Zero Nuclear Weapons and Nuclear Security Enterprise Modernization

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Every president since Franklin D. Roosevelt has authorized the production of nuclear weapons, requiring that the US government both understand the nuclear weapons program and establish policy for nuclear weapons employment.[1] Each of these presidents also has reiterated a desire to eliminate or reduce the role of nuclear weapons, only to confront the reality that as long as other countries possess them the United States must maintain a credible nuclear capability to deter adversaries and protect itself and its allies. Maintaining a credible nuclear deterrent is essential to US national security. Any degradation of its nuclear enterprise will impact negatively on its nuclear deterrent capability; an even greater impact could result if deterrence fails. Therefore, the United States must maintain its focus on nuclear weapons and the supporting infrastructure through modernization of the entire nuclear security enterprise (the enterprise), even while it pursues a world without nuclear weapons. To understand the current and future status of the nuclear enterprise, one must first consider its role in history and that of the National Nuclear Security Administration (NNSA).

Historic Roles

Nuclear deterrence has been a critical component of national security since World War II. During the Cold War, the nuclear weapons complex was a massive operation focused on an arms race with the Soviet Union and mass production of nuclear weapons.[2] As the Cold War endured, the average age of stockpiled weapons increased, reaching a plateau at approximately 12 years (see fig. 1). Weapons designers were focused on maximizing yield-to-weight ratios rather than increasing the longevity of the weapons.

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At the end of the weapons' life expectancy, they were dismantled and replaced with new ones designed to address the current perceived threat and to incorporate technological improvements. This high turnover created a solid base of expertise in weapons design. Between 1945 and 1992, these designers created innovative new designs and ultimately produced more than 65 different types of weapons, including air-dropped bombs, intercontinental ballistic missiles (ICBM), submarine launched ballistic missiles (SLBM), and artillery devices.[3] Due to the evolutionary nature of the weapons, designers did not anticipate stockpiling them more than 12 years and therefore paid limited attention to designing components that would not corrode or fail over an extended life cycle.[4] The end of the Cold War in 1990, the ratification of the first Strategic Arms Reduction Treaty (START) in 1991, and the subsequent US moratorium on underground nuclear testing dramatically changed the landscape of nuclear weapons in US national security strategy. For the first time since the Manhattan Project, the United States was no longer building nuclear weapons and was in fact downsizing its nuclear arsenal.

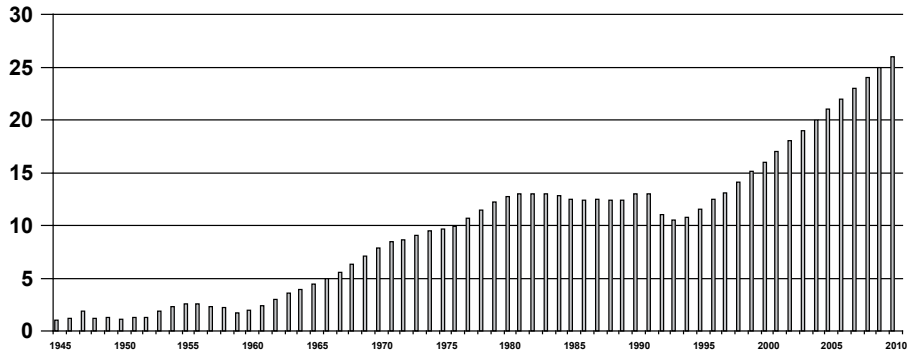


Figure 1. Average age of US nuclear weapons stockpile. (Brig Gen Garrett Harencak, USAF, "Insider View of the NNSA and the Nuclear Enterprise," lecture, Air Command and Staff College, Maxwell AFB, AL, 9 September 2010.)

In 2000, the NNSA was established by congressional mandate as a semiautonomous agency under the Department of Energy with the mission to provide management and "security to the nation's nuclear weapons, nuclear non proliferation, and naval reactors programs."[5] The NNSA maintains the US nuclear weapons stockpile and is tasked, in tandem with the Department of Defense, to ensure the US nuclear deterrent is

safe, secure, and effective to meet national security requirements. This joint task has become increasingly difficult over the past two decades, in part because various treaties and agreements have significantly restricted the development and testing of nuclear weapons. Nuclear weapons that were originally designed for a 10-year lifespan have been in the stockpile for 30-plus years. Each new treaty works to reduce the role of nuclear weapons in the US national security strategy and further restrict what the United States can possess in its active nuclear stockpile. Self-imposed limitations on modernization also thwart efforts to extend the life of the aging nuclear weapons.

Over time, the huge nuclear security enterprise managed by the NNSA has shrunk from 15 to eight sites. Using a government-owned, contractor-operated model, the NNSA provides high-level oversight and requirements coordination. Its sites design, produce, and apply science and engineering to maintain and safeguard the nation's nuclear weapons. The enterprise, depicted in table 1, consists of three national laboratories, four engineering and production plants, and the Nevada National Security Site (until recently called the Nevada Test Site).

Table 1. Nuclear security enterprise facilities

Facility	Location	Primary Responsibility
Los Alamos National Laboratory (LANL)	Los Alamos, NM	Weapons design
Lawrence Livermore National Laboratory (LLNL)	Livermore, CA	Weapons design
Sandia National Laboratories (SNL)	Albuquerque, NM Livermore, CA	Nonnuclear component design
Y-12 National Security Complex (Y-12)	Oak Ridge, TN	Uranium
Savannah River Site (SRS)	Aiken, SC	Tritium
Pantex Plant (PX)	Amarillo, TX	Assembly/disassembly
Kansas City Plant (KCP)	Kansas City, MO	Nonnuclear component production/ procurement
Nevada National Security Site (NNSS)	Nye County, NV	National security experiments

While the size and structure of the enterprise may have changed since the Cold War, lingering elements of that era still affect the present-day mission of the NNSA, not the least of which is the drastic change in political perspective on acceptable weapons longevity.

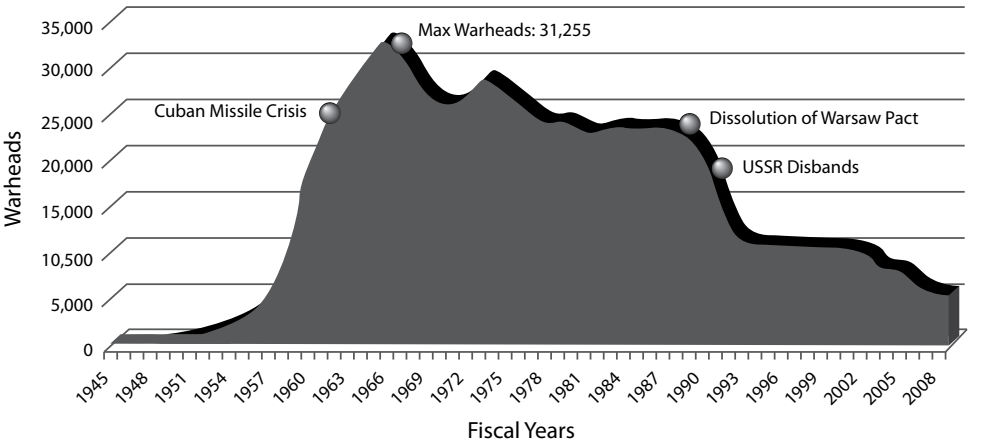
Current Status

The average age of a weapon in the US nuclear stockpile today is over 25 years, well past its intended life. Meanwhile, funding from recent presidents and Congress for the stockpile and supporting infrastructure has reached historic lows due to the perceived reduced role of nuclear weapons in the US national security strategy. In fact, in the last five years the NNSA has lost 20 percent of its buying power although the vital mission to maintain a safe, secure, and effective stockpile has not changed.[6] Collectively, these events have reduced the nation's focus on nuclear weapons as a supporting pillar of US national security policy. This lack of focus has put the NNSA on a path to failure, because insufficient funding makes it more difficult to assess weapon reliability.[7] This means the NNSA must maintain an increasingly dilapidated weapons complex and stockpile with maintenance funds that decrease significantly each year.

The aging weapons problem is further complicated by an unprecedented presidential commitment to achieve a world without nuclear weapons. In an April 2009 speech in Prague, Pres. Barack Obama created a paradox when, first, he said that the United States, as a world leader, would actively pursue a world without nuclear weapons and, second, promised that as long as other countries had nuclear weapons, the United States would maintain an effective nuclear deterrent.[8] Since Prague, the United States has negotiated the "New START" treaty with Russia to reduce the number of nuclear weapons in both countries. Keeping with the Prague promises, the lower weapon levels negotiated in the New START translate into a critical need that the remaining weapons be highly credible and effective. To maintain US nuclear weapons as a credible deterrent, significant funding must go into the entire enterprise to reverse years of atrophy and neglect.

In 2008, the bipartisan Perry-Schlesinger Commission studied the role of nuclear weapons in US security policy and concluded that more money must be spent on the enterprise to maintain a credible US nuclear deterrent.[9] This commission was established by Congress and co-chaired by William Perry, former secretary of defense, and James Schlesinger, former secretary of defense and energy. The commission confirmed in its report that the primary role of nuclear weapons in the US national security strategy is deterrence. They also provide extended deterrence to US allies and support nonproliferation among those allies who otherwise might develop their own arsenal without the US nuclear umbrella.[10] The commission made several key recommendations on the future US strategic posture

which have served as a guide for the Obama administration. Notably, the commission recognized the substantial work that has already been invested in reducing the nuclear threat worldwide. The United States has reduced its arsenal from a peak of 31,255 warheads in 1969 to 5,113 warheads (total active and reserve) today; the lowest numbers since the Truman administration (see fig. 2).[11] Likewise, the Russians have significantly reduced their stockpile from over 45,000 at the peak of the Cold War.[12]



Includes active and inactive warheads. Several thousand additional nuclear warheads are retired and awaiting dismantlement.

Figure 2. US nuclear weapons stockpile, 1945–2009. (Harencak, "Insider View of the NNSA and the Nuclear Enterprise.")

Ratification of the New START will reduce these numbers further, sizably shrinking both countries' nuclear arsenals. More significant, however, is the inverse correlation between reduced nuclear stockpile numbers and increased importance that the remaining weapons remain safe, secure, and effective.

Aging of the nuclear weapons, coupled with the decreased number of weapons available, creates increased operational risk to the nuclear deterrent for the United States and its allies. This risk requires the United States to maintain a significant number of "hedge" weapons that protect it against technical uncertainty. Reducing the technical uncertainty in these aging weapons would allow the United States to reduce the overall number while maintaining the credibility of the weapons. However, current agreements and restrictions do not allow the United States to test weapons or to build newly designed weapons. These restrictions and the weapon-aging problem create a quandary for the directors of Los Alamos, Lawrence

Livermore, and Sandia when they provide an independent assessment of the stockpile each year to the president, certifying the weapons are safe, secure, and effective. To alleviate these credibility concerns, the NNSA must continue to develop and fund two critical programs, the Stockpile Stewardship Program (SSP) and the Life Extension Program (LEP).

Weapon surveillance is the foundation of both programs. Surveillance involves the evaluation of both nuclear and nonnuclear components of a weapon through destructive and nondestructive testing. The process is responsible for identifying original manufacturing flaws, design limitations, and effects of aging.[13] The results from these tests drive the NNSA's understanding of weapon-aging issues and establish a baseline for life extension work. The surveillance results also feed into the modeling and simulation work done in the stewardship program to better understand the internal dynamics during a nuclear detonation.

The stewardship program was established in 1992 when the underground nuclear weapons testing moratorium was instituted "to ensure the preservation of the core intellectual and technical competencies of the United States in nuclear weapons."[14] Its goal was to keep the nuclear stockpile reliable without nuclear testing. The SSP is a comprehensive, experiment-based modeling and simulation effort that applies data from multiple subcritical tests, simulating phases of a nuclear detonation, into high-speed computer models. The compilation of this data provides the NNSA a better understanding of nuclear weapons behavior.[15] In the absence of nuclear weapons testing, the stewardship program becomes the primary tool used to certify weapon reliability each year. The complexity of thoroughly analyzing a nuclear detonation requires multiple nonnuclear experiments and the world's fastest supercomputers, driving up the cost of the program. Without full funding, the safety, security, and effectiveness of the weapons become questionable.

The surveillance program supports the Life Extension Program. The LEP is the solution to maintaining the nuclear weapons stockpile without designing and building a new nuclear weapon.[16] To comply with US policy on nonproliferation and worldwide dismantlement, the 2010 Nuclear Posture Review (NPR) highlights the preference for refurbishment of existing warheads or reuse of components from old weapons. To this end, the NNSA has a full spectrum of life extension options, all of which refurbish, reuse, or replace individual components within a weapon without giving it any newly designed components or new military capabilities. Replacement

of nuclear components is only done as a last resort to maintain a weapon and requires an extremely high level of political scrutiny for approval.[17] The NNSA develops life extension programs based on DoD requirements for the enduring stockpile, which include an approximate 30-year life expectancy as well as added safety and security features to protect the weapons. The enduring stockpile, as established by the NPR, maintains the nuclear triad of SLBM and ICBM warheads and air-dropped bombs. To maintain all three legs of the triad, warheads from each leg must be life extended. Currently, the NNSA is in the production phase for the W76 SLBM life extension program. Already in the initial developmental phases, the B61, W78, and W88 warhead LEPs will follow. The LEP couples databases from the legacy systems and nuclear tests with the SSP data to sustain nuclear weapons for the enduring stockpile without having to test weapons explosively.

Just as aging weapons systems create a perception by some of diminished deterrence capabilities for the United States and its allies, the atrophied physical infrastructure of the enterprise further affects the credibility of US nuclear deterrence. Vital facilities within the enterprise date back 50 to 60 years to the Manhattan Project and are on the verge of catastrophic failure. Caustic chemicals and processes have sped up the corrosion and breakdown of the facilities. Then congressman Lincoln Davis (D-TN) stated on a tour of the nuclear facilities that he felt like he was in a Russian facility, given the utter state of disrepair.[18] This deterioration occurred because the original facilities were built for maximizing production rather than for long-term structural integrity. The mission today is much different. Funding cuts and reduced stockpile numbers have forced the NNSA to consolidate facilities, reducing the overall square footage by 50 percent and the number of sites from 15 to eight.[19] This transition eliminated redundancy, creating single points of failure for the majority of systems needed to maintain the nuclear weapons stockpile. In other words, the NNSA is now a capability-based organization; that is, regardless of the size of the stockpile, it must ensure core competencies in several key areas to maintain the weapons stockpile rather than the capacity-based organization of the Cold War. Without significant investment in modernizing the existing infrastructure, the nuclear weapons program becomes vulnerable. There is no guarantee the sites are capable of maintaining their own operational status, let alone the operational status of nuclear weapons.

The Future of the Nuclear Enterprise

What is the future for the NNSA and the nuclear weapons complex? Most broadly, the NNSA must secure increased funding from Congress to modernize the enterprise. Recapitalization efforts must offset continued reduction in the nuclear stockpile and enable life extension programs, timely dismantlement, and proper management of fissile materials.[20] The smaller, streamlined enterprise must maintain all of the critical capabilities necessary to sustain the nuclear stockpile. The new facilities, although smaller, must be built to twenty-first-century safety and security standards. These standards are significantly different from original construction and will drive the cost of new facilities into the billions of dollars. The major facilities the NNSA anticipates building over the next 10 years to ensure uninterrupted capability and reduced risk include a chemical metallurgy research replacement facility at Los Alamos, a high-explosive pressing facility in Amarillo, and a uranium processing facility at Oak Ridge. While the costs and challenges will be high, there are also benefits in these modernization efforts. First, the new facilities will be more reliable, safe, and secure. Also, the external security benefits of the infrastructure improvements cannot be ignored. For example, at Oak Ridge the security cordon around special nuclear material will be reduced from 150 acres to 15 acres once the uranium processing facility is operational. This reduction will lower security costs and the possibility of loss of special nuclear material due to the smaller footprint and state-of-the-art facilities.

The infrastructure available to support the reduced number of nuclear weapons must be modernized to avoid operational risk that increases as the United States reduces the number of weapons in its arsenal. The modernization of the nuclear infrastructure will require significant, sustained investment and commitment over the next several decades. Without this investment, the risk associated with assessing the safety, security, and effectiveness of the weapons will increase to an unacceptable level.

The Perry-Schlesinger report acknowledges this reality explicitly. It states that to invest effectively in nuclear weapons systems through stewardship and life extension, there must also be investment in the enterprise infrastructure. Without such dual investment, the United States will be unable to maintain a credible nuclear deterrent. As it continues to reduce its stockpile toward zero without fully addressing the aging issues in both the stockpile and the infrastructure, its nuclear umbrella will lack the credibility needed to deter potential adversaries and protect allies. These factors could

lead other countries to question the viability of the US nuclear program and the credibility of the weapons currently in the stockpile. Without the resources and facilities needed to maintain the weapons, the deterrent effect is dramatically reduced.

Even with increased funding for weapons and infrastructure modernization, the complex cannot be properly maintained without the sustained efforts and engagement of the best and brightest scientists and engineers. The world's top scientists initially produced the atomic bomb, and the same critical skills will be needed to maintain the weapons complex for the foreseeable future. The end of underground nuclear testing launched the stewardship program to ensure nuclear weapons reliability through subcritical tests and other experimentation via simulation, modeling, and high-power computing. The critical skills required to maximize the science, technology, and engineering capacity and properly execute the SSP underpin the strength of the US nuclear deterrent and establish a fundamental understanding of nuclear weapon behavior. Consequently, to assess the stockpile, appropriately trained scientists are needed to resolve technical issues, extend the lifespan of weapons, and aid in dismantlement activities.[21] Maintaining the critical skills of the workforce is at the core of meeting mission requirements.

The reduction in mission legitimacy, the increasing age of employees, and other pressures have created the perception that employment on nuclear weapons is no longer important to the national security of the United States. This perception has caused many potential workers to seek other opportunities with higher career potential. The majority of nuclear weapons program personnel have spent their entire careers working on nuclear weapons. As Dr. Chris Deeney says, "The only certainty is the increasing age of the workforce."[22] Only a handful of individuals who still work for the NNSA have experience designing weapons and performing underground tests. Some of those have stayed on well past retirement because of a desire to continue to contribute to US national security.[23] The fact of the matter is, as these individuals retire and eventually die, their knowledge dies with them. Therefore, it is vital to get a young, motivated workforce in place that can learn from the legacy of the past while building the future surety. The surveillance program's success relies on an engaged, highly trained, and motivated workforce. The pool of recruits is inherently small due to the highly focused training and US citizenship requirement. For example, stewardship program experts need specialized

degrees and experience in such areas as high-density physics to understand nuclear weapons behavior. To attract this kind of talent, the NNSA must have important national security work, including development and experimentation that is unavailable anywhere else in the world and aids in the understanding of nuclear behavior. It must also invest in the world's highest-power computers to solve the challenging modeling and simulation problems. These efforts will entice the nation's best scientists into a career of service to the US nuclear program.

As the stockpile decreases, investment in human capital is essential to ensure the next generation of scientists and engineers has the right set of skills, expertise, and experience. The credibility of the reduced stockpile hinges on the workforce's manipulation of the science, technology, and engineering base to fully understand the weapon-aging issues and develop LEPs to address these concerns.

Budget cuts over the past 20 years have reduced both the government and contractor workforce necessary to maintain the nation's nuclear weapons. The president's budget request for FY 2011 starts to correct years of atrophy with a proposed 13.4 percent increase to $11.2 billion from FY 2010. The appeal and rationale for this funding increase is outlined in the NNSA's yearly report to Congress, which includes a "year-by-year resource plan from fiscal year (FY) 2008 through 2030."[24] Figure 3 shows the estimated cost for modernizing the enterprise from FY 2011 to FY 2030. The legend breaks the funding into large program blocks to easily represent the scale of the funding effort the NNSA faces. "Directed Stockpile Work" addresses work on the actual weapons, for example LEPs and component replacements; "ST&E Campaigns" includes any work done to support stewardship, including subcritical experiments and high-powered computing; "Readiness in Technical Base and Facilities" accounts for processes such as tritium operations, maintaining existing infrastructure, and new infrastructure construction; and "Other Weapons Activities" encapsulates other funding requirements, including the Office of Secure Transportation, which is responsible for transporting nuclear weapons throughout the enterprise.

Figure 3 shows a bulge in the funding requirements for the NNSA in approximately the 2017 time frame. This funding spike coincides with several major projects that will be critical in modernizing the enterprise, including the first production unit for the B61 life extension and initial construction of the chemical metallurgy facility and the uranium process-

ing facility. These modernization efforts are being planned to comply with the NPR strategy that articulates a reduced role for nuclear weapons in national security, as well as the president's vision to reduce the number of nuclear weapons in the US stockpile. To turn the president's vision into reality, there must be a long-term fiscal commitment to the modernization of the enterprise to maintain uninterrupted capability. Only through modernizing outdated equipment, processes, and weapons will the NNSA be able to reliably reduce the size of the arsenal while maintaining the stockpile in line with the president's vision.

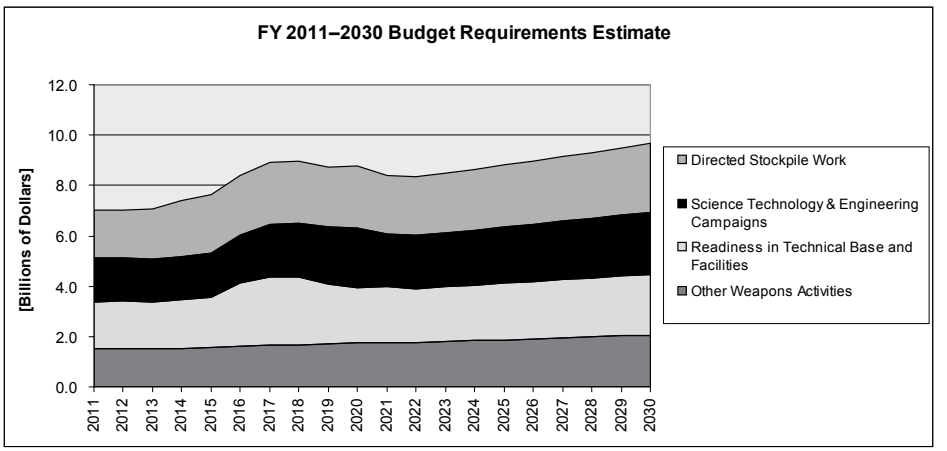


Figure 3. An out-years budget requirements estimate of NNSA weapons activities in then-year dollars. (NNSA, FY 2011 Stockpile Stewardship and Management Plan Summary [Washington: Department of Energy, May 2010], 28.)

Recent political events have demonstrated that all funding of the enterprise has been heavily influenced by the ratification of the New START.[25] The New START has been a primary focus for President Obama and will further reduce the number of accountable strategic nuclear weapons to 1,550 for both parties, 74 percent lower than START I.[26] President Obama and Russian president Dmitri Medvedev signed the treaty on 8 April 2010, and it was ratified by the US Senate in December 2010. Once the New START enters into force, the agreed upon reductions must be complete in seven years.[27]

The nuclear weapons strategy established by the NPR was used to develop the US position for New START negotiations. The NNSA worked closely with the negotiation team to understand the impact of the significant reductions on the nuclear weapons stockpile. The New START

and the NPR provide a clear roadmap for the NNSA to begin executing infrastructure modernization necessary to maintain a safe, secure, and effective stockpile.

President Obama's vision to reduce the role of nuclear weapons in the national security strategy, coupled with his commitment to the New START, has raised the nuclear weapons debate again to the presidential level. This new awareness has fostered an opportunity to obtain a national consensus on the future of nuclear weapons. Initially introduced by the Perry-Schlesinger report and solidified in the NPR and the New START, the NNSA is beginning to both turn the tide on Cold War legacy weapons and determine the right size stockpile for today's global threats. There is currently broad, national consensus that the enterprise must be revitalized to reverse years of neglect and sustain the nuclear weapons stockpile for the foreseeable future. This national consensus is underpinned by the argument that as the United States draws down its nuclear weapons stockpile, it must also fund the enterprise to ensure there is no doubt that the remaining weapons will deliver the expected effects in the expected locations should the president choose to employ them.

The Obama administration's *Nuclear Posture Review Report* states, "To sustain a safe, secure, and effective stockpile today, with the ultimate goal of a world free of nuclear weapons in the future, we must prudently manage our nuclear stockpile and related Life Extension Programs (LEPs), while cultivating the nuclear infrastructure, expert workforce, and leadership required to sustain it."[28] This statement affirms the ultimate goal of reaching a world without nuclear weapons, but until that day, the United States must fund the long-term modernization effort of the entire enterprise. SSQ

Notes

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23. Kuhn, interview.
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25. The agreed-upon levels of strategic nuclear weapons were reached by both parties in 2001. The Moscow Treaty, signed in 2002 by Pres. George W. Bush and Russian president Vladimir Putin, further reduced the number of strategic nuclear weapons to a range of 1,700–2,200 warheads. DoD, "Moscow Treaty Text," http://www.dod.gov/acq/acic/treaties/sort/text.htm.
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