in materials and in production processes. **Russia:** Former Secretary of Defense James Schlesinger stated, “Unlike ourselves, the Russians continue to produce some thousands of weapons each year to replace aging weapons in their inventory.”<sup>45</sup> Russian nuclear weapons also reportedly need more maintenance and have shorter life cycles than their U.S. counterparts.<sup>46</sup> **China** is evidently developing new missiles to upgrade its nuclear forces. Its recent nuclear test program was apparently done to develop smaller, lighter warheads for these missiles.<sup>47</sup> The concurrency of nuclear testing and missile development implies that China will design new warheads, then produce copies of them for these forces for some time. These four nations, then, are producing complete warheads or are likely to do so soon. China will apparently build new-design warheads, France fabricates warheads now and will produce warheads of modified designs on an ongoing basis, and Britain, and reportedly Russia, are manufacturing warheads of existing designs. It can be assumed that these nations conduct weapons maintenance activities as well.

**4. In the United States, plants and laboratories make complementary contributions to nuclear weapons production.** As a weapon or component moves from an idea to a finished product, the labs and plants take certain steps in more or less the following progression: basic research, applied research, design, engineering development of the design, engineering for production, production, and surveillance of the unit in the field or in storage. These activities are complementary: All are needed because each makes a unique contribution to the enterprise. The first four steps belong mainly to the labs, the fifth and sixth mainly to the plants, and the last to both. Interaction occurs mainly between design engineers at the labs and production engineers at the plants, though its nature has changed over time. In the Cold War days, the weapons complex emphasized moving new warhead types into the stockpile. The plants often went into production with hard-to-produce component designs. Recently, however, there has been an increase in “concurrent engineering,” which means taking production concerns into consideration earlier in the process. This is implemented in particular by “product realization teams,” formal groups of lab and plant staff representing key skills applicable to various stages of a part. Team members design the part, engineer its produc-

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<sup>45</sup> James Schlesinger, *Implications of a Zero-Yield Nuclear Test Ban*. Statement Before the Subcommittee on International Security, Proliferation, and Federal Services of the Senate Committee on Governmental Affairs, October 27, 1997, p. 2.

<sup>46</sup> Igor Sutiagin, “Safety Problems of Russian Nuclear Weapons: Ensuring the Technical Safety of Nuclear Charges,” *Voennyi Vestnik*, No. 7, 1993: 62-76; cited in Thomas Cochran et al., *Making the Bomb: From Stalin to Yeltsin*. Boulder, Westview Press, 1995, p. 36. See also Schlesinger, *Implications of a Zero-Yield Nuclear Test Ban*, p. 2.

<sup>47</sup> See U.S. Library of Congress. Congressional Research Service. *Chinese Nuclear Testing and Warhead Development*. Report 97-1022 F, November 14, 1997, 22 p. By Jonathan Medalia.

tion, and offer suggestions based on their differing perspectives. In this new approach, not only is feedback sought and used, but it is sought proactively, before problems arise. This approach makes for closer lab-plant links.

## Summary of Findings on Investment

### **5. In planning recent budgets, DOE has deferred investment at the plants for the longer term in order to fund day-to-day operations.**

DOE sets priorities at the plants. It assigns top priority to meeting operational needs because production is fundamental to DOE's ability to support the stockpile. Given funding limits, this priority has led DOE, in formulating budgets for the plants, to defer investment in areas as diverse as repair, maintenance, infrastructure, facility upgrades, technology, capital equipment, hiring, and training. As investment is delayed, the funds needed to bring the plants to a given level of capability cumulate. Karen Clegg, who heads Kansas City Plant, said, "due to overall budget constraints in the Department [of Energy], we have not been able to apply this funding [provided by Congress for modernization] to address pressing recapitalization and infrastructure requirements as intended" even though "the workload and mission at my ... plant are expanding."<sup>48</sup> It is unclear if DOE's priorities are changing. DOE is planning substantial investment for the plants for FY1999-FY2003, but it projects total expenditure for stockpile management for FY2003 to be slightly less than in FY1998.

**6. Plants have much obsolete equipment.** Obsolete equipment can impede the plants' work. It may break often and is hard to maintain. It often lacks capabilities that new technology offers. It impedes recruitment, as prospective recruits may not want to work with it. It may undercut technical tasks. For example, KCP's Materials Evaluation Laboratory has three tensile testers, machines bought in 1984 that measure materials and finished parts for strength when stretched or compressed. They perform well, but the computer that controls them, a PDP-11 from the mid-1980s, does not. The PDP-11 prints paper charts that must be analyzed by hand. It requires in-house maintenance because the manufacturer no longer supports it. One spare circuit board is left; when the PDP-11 can no longer be maintained, the tester will have to be operated manually. A personal computer-based controller, one of which is in use, runs complex test routines, reduces setup time, automates data analysis, and can link to an electronic data storage network. Obsolete equipment may also undercut production. KCP has some milling machines that cut design features like channels and holes in metal parts. These have been used for two or three shifts a day for some years, are six years beyond their design lives, are in bad condition, have archaic controllers, and have a downtime of 30 to 40 percent. As they wear out, they are less able to hold tolerances, yet are called on to make smaller components requiring tighter tolerances.

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<sup>48</sup> Statement of Karen K. Clegg, President, Government Services and Federal Manufacturing & Technologies, AlliedSignal Inc., before the Subcommittee on Strategic Forces, Committee on Armed Services, United States Senate, March 19, 1997, p. 4.

**7. Infrastructure problems impede the work of plants and laboratories.** Much of the nuclear weapons complex is old, and in many instances the infrastructure has deteriorated as lack of funds forces deferral of maintenance. Examples cited by nuclear weapons complex staff include a leaky 73-acre roof at Kansas City Plant that has led to damage of some weapon components, a run-down maintenance building at Livermore, a steam distribution system at Y-12 that has numerous breakdowns, and failures at Los Alamos's plutonium R&D facility of archaic computers (recently replaced) used to monitor hazards. These problems increase operational costs, require funds to be spent on piecemeal repairs, and pose risks to production schedule and to safety.

## Summary of Findings on People

**8. Demographic trends among engineers and scientists that impede nuclear weapons expertise at laboratories also occur at plants.** A CRS study on lab demographics found trends that are adverse for maintaining weapons expertise.<sup>49</sup> These include an increase in average age, few new hires, and few or no people in some skill areas. These trends flow from downsizing. If total staff size must be reduced, then new hires would compel the dismissal of veteran staff members, a step that managements prefer to avoid because of staff morale and loss of expertise. Retention of the few staff who are newly hired is difficult. Junior staff fear that they would be most vulnerable to involuntary layoffs, and have the mobility that comes with not having made a career commitment to the labs. With few new staff, and with veteran staff members staying, average age increases. Separations are often done on a voluntary basis, such as by offering retirement incentives, which may open gaps in expertise. These trends are also in evidence for engineers and scientists at the plants. At KCP, for example, there are few young degreed science professionals; of the 554 such professionals at the plant as of March 1996, only 73 were hired in the decade from 1986 through 1995. With few new staff, there is little opportunity for veteran staff members to pass on details of the work and the organizational culture, or for new staff to pass on their familiarity with new methods and techniques.

**9. Demographics of key skilled trades personnel, if uncorrected, may leave plants unable to do weapons work over the long term.** U.S. policy is to maintain nuclear weapons for the long term. So doing requires a production agency that can sustain itself for the long term. Yet hiring of machinists, welders, and other skilled trades workers doing direct weapons work (here abbreviated STWW) — who make nuclear weapons and their components — has been negligible at the plants since the mid-1980s. STWW are all union members, and under a seniority system. Many were hired in 1977-1984. With downsizing beginning in the mid-1980s, the least senior staff were laid off but had “recall rights,” the right of first refusal to be rehired (for a specified time, in seniority order) if a

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<sup>49</sup> U.S. Library of Congress. Congressional Research Service. *Nuclear Weapons Stockpile Stewardship: The Role of Livermore and Los Alamos National Laboratories*. Report 94-418 F. May 12, 1994, 75 p. By Jonathan Medalia.

position in their skill areas reopened. As a result, STWW were concentrated by date of first hire. At Kansas City Plant, 72 percent of those on the payroll in October 1996 were first hired in 1977-1981. In a workforce made up mostly of experienced workers of similar age, workers know the culture of the plant, are skilled at operating their equipment, have security clearances, and have acquired the specialized skills required for nuclear weapons work. On the other hand, with a mix of ages, more experienced workers can hand off skills and institutional memory to younger workers, while the latter can bring in familiarity with new technologies and methods. With hiring of new workers all but impossible, and with many workers concentrated in a narrow band of age and length of service, it is likely that many will retire over a short period of time, opening gaps in critical skills. These trends cannot sustain the work of the plants beyond the next decade or so. DOE, though, envisions further staff reductions at the plants that seem likely to intensify the patterns just discussed. For example, CRS projects that downsizing, under specified assumptions, could result in 93 percent of KCP's STWW as of 2003 being first hired between 1977 and 1981. It appears that the plants would benefit by hiring new staff. This might be done through apprenticeships, slowing the pace of downsizing, and buying out recall rights of laid-off workers.

**10. Nonweapons work can help plants retain staff and develop skills.** In 1989, the Navy requested DOE's participation in making the propulsor for the Seawolf submarine. This part, essentially a complex propeller, is about 20 feet tall and weighs tens of tons. Y-12 was tasked with the job in 1990 after the Navy failed to receive an acceptable response to three requests for proposals. Y-12 completed the propulsor prototype in 1993, and as of February 1998 continues to manufacture critical components of it and provides technical support to companies doing most of the follow-on work. Y-12 believes that work of this type (1) exercises weapon skills such as development of electronic models, tooling design, welding, and machining; (2) helps Y-12 adjust to workload fluctuations by retaining people whose skills are needed but who would otherwise be let go; and (3) reduces costs to DOE's weapons program to maintain staff not involved at all times in weapons work by charging some overhead to clients. As another example, Sandia and KCP have researched and developed miniature lasers for initiating a weapon's high explosive. Laser initiation, it is hoped, would make a weapon less vulnerable to unauthorized use and to detonation by spurious electrical signals. KCP recently reached an agreement with an aerospace contractor to develop this technology for igniting fuel in aircraft engines. Work began in March 1996 and continues into FY1998. KCP points to similar technical requirements for lasers on weapons and on aircraft engines, such as operation while cycling between extreme heat and cold. As such, KCP expects the work to help develop weapon skills.

## **Summary of Findings on New Manufacturing Technology and its Consequences**

**11. The plants have substantial expertise in manufacturing technology, and are using it to make evolutionary advances in this area.** The plants have expertise in areas crucial to their mission, such as materials, process development and improvement, and solving problems that arise in production. One

participant calls it “dirty-hands engineering.” Examples include: (1) Molten uranium picked up carbon impurities during casting; Y-12's Development Division cut carbon pickup in half by injecting argon, an inert gas, into the casting crucible. (2) Some manufacturing demands increased precision, which requires improved ability to measure. Y-12 has a laboratory for metrology (the science of measurement); its precise measurement of production units enables operators to adjust their equipment, and allows Y-12 to certify parts and processes. (3) Pantex's Engineering and Design Division designs tooling and test equipment, and works on disposition of weapons and their components. It also develops processes for weapons assembly/ disassembly and dismantlement. These processes must be developed for each warhead type because of differences between warheads; for example, high explosive might be removed from one type of warhead by mechanical means, from another with pressurized water, and from a third with a solvent. The labs also have expertise that supports production.

## **12. Laboratories are developing revolutionary technologies, in such areas as components, materials, and processes, for use in weapons.**

Examples include a chemistry laboratory on a microchip that can be placed inside a warhead to monitor the warhead's condition; a laser that can make such thin cuts in some weapon components that they can be reassembled and reused, rather than remanufactured; and a laser that fabricates components by melting powdered material, building the components layer by layer. Hundreds of such projects are underway. They may increase reliability and ease of fabrication while reducing waste, cost, and worker exposure to dangerous materials. They are often well suited for the smaller lot size likely in future production. On the other hand, there is concern that these technologies might introduce uncertainties that would reduce weapon reliability. Weapon designers analyze potential changes to weapons very closely before approving them, but mechanical, electrical, chemical, or other interactions between new and existing weapon components might have unforeseen results. For these reasons, DoD is uneasy about using some of these technologies.

## **13. Software is changing how nuclear weapon components are designed, engineered, and produced, with computer models becoming the medium for conducting and linking these steps.**

Much software is being developed commercially; the nuclear weapons complex uses some of it as is, modifies some substantially, and designs some itself. Software packages coalesce into a new process in which a product moves as a computer model from requirement through design, engineering, and production. This process enables work to be done faster, more effectively, at lower cost, and with less waste. Design and production knowledge can be stored and retrieved. Designers can address producibility concerns early on, avoiding some problems and improving quality. Designers can simulate and compare the performance and manufacture of alternative designs, expanding choice. One organization can hand off computer models to another, so that nothing is lost or embellished along the way and changes can be tracked and linked to requirements. Machine tool operators can better preserve design intent. Software developed by the weapons complex should also help industry. On the other hand, some software packages are hard to use. Engineers may lose physical touch with the entities they are designing electronically. Integrating the pieces is often difficult. Exploiting the potential would require added investment at the plants in electronic and

other capital equipment, electronic infrastructure, and training. Some skilled trades staff adapt readily to this new process; others do not. Security is an issue. As work moves electronically from one computer to another, might it be vulnerable to interception? Might the accessibility that software provides enable an employee to steal vast amounts of information undetected? Issues of this sort are being addressed.

#### **14. New technologies and declining work volume are changing the skill mix needed for production, often requiring trades workers to increase skills.**<sup>50</sup>

Technology often requires skilled trades workers to become more skilled. Many machinists no longer operate machines directly; rather, they operate computers that operate machines. At Sandia, some machinists making prototypes take electronic files of a part's design off the intranet and use a computer-aided manufacturing program to design a plan to make the part. At Kansas City Plant and Y-12, workers who used manually-controlled machine tools now use personal computer-controlled machine tools. Technology creates a demand for new jobs. People must program computers, train workers, and set up and maintain computers, the electronic infrastructure, and sophisticated manufacturing equipment. Training in manufacturing technology has taken on increased importance. During the Cold War, a worker might have performed a single process step for years. Now, with lower production rates, that approach is unaffordable, so workers need training in multiple skills. While new technology may eliminate or downgrade some jobs, it creates new ones, makes workers more productive, opens avenues for advancement, and often requires increased skill. On balance, then, contrary to the general perception, new technology may well benefit workers.

#### **15. New manufacturing-related technology holds differing implications for the stockpile, laboratories, plants, antinuclear groups, and Russia.**

This technology will affect each of these entities (and doubtless others) differently. This section sketches what this technology might mean for three of them.

*Potential benefits and risks for the stockpile:* New technology should increase reliability by reducing worker error and increasing ease of fabrication. It may lower cost. It may also create risks. Modified components may not behave just like the ones they replace, possibly causing weapons to fail. Would-be proliferators might find new technologies using simpler designs easier to exploit. Electronic networks offer a well-placed agent access to much information.

*Stakes for the plants:* New technologies benefit the plants by reducing cost and waste streams and increasing quality, replicability, and worker safety. Yet a disconnect between technology used by the plants and that used by the labs and industry could arise. The labs have the final say over nuclear weapons production. If the plants cannot embrace new technology, they will be decreasingly able to meet lab requirements, to work with equipment and software used by labs and industry, and to negotiate expertly with external vendors. They could become unable to

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<sup>50</sup> This section is based on discussions with managers and technical staff at Kansas City Plant, Sandia National Laboratories, and Y-12 Plant, and with machinists, inspectors, and metal workers at Sandia.

produce to new standards and use new methods even though replicating old components identically would be extremely hard at best.

*Concerns for Russia:* Nuclear weapons arguably play a larger role for Russian than for U.S. defense. Yet Russian weapons are said to be much shorter-lived than their U.S. counterparts, and Russian nuclear weapons labs are in serious trouble. Russia would have difficulty approaching the pending advances in technology discussed in Findings 11 to 13 because of lack of funds and a less-advanced technology infrastructure. Russia might feel that it can maintain warheads without testing by remanufacturing them to existing designs. If it interprets the U.S. effort as indicating what must be done to maintain weapons without testing, however, its confidence in its weapons would decline, increasing pressure to resume testing.

## Choices

The United States has three fundamental policy choices on nuclear weapons. It could seek worldwide near-term abolition of these weapons and enter the CTBT as a step in that direction; it could reject the treaty and maintain weapons through a robust program that includes underground nuclear testing; or it could enter the treaty and try to maintain weapons for the foreseeable future without testing. This section discusses alternative approaches for implementing the latter choice, which is current policy. It critiques these approaches from the perspectives of opponents of nuclear weapons and opponents of the CTBT. It concludes by discussing the relationship between Stockpile Stewardship and Management (SSM) and the CTBT.

### Approaches to Maintaining Nuclear Weapons under the CTBT

Various approaches might maintain weapons without nuclear testing. This section presents three. They are crafted to illustrate the range and consequences of alternatives. They are *definitions* of ideal types, *not* descriptions of actual plans. As noted on page 8, DOE's SSM plan is to have a robust laboratory effort while retaining but downsizing the plants. Of the approaches discussed next, SSM is closest to "Lab Dominant."

**Omnilab.** The first approach, here called "Omnilab," would close the plants and conduct all R&D and production at the labs. It is divided into two sub-approaches. Under Omnilab Small, the United States would shrink its stockpile to a few hundred warheads and would forswear any surge capacity, whether to respond to a foreign threat or to replace quickly one type of warhead that had been found defective. The labs would maintain this stockpile with mainly existing facilities and staff. Laboratory staff would be familiar with individual warheads and would maintain them on a "first-name" basis, using laboratory rather than industrial processes. There would be only a little new construction to install production processes not already in place, on a small scale, at the labs. "Omnilab Large," in contrast, would maintain a stockpile of a few thousand warheads. It would require building many production facilities sized for a larger workload than the labs can currently handle, hiring and training many new production workers, and using industrial methods.

Either version of Omnilab would help maintain the labs by drawing resources to them. Maintaining the labs is important because only they can certify weapons, and must do so annually. Certification requires strong science, especially without testing. Moreover, if the plants cannot resolve the demographic issues and potential for technology disconnect discussed earlier, an Omnilab could be the Nation's only choice.

It would be easier to establish Omnilab Small, which would use mostly existing lab facilities, than Omnilab Large, which would not. Yet either version would require extensive regulatory approvals and environmental impact analyses, and could face legal challenges and public protests. It would take years to implement either version and qualify it for production of stockpiled weapons. Everything would be changed from the way things were done at the plants: the facilities, computer models (using new, vastly more powerful supercomputers), production sites (which can affect the product<sup>51</sup>), production processes, and (for Omnilab Large) workers. Even the scientific approach would be new; it would use predictive methods and scientific experiments that lead more to a first-principles understanding of weapon issues, rather than emphasizing nuclear tests and empirical models that are based on past nuclear test data. As a result, either version of Omnilab would add great uncertainties that could reduce confidence in U.S. weapons.

Omnilab (Large or Small) would arguably place the labs at risk. It could divert them from R&D, their core mission, to production, a mission for which they have little recent experience and which appears to be at odds with their culture. According to one report, when TA-55, Los Alamos's plutonium R&D facility, was proposed as the future site for pit production, "at first LANL [Los Alamos National Laboratory] Director Sig Hecker blanched at the proposal, worrying that a weapons production role would crowd out research and scare away talented scientists."<sup>52</sup> Omnilab Large could become a Trojan horse: If the need for capacity suddenly were to increase, such as to modify hundreds of warheads of one type to correct a newly discovered flaw, the labs would have to devote many more resources to expansion of capacity. The Nation would have no choice, but the adverse consequences for the labs would multiply. Omnilab Small would avoid this problem because the national decision establishing it would accept sharp limits on capacity.

A move to a force that Omnilab Small could maintain, a few hundred warheads, would hold implications that the other approaches do not. Some involve management of the U.S. stockpile. The U.S. strategic force comprises bombers, ballistic missile-carrying submarines, and land-based intercontinental ballistic missiles (the "triad"). With a few hundred warheads, there would be strong pressure

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<sup>51</sup> For example, LLNL developed and demonstrated a metal-inert-gas process for using aluminum to weld beryllium components. When it was put into production at Rocky Flats Plant, it failed. The problem took about a year to figure out: Rocky Flats is at an elevation of about 5,800 feet, while LLNL is near sea level; at the lower pressure of Rocky Flats, gases come out of solution, creating bubbles in the weld. The solution was to use a pressurized system (pressurized inert gas metal arc welding). Source: Telephone conversation between the author and Los Alamos National Laboratory staff, December 1996.

<sup>52</sup> Jonathan Weisman, "Los Alamos Takes Step Back to Its Roots," *Science*, March 8, 1996: 1356.

to eliminate one or two of these elements to save money. Bombers and submarines are especially costly to operate and maintain; spending vast sums for a bomber force carrying, say, 100 warheads would incur immense costs per deployed warhead. Similarly, there would be strong pressure to reduce the number of warhead types deployed, as maintaining each type entails cost. (Maintaining each warhead type requires some unique surveillance and production capabilities, and fixing a problem in one warhead type would likely require dedicated experiments and calculations.) The foregoing concerns could be dealt with by spending the requisite sums, which, with fewer warheads involved, would be less than current spending. Otherwise, questions might arise regarding the credibility of the U.S. nuclear force.

This small stockpile would involve international issues as well. The United States would be unlikely to go to a force of a few hundred warheads unless parallel large reductions in British, Chinese, French, and Russian forces could be negotiated. Even so, Britain, China, and France could surely not agree to proportional reductions; reducing their nuclear forces by 90 to 95 percent would leave them with perhaps a few dozen warheads apiece, scarcely a viable or cost-effective force. A very small nuclear force would also magnify the value of each warhead vis-a-vis the U.S. force, arguably increasing the incentives for nonnuclear weapon states to go nuclear, or for China or a revanchist Russia to hold warheads covertly. This in turn would increase the importance of monitoring, and might necessitate agreements permitting on-site inspection.

**Lab Dominant.** Under the second approach, “Lab Dominant,” the labs would have a robust R&D program while the plants would do production at a low rate. Much of the plants’ capacity would be in cold storage or dismantled. The labs would develop more expertise in technologies supporting production. They would have more responsibility in manufacturing technology, such as producing some components, leading and integrating the weapons complex effort to develop advanced manufacturing technology, and overseeing weapons surveillance testing at the plants.

Lab Dominant would arguably help maintain near-term confidence in weapons better than Omnilab Large or Small. DOE and DoD claim that their joint involvement in nuclear weapons is beneficial because this arrangement provides checks, balances, and complementary perspectives;<sup>53</sup> Livermore and Los Alamos make the same argument regarding two separate design labs. By the same token, conducting R&D at separate organizations from production should provide the same benefit. By leaving most production at the plants, Lab Dominant would protect the labs from pitfalls of production. Moreover, retaining more production capacity (some of it in cold standby) than under either version of Omnilab would let DOE meet requirements for large production runs, should they be needed to correct warhead flaws that emerged with little or no warning despite the best efforts of stockpile stewardship.

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<sup>53</sup> For a DoD perspective on these points, see Secretary of Defense William J. Perry, letter to Senator Strom Thurmond, Chairman, Senate Armed Services Committee, March 29, 1995.

On the other hand, this approach would undercut production capability at the plants by sacrificing investment to meet the day-to-day needs of production. It might ultimately provide less total (steady-state plus surge) capacity than Omnilab Small if the demographic, technology, and recapitalization problems facing the plants were not addressed and steps were not taken to put in place the requisite capacity at the labs. If capability at the plants is in jeopardy, the expenditures for recapitalization might have to be compressed into a few years, perhaps making them unaffordable. Or, demographic problems and technology disconnects could worsen to the point where restoring the plants becomes impossible. As such, Lab Dominant could undermine the confidence of U.S. policymakers in U.S. ability to maintain weapons for the long term.

Lab Dominant has potential strategic implications. Declining confidence in U.S. ability to maintain its weapons for the long term could undermine U.S. confidence in its deterrent, or (less likely) the confidence of potential adversaries in the effectiveness of U.S. weapons. It could also weaken the U.S. position in strategic arms reduction negotiations. Russia or China might feel less need to make concessions in this area if either felt that U.S. inability to maintain its weapons adequately under Lab Dominant made unilateral U.S. reductions inevitable.

***Plant-Lab Partnership.*** The third approach, “Plant-Lab Partnership,” is defined as follows. The plants would continue production and would invest more in infrastructure, capital equipment, etc., correcting problems noted in Findings 5-7. Technology investment would strengthen their ability to continue production-related development of the sorts noted in Finding 11 to address production problems, and to adapt new technologies, such as in Findings 12 and 13, to production. Plants would continue to reduce floorspace in order to consolidate operations and save money. The labs would continue a strong stockpile stewardship program. Labs and plants would have a partnership centered on technology. Labs would be more responsive to plant needs, such as in developing processes to meet production demands or software to track development and production efforts. The balance between production needs and technological opportunity as drivers of lab R&D would shift toward the former. At the same time, the plants would provide feedback on lab technologies, would consult on producibility issues, and would help “industrialize” lab technology for commercial use.

Compared to the other approaches, Plant-Lab Partnership would provide more capability (as well as capacity) for maintaining weapons, and would most clearly demonstrate U.S. commitment to do so. It would let the plants make the most of technology developed by the labs, and would encourage the plants to influence development of that technology. Strengthening technical expertise would help the plants retain their autonomy. The shift in lab-plant relations from one of tension a few years ago to one of more cooperation now should make Plant-Lab Partnership more sustainable. On the other hand, Plant-Lab Partnership would require substantial investment. Its scope could also raise arms control problems. Many nonnuclear weapon states are pressing for nuclear disarmament, and cite the Nuclear Nonproliferation Treaty as committing the nuclear weapon states, as states party to that treaty, to work toward that end. Nonnuclear weapon states could view Plant-Lab Partnership, the most robust approach, as signaling U.S. disinterest in nuclear disarmament.

## Critiques

The three approaches just discussed — Omnilabs, Lab Dominant, and Plant-Lab Partnership — are consistent with the U.S. policy of (1) maintaining nuclear weapons and (2) doing so without testing. Some disagree with that policy, so would reject all three approaches. One group would eliminate all nuclear weapons worldwide as soon as possible, and until then would have a minimal stewardship program at most. Another group would resume testing on grounds that that is the only way to maintain weapons. This section presents views from these perspectives.

*Critique by Opponents of Nuclear Weapons.* Those who oppose nuclear weapons hold that the three approaches, by trying to maintain weapons indefinitely, evade what they see as the central purpose of the CTBT, a halt to weapons improvement as a prelude to nuclear abolition. The nuclear weapon states, by maintaining their nuclear monopoly, perpetuate a discriminatory regime with nuclear haves and have-nots. This conveys to the world the message that nuclear weapons are important, that they are an essential trapping of great power status, that their use is possible and legitimate, and that the nuclear weapon states will keep them. That message, in this view, undercuts U.S. nonproliferation efforts, U.S. security, and the CTBT. As Paine and McKinzie wrote in 1997,

If implemented over the next decade as presently planned, the SSM Program is poised to seriously erode important nonproliferation policy objectives as well as undermine political assurances the U.S. government provided other nations in connection with the indefinite extension of the NPT and the negotiation of a Comprehensive Test Ban Treaty. Indeed, over the long term the SSMP poses a threat to the strategic relevance of the CTBT itself.<sup>54</sup>

These observers would have a curator-type weapons maintenance program at most until nuclear weapons were abolished, or a program of monitoring and guarding warheads until they are dismantled. They view nuclear weapons as robust, so see all three approaches as spending far more effort and money than is needed even if the United States wants to maintain weapons for some time. As a 1997 press release by three antinuclear groups stated,

“Numerous scientific studies have shown that nuclear testing is not needed to maintain the safety and reliability of the nuclear arsenal,” said Robert Tiller, Director of Security Programs at Physicians for Social Responsibility. “Our nuclear weapons arsenal can be maintained in the future with the same non-explosive tests and inspections that have been used in the past. DOE’s approach to the nuclear stockpile should be drastically revised and redefined into a passive curatorship, not a huge pork barrel program for the weapons labs.” ...

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<sup>54</sup> Christopher Paine and Matthew McKinzie, *End Run: The U.S. Government’s Plan for Designing Nuclear Weapons and Simulating Nuclear Explosions under the Comprehensive Test Ban treaty*, Washington, Natural Resources Defense Council, August 1997, p. 24.

Maureen Eldredge, Program Director of the Military Production Network, denounced the skewed spending priorities. ... “Congress needs to ratify the CTB, kill the SS&M [Stockpile Stewardship and Management] program, and in its place create a truly passive curatorship program for our nuclear arsenal.”<sup>55</sup>

Adherents of this position fear the many efforts to advance technology as leading to new weapon types and increasing pressure to test, both to ensure that changes made to existing weapons will work and to enable certification and production of new ones. Some view these plans as pork-based stockpile stewardship and management — not jobs to do work but work to save jobs. They see some of the concerns by CTBT opponents, discussed next, as overstated. Even if Russia were to have more warheads than the United States, what difference would that make? If Iraq were to develop nuclear weapons, how would 2,000 warheads be more of a deterrent than 500? Even a drop in the reliability of U.S. warheads would not be critical, in this view: Deterrence arises not from U.S. confidence that U.S. weapons will work, but from lack of confidence by others that U.S. weapons will fail. This latter is an easier standard to meet.

Of the various approaches, advocates of nuclear disarmament would probably dislike Omnilab Small the least. It would support the smallest stockpile and have the lowest cost. It could readily be ratcheted down to maintain fewer warheads, but its less formal procedures, limited operating capacity, and lack of surge capacity would increase the time and difficulty involved in ramping up production or supporting a larger stockpile. Also, if a serious defect emerged in warheads of one type, this approach would make it difficult for the United States to replace them in a timely way while maintaining other warheads. Omnilab Small might thus encourage the United States to reduce further its reliance on nuclear weapons and to enter negotiations for further reductions. On the other hand, the great fear of advocates of nuclear disarmament is development of “new weapons,” a mission the labs would dominate. Omnilab Large or Small would enhance the labs, whereas Plant-Lab Partnership, by strengthening plants as well as labs, would place greater emphasis on routine maintenance of weapons.

Two ironies attend this critique. A robust SSM program might promote nuclear disarmament by delaying the need to test to resolve a weapon problem. It may be that SSM works well enough to avoid that need. But even if it does not, the better SSM does, the longer testing might be avoided. U.S. technical ability to conduct a nuclear test might diminish over time under the CTBT or a test halt, as happened for atmospheric testing in the 1958-61 nuclear test moratorium and in the years after the Nuclear Test Ban Treaty of 1963. U.S. political will to test might also decline over time, as happened with atmospheric testing after the 1963 treaty and as appears to be happening with underground testing following the current moratorium that began in September 1992. The longer that SSM can delay the need to test, then, the less politically likely and technically capable the United States would be to test even to

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<sup>55</sup> Military Production Network, Peace Action, and Physicians for Social Responsibility. “National Grassroots Groups Criticize Nuclear Weapon ‘Stewardship’ Plan, Call for Early Ratification of CTB,” press release, October 29, 1997, p. 1-2.

resolve a stockpile problem, and the more likely it would be instead to withdraw questionable weapons or make whatever fixes could be made without testing.

Second, while disarmament advocates believe a small U.S. effort would suffice to *maintain* nuclear weapons, it does not follow that would-be proliferators could readily *develop* such weapons, especially without detection and response. True, these nations would not need to approach the complexity of U.S. weapons. Yet this report suggests that even much simpler weapons would require an elaborate production complex. Planning, building, and operating it would involve many steps. Nuclear testing would be but one of these steps, and an unnecessary one for simple weapons. Discovery of any of these steps could reveal the existence of a clandestine weapons program. Accomplishing such a program would therefore be exceedingly difficult, costly, and time-consuming — though not, as the Iraqi case shows, impossible.

***Critique by Opponents of the CTBT.*** Opponents of the CTBT agree with past and current U.S. policy to maintain nuclear weapons indefinitely, and argue that confidence in weapons must be high to maintain effective deterrence. As the only way proven to maintain weapons, they would conduct an ongoing program of nuclear weapons R&D, design, testing, and production, though sized to meet post-Cold War needs. As Gaffney states, “A responsible and effective Stockpile Stewardship Program requires an ongoing program of low-yield underground testing, *at least* until such time as the various high-tech facilities and technology envisioned under the present SSP are fully validated.”<sup>56</sup> They see nuclear weapons as complicated, and note that they deteriorate over time. Any changes to weapon design, materials, or production processes — or even trying to rebuild warheads to original specifications — would, they believe, inevitably introduce changes. The armada of weapons-related technologies large and small being developed at the plants and labs hold the potential, in this view, to magnify these problems. These changes may cumulate over time to affect weapon performance drastically. Moreover, without testing, the United States could not introduce new weapon types that might be needed to counter advances in weapons or defensive measures by other nations, and might be unable to introduce some new safety features.<sup>57</sup> U.S. confidence in its deterrent would thus erode, encouraging would-be nuclear states to develop nuclear weapons and compelling U.S. allies to develop their own nuclear weapons to compensate for lack of confidence in those of the United States. This, they believe, is a recipe for nuclear proliferation and for undermining U.S. security. In this view, only testing can assure confidence; as the 1996 Republican Platform stated,

To cope with the proliferation of weapons of mass destruction, the United States will have to deter the threat or use of weapons of mass destruction by rogue states. This in turn will require the continuing maintenance and development of nuclear weapons and their periodic testing. The Clinton

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<sup>56</sup> Center for Security Policy, “Warning to the Nuclear Labs: Don’t Count on ‘Stockpile Stewardship’ to Maintain *Either* Overhead *Or* Confidence,” Decision Brief 97-D 183, December 1, 1997, 1 p., original emphasis in text and title.

<sup>57</sup> See “Statement By Dr. Kathleen C. Bailey Before the United States Senate Committee on Governmental Affairs, Subcommittee on International Security, Proliferation, and Federal Services, March 18, 1998,” prepared statement, p. 9-10.

Administration's proposed Comprehensive Test Ban Treaty (CTBT) is inconsistent with American security interests.<sup>58</sup>

As Omnilabs, Lab Dominant, and Plant-Lab Partnership all assume that the United States can maintain its nuclear stockpile without testing, CTBT opponents would view all three approaches as doomed to failure.

CTBT opponents would find particular problems with Omnilab Small because they feel that the force of several hundred warheads that that approach would support would place U.S. security at great risk. While the United States could spend the funds needed to maintain a triad and multiple warhead types for each triad element, CTBT opponents fear that cost pressures would lead to cutbacks, with severe adverse strategic effects. Eliminating one or two triad elements would simplify an attack on the force and increase U.S. vulnerability. Having each triad element carry only one type of warhead, instead of two or three as at present, would in their opinion make the force "fragile": a serious defect emerging in a warhead type would eliminate the entire triad element that carries that warhead. Another vulnerability would be to hidden weapons or covert weapon development programs. If Russia were to hide several thousand warheads, and retained missiles to carry them, it would suddenly have a much larger force than that of the United States. On-site inspection, in this view, would have little prospect of finding such weapons in any nation, let alone the world's largest, yet U.S. agreement to such inspections would permit intrusions by other nations. Still another vulnerability would be that Russia and China would have much greater production capacity than would the United States under Omnilab Small, so that even an overt decision to break out of an agreement mandating small forces would leave the United States at a disadvantage. In sum, CTBT opponents fear that the small force associated with Omnilab Small would increase in vulnerability and decrease in credibility over time, sharply eroding its deterrent value.

***Critique by Those Who Would Maintain Nuclear Weapons under the CTBT.***

Those who would retain nuclear weapons under the CTBT would likely choose among Omnilabs, Lab Dominant, Plant-Lab Partnership, or similar approaches, rather than rejecting all of them. They would see cost as an issue in the choice.

- ! Omnilab Small would probably be the least costly approach for the long term if the United States were to have a stockpile of a few hundred warheads. The labs could maintain the stockpile using mainly existing staff and equipment. The operating savings from closing the plants would, in this approach, probably far outweigh the combined costs of small-scale new construction and low-rate operation at the labs.
- ! Plant-Lab Partnership would be costly. The plants have deferred much investment in order to fund operations — not a formula for success in a technology-driven industry.

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<sup>58</sup> Republican National Committee, 1996 platform, at website <http://www.rnc.org/hq/platform96/plat8.html#stren>

- ! Omnilab Large would arguably be the most costly approach because of the large investment needed. Indeed, a DOE study that considered six major weapon production activities found that, except for plutonium component production, it would be less costly to do the work at the plants even for a stockpile of a thousand warheads.<sup>59</sup> (That figure is well below the 2,000 to 2,500 accountable strategic warheads that the United States and Russia listed in the March 1997 Helsinki summit statement as an objective for START III.<sup>60</sup> More recently, Russia has suggested that the two sides reduce further, to perhaps 1,500 such warheads in START III.) The reason is that establishing production on an industrial scale at the labs would entail high costs, requiring the design and construction of new facilities, buying production equipment, hiring and training new workers, and qualifying the production processes. Moreover, the cost of installing and qualifying new equipment at the labs for surge capacity would likely exceed that of maintaining existing equipment in cold standby at the plants for the same purpose. Any decision to close the plants and move production to the labs would therefore need to weigh the cost of establishing new production capability and capacity at the labs against the cost of maintaining the plants.
- ! Lab Dominant is likely the cheapest for the short term for a stockpile of currently foreseeable size because it defers investment. Yet for precisely that reason it is arguably the least stable for the long term. As its shortcomings became manifest, Lab Dominant would likely lead to either form of Omnilab or to Plant-Lab Partnership. Lab Dominant may thus be seen as a default approach, the result of an unwillingness to move production to the labs or to upgrade the plants.

Cost, however, would not be the only issue, or even perhaps the most important one. The choice among Omnilabs, Lab Dominant, and Plant-Lab Partnership is basically a choice of means and ends. Plant-Lab Partnership is ends-driven. If the United States wants to retain capacity to maintain a stockpile of several thousand weapons and a surge capacity, it needs the plants. Maintaining the plants requires addressing the three issues that are the core of this report — demographics, technology, and recapitalization.

- ! Current demographic trends at the plants will not enable the maintenance of capability over the long term. The data presented later in this report (see Finding 9) show this for KCP; discussions indicate that the situation is similar at other plants as well. The problem must be solved in the face of downsizing and (for crafts personnel) the seniority system. If this problem cannot be

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<sup>59</sup> U.S. Department of Energy. *Stockpile Management Preferred Alternatives Report*, in support of the Stockpile Stewardship and Management Programmatic Environmental Impact Statement, July 1996, p. 12, 15, 17, 18, 22, 24.

<sup>60</sup> “Russia-United States Joint Statement on Parameters on Future Reduction in Nuclear Forces,” March 21, 1997. In U.S. National Archives and Records Administration. Office of the Federal Register. *Weekly Compilation of Presidential Documents*, March 24, 1997: 389.

solved, there may be no alternative to closing the plants and moving production to the laboratories.

- ! Developments of the sort described in Findings 11-13 will compel the plants to enhance their ability to work with new technologies. The labs and plants have many hundreds, if not thousands, of projects in many areas of technology underway at any time, and commercial technology is advancing across an even wider front. Many of these projects will affect production. A potential technology disconnect between labs and plants, as discussed on page 21, threatens the plants over the long term; the plants could minimize this risk by more focus on and investment in technology.
- ! The plants claim to have large unmet needs in the areas of maintenance, infrastructure, capital equipment, technology, personnel, and more, as Findings 5-7 suggest. Recapitalization, however, would take money.

If the United States is unwilling to spend the money for Plant-Lab Partnership, an ends-driven approach, it could take a means-limited, least-cost approach. It could close the plants, shrink the stockpile drastically, forgo surge capacity, and implement Omnilab Small. According to DOE, “if the U.S. were to support a stockpile of only a few hundred weapons, a small [production] capability collocated with its weapons research and development capability would probably be sufficient.”<sup>61</sup>

Lab Dominant seeks the ends of Plant-Lab Partnership without the requisite means. There may be reasons for so doing. The stockpile level is in flux pending Russian ratification of START II, START III negotiations that would follow START II ratification, and possible future agreements. Certainly the stockpile trend has been downward. Delaying a commitment to Plant-Lab Partnership (or to Omnilab Large) would avoid spending money that could be wasted if the United States were to move to a very small stockpile. Moreover, funds may simply be unavailable for Plant-Lab Partnership even as it is clear that the stockpile will be larger for the foreseeable future than that supportable by Omnilab Small. Yet Lab Dominant has severe problems, as noted on page 24. If they cannot be resolved, the United States might be forced by default to Omnilab Large. The need to institute that plan quickly would magnify its high costs, risks to the labs, and stockpile uncertainties.

Given the costs and implications of the three approaches, then, those who would maintain weapons under the CTBT might favor making an explicit decision among these (or other) approaches, as a decision by default is likely to produce poorer results at higher cost. Lab Dominant is in effect a decision by default, a result of an unwillingness either to spend on facilities for maintaining the current stockpile, or to shrink the stockpile to a level that can be maintained at lower cost. Lab Dominant, in turn, could lead to Omnilab Large as another default decision: It would be the only choice available if the plants were to become unsustainable. The decision on approach will likely determine U.S. ability to maintain its weapons for the long term; it is too important to be made by double default.

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<sup>61</sup> Department of Energy. *Stockpile Management Preferred Alternatives Report*, p. 2.

## Conclusion: SSM and CTBT

If the United States chooses to enter a CTBT as a prelude to abolishing nuclear weapons, or to resume nuclear testing in order to maintain weapons, implementing either choice is conceptually simple. Implementing a decision to enter the treaty and maintain nuclear weapons while avoiding a default approach to maintenance is more complicated.

The CTBT might be a vehicle for assuring production capability needed to maintain weapons. As noted on page 3, President Clinton has set forth six “safeguards” for maintaining U.S. security under the CTBT.<sup>62</sup> Safeguards A and B make the treaty a vehicle for assuring weapons R&D. At the same time, placing production on a stable footing seems crucial for obtaining the CTBT. As a result, it may be possible to link the treaty and production.

Each side in the CTBT debate has placed itself in a somewhat difficult position. CTBT opponents are certainly correct to point out that the United States can maintain its weapons more confidently with testing than without. Yet it seems unlikely that the United States would conduct nuclear tests other than for a stockpile emergency, the exception that President Clinton spelled out. (Indeed, it is uncertain if the United States would conduct a test even then because of concerns over international protests, ending the CTBT, and advertising the existence of a major U.S. weapon problem.) If the Senate were to reject the CTBT and the United States did not conduct tests other than for stockpile emergencies, some might wonder why the treaty was rejected. If the United States tested, several decades of nuclear testing history suggest that a domestic and international firestorm of protest would surround each test.

The perceived link between the CTBT and nuclear abolition places the treaty’s advocates in an awkward position as well. Neither Congress nor the Administration has shown serious interest in nuclear abolition. Indeed, both have acted in a sustained manner to retain and maintain U.S. nuclear weapons even under the CTBT. The treaty’s ratification prospects would dim if the Senate saw the treaty as leading to abolition. Yet obstacles to production, as described in this report, undercut U.S. ability to maintain weapons. If these needs continue, they could raise questions about the U.S. commitment to maintaining weapons and about whether the long-term result of the CTBT would be abolition; neither concern would help CTBT prospects. Moreover, as production is needed to maintain weapons, production difficulties could make more likely a stockpile emergency of the sort that could lead the United States to resume nuclear testing.

Linking the CTBT and Stockpile Management might avoid some difficulties just noted. To do so, however, would appear to require substantial added Stockpile Management funds. Such a funding commitment would likely have to be on a long-term scale because the treaty itself is of indefinite duration. Funds would be spent on investment at the production agencies (including Sandia and Los Alamos in their production roles as well as the plants) in areas noted earlier. These funds would be

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<sup>62</sup> U.S. White House. Office of the Press Secretary. “Fact Sheet: Comprehensive Test Ban Treaty Safeguards,” August 11, 1995, 1 p.

needed even if production were to move to the labs. The plants might spend, say, a tenth, of their added funds to buy technology meeting their specifications from the labs. Plant-directed R&D would make for closer lab-plant relationships by strengthening the technology link between the two, and would increase the amount of technology the labs generated in response to the demands of production.

The six current Safeguards deal with the labs, intelligence, and test resumption. They do not deal with production or acknowledge that it is indispensable for maintaining nuclear weapons for the long term, and that it requires ongoing investment in people, infrastructure, equipment, and technology. A possible way to address this concern would be to provide that the United States shall make adequate funds for investment and operations available for production activities at nuclear weapon production facilities.

This provision would refer to “production activities” instead of “production” to clarify that the concern is not only fabricating complete warheads, which is what most people think of as production, but also manufacture of components, life extension programs, repairs, modification of warheads for flight tests, and so on. It could refer to “production facilities” rather than “plants” because it might be in effect a long time. While added investment would help the plants survive, one cannot predict whether production would be done at the labs or plants many years from now given uncertainties on future arms control agreements, stockpile size, weapons complex demographics, and the impact of new technologies. Such a provision, if linked to the CTBT, could come into effect with that treaty and maintain production on the same timescale as the treaty or until the world moved to nuclear disarmament.

SSM and the CTBT, then, are complementary. A strong program of R&D and production counters — though cannot eliminate — the argument against the treaty that the United States will be unable to maintain its nuclear weapons indefinitely without testing. Unless the nuclear weapons complex is maintained on an ongoing basis, though, its capability will diminish. That would undermine confidence in weapons over time, a prospect that could lead the Senate to reject the CTBT and the United States to resume testing. As an inadequate program of R&D and production could lead to defeat of the CTBT, and as a strong program would weaken the case against the treaty, advocates of a strong program for weapons maintenance and advocates of the CTBT share a sometimes-uneasy confluence of interest.