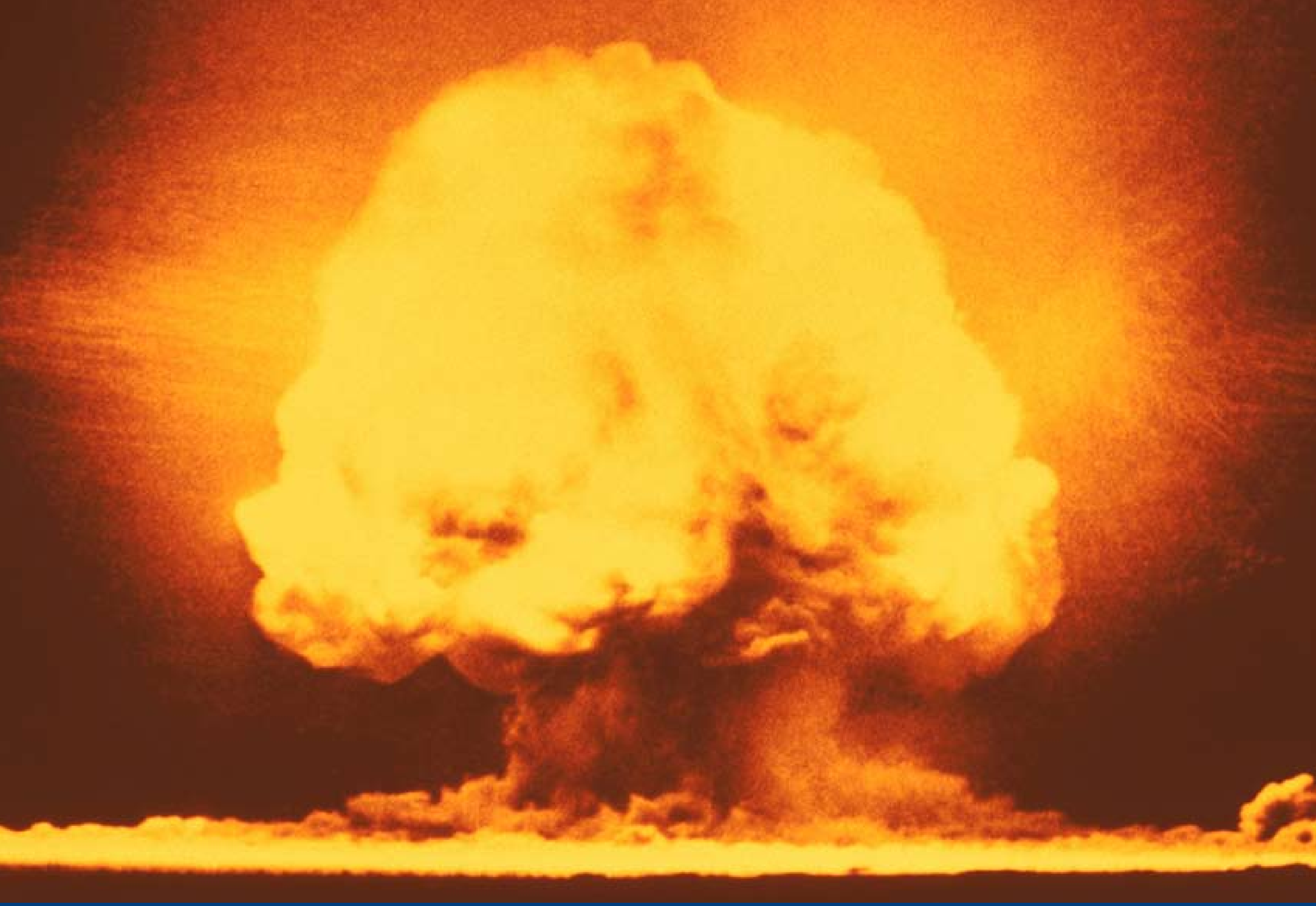

The Comprehensive Nuclear Test Ban Treaty

New Technology, New Prospects?

EastWest Institute
Forging Collective Action for a Safer and Better World

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Edited by Jacqueline McLaren Miller

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The EastWest Institute is an international, non-partisan, not-for-profit policy organization focused solely on confronting critical challenges that endanger peace. EWI was established in 1980 as a catalyst to build trust, develop leadership, and promote collaboration for positive change. The institute has offices in New York, Brussels, and Moscow.

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Cover photo: Explosion of the first atom bomb. This bomb, code-named Trinity, was part of the Manhattan Project, set up by the U.S. government during the Second World War. It was detonated at Alamogordo, New Mexico, on 16 July 1945. Science Photo Library.

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Foreword

In 1999, the Clinton administration was handed a dramatic foreign policy defeat when the United States Senate failed to ratify the Comprehensive Nuclear Test Ban Treaty (CTBT). The treaty had been four decades in the making and had until then enjoyed broad support from Democratic and Republican administrations, prompting President Clinton to characterize it as "the longest-sought, hardest-fought prize in arms control history."

The proliferation of nuclear weapons remains at the top of global security concerns. Ahead of the opening of the Nuclear Nonproliferation Treaty (NPT) review conference in May of this year, the Obama administration is taking on the challenge that eluded President Clinton, framing the CTBT as a core part of its nonproliferation agenda and seeking to reintroduce the treaty in the Senate, where it faces an uphill battle.

If the United States ratifies the CTBT, it will have a positive impact on its relations with Russia, which has already signed and ratified the CTBT. It will also put serious pressure on other states that have not ratified the CTBT—most prominently China, India, Pakistan, and Israel. If the administration continues to signal that it is serious about getting the CTBT ratified—even in the absence of a scheduled ratification vote this spring—and starts to build up bipartisan political support, it may give fresh impetus for a successful NPT review conference in May. However, another defeat will certainly weaken the political and moral leadership of the United States, not only at the NPT Review Conference but also in other nonproliferation and disarmament initiatives. It will provide a convenient argument, especially for non-nuclear weapon states, to question Washington's credentials, seriously undermining the global nonproliferation regime. If this happens, the national security of the United States—and indeed all states—will be weakened.

In 1999, the treaty's critics argued that without nuclear testing, there was no way to ensure the safety, security, and reliability of the U.S. arsenal. They also argued that technical limitations would make it difficult to detect cheating by other states. Further, hostile relations between the legislative and executive branches and the political climate at the end of the Clinton administration ensured the defeat of the treaty.

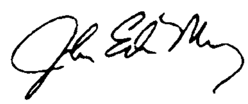
Ten years later, technological advances have changed the picture. But important questions remain—questions that the administration must answer in an atmosphere of bitter partisan confrontation and mounting security fears over non-state actors acquiring weapons of mass destruction. The ongoing Nuclear Posture Review, the National Academy of Science's study on the CTBT, and a new National Intelligence Estimate on the CTBT will help address these questions. But they will not be enough. The Obama administration must also clearly convince skeptics that CTBT ratification should be part of the bipartisan consensus on nonproliferation and that the nuclear test ban strengthens national security.

To facilitate a frank, honest and bipartisan discussion on this crucial issue, the EastWest Institute (EWI) convened a group of some 30 technical and policy experts and officials from both political parties in Washington to discuss prospects for ratification of the CTBT. The Obama administration has argued that the Senate's two primary concerns—the safety and reliability of the U.S. nuclear arsenal and the strength of the CTBTO's verification regime—have clearer answers now than they did in 1999. EWI's workshop examined these technological advances and their impact on the ongoing CTBT debate. The conclusions are presented here to help spur constructive bipartisian consideration of this critical issue and to contribute to what many experts around the world see as the Senate's "make or break" decision affecting the global community's ability to counter nuclear proliferation.

Most participants agreed that the United States' stockpile is safe, secure and reliable and it can be maintained without testing. But the U.S. national laboratories cannot certify that it will be safe forever. Those who were wary about the implications of a test ban for the safety and reliability of the U.S. nuclear stockpile expressed concern that there still isn't adequate funding and that the technology to meet new challenges has not been fully developed. The debate was reminiscent of discussions ten years ago—an inauspicious sign for many participants.

Some sectors expressed serious concerns about the limited resources that recent administrations and Congress have devoted to the nuclear stockpile. A key argument for ratification of the CTBT is that the U.S. need not test its weapons to keep them operational and reliable. But for that case to be made credibly, there has to be a serious effort to continue work on the stewardship of existing weapons and to make sure that there is adequate funding and top scientists committed to these programs. The perception that this hasn't been the case—justified or not—is something the administration must address.

EWI is grateful for the generous support of Kathryn W. Davis as well as its board of directors and core funders, who made this workshop possible. EWI wishes to thank all the participants for their efforts to build a political consensus. At EWI, we constantly look to reframe issues in a way that makes political breakthroughs possible. Our hope is that this report offers recommendations that will encourage bipartisan consensus in dealing with this crucial treaty.



John Edwin Mroz
President and CEO
EastWest Institute

Executive Summary

The following report, based on a workshop convened by the EastWest Institute, is an assessment of technical advances related to the Comprehensive Nuclear Test Ban Treaty (CTBT) and the future of the CTBT in the United States. The report highlights key changes since the Senate failed to ratify the Treaty in 1999 and offers recommendations for the Obama administration and others in advance of an anticipated 2010 Senate debate on CTBT ratification. The main assessments and conclusions to emerge from the workshop and how they relate to the prospects of future CTBT ratification are summarized below:

- There was widespread—but not unanimous—agreement that the U.S. nuclear stockpile can be certified as safe, secure, and reliable without a resumption of nuclear explosion testing. This assessment is primarily based on ongoing improvements to the Department of Energy (DOE) Stockpile Stewardship Program (SSP) and the enhanced understanding of nuclear weapons it has produced in the last ten years. The possible increase in the functional lifetime of U.S. nuclear weapons, as described in DOE studies of nuclear material and life extension programs and assessments of that work by outside expert groups, factors prominently in this judgment.

- The ability of SSP to ensure the reliability of the nuclear stockpile in the absence of testing is tied to maintaining the infrastructure of and expertise in the U.S. nuclear weapons complex. There was strong concern that the nuclear complex—including the national security laboratories—does not have the resources it needs to fulfill its mission.

- The military has more to consider than just the reliability of the nuclear warhead. Reliability is a function of the performance of the nuclear weapon in each of the deployed delivery systems across the specturm of the entire mission. The method to characterize the performance of a weapon system could be adjusted without reducing the ability of the military to carry out nuclear missions.

- Most of the Comprehensive Test Ban Treaty Organization (CTBTO) Preparatory Commission's International Monitoring System (IMS) is certified or in place and the capability of the IMS is improving ahead of the schedule envisioned when treaty negotiations concluded in 1996.

- The IMS was able to better assess its "real-world" capabilities when it successfully detected North Korean nuclear tests in 2006 and 2009, and field-tested its On-Site Inspection (OSI) capability for the first time in 2008.

- Since the treaty was negotiated, there have been important improvements in the ability of systems outside the IMS to detect nuclear explosions. This additional capability is held in National Technical Means (NTM), in auxiliary IMS stations, and in regional seismic monitoring networks not linked to the IMS and is significant since the treaty allows for the incorporation of additional technologies not specified in the treaty. In addition, novel underground explosion detection technologies such as the satellite-based interferometric synthetic aperture radar (InSAR) can now sometimes measure changes in the elevation of the surface of the earth down to the centimeter level. The adoption and incorporation of these additional capabilities and other systems outside the IMS could mean that nuclear explosion detection may continue to improve significantly in the future.

- There remains considerable uncertainty in the Obama administration about whether the technological advances of the last ten years will be sufficient to change the Senate's views enough to obtain the minimum sixty-seven "yes" votes required to ratify the treaty. Many factors—not all of them related to the treaty or even nonproliferation—will determine when the Senate Foreign Relations Committee decides to present the CTBT for debate and consideration for a second time.

- Today, from the perspective of the Obama administration, CTBT ratification is an important part of the nonproliferation agenda. However, the administration has not yet begun a robust outreach effort to make its case for CTBT ratification. In fact, the opponents of ratification have forced the administration into a defensive posture by narrowly defining the debate around the technological capabilities needed to ensure the safety, security, and reliability of the U.S. nuclear stockpile and the ability of the IMS to detect nuclear tests.

- The completion of the Nuclear Posture Review, a new National Academy of Sciences study on technical issues related to the CTBT, and a new National Intelligence Estimate on the CTBT as well as the anticipated START follow-on agreement will help shape the ratification timeline for the administration. Their contents will be central to the anticipated ratification debate.

- Since treaty opponents have been able to shape the debate so far, the Obama administration must clearly tie CTBT ratification into the bipartisan consensus on nonproliferation. Specifically, it needs to change the focus from technological capacity to national security. It must also be prepared with strong and clear explanations of the technical aspects of the debate, which will likely dominate any Senate discussion of the treaty.

Introduction

On August 12, 2009, the EastWest Institute (EWI) hosted an off-the-record meeting of experts in Washington, D.C., to evaluate the United States' technical and scientific capacity to maintain the safety, security, and reliability of its nuclear arsenal and to detect nuclear explosions. The meeting was particularly focused on determining how these technical issues will play in the expected debates in the U.S. Senate about ratification of the Comprehensive Nuclear Test Ban Treaty (CTBT). The discussion included an assessment of the history of the treaty, the reasons for the U.S. Senate's failure to ratify it in 1999, and the status of the current debate under the new administration. It focused on the technological and scientific advances made since the U.S. Senate first considered the CTBT in 1999 and whether these advancements make the CTBT more viable for future Senate consideration, ratification, and ultimately entry into force. Participants included representatives from U.S. national laboratories, former military officials involved in the U.S. nuclear complex, former and current U.S. government officials, and experts closely involved in the policy debates on arms control and nonproliferation.

The 1996 CTBT is the result of more than fifty years of international discussions on banning nuclear testing. The negotiations began in 1994 in the Geneva Conference on Disarmament (CD) after a December 1993 United Nations General Assembly resolution calling for a CTBT.[1] The negotiations and resultant treaty were built on past efforts to limit or ban nuclear explosions in different environments (underground, atmospheric, underwater, and outer space) or yield thresholds (above a specified number of kilotons of TNT equivalent). The treaty consists of seventeen articles, two annexes, and one protocol that outlines additional measures related to the International Monitoring System (IMS), an On-Site Inspection (OSI) mechanism, and confidence-building measures. The critical articles cover the organization of the treaty, including the composition of the fifty-one-member rotating executive council; monitoring and verification measures using the IMS and OSI; and formalities of membership such as settling disputes, amendment, review, duration, and withdrawal.

The treaty was adopted by the U.N. General Assembly on September 10, 1996, and has enjoyed broad support from the international community. As of December 2009, 182 states had signed the treaty and 151 of those had ratified it. The treaty, however, cannot enter into force until all the "Annex II" states—states that formally participated in the 1996 session of the Conference on Disarmament and that possessed a nuclear research reactor or had nuclear power capability at the time the treaty was adopted (including the United States)—ratify the treaty.[2]

After it was signed by President Bill Clinton on September 24, 1996, the U.S. Senate first considered the CTBT in 1999. Following what was characterized as a rushed, limited, and highly politicized debate, the treaty failed to gain the required two-thirds majority and was not ratified (the vote was 51 to 48—16 votes short of the 67 needed for ratification). Even before the vote, some argued that the complex treaty required many months of examination. Instead, the debate that occurred between the time the Senate Foreign Relations Committee presented the treaty to the Senate on October 8 and when the Senate voted on October 13 was abrupt, truncated, partisan, and without sufficient technical input. It demonstrated a lack of confidence in enforcement provisions, and uncertainty over whether the U.S. stockpile could be safely and reliably maintained without testing. It also raised questions about the ability of the treaty's proposed monitoring system to detect tests at a yield low enough to eliminate militarily useful detonations. These complex technical issues could not be adequately addressed in the rushed time frame.

Key testimony came from senior scientists, current and former directors of the U.S. nuclear weapons laboratories, and high-ranking government and military officials. The lukewarm testimony by the three nuclear weapons laboratory directors—C. Paul Robinson of the Sandia National Laboratories, John C. Browne of the Los Alamos National Laboratory, and C. Bruce Tarter of the Lawrence Livermore National Laboratory—proved to be critical to several key senators.[3] Then-chairman of the Joint Chiefs of Staff (JCS) General Henry H. Shelton had given testimony in support of the CTBT in earlier appearances before the Senate and House Armed Services Committees. Previous JCS chairmen had also endorsed the treaty, including General John

1 The U.N. General Assembly adopted a resolution for the multilateral negotiation of a CTBT for the first time on December 16, 1993. See http://daccess-dds-ny.un.org/doc/UNDOC/GEN/N94/007/55/PDF/N9400755.pdf?OpenElement.

2 The second annex of the treaty lists forty-four states that formally participated in the 1996 sessions of the CD and are listed in the International Atomic Energy Agency (IAEA) publications "Nuclear Power Reactors in the World" (1996) and "Nuclear Research Reactors in the World" (1995). They are required to ratify the treaty before the treaty enters into force. As of November 2009, nine states on the list—China, Egypt, India, Indonesia, Iran, Israel, North Korea, Pakistan, and United States—had not ratified the CTBT. See http://www.ctbto.org/the-treaty/status-of-signature-and-ratification/.

3 For the prepared statements of the lab directors, see http://armed-services.senate.gov/hearings/1999/c991007.htm.

Shalikashvili (under Clinton), General Colin Powell (under George H. W. Bush), General David Jones (under Reagan), and Admiral William Crowe (under Carter).[4]

During the postmortem on the vote, the Clinton administration was criticized for its failure to aggressively make its case on the Hill and for relying on outdated assessments (such as a two-year-old National Intelligence Assessment, or NIE) to address concerns about verification. Only after losing the "longest-sought, hardest-fought prize in arms control history," as Clinton called it, did the administration put together a task force (led by General Shalikashvili) to gain support for the CTBT in preparation for the next ratification effort. As part of that task force, Shalikashvili asked the nonpartisan National Academy of Sciences (NAS) to analyze the technical issues related to CTBT ratification. The study, issued by the NAS's Committee on International Security and Arms Control (CISAC), became one of the key assessments of the science and technical issues[5] (and is summarized in the appendix to this document). However, the technical concerns about the treaty that the Senate voiced in 1999 were, in the opinion of some of the workshop participants, merely a convenient political cover to strike a blow at the Clinton administration when it was politically vulnerable.

U.S. President Barack Obama has supported a global ban on nuclear testing and early in his tenure stated his desire to "immediately and aggressively pursue U.S. ratification of the Comprehensive Test Ban Treaty."[6] The Obama administration has stated that during its first term, its three major arms control goals include CTBT ratification, negotiating a follow-on to the START nuclear arms reduction agreement,[7] and the negotiation of a global Fissile Material Cut- Off Treaty (FMCT). In subsequent speeches, U.S. administration officials have said that this agenda will be pursued in advance of the quinquennial Nuclear Non-Proliferation Treaty (NPT) Review Conference in May 2010.

4 See http://dosfan.lib.uic.edu/acda/ctbtpage/tbn33.htm for the JCS posture statement.

5 The Obama administration has asked the NAS-CISAC to review and update the 2002 report. The new report study is expected to be released in early 2010. See http://www8.nationalacademies.org/cp/projectview.aspx?key=49131.

6 White House Office of the Press Secretary, April 5, 2009. Remarks by President Barack Obama, Hradcany Square, Prague, Czech Republic. See http://www.whitehouse.gov/the_press_office/Remarks-By-President-Barack-Obama-In-Prague-As-Delivered/.

7 The United States and Russia are actively negotiating a follow-on to the Strategic Arms Reduction Treaty (START) which is considered one of the cornerstones of nuclear arms control. The treaty, originally negotiated with the Soviet Union, limits strategic warheads and requires robust data exchange and intrusive monitoring and inspection. It expired on December 5, 2009.

Maintaining the Safety, Security, and Reliability of the U.S. Nuclear Stockpile Under the CTBT

Many in the U.S. nuclear weapons complex view maintenance of the safety, security, and reliability of U.S. nuclear weapons as the most important issue driving the CTBT ratification debate. The treaty bans each state party from "causing, encouraging, or in any way participating in the carrying out of any nuclear weapon test explosion or any other nuclear explosion."[8] Although this clause is widely interpreted to ban tests or experiments that produce any nuclear yield, the treaty does not contain a formal definition of "nuclear explosion." Since zero nuclear yield is difficult to define, some feel that the definition is open to interpretation. Although the treaty has yet to enter into force, the United States has observed a de facto nuclear test moratorium since 1992 and maintains its nuclear stockpile in the absence of nuclear explosive testing, relying on the scientific and technological capabilities of the U.S. nuclear weapons complex to assure the safety, security, and reliability of the U.S. nuclear stockpile.

Today, the U.S. nuclear stockpile consists of seven types of warheads and twelve weapons systems designed to deliver them.[9] The oldest warhead design entered the arsenal in 1976 and the newest dates from 1989; all of them must be certified by the U.S. Nuclear Weapons Council (NWC)[10] on an annual basis. The certification of these weapons relies on an advanced understanding of how the nuclear components of the weapon work and how these components are integrated into the weapons (bomb and missile) system. The program that ensures certification—the Stockpile Stewardship Program (SSP)—is overseen by a semiautonomous agency of the U.S. Department of Energy: the National Nuclear Security Administration

8 Comprehensive Nuclear Test Ban Treaty text, p. 4 See http://www.ctbto.org/fileadmin/content/treaty/treaty_text.pdf.

9 Kevin P. Chilton, "Managing the U.S. Nuclear Deterrent—Warheads and Infrastructure," United States Strategic Command, September 3, 2009, p. 3, available at http://media.washingtontimes.com/media/docs/2009/Sep/03/090903-ring.pdf.

10 The Nuclear Weapons Council is a joint group from the Defense and Energy departments that reports "regularly to the President regarding the safety and reliability of the U.S. stockpile, as well as to provide an annual recommendation on the need to resume [nuclear testing] in order to preserve the credibility of the U.S. nuclear deterrent. The NWC evaluates the surety of the stockpile and reports its findings to the President each year." See http://www.acq.osd.mil/ncbdp/nm/nuclearweaponscouncil.html.

(NNSA).

The Stockpile Stewardship Program (SSP)

Since the United States ceased nuclear testing in 1992, the SSP has used simulation—backed by data from more than one thousand nuclear tests over forty-seven years—combined with a robust basic science research capability to maintain the safety, security (referred to jointly as surety), and reliability of the U.S. stockpile. Under SSP, ensuring that nuclear weapons will function according to their design specifications is based on an understanding of the complex interactions that occur during the nuclear chain reaction and how the materials used in nuclear weapons age over time. The SSP was formalized during the Clinton administration, but many of the components and methods of the program date back much further. Some of the technologies can be traced back to the Manhattan Project, which produced the first U.S. nuclear weapons in 1945.

The SSP examines the range of physical phenomena that occur when a weapon is used for its intended purpose. The entire sequence of arming, fusing and firing, high-explosive denotation, primary implosion, fission burn, boosted burn, radiation flow, secondary implosion, burn/explosion, and weapon effects are replicated or simulated in place of nuclear explosion testing. The Department of Energy (DOE) maintains the fastest computers in the world as part of the Advanced Simulation and Computing (ASC) Program to model and simulate the environment created during a nuclear explosion. Additional tools to examine the physical phenomenon that occur during a nuclear explosion, such as the National Ignition Facility (NIF) and the Dual-Axis Radiographic Hydrodynamic Test Facility (DARHT), are coming on line.[11] Meeting participants agreed that SSP has done much to provide an enhanced physical understanding of the science behind nuclear weapons but some are cautious about concluding that the program can keep the Cold War–era or "legacy" stockpile of nuclear weapons safe, secure, and reliable indefinitely.

Some participants felt that the SSP program is finally beginning to produce enough data from tools designed and developed over the last fifteen years to simulate the spectrum of physical behavior necessary to renounce nuclear explosion testing under a universal test ban. Others felt that the package of SSP capability is already good enough to allow weapons to continue to be certified and that new tools such as simulation and partial simulation and testing systems (ASC, NIF, and DARHT) will simply provide even better information to an already very good system.

Maintaining and Replacing Warheads Under a Test Ban

Some participants proposed a "spectrum of modernization" to help conceptualize the range of options regarding changes to the U.S. nuclear stockpile.[12] On one end of the spectrum, the ongoing warhead Life Extension Program (LEP) allows for improvement to a weapon's components without modifying the core functionality of the nuclear fission primary—the plutonium implosion device that initiates the thermonuclear fusion secondary and provides the majority of a weapon's energy. Individual components can be refurbished, reused, or replaced with components of identical or nearly identical design and material composition. Reuse refers to using new or cannibalizing newer plutonium "pits"—the spherical cores of plutonium contained in the nuclear weapon primary—from the stockpile and non-nuclear components for weapons on alert.[13] Replacement consists of exchanging some of the non-nuclear components of the warhead with modern components that are more easily manufactured and that will provide increased performance margins and use less exotic or hazardous materials. Comprehending the integration of the new or replacement components under the LEP relies on the advanced physical understanding of weapons performance that SSP provides and how the replacement components affect each other, work together, and change the weapon's nuclear system. The JASON government advisory group[14] released an unclassified executive summary of their assessment of the LEP program in the fall of 2009. They concluded: "Lifetimes of today's

11 The NIF conducts Inertial Confinement Fusion experiments that use high-energy lasers to study the fusion reactions in a thermonuclear weapon. DARHT replicates the high pressures and temperatures experienced by plutonium and uranium "pits" during the fission reaction that takes place in the nuclear weapon primary.

12 Benn Tannenbaum "Summary of AAAS Meeting" pg. 5. Available at: http://cstsp.aaas.org/files/SnTSummary.pdf

13 Pit manufacturing at the DOE's Rocky Flats, Colorado, plant stopped in 1989 due to safety concerns. To date, Congress has shown no interest in funding a new large-scale pit facility, although a pilot program at the Los Alamos National Laboratory has the capability to manufacture up to twenty replacement pits per year.

14 The JASON group is an independent scientific advisory body established in 1960. It provides classified and unclassified studies and analysis for the federal government on arms control and defense issues. Members are selected by the group to maintain autonomy and independence in its analyses.

nuclear warheads could be extended for decades, with no anticipated loss in confidence, by using approaches similar to those employed in LEPs to date."[15]

On the other end of the modernization spectrum is the concept of replacing warheads with new designs. The "Reliable Replacement Warhead" (RRW) program was envisioned as a way to eventually replace each legacy weapon in the stockpile with a similar design that provided no new military capability but incorporated improved surety and reliability features while being easier to manufacture and maintain. During the George W. Bush administration, Congress stipulated that RRW must be able to be incorporated into the nuclear stockpile without nuclear-explosion tests and that it not improve the military capabilities of the legacy weapon it replaced.[16] In 2007, the Lawrence Livermore National Laboratory won the first RRW design competition but Congress declined to fund the RRW beyond the design phase.[17]

There was a vigorous debate on weapon replacement options at the meeting. Some argued that the SSP has replaced nuclear explosion testing to such a degree that the data it collects and produces may actually make it easier for the NWC to certify weapons in the stockpile. Many agreed that it was difficult to understand how replacing legacy weapons with even conservative replication designs under RRW stipulations would add more confidence than refurbishing current weapons under the LEP. After all, replacement weapons designed without nuclear testing might not exceed the 98 percent reliability that, according to the nuclear weapons laboratories, the stockpile currently enjoys.

An important aspect of this debate is the integrity of the nuclear explosive material contained in U.S. nuclear weapons primaries. After reviewing a 2006 study on the lifetime of plutonium pits by the U.S. nuclear weapons laboratories, the JASON group concluded that plutonium may maintain its integrity longer than was previously understood.[18] The JASON report of the nuclear weapons laboratories' classified plutonium assessment judges that the work by the labs to date is "scientifically valid." It states that the assessment concludes that pits have life expectancies of upwards of eighty-five years and "the primaries of most weapons system types in the stockpile have credible minimum lifetimes in excess of 100 years and that the intrinsic lifetime of [plutonium] in the pits is greater than a century."[19] Some meeting participants argued that these studies only illustrate the beginning of the nuclear weapons laboratories' attempt to assemble a comprehensive knowledge base on plutonium aging, and that how pits actually age and their lifetime in each of the legacy weapons are largely uncertain.

Former members of the military commented on weapons surety and reliability from the perspective of the Department of Defense (DOD). The first point they made was that the military "doesn't have a dog in this fight," meaning that the assessment of whether to ratify the CTBT is largely a decision that should be left to the technical community and ultimately Congress. Second, the DOD has more to consider than just the nuclear warhead, since reliability is a function of the performance of the nuclear weapons system in each of the deployed delivery systems across the spectrum of the entire mission. The probability of the warhead functioning as intended is just one factor that must be considered; the delivery vehicle, whether an ICBM or bomber or submarine, each have a probability calculation that is factored into the overall reliability of the weapon system. The method to characterize the performance of a weapon system could be adjusted without reducing the ability of the military to carry out nuclear missions.

Participants noted that NWC certification includes surveillance through periodic destructive and more frequent nondestructive weapons testing. Nondestructive testing involves the removal of warheads from active duty and transporting them to DOE laboratories for testing without destroying any of the components during the evaluation process. Weapons are also launched or dropped with

15 JASON, "Lifetime Extension Program (LEP) Executive Summary," MITRE Corporation, JSR-09-334E, September 9, 2009, p. 2, available at http://www.armscontrolwonk.com/file_download/213/JASON_LEP.pdf.

16 Congress stipulated that "any weapon design work done under the RRW program must stay within the military requirements of the existing deployed stockpile and any new weapon design must stay within the design parameters validated by past nuclear tests.'' U.S. Congress, ''Making Appropriations for Energy and Water Development for the Fiscal Year Ending September 30, 2006, and for Other Purposes [Conference Report to Accompany H.R. 2419],'' Report 109-275, 109th Cong., 1st sess., p. 159, available at http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=109_cong_reports&docid=f:hr275.109.pdf.

17 Congress declined to fund the RRW until a need for the weapon was more explicitly defined. "It is premature to proceed with further development of the RRW . . . until a three-part planning sequence is completed, including: (1) a comprehensive nuclear defense strategy, based upon current and projected global threats; (2) clearly defined military requirements for the size and composition of the nuclear stockpile derived from the comprehensive nuclear defense strategy; and (3) alignment of these military requirements to the existing and estimated future needs and capabilities of NNSA's weapons complex." See U.S. Congress, House Committee on Appropriations, Energy and Water Development Appropriations Bill, 2008, H.Rept. 110-185,conference report to accompany H.R. 2641, 110th Congress, 1st Session, 2007, p. 94, available at http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=110_cong_reports&docid=f:hr185.110.pdf.

18 JASON, R. J. Hemley et al., "Pit Lifetime," MITRE Corporation, JSR-06-335, January 11, 2007, http://www.fas.org/irp/agency/dod/jason/pit.pdf.

19 Ibid., p. 19.

simulated (nonnuclear) warheads that mimic the behavior and flight characteristics of real warheads. Participants agreed that this is a useful way to learn more about the aging stockpile since a percentage of the stockpile is taken out and tested each year. Some noted, however, that each weapon system goes through full destructive testing just once every three or four years—less than had been the case in the past—and that this method does not shed much light on how the plutonium in the weapons ages or behaves relative to the other components.

There is an additional fear of a "brain drain" at the laboratories. Participants agreed that an important key to maintaining the stockpile is keeping a talented pool of workers employed in the nuclear weapons complex. It is especially important to retain design expertise at the Los Alamos and Lawrence Livermore national laboratories because the capability to maintain this expertise will become increasingly difficult as designers that have conduted nuclear explosion tests retire. Although management of the nuclear weapons laboratories has been privatized, the NNSA oversees these facilities and a consistent level of funding for NNSA from Congress is necessary to maintain the capability to support the nuclear mission of the labs.[20]

Detecting Nuclear Tests Under the CTBT

The discussion on detecting nuclear tests centered on the ability of the CTBTO Preparatory Commission to monitor and verify that a nuclear explosion has occurred. The CTBTO Preparatory Commission (PrepCom), the international organization established in Vienna, Austria, after the U.N. adopted the treaty, oversees the implementation of the CTBT verification regime, including construction and certification of the monitoring stations that make up the International Monitoring System (IMS). Specifically, it determines the characteristics of an event and distinguishes nuclear tests from background noise such as naturally occurring earthquakes. The CTBTO also oversees the integration and processing of data produced by the IMS at the International Data Centre (IDC) and coordinates the development of the CTBT's On-Site Inspection (OSI) capability. The CTBTO PrepCom will oversee the implementation of the CTBT until the treaty enters into force and it is replaced by a permanent organization.

The CTBTO PrepCom manages the most comprehensive and complex arms control monitoring and verification system in history. As defined in the treaty, the IMS is composed of a network of 337 monitoring facilities and labs designed to detect a nuclear explosion in any environment[21] and verify that an explosion has taken place. The IMS was designed around four core technologies that monitor for seismic (underground), hydroacoustic (underwater), infrasound (atmospheric), and radionuclide signals. Participants agreed that the capability of the IMS has improved drastically since treaty negotiations concluded in 1996. In many parts of the world the IMS can now detect nuclear explosions well below the one-kiloton threshold that was originally envisioned. Participants were divided on whether the IMS is good enough—or will ever be good enough—to function as the monitoring and verification mechanism for a treaty that stipulates that state signatories will not explosively test nuclear weapons at any yield.

Monitoring

Participants agreed that monitoring the world for nuclear tests becomes much more difficult as the standard of detection approaches zero yield. For instance, distinguishing nuclear events from normal seismic background noise becomes increasingly important as the threshold for detection goes down. About 600–700 earthquakes and hundreds of mining explosions occur every day and many at first glance produce a seismic signature that closely mimics the signature produced by a small underground nuclear explosion. Effective monitoring depends on detecting these events and quickly determining that they are not an indication of a nuclear explosion. One participant explained that in the mid-1990s, seismic stations detected several substantial mine collapses that superficially looked like nuclear explosions. Their mix of body waves and surface waves made the events suspect. Distinguishing and properly characterizing these events was a challenge for the IMS but it was resolved by a closer examination of the data, which determined that the explosion had a negative

20 For more on infrastructure and workforce issues at the U.S. nuclear labs see "Nuclear Deterrence Skills," Report of the Defense Science Board Task Force on Nuclear Deterrence Skills, Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics, September 2008, available at http://www.acq.osd.mil/dsb/reports/2008-09-NDS.pdf.

21 Possible environments are underground, underwater, atmospheric, and outer space. The IMS must rely on state parties to monitor nuclear tests in outer space.

yield (since the event was actually an implosion).

Today the IMS performs at a slightly higher level than the 2002 National Academy of Sciences study, *Technical Issues Related to the Comprehensive Nuclear Test Ban Treaty*, predicted (see the summary in the appendix to this document). With 254 (or approximately 75 percent) of the IMS stations certified,[22] the system claims to have already reached its design goal of being able to detect Richter Scale magnitude 4 (approximately one kiloton) explosions anywhere in the world.[23] The CTBTO Preparatory Commission budget, about $100–110 million U.S. per year, has thus far been sufficient to build the system but consistent funding is necessary to complete the system and ensure monitoring capability in the future. One participant stated that $150–160 million would be sufficient to increase the capabilities of the system since monitoring smaller events will require distinguishing between much more "noise" and actual events and require improved/more sensors. This level of funding would allow the eventual completion and inclusion of 150 auxiliary IMS stations. A capability to detect tests down to magnitude 3.5 (approximately 200 tons) anywhere in the world would be possible if additional monitoring stations were added. Additional funds would also allow for the inclusion of InSAR satellite monitoring technology and the incorporation of electromagnetic pulse (EMP) detection using commercially available satellites.

Some participants felt that the most basic way to improve the system would be for the United States to again support the highest level of technological capability for the IMS by fully engaging the CTBTO PrepCom after its eight-year absence. Also, the IDC computer systems can be upgraded and OSI ability improved. The OSI was recently exercised for the first time during the Integrated Field Exercise (IFE 08) at the former Soviet nuclear test site in Semipalatinsk, Kazakhstan. The United States did not support OSI capability under the George W. Bush administration. The Obama administration could now make an immediate positive impact by helping to make the OSI manual a better tool to detect and deter nuclear tests, and support efforts at the IDC to better calibrate the IMS in certain parts of the world. This work would prove useful and be inexpensive relative to adding InSAR and EMP capabilities.

Other participants argued that even an improved IMS would inherently be limited, with debate focusing on the implications of the CTBT's zero-yield stipulation. For instance, even if the monitoring capability for the Russian test site of Novaya Zemlya became greater than what is currently possible (ten tons), based on the capability of stations in Norway and Finland, Russia could still theoretically hide a one-ton test or a small hydronuclear experiment.[24] Some argued that since the treaty prohibits any test with a nuclear yield, the IMS is not prepared (and may never be prepared) to meet the standard. The counterargument is that even if the capability of the IMS is improved by a factor of 1000 (the ability to detect down to one ton) everywhere on earth and in outer space, it would still not meet this requirement. It was also argued that a Russian test of ten tons or less would make little difference to U.S. national security: Russia has conducted many nuclear tests and would have little to gain (and much to lose if discovered). Additionally, an in-force CTBT would be a useful proliferation deterrent even if it is not able to provide complete assurance that no nuclear tests are taking place.

Participants also discussed the ability of state-based and regional seismic networks to augment the IMS. For instance, Japan has developed some of the best monitoring capabilities in the world due to the high earthquake rate in its territory. China also has a high-quality monitoring capability and a superb national seismic facility. There has been no halt in the growth of this capability because it is driven by the need to understand the global earthquake hazard. Although these systems are beyond the IMS, they are complementary to nuclear test detection and will improve in the future. It is also important to point out that participants were unclear on how the data would be incorporated and assessed by the CTBTO PrepCom.

Verification

Adequate verification is always based on a subjective policy judgment. The late ambassador Paul Nitze's definition of effective verification was proposed as a useful way to think about CTBT verification: "[I]f the other side moves beyond the limits of the treaty in any militarily significant way, we would be able to detect such violation in time to respond effectively and thereby deny the other

22 As of January 1, 2010. See CTBTO World Map. Available at http://www.ctbto.org/map/#ims

23 See Tibor Toth, "Building up the Regime for Verifying the CTBT," *Arms Control Today*, September 2009, http://www.armscontrol.org/act/2009_09/Toth.

24 Hydronuclear experiments are "highly sophisticated experiments utilizing devices whose nuclear yield is less than that of the high explosive, and whose results must be interpreted by using extensive data on actual, full-scale nuclear explosives testing." See K. C. Bailey, "Hydronuclear Experiments: Why They Are Not a Proliferation Danger," Lawrence Livermore National Laboratory, September 28, 1994, UCRL-ID 118538, available at http://www.osti.gov/bridge/servlets/purl/78801-AmDMhO/webviewable/78801.pdf.

side the benefit of the violation."[25] "Military significance" is especially relevant to the CTBT debate when considering the ability of nuclear states to test under the IMS detection threshold or in an evasive manner. How important is it to detect a test if it is so small as to not be detrimental to U.S. security (by improving the military capabilities of the tester)? Some participants stated that very small nuclear tests below the detectable level of even an improved IMS could only be used to test warhead surety and would not add military capability. Assessing effective verification is important to the ratification debate. An underlying policy assumption in the United States is that parties to any treaty will try to cheat and therefore any assessment of a treaty must include an evaluation of the United States' ability to detect cheaters using domestic capabilities.

Monitoring can be improved but, as was widely noted, no system will ever be able to provide perfect verification. And indeed, the verification requirements of the treaty (in Article IV) are deliberately vague and circular: "At entry into force of this Treaty, the verification regime shall be capable of meeting the verification requirements of this Treaty."[26] A participant explained that the text was written in this manner to allow for the buildup of the IMS before entry into force. There was some concern expressed about the limitations of the CTBT verification system. Under the CTBTO PrepCom, the IDC does not interpret all of the data it collects from the IMS; it makes summaries available to all member states in the form of the Reviewed Event Bulletin (REB), which relies on software and human analysis to screen out events that could not be nuclear explosions. It is unlikely that this will change, since some states are uncomfortable with further IDC interpretation because they do not want to be pressured to respond to assessments made by an international organization.

The limitations of OSI under the treaty were also a focus of discussion. The IMS detection and characterization of the 2006 and 2009 North Korean tests pinpointed the events well within the thousand-square-kilometer ellipse required by the CTBT to trigger an OSI if the treaty were in force. However, some participants worried that the treaty framework stipulates that sections of a country can be excluded from inspection (although a state's ability to ban an OSI from an area is hampered by the limited size and number of permitted exclusion zones). The ability of the CTBT Executive Council to authorize an OSI was also questioned, reflecting some of the opposition the CTBT may face from senators fearful of an Executive Council stacked against the United States. For example, if the United States believes that China is acting in violation of the treaty, the U.S. could trigger a request for an OSI. But the council would need 33 of 51 votes to actually launch the inspection. (This may also allow a state to launch an OSI against the United States.) Other participants argued that this provision was put in place to prevent frivolous inspections and that an OSI would thus be useful for addressing anomalies rather than verifying that a test has taken place. For example, it is easy to imagine that some might mistake an earthquake in Iran for a nuclear test. If the treaty is in force, the real nature of the event could be verified using an OSI. But participants agreed that an inspection is unlikely to proceed if a country willfully violates the treaty.

It is important to note that a state would use much more than IMS data when pursuing a perceived violator. The 1963 Limited Test Ban Treaty (LTBT), the 1974 Threshold Test Ban Treaty (TTBT), and the unofficial nuclear testing moratorium independently agreed to by the United States and Russia (and others) in the mid-1990s were all effectively monitored by National Technical Means (NTM).[27] In addition, techniques such as satellite imagery and communication intercepts are collected independent of detecting the event and would be important factors.

Some participants noted that NTM would be the primary method of detection and verification in the United States but may not be public, complicating the ability of the U.S. to report a violation of the CTBT in some cases. In the end, some think that only NTM will matter or that only the IMS will matter, while others think that whatever system provides accurate information to a state's leader first is the most important. Participants also noted that adequate funding must be provided to maintain U.S. NTM capability independent of the IMS in order to ensure effective verification. Unlike SSP, this capability must be maintained regardless of CTBT ratification.

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25 David Hafemeister, "The Comprehensive Test Ban Treaty: Effectively Verifiable," *Arms Control Today*, October 2008, http://www.armscontrol.org/act/2008_10/Hafemeister.

26 Comprehensive Nuclear Test Ban Treaty text, p. 33. See http://www.ctbto.org/fileadmin/content/treaty/treaty_text.pdf.

27 To monitor CTBT compliance, some states maintain independent systems that are often referred to in international treaties as National Technical Means (NTM). Today, in addition to augmenting IMS technologies, these systems can bring a suite of technologies not formally available to the IMS, including mobile radionucleotide monitoring and satellite-based sensors, to detect and, unlike the IMS, confirm that an event is a nuclear explosion. These systems can be concentrated in or moved to areas (for instance, around known nuclear test sites) or regions of concern to improve detection ability beyond the capabilities of the IMS. However, the CTBTO relies on the goodwill of the NTM collector state to transfer NTM information to the IMS.

Do New Technological Advances Make CTBT Ratification More Likely?

It is well-known that the Obama administration would like the United States to ratify the CTBT and see the treaty enter into force. The United States, having agreed to abide by the terms of the treaty through a unilateral nonbinding moratorium, is not gaining the full benefits that would follow from being a state party to it. Participants also agreed that U.S. ratification would help pressure states that are outside the treaty to sign or ratify. However, the administration will have to carefully lay a proper foundation that allows the Senate to reconsider the CTBT in a way that ensures that at least sixty-seven votes are cast in favor of ratification.

Several efforts are under way to clarify CTBT issues in anticipation of a new Senate debate; some of which appear to be "lessons learned" from the 1999 vote. The administration has commissioned a new classified National Intelligence Estimate on the CTBT. At the time of the debate in 1999, the most recent classified NIE related to the CTBT was more than two years old. The administration has also called for a review and update to the 2002 NAS study *Technical Issues Related to the Comprehensive Nuclear Test Ban Treaty* to address how new technical developments in the last ten years might influence the U.S. position on CTBT. A congressionally mandated Nuclear Posture Review (NPR) is under way. The NPR will address key deterrence and extended deterrence issues that will impact future U.S. nuclear policies. This has already informed the START follow-on agreement between the United States and Russia and will play a role in the composition of the overall stockpile and the future of the nuclear weapons complex and supporting infrastructure. These three products are central to the anticipated CTBT ratification debate and their delivery will help shape the ratification timeline for the administration.

Despite this framework, there was criticism of the efforts the administration has taken on CTBT. Some argued strongly that since President Obama pointedly referred to working toward its passage in his April 2009 speech in Prague, very little has actually been done to lay the groundwork for passage. According to U.S. administration officials, this effort will take place later since other arms control issues make ratification before the March 2010 Non-Proliferation Treaty Review Conference extremely unlikely. In the absence of a forceful administration message and effort on CTBT, some argued that the terms of the debate have already been defined by opponents to the CTBT. By focusing on narrow technical arguments, opponents of the CTBT have had some early successes in reframing the CTBT debate in their favor.

Administration officials must shape the arguments and try to frame the debate within the wider and broadly bipartisan national security and nonproliferation consensus. The administration must engage the Senate during preliminary briefings and work to keep senators from making up their minds before the real debate and discussion occurs; they must effectively prevent as many senators from locking in "no" votes before the debate has even had a chance to start. But given that treaty opponents have had initial early success in framing the terms of the debate, more work must be done right now, even in light of the many other pressing issues dominating the national agenda (including health-care reform and the ongoing economic crisis). It will be especially important to engage the approximately half of the Senate that was not in office during the 1999 debate.

Part of this effort should be an update of the CTBT "safeguards" that were presented as part of the Clinton administration's ratification effort, to demonstrate the Obama administration's position on the CTBT. In August 1995, President Clinton announced six safeguards as guiding principles for his administration's pursuit of a zero-yield nuclear test ban:

1. The conduct of a Science-Based Stockpile Stewardship program—for which there must be sustained bipartisan support from Congress—to ensure a high level of confidence in the safety and reliability of our nuclear weapons stockpile;
2. The maintenance of modern nuclear laboratory facilities and programs in theoretical and exploratory nuclear technology;
3. The maintenance of a basic capability to resume nuclear test activities prohibited by the CTBT should the United States cease to be bound to adhere to the Treaty;
4. A continued comprehensive research and development program for treaty verification and monitoring operations;
5. The continued development of a broad range of intelligence gathering and analytical capabilities; and
6. The understanding that if the President is informed by the Secretaries of Defense and Energy as advised by the Nuclear Weapons Council, the Directors of the nuclear weapons laboratories, and Commander

of U.S. Strategic Command that a high level of confidence in the safety and reliability of a nuclear weapon type, which the two secretaries consider critical to our nuclear deterrent, could no longer be certified, the President, in consultation with the Congress, would be prepared to withdraw from CTBT under the supreme national interest clause.[28]

Some participants suggested that the administration create an interagency task force similar to the group that was created to present the World Trade Organization (WTO) treaty to the Senate during the Clinton administration. The WTO task force was an internal administration effort to ensure passage of the treaty. Several hundred officials from all relevant parts of the government were assigned to the approximately six-month effort for various periods of time (many on a part-time basis). This successful effort was cited as an example of how an administration that is serious about getting a treaty ratified could go about the job. That the Clinton administration undertook no such efforts prior to the 1999 vote was indicative to some in the room that it was not serious about CTBT ratification.[29]

To encourage entry into force, the United States will have to commit to diplomatic engagement and persuade other countries to sign and ratify the treaty. Indonesia has signaled that it will ratify the treaty after the United States ratifies, and China may take action as well. Once the United States ratifies the treaty, it can join forces with others to attempt to convince India, Pakistan, and Egypt to ratify and can participate in discussions of possible provisional application of the treaty as a way of applying pressure on Israel, Iran, and North Korea in the near term.

28 White House, Office of the Press Secretary, "Fact Sheet: Comprehensive Test Ban Treaty Safeguards," August 11, 1995, available at http://scipp.ucsc.edu/~haber/UC_CORP/ctbt-cli.htm. For more information about the evolution of the safeguards, see Jonathan Medalia, "Comprehensive Nuclear-Test-Ban Treaty: Updated 'Safeguards' and Net Assessments," Congressional Research Service, June 3, 2009, available at http://www.fas.org/sgp/crs/nuke/R40612.pdf.

29 The Clinton administration did end up forming a CTBT "task force" of sorts after the 1999 ratification vote. The 2001 Shalikashvili report was designed to chart a course to build bipartisan support for future CTBT ratification. The report forcefully argued that U.S. national security would be enhanced by ratifying the CTBT and suggested concrete measures to appease critics, including increased spending on verification, greater efforts to maintain the safety and reliability of the U.S. nuclear arsenal, and a joint review by the Senate and administration every ten years. General John M. Shalikashvili, Report on the Findings and Recommendations Concerning the Comprehensive Test Ban Treaty, January 4, 2001, http://www.state.gov/www/global/arms/ctbtpage/ctbt_report.html#report.

Moving Toward Ratification

Many participants felt that the CTBT was "good enough" for U.S. ratification in 1999 but agreed that for a senator to change his or her initial vote or to vote outside their party's position, the senator will have to be able to argue that something significant has changed. In other words, they must be given the political cover to say that their "no" vote was right in 1999 and a "yes" vote in 2010 is also right. The administration should aim to explain clear, obvious, simple changes that will communicate the issues to nonscientists in a way that they can understand and that helps make the treaty more viable in the minds of senators. Some at the meeting felt that the key technological change has been the improvement in the seismic monitoring capability and the possible augmentation of the IMS with auxiliary and regional seismological networks. But others felt that demonstrating better seismology is not by itself sufficient to change votes and that it will be important to prove that a suite of technical capabilities relevant to the CTBT have improved since the debate in 1999.

First, it is widely understood that the U.S. nuclear stockpile can be certified as safe, secure, and reliable without a resumption of nuclear explosion testing. This is due to improvements in the Stockpile Stewardship Program and the enhanced understanding of nuclear weapons the program has produced since the 1999 vote. The administration should highlight the studies of nuclear material and life extension programs by the DOE national security laboratories and assessments of that work by the JASON outside expert group that indicate an increase in the functional lifetime of U.S. nuclear weapons.

Second, the administration should highlight the IMS's performance in noncontrolled "real-world" situations during the North Korean tests. The circumstances of the detection of the two North Korean tests in 2006 and 2009 demonstrated the capabilities of the IMS and the improvements to the system that are possible over a short period. Although North Korea alluded to its tests before both were conducted, the precise location was unknown and they were conducted at a yield below one kiloton. After the 2006 test, an IMS radionuclide detection station more than 7,500 miles away in Canada's North West Territories detected traces of xenon-133—a telltale sign that a nuclear explosion has occurred, since the isotope does not occur naturally—and twenty-two seismic stations recorded the event. Although no stations detected radionuclides after the larger May 2009 test, sixty-one IMS seismic stations registered the test.[30]

Third, the administration should emphasize the development and utility of the CTBT On-Site Inspection protocol. Under the provisions of an in-force CTBT, the 2009 test, even without the detection of radionuclides, would have triggered an OSI. The existing IMS detection network was able to determine the location of the tests inside the error ellipse required by the treaty for an OSI to take place (if the treaty were in force). The Semipalatinsk, Kazakhstan, IFE 08 was extremely useful for improving the capabilities of the CTBTO to conduct an OSI. Local seismic monitoring can detect as little as seventy-five grams of high-explosive equivalent in the inspection area and OSI instruments will be able to detect nuclear-explosion-triggered aftershocks and cavity collapse to help verify that an event has taken place and determine that it was a nuclear explosion. Although an OSI is unlikely to proceed if a country willfully violates the treaty, the existence of a strong OSI mechanism can serve as a further deterrent to those that feel they may be able to violate the treaty or test evasively.

Fourth, as important as the IMS and OSI are to the treaty ratification debate, the administration would be wise to highlight the improvements to and importance of U.S. National Technical Means and other systems that can augment international monitoring and verification. InSAR-equipped satellites can measure the minute changes in topography that can occur after an underground explosion. This technology exists outside the IMS but it can be a component of a country's NTM and is also available commercially.

Finally, participants suggested highlighting the withdrawal article (IX) of the treaty, which provides for withdrawal from the treaty if a state feels that its "supreme national interest" is in jeopardy.[31]

30 Tibor Toth, "Building Up the Regime for Verifying the CTBT," *Arms Control Today*, September 2009, http://www.armscontrol.org/act/2009_09/Toth.

31 This reflects one of the suggestions of the 2001 Shalikashvili report, which called for a review of the treaty every ten years to confirm that U.S. national security interests were still best served by being a state party to the CTBT: "Should developments at home or abroad ever cast doubt on our ability to maintain a safe, reliable, and effective nuclear deterrent, however, we should withdraw from the Treaty if a resumption of nuclear testing would make us more secure." See Shalikashvili, letter to the president, January 4, 2001, http://www.state.gov/www/global/arms/ctbtpage/ctbt_report.html.

Conclusion

Almost ten years after the failure of the U.S. Senate to ratify the CTBT, the Obama administration announced its intention to revisit the treaty. The 1999 Senate debate considered the technical issues but many feel that the treaty failed for political rather than technical reasons.

Today there is widespread agreement that the technical capacity that existed in 1999 both to ensure the reliability of the U.S. nuclear stockpile and to detect low-yield nuclear tests has been improved drastically. The U.S. Stockpile Stewardship Program has had almost ten more years to improve its capability to ensure the reliability of the U.S. nuclear stockpile. Approximately 75 percent of the International Monitoring System is in place and it has succeeded in detecting two low-yield tests.

The Obama administration is politically motivated to see the United States ratify the treaty and should be aware of the "lessons learned" from 1999. The treaty's ratification is by no means assured. When the time is right, the Obama administration must carefully make its case to the Senate, frame the debate in the wider, broadly bipartisan national security and nonproliferation consensus, and clearly present the results of the technical assessments that are completed or are already well under way.

Appendix: Technical Issues Related to the Comprehensive Nuclear Test Ban Treaty

The 2002 U.S. National Academy of Sciences (NAS) Committee on International Security and Arms Control (CISAC) Study, *Technical Issues Related to the Comprehensive Nuclear Test Ban Treaty*, is often cited as the key assessment of the science and technical issues that form the heart of the CTBT ratification debate. After talking to seventy senators to determine what technical issues drove the 1999 Senate debate, General John M. Shalikashvili, special advisor to the president and the secretary of state for the Comprehensive Test Ban Treaty, tasked the NAS to undertake a study to address key technical obstacles to ratification. The NAS reviewed the following issues:

1. Confidence in the safety and reliability of the U.S. nuclear stockpile (as well as its weapon design/evaluation capabilities) under the CTBT;
2. the capabilities of the international nuclear test monitoring system;
3. additions to nuclear weapon capabilities other countries could achieve through undetected nuclear testing and their potential effect on U.S. security.

The conclusions of the study were raised several times during the meeting and are summarized below.

Confidence in the Safety and Reliability of the U.S. Nuclear Weapon Stockpile and in Related Capabilities

The NAS committee concluded that the United States has the technical capabilities to maintain confidence in the safety and reliability of its stockpile under a test ban, provided the Department of Energy is allotted adequate resources for this mission. However, to ensure such confidence, DOE must maintain: a competent and motivated weapon laboratory workforce; stockpile surveillance; (re) manufacturing capabilities; an assurance that nuclear weapon primaries yield within acceptable margins; the capacity to develop non-nuclear components of nuclear weapons; and exercise "change discipline" regarding the maintenance and remanufacture of nuclear subsystems. The committee noted that activity in the above areas historically contributed far more to confidence in the safety and reliability of the stockpile than nuclear testing ever has and that nuclear testing would not substantially help the Stockpile Stewardship Program (SSP) assess the stockpile.

The report supported the continued development of advanced diagnostic tools for stockpile surveillance and predicted that the capabilities of the mechanisms used to maintain confidence in the stockpile will grow faster than the requirements imposed upon them due to aging and other influences. In addition, the development of large-scale diagnostic tools and research facilities helps to both attract new technical talent to the SSP mission in the short term and strengthen the confidence in the underpinnings of the technology in the stockpile in the long term.

Capabilities for Monitoring Nuclear Testing

The committee considered the spectrum of detection, identification, and attribution of nuclear explosions; methods both specific to and independent of the CTBT. The report assessed the capabilities proposed under the Comprehensive Test Ban Organization International Monitoring System (IMS) and stated that under full implementation the IMS could detect and identify nuclear explosions with a yield of at least one kiloton with high confidence in all environments, assuming no special efforts at evasion.

The report addressed testing in specific environments and noted the yields sufficient for detection and identification in each at the time of the report. For underground explosions, a yield of 10–100 tons would be detectable, although explosions of less than a few kilotons might require an On-Site Inspection to positively identify the explosion as nuclear. Tests above 500–1,000 tons for atmospheric explosions could be identified as nuclear, and tests as low as one ton would be detected if they were conducted underwater.

The committee considered several evasion scenarios proposed by the intelligence community and determined that the only plausible technique for evading detection, identification, or attribution was cavity decoupling and that the only evasion technique with a good chance of success without prior nuclear experimentation was mine masking. The committee also concluded that both of these techniques would be difficult to employ successfully and have a significant chance of being detected by the IMS for all but very low yields. Even a decoupled or mine-masked nuclear explosion "cannot be confidently hidden if its yield is larger than 1 or 2 kilotons." The committee concluded that capabilities for monitoring nuclear testing will likely increase in the future and that the threshold for detection would improve.

Potential Impact of Foreign Testing on U.S. Security Interests and Concerns

The committee considered how continued testing could benefit states that had already tested nuclear weapons. Russia could use testing to refine its nuclear arsenal, although this would not significantly increase threats to U.S. security interests beyond those already imposed by Russia's current weapons. Testing would allow China to improve efficiency of its arsenal with regard to size, weight, and yield, thereby allowing it to add Multiple Independently Targeted Reentry Vehicles (MIRVs) to its ICBM arsenal and hence affect U.S. security interests, but it could also expand and MIRV its arsenal without testing if it uses previously tested nuclear weapon types. India and Pakistan could use nuclear testing to perfect boosted-fission and thermonuclear weapons, greatly increasing the destructive power of a given quantity of fissile material delivered by a given force of aircraft or missiles. Both countries seem unlikely to use nuclear weapons against the United States, but concerns would be raised about the potential for an arms race in and around South Asia should such developments occur.

The committee considered the effect of a cessation of testing under a rigorously observed CTBT and how the ban would affect states that had already tested nuclear weapons and the resulting effect on U.S. security. The only such states that are a possible security concern to the United States are Russia and China, both of which have such sufficiently advanced weapons that the marginal gain they could achieve through limited clandestine testing is negligible. States with extensive prior test experience are the ones most likely (although the possibility is remote) to be able to successfully perform clandestine testing, but in situations where serious reliability questions arise that necessitate testing for Russia or China, it is unlikely that such testing could evade detection.

The committee concluded that a CTBT, to the extent that it is observed, brings security benefits for the United States both by limiting the nuclear weapon capabilities that others can achieve and by eliminating the inducement of states to react to the testing of others with testing of their own. The worst-case scenario under a no-CTBT regime poses far larger threats to U.S. security than the worst-case scenario of clandestine testing in a CTBT regime within the detection constraints posed by the monitoring system.

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