

CRS Report for Congress

Comprehensive Nuclear-Test-Ban Treaty: Issues and Arguments

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Summary

The Comprehensive Nuclear-Test-Ban Treaty would ban all nuclear explosions. It was opened for signature in 1996. As of March 2008, 178 nations had signed it and 144 had ratified. To enter into force, 44 specified nations must ratify it; 35 have done so. The Senate rejected the treaty in 1999; the Bush Administration opposes it. The United States has observed a nuclear test moratorium since 1992.

There have been many calls worldwide for the United States and others to ratify the treaty. Many claim that it would promote nuclear nonproliferation; some see it as a step toward nuclear disarmament. Several measures have been introduced in Congress regarding the treaty; it might become an issue in the presidential election.

The U.S. debate involves arguments on many issues. To reach a judgment on the treaty, should it come up for a ratification vote in the future, Senators may wish to balance answers to several questions in a net assessment of risks and benefits.

Can the United States maintain deterrence without testing? The treaty's supporters hold that U.S. programs can maintain existing, tested weapons without further testing, pointing to 12 annual assessments that these weapons remain safe and reliable, and claim that these weapons meet any deterrent needs. Opponents maintain that there can be no confidence in existing warheads because many minor modifications will change them from tested versions, so testing is needed to restore and maintain confidence. They see deterrence as dynamic, requiring new weapons to counter new threats, and assert that these weapons must be tested.

Are monitoring and verification capability sufficient? "Monitoring" refers to technical capability; "verification" to its adequacy to maintain security. Supporters hold that advances in monitoring make it hard for an evader to conduct undetected tests. They claim that any such tests would be too small to affect the strategic balance. Opponents see many opportunities for evasion, and believe that clandestine tests by others could put the United States at a serious disadvantage.

How might the treaty affect nuclear nonproliferation and disarmament? Supporters claim that the treaty makes technical contributions to nonproliferation, such as limiting weapons programs; some supporters believe that nonproliferation requires progress toward nuclear disarmament, with the treaty a key step. Opponents believe that a strong nuclear deterrent is essential for nonproliferation, that nonproliferation and disarmament are unrelated, and that this nation has taken many nonproliferation and disarmament actions that the international community ignores.

This report presents a detailed, comprehensive discussion of the treaty's pros and cons from a U.S. perspective. It contains an appendix outlining relevant history. It will be updated periodically with views from protagonists. CRS Report RL33548, *Nuclear Weapons: Comprehensive Test Ban Treaty*, by Jonathan Medalia, tracks current developments.

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Comprehensive Nuclear-Test-Ban Treaty: Issues and Arguments

Introduction

The Comprehensive Nuclear-Test-Ban Treaty, or CTBT, would ban all nuclear explosions.¹ It was opened for signature in September 1996; as of February 2008, 178 nations had signed it and 144 of them had ratified.² To enter into force, 44 nations with nuclear reactors must ratify it; so far, 35 of them have ratified and another 7 have signed. The United States signed the treaty in September 1996; the Senate rejected it in October 1999.

Nuclear test bans have a long history (see Appendix A). There has been strong international support for test ban treaties; U.S. opinion has been divided. Most U.S. Presidents have sought agreements to limit testing. The Eisenhower Administration devoted great, but unsuccessful, effort to negotiating a treaty. The Kennedy Administration sought a CTBT; when that proved nonnegotiable, it achieved the Limited Test Ban Treaty (LTBT) in 1963, which bans nuclear tests in the atmosphere, under water, and in space. The Nixon Administration negotiated the Threshold Test Ban Treaty (TTBT) with the Soviet Union in 1974, which limits underground tests to a yield of 150 kilotons.³ The Ford Administration negotiated the Peaceful Nuclear Explosions Treaty (PNET) in 1976, which extended the 150-kiloton limit to peaceful nuclear explosions. The Carter Administration did not pursue entry into force of these two treaties, but sought a CTBT; partly because of strong opposition within the Administration, no treaty was concluded. The Reagan Administration rejected the TTBT and PNET because of verification concerns, but in 1987 began to negotiate new verification protocols. The George H.W. Bush Administration concluded negotiation of these protocols; the Senate approved the two treaties in 1990, and they entered into force in that year. President Bush also signed into law a provision implementing a nine-month moratorium on nuclear testing starting in October 1992. President Clinton extended the moratorium; he had initially thought to pursue a test ban treaty of limited duration and permitting a low explosive yield, but in 1995 he opted for a CTBT of zero yield and unlimited duration. The George W. Bush Administration has continued the moratorium but has not pursued the CTBT.

¹ For treaty text, see [<http://www.state.gov/www/global/arms/treaties/ctb.html>]. For CTBT developments, see CRS Report RL33548, *Nuclear Weapons: Comprehensive Test Ban Treaty*, by Jonathan Medalia.

² For status of signatures and ratifications, see [<http://www.ctbto.org/>].

³ One kiloton is equivalent to the explosive force of 1,000 tons of TNT; for comparison, the yield of the Hiroshima bomb was 15 kilotons.

U.S. interest in the CTBT waned after 1999, but has since reemerged. In the wake of 9/11 and the rise of nuclear programs in Iran and North Korea, the risk of nuclear proliferation has become more stark; some claim the treaty would curb that risk. An op-ed in January 2007 by Henry Kissinger, Sam Nunn, William Perry, and George Shultz called for steps toward eliminating nuclear weapons, including ratification and entry into force of the CTBT.⁴ The Administration is pursuing the Reliable Replacement Warhead (RRW), which it argues would make nuclear testing less likely; some envision a CTBT-RRW bargain. Scientists around the world have made progress in detecting nuclear explosions, and U.S. scientists have made progress in maintaining nuclear weapons without testing; both topics were of concern in the 1999 debate. Others hold that monitoring capability is insufficient and that new weapons requiring testing are needed. International pressure for the treaty has continued through U.N. General Assembly votes and international conferences. The treaty might be an issue in the presidential campaign.⁵ Several bills and resolutions in the 110th Congress call for ratification of the CTBT.⁶

Opinions on the treaty reflect contending views on how to obtain security; the role of nuclear weapons; nuclear nonproliferation and its relationship, if any, to nuclear disarmament; and international relations generally. (1) Some opponents would revoke the U.S. signature of the treaty and resume testing to maintain U.S. nuclear weapons, weapons expertise, and the credibility of the nuclear deterrent, and to develop new weapons. (2) Some supporters and opponents prefer to maintain the moratorium because of concern for political and international ramifications, but would test if necessary to fix a warhead problem. (3) Some supporters favor the treaty on grounds that it has significant value for nonproliferation and can help the United States monitor nuclear testing by other nations. (4) Others favor the CTBT as a step toward abolition of nuclear weapons. While many people of all stripes favor abolition of nuclear weapons as an ultimate goal, those in the fourth group see abolition as a realistic if long-term possibility and believe that the CTBT is a critical step toward reaching that goal. These views are on a continuum, with overlaps and shades of gray between positions. Still others feel the treaty would make little difference in restraining weapons development because technical advances enable such development without testing, or that it would make little difference in countering nuclear proliferation as a stand-alone measure. While the United States has observed a nuclear test moratorium since 1992, few appear to hold it as their preferred position; instead, the treaty's supporters accept the moratorium as better than a return to testing, and opponents accept it as better than the CTBT.

⁴ George Shultz, William Perry, Henry Kissinger, and Sam Nunn, "A World Free of Nuclear Weapons," *Wall Street Journal*, January 4, 2007, p. 15.

⁵ See "2008 Presidential Candidates' Responses to Seven Key National Security Questions," Council for a Livable World, August 16, 2007, at [http://www.clw.org/elections/2008/presidential/2008_presidential_candidates_questionnaire_responses/].

⁶ These include Section 3122 of S. 1547, the FY2008 national defense authorization bill, as passed by the Senate but not included in the final legislation; H.Res. 68, recognizing the dangers posed by nuclear weapons and calling on the President to engage in nonproliferation strategies designed to eliminate these weapons of mass destruction from United States and worldwide arsenals; and H.Res. 882, expressing the sense of the House that the Senate should initiate a bipartisan process to give its advice and consent to CTBT ratification.

This report seeks to present information that may help Members understand many CTBT issues and to assess whether, on balance, the United States is better off with or without the CTBT. It is organized around three aspects of how the treaty might affect U.S. security that were prominent in the 1999 debate: the CTBT and deterrence; monitoring and verification; and implications for nuclear nonproliferation and disarmament. In the public debate since 1999, CTBT supporters have written extensively on all aspects of the treaty, while opponents have written much less. To provide balance, CRS has obtained many comments from people representing all perspectives. As a result, this report contains a substantial amount of new material.

Can the United States Maintain Deterrence Under the CTBT?

During the Cold War, the United States and Soviet Union engaged in an arms competition, often called an “arms race” or “action-reaction cycle.” This competition was dynamic. The United States built submarines carrying ballistic missiles; the Soviet Union followed suit. The Soviet Union built deeply buried bunkers for its leaders; the United States built very high yield weapons to destroy them. Scores of such examples could be listed. Despite this effort, U.S. and Soviet nuclear strategies and programs resulted in a rough parity between the two sides, and the Cold War passed into history with no nuclear or conventional war between them.

While deterrence has had many permutations over the years, most in the United States supported it during the Cold War for want of a better alternative. To be sure, some argued that the United States should seek superiority, while others held that a minimum deterrent sufficed. Others reluctantly supported deterrence as an interim measure, arguing that while it purports to reduce the risk of nuclear war, that very outcome could be expected if a low probability per year is aggregated over many years. Despite these differing views, Congress supported the forces to implement a deterrent strategy over many decades. The capability to deter the Soviet Union was by far the most stressing case, so it was seen as more than sufficient to deter other threats.⁷ In that environment, nuclear testing served many purposes. Nuclear tests were mainly conducted for weapons development, but also for safety, weapons physics, stockpile confidence, and certification of modifications. Tests also served to maintain skills in weapons science, engineering, and manufacturing, and to demonstrate the credibility of the U.S. deterrent.

With the end of the Cold War and the Soviet Union, the “comfort” of dealing for four decades with a single more-or-less predictable adversary ended, to be replaced by considerable uncertainty. R. James Woolsey, in his 1993 nomination hearing to be Director of Central Intelligence, said “Yes, we have slain a large

⁷ For information on U.S. nuclear policies, see CRS Report RL34226, *Nuclear Weapons in U.S. National Security Policy: Past, Present, and Prospects*, by Amy Woolf.

dragon, but we live now in a jungle filled with a bewildering variety of poisonous snakes. And in many ways the dragon was easier to keep track of.”⁸

Despite this changed situation, there remains wide, but not universal, agreement in the United States on the need to maintain a nuclear deterrent for the foreseeable future. Lawrence Korb and Max Bergmann of the Center for American Progress wrote, “To maintain an effective deterrent, the United States must continue to possess conventional and nuclear forces capable of quickly and decisively destroying these regimes,” referring to “extreme regimes ... such as Iran and North Korea.”⁹ Sidney Drell and James Goodby, in an Arms Control Association report, “estimate that a U.S. strategic force of some 500 operationally deployed warheads would be more than adequate for deterrence. ... this force level would be enough to provide a degree of flexibility in a fluid security environment.” A responsive force of 400 to 500 warheads would supplement this force.¹⁰ The Administration’s Nuclear Posture Review of 2001 stated that with the end of the Cold War, “U.S. nuclear forces still require the capability to hold at risk a wide range of target types. This capability is key to the role of nuclear forces in supporting an effective deterrence strategy relative to a broad spectrum of potential opponents under a variety of contingencies.”¹¹

At issue, though, is what is needed for deterrence. The aim of deterrence has always been to make an adversary fear it will suffer unacceptable consequences if it takes certain actions. Many believe that the U.S.-Soviet deterrent relationship worked during the Cold War because threats were credible and each side understood the consequences of attacking the other. In the post-Cold War, post-9/11 world, many questions arise. Who is to be deterred, by what threats? What weapons are needed to make them credible? Is deterrence dynamic, with constant weapons development needed to respond to changing threats, or is a modest number of nuclear weapons of existing designs, together with U.S. conventional forces and economic might, more than sufficient? Are existing nuclear weapons sufficient to deter North Korea, or are new ones needed that could destroy underground bunkers where leaders might hide, or is the nation so irrational that it is beyond deterrence, or is a North Korean nuclear attack wildly implausible? Is a satisfactory outcome possible through diplomacy? What capabilities are needed to deter Iran or to roll back its nuclear program? Do nuclear forces have any relevance to deterring terrorists or their state sponsors?

This report now considers CTBT and nuclear testing issues that link to these broader issues of deterrence.

⁸ U.S. Congress. Senate. Select Committee on Intelligence. *Nomination of R. James Woolsey*. S.Hrg. 103-296, 103rd Congress, 1st Session, 1993, p. 76.

⁹ Lawrence Korb and Max Bergmann, *Restoring American Military Power: Toward a New Progressive Defense Strategy for America*, Center for American Progress, December 2007, p. 17.

¹⁰ Sidney Drell and James Goodby, *What Are Nuclear Weapons For?* Arms Control Association, revised and updated October 2007, p. 15.

¹¹ U.S. Department of Defense. *Nuclear Posture Review [Excerpts] Submitted to Congress on 31 December 2001*, p. 7, available at [<http://www.globalsecurity.org/wmd/library/policy/dod/npr.htm>].

- Without testing, can the United States maintain the facilities and skilled personnel supporting U.S. nuclear weapons? This question is considered first because these capabilities are the bedrock on which nuclear weapons rest.
- Can existing weapons be maintained without testing? This is a necessary criterion for deterrence under the CTBT, as it would take many years to develop and deploy new weapons.
- Does deterrence require new weapons that incorporate new military capabilities, and is testing required to develop them?
- Do U.S. weapons need more features for safety and security, and is testing required to add them? Such features might deter terrorist attempts to seize and detonate these weapons.

Can the United States Maintain the Nuclear Weapons Enterprise Without Testing?

The nuclear weapons enterprise is here taken to mean the nuclear weapons complex managed by the National Nuclear Security Administration (NNSA), a semiautonomous agency of the Department of Energy (DOE) responsible for the U.S. nuclear weapons program;¹² scientists, engineers, and production staff of the complex; and Department of Defense (DOD) agencies that deal with nuclear weapons. Collectively, they provide the skills and capabilities that support and would use nuclear weapons.

Whether the United States can maintain this enterprise without nuclear testing has been at issue for decades. In 1963, the Joint Chiefs of Staff conditioned their support for the LTBT on four “safeguards,” or actions this nation would take within the confines of that treaty. The first three would help maintain this enterprise: Safeguard A, an aggressive underground nuclear test program; Safeguard B, technology facilities and programs to attract and retain scientists; Safeguard C, maintenance of the ability to resume atmospheric testing promptly; and Safeguard D, improvement of monitoring capability.¹³ President Kennedy’s assurance to Senators Mansfield and Dirksen, the majority and minority leaders, that the United States would observe these and other safeguards¹⁴ was instrumental in securing Senate

¹² The nuclear weapons complex consists of eight sites: Los Alamos, Livermore, and Sandia National Laboratories; Pantex Plant, Y-12 Plant, Kansas City Plant, and Savannah River Site, which together produce, maintain, and dismantle nuclear weapons; and the Nevada Test Site, which until 1992 was used to conduct nuclear tests but is now used for other nuclear weapons-related activities and other purposes.

¹³ Testimony of General Maxwell Taylor, Chairman, Joint Chiefs of Staff, in U.S. Congress. Senate. Committee on Foreign Relations, *Nuclear Test Ban Treaty*, hearings on Executive M, 88th Congress, 1st Session, 1963, pp. 274-275.

¹⁴ Letter from President John Kennedy to Hon. Mike Mansfield and Hon. Everett McKinley Dirksen, in address by Senator Dirksen on the Nuclear Test Ban Treaty, U.S. Congress. (continued...)

advice and consent to ratification. The safeguards have been observed over time, though Safeguard C has been modified as the perceived need for atmospheric tests waned and ended. As Appendix A details, other nuclear test limitation treaties were negotiated and entered into force between 1974 and 1990.

The Hatfield-Exon-Mitchell amendment, Section 507 of the FY1993 Energy and Water Development Appropriations Act, P.L. 102-377, mandated a nine-month moratorium on nuclear testing beginning in October 1992, limited testing thereafter, and directed the President to report on a plan for achieving a CTBT by September 30, 1996. President Clinton extended the moratorium several times. In response to the prospect of a permanent halt to testing, Congress, in Section 3138 of P.L. 103-160, the FY1994 National Defense Authorization Act, and the President, in Presidential Decision Directive 15, mandated a Stockpile Stewardship Program (SSP) to maintain U.S. nuclear capabilities in a no-test era.

In 1995, President Clinton announced his decision to seek a zero-yield CTBT. He conditioned the CTBT on six safeguards: (A) SSP, (B) modern laboratory facilities and nuclear technology programs to attract and retain scientists, (C) the “basic capability to resume nuclear test activities,” (D) continued R&D to improve the ability to monitor compliance with the treaty, (E) continued improvement of intelligence capabilities to provide information on nuclear weapons programs worldwide, and (F) the understanding that if a key nuclear weapon type could no longer be certified as safe or reliable, “the President, in consultation with Congress, would be prepared to withdraw from the CTBT under the standard ‘supreme national interests’ clause in order to conduct whatever testing might be required.”¹⁵ Safeguards A, B, C, and F would help maintain the nuclear weapons enterprise.

In the 1999 CTBT debate, SSP, as the core of U.S. ability to maintain the nuclear weapons enterprise without testing, was a major issue. SSP had been in being for a short time, resulting in uncertainty on its ability to maintain existing weapons. Former National Security Adviser Brent Scowcroft, former Secretary of State Henry Kissinger, and former Deputy Secretary of Defense John Deutch questioned whether funding would be maintained and wrote that SSP “is not sufficiently mature to evaluate the extent to which it can be a suitable alternative to testing.”¹⁶ Former Secretary of Defense Caspar Weinberger said, “[i]f we need nuclear weapons, we have to know that they work. That is the essence of their deterrence.... The only assurance that you have that they will work is to test them.”¹⁷ John Browne, Director

¹⁴ (...continued)

Congressional Record, September 11, 1963, p. 16790-16791.

¹⁵ U.S. White House. Office of the Press Secretary. “Fact Sheet: Comprehensive Test Ban Treaty Safeguards.” August 11, 1995, p. 1.

¹⁶ Letter to Hon. Trent Lott, Majority Leader, U.S. Senate, and Hon. Thomas A. Daschle, Minority Leader, U.S. Senate, October 5, 1999, in U.S. Congress. Senate. Committee on Armed Services. *Comprehensive Test Ban Treaty*. S.Hrg. 106-490, 106th Congress, 1st Session, 1999 (hereinafter *SASC CTBT hearings*, 1999), pp. 100-101.

¹⁷ U.S. Congress. Senate. Committee on Foreign Relations. *Final Review of the* (continued...)

of Los Alamos, argued that Safeguard F was absolutely essential,¹⁸ while Weinberger expressed concern that the President would not exercise it.¹⁹ Six former Secretaries of Defense were concerned that an indefinite-duration CTBT could lead to loss of expertise, the topic of President Clinton's Safeguard B:

Another implication of a CTBT of unlimited duration is that over time we would gradually lose our pool of knowledgeable people with experience in nuclear weapons design and testing. Consider what would occur if the United States halted nuclear testing for 30 years. We would then be dependent on the judgment of personnel with no personal experience either in designing or testing nuclear weapons. In place of a learning curve, we would experience an extended unlearning curve.²⁰

Such uncertainties cast doubt for some Senators on the CTBT. Senator Olympia Snowe said, "there are [SSP] methods that are yet to be proven and we are years or decades away from knowing whether or not they are reliable."²¹ Senator John Warner said, "there are honest differences on both sides leaving clearly a reasonable doubt, and I come from the old school that it should be beyond any reasonable doubt if we are going to take a step that affects our vital security interests for decades to come, indeed possibly into perpetuity as it relates to this cadre of weapons."²²

The treaty's defenders tried to give assurance on these points. Secretary of State Madeleine Albright said, "We have also now said that [the nuclear weapons laboratories] would have \$45 billion over a 10-year period to be able to update and keep going all of the various parts of the stewardship program," and the United States would "maintain the capability to test again should the need ever arise."²³ Secretary of Energy Richardson "stress[ed] that the President, in consultation with Congress, can withdraw from this treaty if a high level of confidence in the safety and reliability of a nuclear weapon critical to our nuclear deterrent cannot be certified. As Secretary of Energy, I would not hesitate to so advise the President in the event it becomes necessary for our country to conduct tests."²⁴ Senator Carl Levin also emphasized Safeguard F:

¹⁷ (...continued)

Comprehensive Nuclear Test Ban Treaty (Treaty Doc. 105-28), S.Hrg. 106-262, 106th Congress, 1st Session, 1999 (hereinafter *SFRC CTBT hearing, 1999*), p. 14.

¹⁸ *SASC CTBT hearings, 1999*, p. 111.

¹⁹ *SFRC CTBT hearing, 1999*, p. 42.

²⁰ Letter from James Schlesinger, Richard Cheney, Frank Carlucci, Caspar Weinberger, Donald Rumsfeld, and Melvin Laird to The Honorable Trent Lott, Majority Leader, United States Senate, and The Honorable Tom Daschle, Democratic Leader, United States Senate, in *SASC CTBT hearings, 1999*, p. 57.

²¹ *SASC CTBT hearings, 1999*, p. 43.

²² *SFRC CTBT hearing, 1999*, p. 52.

²³ *SFRC CTBT hearing, 1999*, pp. 90, 92.

²⁴ *SASC CTBT hearings, 1999*, p. 107.

if lab directors and other experts ... cannot certify to us 2 years, 4 years, 6 years, 10 years from now that this is a safe and reliable stockpile, then we are giving everybody notice who signs this treaty that under our supreme national interest clause we are prepared to withdraw.

So in a sense this treaty is almost a year to year treaty.²⁵

How have President Clinton's safeguards fared since 1999? Safeguards A and B called for SSP and facilities and programs to attract and retain scientists. CTBT supporters claim that SSP has made great progress under NNSA. They cite Thomas D'Agostino, then Acting NNSA Administrator, who said, "stockpile stewardship is working. This program has proven its ability to successfully sustain the safety, security and reliability of the stockpile without the need to conduct an underground test for well over a decade."²⁶ K. Henry O'Brien, RRW Program Manager at Lawrence Livermore National Laboratory, called SSP a "dramatic success."²⁷ SSP has developed sophisticated computer models of nuclear weapons and explosions, has built some of the world's most powerful computers, is building the world's largest laser, and conducts nonnuclear experiments. Its surveillance program examines warheads for problems, and its Life Extension Program (LEP) is designed to correct them by replacing components that are, or are expected to become, defective. Life-extended W87 warheads have been certified for use in the stockpile. While the first RRW design, "WR1," is to replace some W76s, Barry Hannah, Chairman of the RRW Project Officers Group, called the W76 LEP an "excellent program" that he believes "meets the Navy's needs."²⁸ Richard Garwin, IBM Fellow Emeritus who has been involved with nuclear weapon issues since 1950, does not "agree with the generally stated assumption that confidence and the reliability of our existing nuclear weapons will inevitably decline with time as the weapons age." Instead, "with the passage of time and the improvement in computing tools, I believe that confidence in the reliability of the existing legacy weapons will increase rather than diminish."²⁹ SSP has permitted 12 annual assessments that the U.S. nuclear stockpile is safe and reliable. It has permitted design of RRW, as discussed later. NNSA is planning to modernize the nuclear weapons production complex.³⁰ For

²⁵ *SASC CTBT hearings*, 1999, p. 87.

²⁶ Testimony of Thomas D'Agostino, Acting Administrator, National Nuclear Security Administration, in U.S. Congress. House. Committee on Appropriations. Subcommittee on Energy and Water Development. Hearing on the Department of Energy's FY2008 budget for programs in the National Nuclear Security Administration, 110th Congress, 1st Session, March 29, 2007, transcript by CQ Transcriptions.

²⁷ Personal communication, April 2, 2007.

²⁸ Information provided by Dr. Barry Hannah, SES, Branch Head, Reentry Systems, Strategic Systems Program, U.S. Navy, telephone conversation, October 23, 2006.

²⁹ U.S. Congress. House. Committee on Appropriations. Subcommittee on Energy and Water Development. Hearing on nuclear weapon activities, 110th Congress, 1st Session, March 29, 2007. Transcript by CQ Transcriptions.

³⁰ See, for example, U.S. Department of Energy. National Nuclear Security Administration. Office of Defense Programs. "Report on the Plan for Transformation of the National (continued...)"

FY2001-FY2007, SSP received about \$42.2 billion;³¹ its FY2008 current appropriation is \$6.3 billion and its FY2009 request is \$6.6 billion.³²

CTBT opponents are concerned that without nuclear tests that integrate all phenomena, there is no experimental basis on which designers can be sure that their understanding of a design corresponds to what they would learn with a nuclear test. As Kathleen Bailey, former Assistant Director for Nuclear and Weapons Control, Arms Control and Disarmament Agency, testified in 1998, “Virtual reality cannot replace reality.”³³ Without new nuclear test data, in this view, stewardship tools are unvalidated, so certifications are political statements and it is not possible to be certain that the stockpile is safe and reliable.³⁴ Supporters say that the computer models are valid because they fit a vast array of experimental data, notably including the results of the U.S. nuclear test program; critics respond that while the performance of an individual electronic component can be validated through repeated testing, a nuclear explosion is an integrated event that cannot be predicted by analyzing the performance of individual components. It is a different, and easier, exercise to fit computer models to past tests, they argue, than to see how well a computer model predicts the outcome of a future test.

SSP rests on skilled personnel. CTBT opponents point to concerns raised by Carol Burns of Los Alamos National Laboratory: “In 2006, NNSA indicated that about 40% of nuclear weapons program technical staff members were eligible for retirement.” She noted a decline in production of students with doctoral degrees in nuclear science, and pointed to a drop in doctoral degrees earned at U.S. universities in radiochemistry and nuclear chemistry from 33 in 1968 to 4 in 2003.³⁵ Opponents

³⁰ (...continued)

Nuclear Security Administration Nuclear Weapons Complex.” January 31, 2007, 31 p, Available at [http://www.nnsa.doe.gov/docs/Trans_of_NNSA_WC_2007-31-07.pdf].

³¹ Data for FY2001-FY2004 are for NNSA annual request documents for FY2003-FY2006; data for FY2005-FY2007 are from U.S. Department of Energy. “FY 2007 Operating Plan by Appropriation,” p. 2, [<http://www.energy.gov/media/FY2007OperatingPlanForDOE.pdf>]. NNSA budget documents list SSP funds as “Weapons Activities.”

³² U.S. Department of Energy. Office of Chief Financial Officer. *FY 2009 Congressional Budget Request*. Volume 1, National Nuclear Security Administration. DOE/CF-024, February 2008, p. 71.

³³ “Testimony of Kathleen Bailey, Senior Fellow, Lawrence Livermore National Laboratory,” in U.S. Congress. Senate. Committee on Governmental Affairs. Subcommittee on International Security, Proliferation, and Federal Services. *The Comprehensive Test Ban Treaty and Nuclear Nonproliferation*, S. Hrg. 105-699, 105th Congress, 2nd Session, 1998, p. 26.

³⁴ This view provided by Kathleen Bailey, former Assistant Director for Nuclear and Weapons Control, U.S. Arms Control and Disarmament Agency, personal communication, April 20, 2007.

³⁵ “Testimony of Dr. Carol J. Burns, Group Leader, Nuclear and Radiochemistry, Los Alamos National Laboratory, Before the U.S. House of Representatives, Committee on Homeland Security, Subcommittee on Emerging Threats, Cybersecurity and Science and Technology, Hearing on H.R. 2631, the Nuclear Forensics and Attribution Act,” October (continued...)

see problems with LEPs. As Ambassador Linton Brooks, then Administrator of NNSA, said in 2005, “it is becoming more difficult and costly to certify warhead remanufacture. The evolution away from tested designs resulting from the inevitable accumulations of small changes over the extended lifetimes of these systems [i.e., warheads] means that we can count on increasing uncertainty.”³⁶ John Foster, former Director of Defense Research and Engineering, raised other concerns:

The Stockpile Stewardship Program has been a lifesaver for the nuclear weapons labs. It has attracted and maintained scientists and engineers and provided new world-class tools for understanding nuclear weapon performance and advancing weapon science. But I have three salient concerns. First, U.S. nuclear weapon pit production was stopped in 1989, leading quickly to a halt in weapons production. The capability to produce nuclear weapons has atrophied since then. Second, we have not conducted underground nuclear tests since 1992 and we are running risks regarding the safety, reliability and performance of the stockpile. Third, periodic surveillance of the aging stockpile has revealed the necessity to initiate Life Extension Programs to refurbish several warhead types. This process introduces new materials and components into the warheads, which introduces the possibility of “birth defects” that raise risks.³⁷

Supporters claim that Safeguard C, the “basic capability to resume nuclear test activities,” has been met, as NNSA reduced the time needed to conduct a nuclear test from 36-plus months to 24 months.³⁸ Opponents respond that without nuclear testing, the capability to test declines as skills atrophy, procedures become outdated, and equipment falls into disuse. Safeguards D and E do not deal with SSP. One cannot prove whether the United States would withdraw from the CTBT, as per Safeguard F, especially as it has not ratified the treaty. U.S. withdrawal from the Antiballistic Missile Treaty in 2002 might make the prospect of withdrawal from the

³⁵ (...continued)

10, 2007, pp. 2-4, [<http://homeland.house.gov/SiteDocuments/20071010175138-84437.pdf>].

³⁶ “Statement of Ambassador Linton F. Brooks, Administrator, National Nuclear Security Administration, U.S. Department of Energy, Before the Senate Armed Services Committee, Subcommittee on Strategic Forces,” April 4, 2005.

³⁷ Personal communication, October 22, 2007.

³⁸ A 2003 NNSA report stated, “Over the past several years the NNSA conducted reviews of the 24- to 36-month test readiness posture [i.e., the time between a presidential decision to conduct a nuclear test and the actual conduct of that test] that the NNSA has maintained since Fiscal Year 1996. ... From these reviews, NNSA concluded that because of a loss of expertise and degradation of some specific capabilities, the U.S. would more likely require about 36 months to test, with less confidence in being able to achieve the 24-month end of the range. Furthermore, as time passes without further action, the 36-month posture is viewed as increasingly at risk.” U.S. Department of Energy. National Nuclear Security Administration. *Report to Congress: Nuclear Test Readiness*. April 2003, p. 5. In contrast, NNSA said that in FY2005 it “[a]chieved a 24-month [test] readiness posture.” U.S. Department of Energy. Office of the Chief Financial Officer. *FY 2007 Congressional Budget Request*. Volume 1, National Nuclear Security Administration. DOE/CF-002, February 2006, p. 95. However, the FY2009 NNSA request plans to “maintain a minimum readiness posture of 24 to 36 months.” U.S. Department of Energy. *FY 2009 Congressional Budget Request*. Volume 1, National Nuclear Security Administration, p. 147.

CTBT appear more credible, though critics see prospects for withdrawal dependent on who is President, and thus uncertain.

Can the United States Maintain Existing Warheads Without Testing?

During the Cold War, as noted, deterrence was dynamic, with nuclear moves and counter-moves by the United States and Soviet Union. Testing was essential for both sides to develop new weapons. In the 1999 debate, arguments over the treaty and deterrence played a minor, and predictable, part. Both sides in the debate agreed that maintaining the nuclear deterrent was crucial. Opponents held that without testing, it would be impossible to do so. As former Secretary of Defense James Schlesinger testified, “In the absence of testing, confidence in the reliability of the stockpile will inevitably, ineluctably decline.”³⁹ They questioned whether the United States could, in 1999 if ever, rely on SSP to maintain weapons. The treaty’s supporters had a different view. Secretary of State Madeleine Albright said, “Under the treaty, America would retain a safe and reliable nuclear deterrent.”⁴⁰ And General Henry Shelton, Chairman of the Joint Chiefs of Staff, testified:

Senator Levin: What you are telling us is that our top uniformed leadership unanimously support this Treaty?

General Shelton: I might add, Senator Levin, that we would never say that unless we felt that we could maintain a credible nuclear deterrent and also a safe and reliable stockpile.⁴¹

Since 1999, support has continued for this nation to maintain nuclear weapons as long as it retains them. There are three main approaches for so doing. Supporters of the Reliable Replacement Warhead (RRW) program and supporters of the Life Extension Program (LEP) each argue that their approach will reduce the likelihood of testing while the other will increase it. In contrast, others believe that neither RRW nor LEP can provide sufficient confidence in the safety and reliability of current warheads without nuclear testing; they therefore see testing as necessary.

RRW, as a funded program, began in the FY2005 Consolidated Appropriations Act, P.L. 108-447; it was described as a “program to improve the reliability, longevity, and certifiability of existing weapons and their components.”⁴² In the FY2006 National Defense Authorization Act, P.L. 109-163, Congress set as an objective that the program “further reduce the likelihood of the resumption of underground nuclear weapons testing.” The first proposed RRW, WR1, would be

³⁹ SASC, *CTBT hearings*, 1999, p. 59.

⁴⁰ SFRC, *CTBT hearing*, 1999, p. 72.

⁴¹ SASC, *CTBT hearings*, 1999, pp. 23-24.

⁴² U.S. Congress. Committee of Conference. *Making Appropriations for Foreign Operations, Export Financing, and Related Programs for the Fiscal Year Ending September 30, 2005, and for Other Purposes*, conference report to accompany H.R. 4818, 108th Congress, 2nd Session, H.Rept. 108-792, 2004, p. 951.

used in place of some W76 warheads on Trident II submarine-launched ballistic missiles. WR1s would be designed to meet post-Cold War requirements, such as enhanced safety, increased ease of manufacture, and high confidence without nuclear testing. However, the FY2008 Consolidated Appropriations Act, P.L. 110-161, eliminated RRW funds, leaving its prospects unclear. An issue for any future CTBT debate is which approach — RRW or LEP — is less likely to require nuclear testing in the long term.⁴³

NNSA claims that RRW will make the need for testing unlikely because of steps to increase confidence. For example, RRW designers used high margins, basically building in more performance than is needed, to make material deterioration or design or manufacturing defects less likely to degrade warhead performance below the minimum required. They argued that they could do so because the design was unconstrained by technologies and design choices made decades ago. They view added margin as the single most important goal of the design. Another basis for confidence is that the design stayed close to past experience. Lawrence Livermore National Laboratory, which designed the nuclear components of WR1, states that components very similar to those of the WR1 were nuclear tested in the past. For this and other reasons, “there is direct nuclear test proof that the [WR1] design will perform properly.”⁴⁴

NNSA and its labs have expressed concerns that, over the long term, minor changes to current warheads through repeated LEPs will introduce defects and make it harder to maintain reliability, possibly requiring nuclear testing. They argue that LEPs replace defective or deteriorated components with replicas. As Thomas D’Agostino said, “The W76 LEP and the life extension approach is an exact rebuild of what we’ve had in the Cold War stockpile. We try to mimic the manufacturing processes exactly the way it was done 30 years ago.”⁴⁵ The concern is that components and manufacturing processes cannot be replicated precisely, pushing the warhead beyond the design envelope validated by nuclear testing.⁴⁶ This problem could result in defects in life-extended warheads that could cause them to fail.

LEP supporters question whether RRW will provide high confidence. As Steven Fetter of the University of Maryland said, “Like most other warheads, RRW will have, or could be expected to have, birth defects or reliability problems that would be discovered and corrected soon after the warhead was deployed. No one can say whether the unreliabilities introduced by these birth defects would be greater or smaller than the unreliabilities that would crop up in the existing warheads due to

⁴³ For more detail, see CRS Report RL33748, *Nuclear Warheads: The Reliable Replacement Warhead Program and the Life Extension Program*, by Jonathan Medalia.

⁴⁴ Information provided by Lawrence Livermore National Laboratory, September 19, 2006.

⁴⁵ Testimony of Thomas D’Agostino to House Appropriations Committee, Subcommittee on Energy and Water Development, March 29, 2007.

⁴⁶ On this point, see George Miller, Paul Brown, and Carol Alonso, *Report to Congress on Stockpile Reliability, Weapon Remanufacture, and the Role of Nuclear Testing*, Lawrence Livermore National Laboratory Report UCRL-53822, October 1987, Chapter 3, “Weapon Remanufacture,” pp. 25-30.

their age.”⁴⁷ They thus doubt that a new-design RRW can be certified without testing. Robert Peurifoy, a former vice president at Sandia National Laboratories, stated, “The present nuclear weapon stockpile contains 8 or so nuclear weapon types. That population has enjoyed perhaps 100 successful yield tests. These weapons have benefitted from a test base of perhaps 1,000 yield tests conducted during the 40 or so years when nuclear testing was allowed. Is the DoD really willing to replace tested devices with untested devices?”⁴⁸

LEP’s supporters argue that current warheads are reliable, as evidenced by 12 stockpile assessments, and that LEP can keep them reliable for many years without testing. While problems emerge, solutions do as well, and LEP supporters argue that SSP has been keeping at least even in this race. RRW supporters agree that SSP is making progress; an NNSA official stated, “Each year, we are gaining a more complete understanding of the complex physical processes underlying the performance of our aging nuclear stockpile.”⁴⁹ Further, say LEP advocates, current warheads stay within design parameters validated by nuclear tests. In this view, SSP and LEP can maintain margins through careful remanufacture to minimize changes. They also state, to general agreement, that margins for some warheads could be increased in certain ways with no change to a warhead.⁵⁰ While RRWs, as new designs, are likely to have “birth defects,” LEP supporters claim such defects have been wrung out of existing designs.

Some, however, doubt that *either* LEP or RRW can be assessed as reliable, in the case of RRW because it will never be tested and in the case of LEPs because small changes will undermine confidence in reliability.⁵¹ In this view, SSP has enabled only political assessments rather than technical ones. Since SSP emerged *after* the moratorium on testing began, these critics hold that its tools were never validated with nuclear tests dedicated to that purpose, so they could lead to false

⁴⁷ Arms Control Association, “The Future of U.S. Nuclear Weapons: The Weapons Complex and the Reliable Replacement Warhead,” press briefing, Washington, DC, April 19, 2007.

⁴⁸ Personal communication, September 24, 2006.

⁴⁹ “Statement of Thomas P. D’Agostino, Deputy Administrator for Defense Programs, National Nuclear Security Administration, Before the House Armed Services Committee, Subcommittee on Strategic Forces,” April 5, 2006, p. 1.

⁵⁰ One such change involves a revised means of dealing with the boost gas, a mixture of tritium and deuterium gases injected into the pit to increase its explosive energy. A study found, “Primary yield margins can be increased by appropriate changes specific to each stockpile system. These include changes to initial boost-gas composition, shorter boost-gas exchange intervals, or improved boost-gas storage and delivery systems. These modifications have been validated by nuclear test data for the appropriate systems, and they would not place burdens on the maintenance or deployment of the systems by the military.” National Academy of Sciences, Committee on Technical Issues Related to Ratification of the Comprehensive Nuclear Test Ban Treaty, *Technical Issues Related to the Comprehensive Nuclear Test Ban Treaty*, Washington, National Academy Press, 2002 (*hereinafter NAS report*), p. 31. See also JASON report JSR-99-305, *Primary Performance Margins*, McLean, VA, MITRE Corporation, 1999, p. 2.

⁵¹ Information provided by Robert Barker, former Assistant to the Secretary of Defense for Atomic Energy, November 29, 2006.

conclusions. Accordingly, in this view, NNSA will not know for sure if SSP, and thus RRW or LEP, work until it conducts nuclear tests. With confidence in the U.S. nuclear arsenal — by the United States, its friends, and its foes alike — central to deterrence, in this view, the United States must conduct nuclear tests regardless of political concerns because only testing can maintain confidence.⁵²

This section has discussed three views: RRW is less likely to require testing than LEP; LEP is less likely to require testing than RRW; and the United States can have confidence in neither RRW nor LEP without testing. One could argue a fourth view, that both RRW and LEP are unlikely to need testing. This view could lead to a mixed LEP-RRW force. As Henry O'Brien of Lawrence Livermore National Laboratory stated, "Our best approach for a small stockpile and complex would be to retain a couple of the better current weapon types (i.e., those with relatively higher margins, more advanced safety and security technologies, and more sustainable materials), and replace the rest with a small number of RRW types."⁵³

Does Deterrence Require New Warheads That Must Be Tested?

CTBT opponents argue that the ability to maintain existing weapons without testing through LEP, even if it can be done, misses the point. Deterrence, as they see it, requires continuing to hold at risk assets that enemy leaders prize. However, they argue, current nuclear warheads have many limitations.

- Current warheads, which were designed during the Cold War, were given high yield to destroy hard targets like Soviet missile silos. But that yield, in this view, could cause the United States to refrain from using these weapons out of concern for inflicting massive civilian casualties in the target area and beyond. As a 2006 Defense Science Board study stated, "*weapons that are not seen as useable and effective by potential adversaries cannot be an effective, reliable deterrent.*"⁵⁴
- Current warheads, if exploded near the Earth's surface, would leave much residual radiation that would contaminate large areas and kill many people, barring the United States from using them, the treaty's opponents believe.

⁵² Information provided by Kathleen Bailey, November 28, 2006.

⁵³ Personal communication, November 7, 2007.

⁵⁴ U.S. Department of Defense. Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics. Defense Science Board. *Report of the Defense Science Board Task Force on Nuclear Capabilities*. December 2006. Report summary, p. 15, original emphasis.

- The radiation output of current warheads, they argue, differs from that needed for such missions as destroying chemical or biological agents or generating electromagnetic pulse.
- Current warheads cannot destroy key targets that enemy leaders would value highly, such as hardened and deeply buried bunkers where weapons of mass destruction, key communications nodes, or the leaders themselves might hide.

WR1 shares these limitations. For example, it would have about the same yield as the W76 it would replace, and would use a reentry body⁵⁵ that cannot penetrate the ground.

CTBT opponents see deterrence as dynamic, so that it continues to require new military capabilities that can only be embodied in new weapons that could only be developed with nuclear testing. The Threat Reduction Advisory Committee, an expert panel advising DOD, stated that one reason to test would be “[t]o support certification — prior to quantity production — of new nuclear weapons, should the decision be made that a new weapon design requiring testing is the only option to achieve a needed capability.” It provided examples of weapons requiring “tailored physics package design for nuclear effects for new missions,” including:

- Earth-penetrating warheads with reduced collateral effects to defeat hard, deeply buried targets;
- Warheads to defeat chemical or biological sites ... while simultaneously neutralizing released chem-bio agents;
- Reduced residual radiation warheads.⁵⁶

The 9/11 attacks brought concerns about nuclear terrorism to the fore, and raised questions about the link between nuclear weapons and deterrence of rogue states and terrorists. According to the Nuclear Posture Review of December 2001,

Greater flexibility is needed with respect to nuclear forces and planning than was the case during the Cold War. The assets most valued by the spectrum of potential adversaries in the new security environment may be diverse and, in some cases, US understanding of what an adversary values may evolve. Consequently, although the number of weapons needed to hold those assets at risk has declined, US nuclear forces still require the capability to hold at risk a wide range of target types.⁵⁷

⁵⁵ A reentry body, also called a reentry vehicle or aeroshell, is the cone-shaped device that contains a single warhead and protects it from heat and other stresses as it reenters the atmosphere on the way to its target.

⁵⁶ Threat Reduction Advisory Committee. Nuclear Deterrent Transformation Panel. *Underground Nuclear Testing: Issues Regarding Resumption*, approved for limited distribution, October 2003, updated for general distribution, March 2005, p. 6.

⁵⁷ *Nuclear Posture Review [Excerpts]*, submitted to Congress on 31 December 2001, at [<http://www.globalsecurity.org/wmd/library/policy/dod/npr.htm>].

The treaty's opponents see another value in testing. According to Vice Admiral Robert Monroe (USN, Ret.), former Director of Defense Nuclear Agency, "an ongoing underground nuclear test program adds immensely to the credibility of the U.S. deterrent. Conversely, failure to test virtually destroys the credibility of our nuclear forces. A nation which lacks the strength to test nuclear weapons will almost surely lack the strength to use them."⁵⁸

CTBT supporters hold that current nuclear weapons suffice for deterrence; no adversary leader would gamble that they would not work, or that the United States would not use them if severely provoked. At the same time, supporters see nuclear weapons as most unlikely to be used, regardless of their characteristics or yield, because of the norm that has built up since 1945 against their use. Current nuclear weapons deterred a Russian or Chinese nuclear attack during the Cold War, it is argued, and will continue to do so, especially as the probability of such attack must be judged as remote. U.S. conventional forces, the treaty's supporters claim, deter threats from other nations. Use of these forces is credible, they can be precisely targeted, and they would create very much less collateral damage than nuclear weapons.

Further, it is argued, adversaries could readily counter new U.S. nuclear capabilities. Nuclear weapons to destroy chemical or biological weapons could be defeated by placing the weapons deep underground; even earth penetrator weapons could not destroy them because the heat and radiation of the blast would not reach down that far. More simply, the weapons could be moved to nondescript buildings in cities or to caves in rural areas; U.S. intelligence, in this view, could locate few if any sites. Earth penetrators could be defeated by deeper burial, greater hardening, tunneling under a mountain, or dispersing assets to secret aboveground locations.

The treaty's proponents see several congressional actions as implying that Congress would not support testing to develop new weapons. In the last several years, Congress terminated the "bunker buster" Robust Nuclear Earth Penetrator (RNEP)⁵⁹ and the Advanced Concepts Initiative, widely but erroneously thought to be developing a "mini-nuke." It specified in the FY2006 National Defense Authorization Act that an objective of the RRW program was to further reduce the likelihood of a return to testing. It eliminated FY2008 funding for RRW.

Do U.S. Warheads Require New Surety Features? Is Nuclear Testing Needed to Add Them?

While there are several definitions, surety is here taken to include safety, security, use control, and use denial. *Safety* involves protecting a warhead against accidental detonation; *security* is handled through a layered approach that includes everything from warhead features to physical security; *use control* permits authorized

⁵⁸ Personal correspondence, November 26, 2007, and January 29, 2008.

⁵⁹ For a discussion of congressional handling of RNEP, see Jonathan Medalia, "Water Power: Why Congress Zeroed 'Bunker Buster' Appropriations," *Comparative Strategy*, no. 26, 2007, pp. 231-248.

persons to use a warhead only at the direction of the national command authority; and *use denial* prevents any unauthorized use of a nuclear weapon. Surety has always been the most important characteristic in nuclear weapons design, and its technology has constantly improved, such as with several generations of permissive action links that require a user to enter a code in order to arm the weapon, and with various safety enhancements. During the Cold War, nuclear testing was routine, so the question of whether testing was essential for incorporating these features was moot.

In 1999, CTBT opponents argued that new surety features could and should be added to U.S. warheads, and could only be added through nuclear testing. In 1997, Siegfried Hecker, then Director of Los Alamos, testified that “with a CTBT it will not be possible to make some of the potential safety improvements for greater intrinsic warhead safety that we considered during the 1990 time frame.”⁶⁰ Robert Barker, former Assistant to the Secretary of Defense for Atomic Energy, said in 1999, “Of the nine types of weapons that will remain in the inventory only three types have all three of the most modern safety features while three types have only one such feature. These safety deficiencies will remain as long as we cannot conduct the necessary nuclear tests.”⁶¹ Secretary of Energy Richardson, in contrast, stated, “Seven years after our last underground test our stockpile of nuclear weapons is safe and reliable. Three times since 1996 the Secretary of Energy and the Secretary of Defense have certified this to the President.... Our nuclear deterrent will continue to be safe and reliable under the Comprehensive Test Ban Treaty.”⁶²

Also at issue was the need for new surety features. Sidney Drell, emeritus professor of physics at Stanford University, said in 1999,

I did not support the CTBT then [in 1990]. I thought of some further safety improvements. I presented some arguments.

First of all, the Department of Defense had zero interest. It wanted to spend no money on making them. Second, some of the problems have been retired. Others have been altered by handling procedures in the Navy, and they have satisfied themselves and the Department of Defense that the safety requirements are safe and sound now.⁶³

⁶⁰ S.S. Hecker, “Answers to Senator Kyl’s questions,” attachment to letter from S.S. Hecker, Director, Los Alamos National Laboratory, to Honorable Jon Kyl, September 24, 1997, in U.S. Congress. Senate. Committee on Governmental Affairs. Subcommittee on International Security, Proliferation, and Federal Services. *Safety and Reliability of the U.S. Nuclear Deterrent*. Senate Hearing 105-267, 105th Congress, 1st Session, 1997, p. 84.

⁶¹ *SASC CTBT hearings*, 1999, p. 175.

⁶² “Prepared Statement by Secretary Bill Richardson,” in *SASC CTBT hearings*, 1999, p. 109.

⁶³ *SASC CTBT hearings*, 1999, p. 180.

Others took the opposite view. Bailey and Barker argued, “Given the increasing threat of terrorism, it would seem prudent to ensure that U.S. nuclear weapons are as safe, secure, and invulnerable to unauthorized use as possible.”⁶⁴

In the wake of 9/11, surety has become even more important. As Linton Brooks said in 2005, “We now must consider the distinct possibility of well-armed and competent terrorist suicide teams seeking to gain access to a warhead in order to detonate it in place.”⁶⁵ The prompt response, adding physical security, has been costly. Added use-denial features could reduce the burden on guard forces.

Surety features, it is argued, would enhance deterrence, though in a different way than during the Cold War. One form of nuclear attack would be for suicide terrorists to seize a U.S. nuclear weapon and detonate it in place; another would be for terrorists to seize a U.S. nuclear weapon, dismantle it, and use its fissile material to build a weapon. It is difficult at best to deter terrorists by threatening to use nuclear weapons to destroy a city or training camp in response to a terrorist nuclear attack; they might view U.S. nuclear use as desirable if it turned many nations against the United States. Instead, it is hoped, enhanced surety features would deter attack by creating an unacceptable consequence, namely a high probability of failure. In addition, if such attacks were to occur, enhanced surety might defeat them.

Weapon designers and NNSA argue that the WR1 design shows that surety features can be added without testing, and see RRW as essential to obtaining them. Livermore states that the relaxation of weight constraints for WR1, for example, has allowed a design that incorporates revolutionary advances in safety and security without nuclear testing.⁶⁶ In contrast, according to NNSA testimony, “[m]ajor enhancements in security are not readily available through system retrofits via the LEP approach.”⁶⁷

CTBT supporters dismiss enhanced surety as an argument for testing. They see current weapons as safe enough, as shown by 12 assessments and the absence of accidental U.S. nuclear detonations. They see a goal of as much surety as possible as a recipe for unending generations of weapons to add new features. They also see scenarios involving terrorist seizure and detonation of U.S. warheads as far-fetched because of physical security measures, and feel that such measures could be enhanced

⁶⁴ Kathleen Bailey and Robert Barker, “Why the United States Should Unsign the Comprehensive Test Ban Treaty and Resume Nuclear Testing,” *Comparative Strategy*, no. 22, 2003, p. 132.

⁶⁵ “Statement of Ambassador Linton F. Brooks, Administrator, National Nuclear Security Administration, U.S. Department of Energy, Before the Senate Armed Services Committee, Subcommittee on Strategic Forces,” April 4, 2005.

⁶⁶ Information provided by Lawrence Livermore National Laboratory, personal communication, May 10, 2007.

⁶⁷ “Statement of Thomas P. D’Agostino, Acting Under Secretary for Nuclear Security and Administrator, National Nuclear Security Administration, U.S. Department of Energy, Before the Committee on House Armed Services [sic], Subcommittee on Strategic Forces,” March 20, 2007, p. 4.

to add surety if needed. They doubt that new surety features that can be added only by testing are so critical as to warrant testing.

CTBT opponents favor the most surety possible in light of the terrorist threat, and hold that more surety features can be added with testing than without. While it is possible to add guns, gates, and guards, so doing would be very costly. They maintain that current warheads are not as safe and secure as possible, and argue that their surety can only be increased through testing. While RRW offers more advanced surety features than do current warheads, CTBT opponents hold that the United States can never know if these features will work without testing. They see testing as needed also to reveal if new surety features on existing warheads or RRWs would impact performance.

Does the Treaty Provide Adequate Protection Against Cheating?

Monitoring and verification have been central to the debate and negotiations on nuclear test bans for a half-century.⁶⁸ While the terms are often used interchangeably, there is a difference. Monitoring involves looking for indicators that a nuclear test has taken place. It is a dynamic contest between hiders and seekers, with CTBT supporters showing that monitoring capability is improving and treaty opponents raising doubts about that capability and claiming that evasion capability is improving.

Verification, literally “truth making,” involves deciding whether a nation is in compliance with its treaty obligations. At issue is not perfect verification but effective verification. In 1988, Paul Nitze offered a widely-used definition: by effective verification, “[w]e mean that we want to be sure that, if 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 side the benefit of the violation.”⁶⁹ Thus monitoring is a technical activity that provides data, while verification uses the data to form judgments on compliance. It is for this reason that the CTBT establishes an International *Monitoring* System and leaves it to individual nations to determine whether a nation has violated the treaty.

Monitoring capability, the military value of clandestine tests, and effective verification are linked. If, as a hypothetical example, tests above 0.1 kiloton had significant military value and the threshold of detection was 10 kilotons, the CTBT could not be effectively verified, but it could be if the numbers were reversed. Thus CTBT opponents claim the threshold for detection is high and that for military value

⁶⁸ For discussions of test ban monitoring and verification issues up to the early 1960s, see Harold Karan Jacobson and Eric Stein, *Diplomats, Scientists, and Politicians: The United States and the Nuclear Test Ban Negotiations*, Ann Arbor, University of Michigan Press, 1966, 538 p.; and Benjamin Greene, *Eisenhower, Science Advice, and the Nuclear Test-Ban Debate, 1945-1963*, Stanford, CA, Stanford University Press, 2007, 358 p.

⁶⁹ U.S. Congress. Senate. Committee on Foreign Relations. *The INF Treaty*. S.Hrg. 100-522, pt. 1, 100th Congress, 2nd Session, 1988, part 1, p. 289.

is low; supporters make the opposite claim. Accordingly, the following section examines what the treaty bans; describes several monitoring technologies and arguments about their capabilities and weaknesses; considers whether clandestine testing would confer military advantages; and discusses risks a nation might run if it is caught cheating.

The public 1999 debate on ratification did not go into detail on the technical ability to monitor the CTBT. For example, no scientists with primary expertise in a monitoring technology testified in Senate hearings on the treaty. However, members and staff received extensive classified briefings from scientists from the national laboratories and from the intelligence community.⁷⁰ Since 1999, scientists have made many advances in detection capability that have been widely published. The most important technical report on monitoring was prepared in 2002 by the National Academy of Sciences (NAS).⁷¹ It is generally favorable to the treaty. Two other overviews of technical progress prepared in 2007 also favor the treaty.⁷² Many journal articles discuss specific technical advances. In contrast, few if any unclassified technical reports rebut claims of progress in monitoring. Nevertheless, CTBT opponents have developed many arguments, so any future debate on monitoring is likely to be less lopsided than one might infer from the imbalance in writing.

What Does the Treaty Ban?

Article I of the CTBT sets out the treaty's basic obligation: "Each State Party undertakes not to carry out any nuclear weapon test explosion or any other nuclear explosion...." The treaty does not define "nuclear explosion." Yet it is physically possible to conduct tiny nuclear explosions that cannot be detected without cooperative measures. For example, the United States conducted several dozen "hydronuclear" tests, many releasing fission energy equivalent to less than a gram of high explosive, during the 1958-1961 nuclear test moratorium.⁷³ As discussed later, some see the prospect of undetected tests of very low yield as a concern. As a result, a point of contention in the 1999 debate was whether the treaty barred very low yield tests. Some CTBT critics argued that Russian and U.S. definitions of zero differed. Senator Richard Shelby referenced "public statements from the Russian First Deputy Minister of Atomic Energy that Russia intends to continue to conduct low-yield hydronuclear tests and does not believe that these constitute nuclear tests prohibited

⁷⁰ Personal communication, Bureau of Verification, Compliance, and Implementation, U.S. Department of State, January 25, 2008.

⁷¹ *NAS report*.

⁷² David Hafemeister, "Progress in CTBT Monitoring Since Its 1999 Senate Defeat," *Science and Global Security* 15, 2007, pp. 151-183; and Raymond Jeanloz, "Comprehensive Nuclear-Test-Ban Treaty and U.S. Security," paper prepared for delivery at conference, "Reykjavik Revisited: Steps Toward a World Free of Nuclear Weapons," Hoover Institution, Stanford University, October 24-25, 2007.

⁷³ Robert Thorn and Donald Westervelt, "Hydronuclear Experiments," Los Alamos National Laboratory, LA-10902-MS, UC-2, February 1987, p. 4-5.

by the treaty.”⁷⁴ In this view, then, Russia might conduct militarily useful low-yield nuclear tests and still consider itself as observing the CTBT.

Administration officials responded that all parties understood the treaty was zero yield. Under Secretary of State John Holum said that the treaty “does ban any nuclear test explosion or any other nuclear explosion, and in the negotiating record it is very clear that that means there cannot be any critical yield from a nuclear event. You can do things that do not go critical; you cannot do things that do.”⁷⁵ ⁷⁶ Ambassador Stephen Ledogar, who retired from the Foreign Service in 1997 and was the chief negotiator for the CTBT under Presidents Reagan, Bush, and Clinton, elaborated:

As the name suggests, the treaty imposes a comprehensive ban on all nuclear explosions, of any size, in any place. I have heard some critics of the treaty seek to cast doubt on whether Russia, in the negotiating and signing of the treaty, committed itself under treaty law to a truly comprehensive prohibition of any nuclear explosion, including an explosion or experiment or event of even the slightest nuclear yield. In other words, did Russia agree that hydronuclear experiments which do produce a nuclear yield, although usually very, very slight, would be banned and that hydrodynamic explosions, which have no yield because they do not reach criticality, would not be banned.

⁷⁴ *SFRC CTBT hearing, 1999*, p. 56.

⁷⁵ *SFRC CTBT hearing, 1999*, p. 99.

⁷⁶ This paragraph explains terms and concepts relevant to the question of what is a nuclear explosion. A fissile material is one whose atoms split (fission) when struck by a neutron regardless of its speed; uranium-235 and plutonium are the fissile materials used in atomic bombs. Each nuclear fission releases a tiny amount of energy, as well as two or three neutrons. A self-sustaining nuclear chain reaction occurs if the number of neutrons produced by fission equals the number of neutrons that escape the material or are absorbed within it without causing further fissions. “Criticality” is the point at which this chain reaction occurs; a “critical mass” is the amount of fissile material just enough to support criticality. The amount of material for a critical mass depends on many factors, such as shape, density, impurities that absorb neutrons, and use of material to reflect neutrons back into the fissile material. A nuclear reactor is an example of a critical chain reaction; it releases energy in a controlled manner. In contrast, a chain reaction in which the number of neutrons generated increases over time is said to be supercritical; an atomic bomb exemplifies a supercritical chain reaction, releasing a vast amount of energy in a tiny fraction of a second. The energy released is expressed as yield. It is typically measured in kilotons, where one kiloton equals the energy released by the explosion of 1,000 tons of TNT; modern nuclear weapons typically have yields in the range of tens to hundreds of kilotons. In contrast, several types of experiments producing little to no nuclear yield have been conducted over the years. Hydronuclear experiments were conducted during the 1958-1961 nuclear test moratorium. They initially used less than a critical mass of fissile material; as the amount of this material was stepped up toward criticality from one experiment to the next, some of these experiments resulted in the release of tiny amounts of energy from fission, even as little as a gram of TNT equivalent or less. Hydrodynamic experiments implode a pit (the first stage or “trigger” of a nuclear weapon) in order to examine how the pit behaves; these experiments use non-fissile material as a surrogate for fissile material, so they cannot become critical. Subcritical experiments examine how plutonium behaves when subjected to a spike in pressure, such as when struck by an explosive-driven metal plate. The plutonium is configured in a way, such as by its shape and quantity, that it cannot go critical.

The answer is a categorical “yes.” The Russians as well as the rest of the P-5 [China, France, Russia, the United Kingdom, and the United States, the permanent five members of the U.N. Security Council] did commit themselves. That answer is substantiated by the record of the negotiations at almost any level of technicality and national security classification that is desired and permitted. More importantly, for the current debate, it is also substantiated by the public record of statements by high level Russian officials as their position on the question of thresholds evolved and fell into line with the consensus that emerged.⁷⁷

The issue remains unresolved. In a 2007 letter, the State Department stated:

the Department of State is not aware of any international agreement on what “zero” yield means. During the negotiation of the Treaty, the P-5 reached an understanding that subcritical nuclear experiments would not be prohibited under the Treaty. The United States also made clear that, in its view, supercritical nuclear explosive-driven device tests would be prohibited under the Treaty. However, there was no agreement among the P-5 that criticality would be the basis for determining which activities would be permitted under the CTBT and which activities would not be permitted. Therefore, it is left to the individual State Party to decide for itself whether a test that produced more than a zero yield would violate the Treaty.⁷⁸

How Capable Is the CTBT Monitoring Regime?

Monitoring Systems and Methods. Because of concerns that states parties to the CTBT could cheat and thereby change the strategic balance, the ability to monitor the treaty has always been an integral part of the debate over the treaty. Monitoring has always been more difficult for underground nuclear tests than for tests in other environments. Radioactive particles in the atmosphere (fallout) are readily detectable in trace amounts. Sound waves in the oceans travel great distances. Tests in space can be detected by national technical means. It is for this reason that the LTBT banned tests only in the atmosphere, in space, and under water. Accordingly, much of this section focuses on detection, and evasion of detection, of underground tests. This section presents a technical background and contending views for several monitoring technologies.

The treaty contains complex provisions in an effort to monitor compliance with its basic obligation of conducting no nuclear explosions. It establishes a Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) that would begin operation upon the treaty’s entry into force. Its elements are a Conference of States Parties; an Executive Council to promote implementation of, and compliance with, the treaty; and a Technical Secretariat for monitoring. The secretariat is deploying an International Monitoring System (IMS) to detect nuclear tests;⁷⁹ an International

⁷⁷ *SFRC CTBT hearing, 1999*, pp. 16-17.

⁷⁸ Enclosure, in letter from Jeffrey T. Bergner, Assistant Secretary, Legislative Affairs, U.S. Department of State, to The Honorable Jon Kyl, United States Senate, August 9, 2007.

⁷⁹ For a map of IMS stations, at [<http://www.ctbto.org>] see Verification Regime > (continued...)

Data Center (IDC) to analyze data and disseminate the results to member states; and a Global Communications Infrastructure to transmit data to, and reports from, the IDC. The treaty provides for on-site inspections (OSIs) if 30 of the 51 Executive Council members approve. In 1996, the signatory states established a Preparatory Commission for the CTBTO to implement the organization, the IMS, and the IDC, and to prepare for OSIs, so that the CTBTO would be fully operational upon the treaty's entry into force.

The treaty calls for the IMS to have 321 stations worldwide to monitor signals that might indicate a nuclear explosion: 170 seismic stations to monitor seismic waves in the Earth; 11 hydroacoustic stations to monitor underwater sound waves; 60 arrays of infrasound detectors to monitor very low frequency sound waves in the atmosphere; and 80 radionuclide stations to detect radioactive particles that a nuclear explosion might produce; as well as 16 radionuclide laboratories to analyze radioactive samples. Of the seismic stations, 50 are to be primary stations to provide data to IDC continuously and in real time, while 120 are to be auxiliary stations to provide data when requested by the IDC. As of November 26, 2007, 37 primary seismic stations, 76 auxiliary seismic stations, 10 hydroacoustic stations, 37 infrasound arrays, 47 radionuclide stations, and 9 radionuclide laboratories had been certified. That is, they are completed and meet the technical requirements of the Preparatory Commission. They transmit data automatically and continuously to the IDC, excepting for the auxiliary stations and the radionuclide laboratories, which transmit data as requested by the IDC.⁸⁰

The United States has operated its own system to detect nuclear tests since the 1940s. The present system, the U.S. Atomic Energy Detection System (USAEDS), is operated by the Air Force Technical Applications Center (AFTAC). AFTAC states that USAEDS is a "global network of nuclear event detection sensors" including underground, underwater, atmospheric, and space sensors.⁸¹ NNSA provides technical support for satellite- and ground-based nuclear explosion monitoring. Other organizations are conducting research on nuclear explosion monitoring as

⁷⁹ (...continued)

Monitoring Facilities > Map of Facilities.

⁸⁰ Information provided by Annika Thunborg, Chief, Public Information, Comprehensive Nuclear-Test-Ban Treaty Preparatory Commission, personal communication, November 26, 2007.

⁸¹ U.S. Air Force. Intelligence, Surveillance, and Response Agency. "Fact Sheet: Air Force Technical Applications Center." June 2007. [<http://www.afisr.af.mil/library/factsheets/factsheet.asp?id=10309>].

well.⁸² While 21 USAEDS seismic stations were part of IMS as of August 2007⁸³ (i.e., they provide data to IDC), USAEDS also has other capabilities, such as detectors on satellites, that are not part of IMS. USAEDS and IMS are to some extent complementary. USAEDS, as a national system, focuses on areas of concern to the United States; IMS, as an entity of an international treaty, maintains a worldwide detection network so no nation feels singled out for special monitoring attention. IMS makes available to all states signatories, including the United States, data from its network; some data are from sites that the United States could not access. Further, IMS data may be more credible to some of those nations than data from USAEDS. The former come from a transparent, internationally-controlled system, while USAEDS data might be less convincing to Executive Council members if they suspected that the United States was releasing information selectively or if the sensors and resulting data were unfamiliar and thus difficult for some council members to interpret. As the State Department said, “In the case of the DPRK [North Korean] test, several countries have noted that the combination of IMS and IDC data and analysis with U.S. national data and analysis provided them with greater confidence in assessing the event than would have been the case with the U.S. data and analysis alone.”⁸⁴ In addition to IMS and USAEDS, academic institutions and national governments operate thousands of other seismic stations worldwide.⁸⁵ Some of these stations may feed information to IDC on an ad hoc basis.

There is general agreement that IMS will be able to detect most *nonevasive* tests at 1 kiloton or less. C. Paul Robinson, then director of Sandia National Laboratories, said in 1999, “The detection threshold that was used informally by treaty negotiators as an unofficial target for the IMS was about 1 kiloton, non-evasively tested, in environments other than outer space. Although IMS coverage will not be uniform over the entire globe, it is expected to generally achieve that informal target.”⁸⁶ A National Academy of Sciences report places the threshold for nonevasive underground tests at “significantly better than 1 kt [kiloton]” and says, “For most of Europe, Asia, and Northern Africa, the detection threshold is down in the range from 30 to 60 tons [i.e., 0.03 to 0.06 kilotons] in hard rock.”⁸⁷ The detection of the 2006 North Korean nuclear test, with a yield the United States placed at less than a

⁸² These organizations include the Air Force Research Laboratory, the Army’s Space and Missile Command, the Office of Naval Research, the Special Geology Program of the U.S. Geologic Survey, and the U.K. Atomic Weapons Establishment’s Forensic Seismology Group. In addition, other organizations are conducting research relevant to nuclear explosion monitoring. Information provided by Bureau of Verification, Compliance, and Implementation, U.S. Department of State, personal communications, February 1 and 4, 2008.

⁸³ Letter from Jeffrey T. Bergner, Assistant Secretary, Legislative Affairs, U.S. Department of State, to The Honorable Jon Kyl, United States Senate, August 9, 2007, enclosure, answer to question 2.

⁸⁴ *Ibid.*, answer to question 9.

⁸⁵ See, for example, Incorporated Research Institutions for Seismology, “Stations & Instrumentation,” available at [<http://www.iris.edu/stations/>].

⁸⁶ *SASC CTBT hearings, 1999*, p. 131.

⁸⁷ *NAS report*, p. 42.

kiloton,⁸⁸ by IMS and non-IMS stations supports the claim of a low detection threshold for nonevasive underground tests.

Seismic technology. Seismology has been used for decades to detect and differentiate between earthquakes and explosions, though it is very difficult for seismology to differentiate between conventional and low-yield nuclear explosions. Earthquakes and explosions generate many types of seismic waves that propagate through the Earth. Various techniques are used to obtain more information from these waves. For example, seismic arrays are typically groups of 5 to 30 seismometers spread out over several square kilometers linked to a central point.⁸⁹ Because of the distance between seismometers, seismic waves from an event arrive at each seismometer at slightly different times. These differences can be used to calculate the direction from which the waves arrived. This technique has been in use for decades.

Other techniques also help extract information. Some seismic waves are teleseismic, detected even at distances over 9,000 km.⁹⁰ For example, an IMS station in South America detected seismic waves from the 2006 North Korean nuclear test.⁹¹ Some teleseismic waves travel along the Earth's surface, while others travel through the interior. Of the latter, some are shear waves; an earthquake generates them strongly as the two sides of a fault slide past each other. Others are pressure waves; an explosion generates them strongly as the pressure of an explosion radiates outward. The appearance of shear and pressure waves on a seismogram differs, giving a clue whether an event is an earthquake or explosion. Another difference is that the first waves from an explosion arrive suddenly, while those from an earthquake build up over a short time. More recently, regional seismic waves have come into use to differentiate between earthquakes and explosions. These waves are generally observed at distances of up to 2,000 km; they can often be detected even when teleseismic waves from an event cannot be.

The direction from which seismic waves from an event arrive at multiple seismic stations around the world can be used to determine the approximate location of the event. The magnitude of seismic waves can also be used to calculate the yield of an explosion, though with considerable uncertainty. The CTBT limits the area of an OSI to 1000 sq. km,⁹² and the CTBTO Preparatory Commission stated that in the case of the North Korean nuclear test, "analysis of all available data allowed for the

⁸⁸ U.S. Office of the Director of National Intelligence. Public Affairs Office. "Statement by the Office of the Director of National Intelligence on the North Korea Nuclear Test," ODNI news release no. 19-06, October 16, 2006.

⁸⁹ *NAS report*, p. 40.

⁹⁰ *NAS report*, p. 39.

⁹¹ "The CTBT Verification Regime Put to the Test — The Event in the DPRK on 9 October 2006," Comprehensive Nuclear-Test-Ban Treaty Preparatory Commission, 2007, available at [http://www.ctbto.org/press_centre/featured_articles/2007/2007_0409_dprk.htm].

⁹² Protocol to the Treaty, Part II, On-Site Inspections, Section A, General Provisions, Paragraph 3.

identification of a potential inspection area of considerably less than 1000 square kilometers” despite the low yield of the explosion.⁹³

Contending views. CTBT critics point to “decoupling” as a method of evading seismic detection. It dates from the late 1950s.⁹⁴ This technique involves setting off a blast in an underground cavity large enough to absorb the force of the blast elastically, thus muffling the resulting seismic signal. Critics point to a 1966 decoupling experiment conducted in a salt dome in Mississippi in which a 0.38 kiloton explosion generated a seismic signal that appeared to be from an explosion one-seventieth as large.⁹⁵ Larry Turnbull of the Central Intelligence Agency said,

In judging whether this evasion scenario is credible, both the feasibility of constructing a large cavity and of containing the debris from the nuclear explosions must be examined ... construction of large cavities in both hard rock and salt is feasible, with costs that would be relatively small compared to effort to produce the material for a nuclear device ... containing both particulate and gaseous debris is feasible in salt, and more difficult — though not impossible — in hard rock. Therefore, we judge that the cavity decoupling evasion scenario to be credible and should be factored into any underground CTB monitoring.⁹⁶

CTBT supporters respond that while decoupling works for very low yield explosions, it is much harder for larger ones. The National Academy of Sciences (NAS) report raised ten difficulties in conducting a decoupled test, such as constructing a cavity clandestinely, predicting the signals from the test, ensuring that the yield of the device is not greater than planned, and containing radionuclides. It finds, “Accepting the possibility of a cavity decoupled test, we conclude that such an underground nuclear explosion cannot be reliably hidden if its yield is larger than 1 or 2 kilotons.”⁹⁷

CTBT critics believe that decoupling could be concealed. Kathleen Bailey, former Assistant Director for Nuclear and Weapons Control, Arms Control and Disarmament Agency, and Robert Barker, former Assistant to the Secretary of Defense for Atomic Energy, reject the claim that the earth and rock removed to create a cavity would be an indicator of decoupling: “In India, where the very test site used had been closely observed, no such activity was detected prior to a nuclear test.”⁹⁸ CTBT advocates respond that this example is not a valid indicator of U.S. capability to detect the excavation for decoupling because the test was not decoupled, and a decoupled test would require excavation of far more material. For example, a cavity

⁹³ CTBTO Preparatory Commission, “The CTBT Verification Regime Put to the Test.”

⁹⁴ See Jacobson and Stein, *Diplomats, Scientists, and Politicians*, pp. 151-154.

⁹⁵ *NAS report*, p. 46.

⁹⁶ Larry Turnbull, Central Intelligence Agency, “U.S. Monitoring Goals for the Comprehensive Test Ban Treaty,” address to the Council on Foreign Relations, March 16, 1998, in *SASC CTBT hearings, 1999*, p. 204; see also p. 200.

⁹⁷ *NAS report*, pp. 47-48.

⁹⁸ Bailey and Barker, “Why the United States Should Unsign the Comprehensive Test Ban Treaty and Resume Nuclear Testing,” p. 135.

37 meters in radius would be needed to decouple a 3-kiloton device, with a volume of 212,175 cubic meters. In contrast, a shaft 10 feet in diameter and 600 feet deep, possible dimensions for a non-decoupled 3-kiloton test, has a volume of 1,327 cubic meters.⁹⁹ CTBT opponents reply that excavated material may not be observed by satellites if someone wants to hide the fact that digging is occurring. Material could be removed when satellites are not overhead, or it could be moved underground in existing tunnels. Aqueous excavation could be used to create large cavities in salt domes. In particular, according to the State Department, “Iran presents particular challenges from a seismic detection perspective. Iran’s vast numbers of salt domes offer an effective decoupling environment, making detection particularly difficult in the absence of close-in sensors.”¹⁰⁰

Supporters of the treaty point to numerous advances in seismological capability that would help monitor the CTBT. Foremost is the ongoing rollout of the IMS; many of its seismic (and other) stations around the globe provide data to IDC in real time. As the IMS is an international system, many of its stations are in areas that the United States could not access, such as in Iran. Further, it is important that the seismic stations will contribute regional as well as teleseismic data because regional data is of particular value in detecting low-yield tests and decoupling. One source states, “Regional waves enhance the ability to detect cavity decoupling because higher frequency waves are more observable at regional distances and decoupling is smaller at higher frequencies ... compared to teleseismic waves ...”¹⁰¹ Regional stations have proven more valuable than was expected; according to U.K. seismologists,

When the IMS was negotiated, the rationale for auxiliary seismic stations [those that provide data only when interrogated, not on a continuous basis, to the International Data Center] was that these stations would improve the ability of the IMS to locate seismic events, and to more finely characterize the seismic source. With the ongoing deployment of the IMS, seismologists have discovered that the auxiliary stations are of particular value for identifying the source of a seismic signal as an earthquake or explosion because they pick up certain seismic waves that can be used in identification. In addition, it has turned out that having many seismic stations, such as those in individual national or university networks, complements the IMS stations and increases the availability of data.¹⁰²

⁹⁹ Source for radius of a spherical cavity for full decoupling: “The Soviet Union carried out a partially decoupled test of about 8 to 10 kt in 1976, in a cavity (in salt) of mean radius 37 m (sufficient to fully decouple about 3 kt).” *NAS report*, p. 46. Source for dimensions of a shaft: According to one report, “[underground] tests are conducted in vertical drill holes up to 10 feet in diameter and from 600 ft to more than 1 mile deep.” U.S. Congress. Office of Technology Assessment. *The Containment of Underground Nuclear Explosions*. OTA-ISC-414, October 1989, p. 16. Note that the diameter of the shaft depends on the drilling equipment used, not on the yield of the device.

¹⁰⁰ Letter from Jeffrey T. Bergner, Assistant Secretary, Legislative Affairs, U.S. Department of State, to The Honorable Jon Kyl, United States Senate, August 9, 2007, enclosure, answer to question 9.

¹⁰¹ Hafemeister, “Progress in CTBT Monitoring Since Its 1999 Senate Defeat,” p. 160.

¹⁰² Information provided by seismologists at the U.K. Atomic Weapons Establishment, (continued...)

CTBT supporters note that other signatures in addition to characteristics of seismic waves help differentiate between earthquakes and explosions. Finding that the epicenter of an event is more than 10 km deep rules out an explosion, as does finding the epicenter at sea in the absence of hydroacoustic waves indicative of an explosion. Other characteristics specific to local geology aid determining whether an event is an earthquake or explosion. The CTBTO Preparatory Commission states that IMS stations around the world detected the North Korean nuclear test of 2006, and IMS was able to locate the test to well under 1000 square km. As another indicator, the seismic record shows a clear difference between that explosion and an earlier earthquake. According to seismologists Paul Richards and Won-Young Kim,

The seismogram of 9 October [2006, the North Korean test] has three important features. First, it shows an impulsive onset of compressional waves ... characteristic of an explosion. Second, peaks indicative of shear waves in the [Earth's] crust, which would be typical of an earthquake, are very weak ... And third, short-period 'Rayleigh waves' are apparent. They ... are known to be excited only by sources at a depth not much more than about 3 or 4 km, which is much shallower than typical earthquakes.¹⁰³

Critics point to evasive tactics and weaknesses in seismic monitoring that open prospects for clandestine testing. Yield can be calculated from the magnitude of seismic waves. Yet many factors affect the intensity of seismic signals in addition to the yield of a nuclear device. The NAS report states, "[regional] waves are dependent on local properties of the Earth's crust and uppermost mantle — which can vary strongly from one region to another."¹⁰⁴ For example, a device detonated in soft rock can have ten or more times the yield as one detonated tamped (fully coupled) in hard rock, yet the seismic signals from each can indicate the same apparent yield because soft rock transmits seismic energy much less efficiently than does hard rock.¹⁰⁵ An evader, knowing this from the unclassified literature, would consider this difference in selecting a test site. While CTBT supporters note that regional seismic signals can aid in detecting lower-yield nuclear detonations, opponents reply that Russia and China did not permit IMS stations to be located within hundreds of kilometers of their nuclear test sites, at Novaya Zemlya and Lop Nor, respectively. The closest IMS station is 1,112 km from Novaya Zemlya, and 783 km from Lop Nor. In contrast, the three IMS stations closest to the Nevada Test Site (NTS) are at distances of 249, 380, and 417 km.¹⁰⁶ The State Department observes,

¹⁰² (...continued)

personal communication, October 11, 2007.

¹⁰³ Paul Richards and Won-Young Kim, "Seismic Signature," *Nature Physics*, January 2007, p. 5. For a seismogram of the North Korean test, see CTBTO Preparatory Commission. "The CTBT Verification Regime Put to the Test."

¹⁰⁴ *NAS report*, p. 39.

¹⁰⁵ *NAS report*, pp. 41-42.

¹⁰⁶ U.S. Department of State. Bureau of Verification, Compliance, and Implementation. "Response to Medalia Questions of 27 Nov [2007]." January 14, 2008. Hereinafter "Response to Medalia Questions."

There is no doubt that we would be better off if we had close-in seismographs around Lop Nor and Novaya Zemlya. If IMS were allowed to install three seismographs surrounding Lop Nor at the distances similar to those surrounding the NTS, it would be much easier not only to detect smaller events, but also to identify the nature of smaller events and to determine a better location as well as the origin time.¹⁰⁷

Iran has numerous salt domes many hundred of miles from the IMS station near Teheran. Critics argue that Iran could easily create cavities for decoupling by using water to dissolve salt. It has extensive experience in drilling for oil, which is often found near salt deposits. As such, it is argued, it is well equipped to excavate cavities for decoupling. Further, much of Iran is seismically active, making it easier for Iran to conduct a test during an earthquake to mask the explosion's signals. Others respond that hiding a test in an earthquake requires holding the test in readiness, possibly for years, for the "right" earthquake to come along, and it may still be possible to distinguish signals from an earthquake from those of an explosion.

Other techniques can also reduce seismic signals from underground nuclear tests. Don Linger, Senior Scientific Advisor, Advanced Systems Concepts Office, Defense Threat Reduction Agency, and former director of the Defense Nuclear Agency's nuclear effects testing program, provided the following information.¹⁰⁸

One technique for reducing seismic signals is "geologic preconditioning." A nuclear test in hard rock will fracture or microfracture the surrounding rock to distances of several hundred meters, fragmenting it and changing the shock propagation and attenuation characteristics. As a result, a test conducted underground in a hard rock geology region in which a previous nuclear test was conducted will in effect be conducted in fragmented rock, which absorbs much more energy than undisturbed rock, weakening the seismic signal. This attenuation was observed in experiments using 100 tons of chemical explosive, conducted by the U.S. Departments of Defense/Defense Nuclear Agency (now the Defense Threat Reduction Agency) in a series of tests in Kazakhstan during the closing of the former Soviet Nuclear Test site in 1993 to 2002. Moreover, the Russian test site at Novaya Zemlya, which is comprised mainly of similar hard rock, has similar regions of preconditioned hard rock created by previous tests that could be used to muffle seismic signals of clandestine tests. This is a proven technology, clearly understood by the testing community.

A second technique to reduce seismic signals, "radiation spectrum tuning," is to reduce the radiation coupling of the nuclear device to the ground. The amount of energy that a nuclear device deposits into the surrounding geology is very sensitive to specifics of its radiation output spectrum, and strongly affects the manner in which the blast is coupled to the ground, causing large changes in the ground shock and seismic signature. Radiation spectrum is entirely different than yield. For a given test cavity, a 10-kiloton weapon with energy concentrated in the thousand-electron-volt range will produce a significantly lower seismic signal than a 10-kiloton weapon with electromagnetic energy concentrated in the tens-of-million-electron-volt range. Nuclear explosives have been designed with different energy spectra. For example, the U.S. Plowshare program of nuclear

¹⁰⁷ "Response to Medalia Questions."

¹⁰⁸ Information provided by personal interview and emails, December 3-13, 2007.

explosives for peaceful purposes, and the parallel Soviet program, developed nuclear explosive devices with energies concentrated in a part of the electromagnetic spectrum different than that of typical nuclear weapons.

CTBT proponents respond that geologic preconditioning may be of use to Russia or China, which have a “stockpile” of cavities left by nuclear test explosions, and possibly to India and Pakistan, which may have a few small cavities, but not to other nations. Opponents dismiss this argument because they view the prospect of Russian or Chinese covert testing as the greatest threat. Proponents, in turn, reply that the decoupling capability of geologic preconditioning would vary greatly depending on specifics of the surrounding rock and the extent of its fracturing, which would be extremely difficult to determine. Regarding radiation spectrum tuning, proponents ask if modifications to the test device that would be needed to reduce the seismic signature would interfere with the purpose of, and results from, the test so much as to diminish its value significantly.

Seismic monitoring entails other arguments. Critics state that the ability to detect lower-yield tests increases many-fold the number of seismic events that must be analyzed as possible nuclear tests. Supporters reply that improved seismic detection and data analysis capability rule out most such events as possible explosions, and that low-yield tests are of little military significance. Critics respond that low-yield explosions have military significance, as discussed below, and that it would be easier for IDC to miss a low-yield explosion among thousands of low-magnitude earthquakes than to miss a higher-yield explosion. Supporters retort that the North Korean test of October 2006 was clearly detected even though it had a yield of less than a kiloton; critics counter that it was not conducted evasively.

Detection of radioactive gases. Nuclear explosions generate a great variety of radioactive atoms, or radionuclides, some of which are gases. Of special interest are radioactive isotopes of noble gases, such as argon-37, krypton-85, xenon-131, and xenon-133. The background level of these gases is extremely low. Because noble gases are chemically inert, they do not bond with the rocks and soil surrounding an underground nuclear explosion. As a result, they work their way to the surface and disperse into the atmosphere, where they may be detected thousands of miles away. For example, the Automated Radioxenon Sampler/Analyzer, in use by IMS, concentrates and measures minute quantities of the isotopes of radioactive xenon.¹⁰⁹ Once a detection system has accumulated a data archive of background levels of radioactive noble gases, a spike above that level can indicate a release from a nuclear reactor or nuclear explosion. Computer models of global atmospheric conditions in the days before a spike can then be worked backwards to provide a general location of the source.

At entry into force of the CTBT, the IMS is to have 80 radionuclide stations around the world; all are to monitor radioactive particles and upon the treaty’s entry into force 40 of them would have capability to monitor radioactive noble gases.

¹⁰⁹ “Breakthrough Systems to Detect Nuclear Explosions Worldwide,” Pacific Northwest National Laboratory, press release, July 24, 1998, at [http://www.pnl.gov/news/1998/Bnw98_24.htm]. See also Hafemeister, “Progress in CTBT Monitoring Since Its 1999 Senate Defeat,” p. 168.

Sixteen laboratories would analyze samples from these stations. The CTBTO PrepCom states: “The relative abundance of different radionuclides in these [air] samples can distinguish between materials produced by a nuclear reactor and a nuclear explosion.... The presence of noble gases can indicate if an underground explosion has taken place.”¹¹⁰

Contending views. The treaty’s supporters claim that the 2006 North Korean nuclear test shows the value of noble gas monitoring and the capability of the IMS. An IMS radionuclide system at Yellowknife, Northwest Territories, Canada, collected samples two weeks after the test that, upon analysis, indicated a trace amount of xenon-133. By comparing this amount to data in its archive, analysts were able to determine that the level was elevated. By examining wind currents for the preceding two weeks, and data on releases from the Chalk River Laboratories, a Canadian nuclear research site several thousand kilometers southeast of Yellowknife, analysts were able to conclude that the xenon-133 was “consistent with a release from the location and time of the DPRK event.”¹¹¹

Opponents see numerous ways to evade detection of radioactive noble gases. They recognize that noble gases will reach the surface if there is no effort at containment, but believe containment can work. They point to a statement by Donald Barr, a retired Los Alamos radiochemist with over 50 years of nuclear testing and related experience: “Deep burial of a nuclear device, combined with gas blocking techniques, virtually eliminates the seepage of noble gases to the surface, though some such gases might occasionally be detected, but only at the surface above the detonation point.”¹¹² Burying a nuclear test device at greater depth than would be typically used for containment would also delay the time when these gases would reach the surface, providing more time for radioactive decay to reduce the amount reaching the surface. Certain geologies, such as salt domes, would more readily seal the cavity, blocking the escape of these gases.

CTBT supporters point to experimental data to buttress their claim that it is very difficult to contain noble gases following an underground nuclear explosion because they rise to the surface through faults or fractures, especially during periods of low barometric pressure.¹¹³ Opponents would note that the experiment in question used surrogate gases (sulfur hexafluoride and helium-3), not argon and xenon. Further, the report stated that the decay of argon-37 to chlorine-37 “will limit the sampling ‘window’ during which surface detection is possible,” and that “selecting the timing of a challenge inspection to include the arrival of weather fronts may be necessary

¹¹⁰ Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty, “Verification Technologies: Radionuclide,” at [<http://www.ctbto.org>], link to “Verification Regime” > “Monitoring Technologies” > “Radionuclide.”

¹¹¹ P.R.J. Saey et al., “A Long Distance Measurement of Radioxenon in Yellowknife, Canada, in Late October 2006,” *Geophysical Research Letters*, vol. 34, L20802, doi: 10.1029/2007FL030611, October 16, 2007, p. 5 of 5.

¹¹² Personal communication, November 21, 2007.

¹¹³ C.R. Carrigan et al., “Trace Gas Emissions on Geological Faults as Indicators of Underground Nuclear Testing,” *Nature*, vol. 382, August 8, 1996, pp. 528-531.

to optimize the possibility of detection.”¹¹⁴ An evader, knowing this, might try to delay inspections beyond the time such a front is due to arrive.

Detection of radioactive particles. Underground nuclear explosions may vent radioactive particles (fallout) into the atmosphere, where they may travel for thousands of miles, depending on wind, rain, particle size, and other factors. Fallout analysis has provided a clear indication of a nuclear test for many decades. For example, the United States learned of the first Soviet nuclear test (an atmospheric test) in 1949, and learned much about the design of the first Soviet thermonuclear device in 1953, through collection and analysis of these particles.¹¹⁵ The ease of detecting fallout particles was a main reason why the United States, Soviet Union, and United Kingdom were able to negotiate the LTBT in 1963, and worldwide protests against fallout were a main impetus for the treaty.

Contending views. CTBT supporters assert that containment of radioactive debris from a nuclear test is difficult, and many techniques are learned through trial and error. Geologic features, such as faults, can provide a path through which debris can vent. Certain types of soil or rock are better for containment than others. Underground water, turned to steam by an explosion, generates a great deal of pressure. Depth of burial must be adequate. Elaborate methods must be used to prevent debris and gases from escaping through the shaft dug for the test.¹¹⁶ Despite extensive experience with contained underground tests beginning in the 1950s, many U.S. underground tests through 1970 released radioactive material.¹¹⁷ CTBT supporters therefore argue that it would be difficult for Russia or China, and much more so for first-time testers, to have high confidence that they could contain a clandestine test.

CTBT opponents respond that Russia and China would have high confidence in their ability to contain a nuclear test because of their test experience. Opponents point to a U.S. example. Following the “Baneberry” test of 1970, which vented a large radioactive cloud, the United States took further steps to contain underground tests, and of the 386 post-Baneberry tests conducted at the Nevada Test Site through 1992, only 2 resulted in accidental release of radioactivity detected outside the test site.¹¹⁸ Even nations without nuclear test experience could learn much about containment from the open literature, and could make containment more likely by burying the test device more deeply, examining geologic characteristics in selecting a test site, and building a large margin of error into containment techniques.

¹¹⁴ Ibid., p. 531.

¹¹⁵ Richard Rhodes, *Dark Sun: The Making of the Hydrogen Bomb*, New York, Simon and Schuster, 1995, pp. 370-372, 524.

¹¹⁶ For a detailed discussion of containment, see Office of Technology Assessment. *The Containment of Underground Nuclear Explosions*, pp. 31-55.

¹¹⁷ U.S. Department of Energy. Nevada Operations Office. *United States Nuclear Tests, July 1945 through September 1992*, DOE/NV-209, rev. 15, December 2000, pp. 2-63.

¹¹⁸ Department of Energy, *United States Nuclear Tests*, pp. 64-88.

The treaty's supporters point to data on Soviet nuclear tests at Russia's only nuclear test site, Novaya Zemlya in the Arctic Ocean, to show the difficulty of containment. Using the period beginning in 1971 so as to be comparable to U.S. post-Baneberry tests, 30 underground tests were conducted from 1971 to 1990, with data unclear for two. Of the other 28, 10 vented radioactive gases offsite, another 7 vented such gases onsite only, 1 vented radioactive gases and debris offsite, and 10 were contained. The treaty's opponents counter that there was a sharp improvement in containment. Of the 28 tests, for the period 1971 through August 1978, 10 of 16 tests vented offsite, 1 vented onsite, and 5 were contained; for September 1978 through 1990, 6 vented onsite only, 1 vented offsite (both gases and particles), and 5 were contained.¹¹⁹

Interferometric synthetic aperture radar (InSAR). This technique was developed in the early 1990s to study ground deformation around earthquakes. In it, a satellite-borne radar sends out microwave radar beams to a swath of ground some 100 km wide, and records, pixel by pixel, what is in effect the distance between the satellite and each point on the ground.¹²⁰ If another radar picture of the same terrain is taken later from nearly the same point in space,¹²¹ one image can be digitally subtracted from the other, with any difference shown as bands of color that reveal ground motion. According to the technical literature, InSAR can detect ground deformation of less than 1 cm¹²² and can take pictures through many types of clouds. Because it does not use visible light, it can take pictures night or day. This technique has also been used to detect ground deformation due to oil and gas reservoirs and to measure the stability of retaining walls around a reservoir in London.¹²³

While IMS does not use satellite monitoring techniques, the CTBT (Article IV, section A, paragraph 5) permits the use of national technical means. According to David Hafemeister, professor emeritus of physics at California Polytechnic State University, "InSAR is now a widely adopted technology, available to all CTBT States Parties at reasonable prices from commercial vendors."¹²⁴ The depression formed by an underground nuclear test — assuming the rock or ground above the test

¹¹⁹ Vitaly Kjalturin et al., "A Review of Nuclear Testing by the Soviet Union at Novaya Zemlya, 1955-1990," *Science and Global Security*, no. 13, 2005, pp. 40-42.

¹²⁰ For brief descriptions of InSAR, see Gabriele Rennie, "Monitoring Earth's Subsurface from Space," *S&TR*, April 2005, pp. 4-11; and U.S. Department of the Interior. U.S. Geologic Survey. "Using Satellites to Monitor Deformation: Radar Interferometry," updated October 11, 2007, at [http://volcanoes.usgs.gov/insar/more_insar.html].

¹²¹ The U.S. Geologic Survey states, "It isn't possible to steer a satellite accurately enough to return it to exactly the same point in space on different orbits, but it's relatively easy to get within a few hundred feet and then do the necessary geometric corrections." *Ibid.*

¹²² Rennie, "Monitoring Earth's Subsurface from Space," p. 5.

¹²³ On the latter point, see European Space Agency, "Groundmotion: Service Examples," at [<http://www.esa.int/booklets/booklet183.asp>].

¹²⁴ Hafemeister, "Progress in CTBT Monitoring Since Its 1999 Senate Defeat," p. 169.

does not collapse into the cavity left by the test, leaving a clearly visible crater — may be 1 to 2 km across and one to several cm deep.¹²⁵

Contending views. CTBT advocates hold that InSAR complements other monitoring techniques. It can monitor large areas for subsidence. It can localize a suspicious site, even with a test of yield less than 1 kiloton (depending also on other factors such as depth of burial and geology) to within 100 meters, thus helping to guide an OSI.¹²⁶ It can discriminate between an earthquake and an explosion based on changes in ground deformation revealed by InSAR; an earthquake produces a more or less linear pattern caused by the two sides of a fault sliding past each other, while an explosion produces a roughly circular depression. It can help find construction of a decoupling cavity, as ground above the cavity may subside slightly. The wide availability of InSAR data would arguably make a request for an OSI based on this data more convincing to the CTBTO Executive Council.

Critics respond that InSAR requires before-and-after pictures of the same piece of ground in order to detect slight subsidence. If only an “after” picture is available, the technique is thought to work only for nuclear tests of 20 kilotons of yield or so, a level that seismic techniques can easily locate, rendering InSAR superfluous. The State Department points to other limitations.

NASA, [Lawrence Livermore National Laboratory], Canadian Space Agency, and European Space Agency all have InSAR systems and should have libraries of data covering much of the world, at least up to middle latitudes. However, in some areas where there is rugged terrain, terrain shadowing will likely cause large areas to be uncovered. Additionally, one would need to have “before” images that are fairly recent to do an accurate comparison. If significant changes have occurred in the terrain (other than those caused by the test) by wind, rain or other natural factors, the “before” image will not be useful in constructing an InSAR image. Furthermore, this is complicated by the fact that the subsidence may not occur until some time after the test, perhaps years. So, whereas libraries do exist, without specific tasking, they’re unlikely to be good enough.

Further, “It is particularly noteworthy that no evidence of subsidence was observed by the InSAR technique after the North Korean test.” For these and other reasons, State concludes, “the potential of InSAR in assisting detection of a nuclear explosion is limited and cannot be considered a useful technique in many test scenarios.”¹²⁷

Critics assert that subsidence could occur too late to aid an OSI. They also argue that some very low yield tests, the kind an evader is most likely to attempt, conducted at Nevada Test Site did not form depressions,¹²⁸ and that deep burial and certain geologies (e.g., deep inside a granite mountain) may preclude subsidence. Supporters

¹²⁵ Paul Vincent et al., “New Signatures of Underground Nuclear Tests Revealed by Satellite Radar Interferometry,” *Geophysical Research Letters*, vol. 30, no. 22, November 2003, p. SDE 1-1.

¹²⁶ Hafemeister, “Progress in CTBT Monitoring Since Its 1999 Senate Defeat,” p. 171.

¹²⁷ “Response to Medalia Questions.”

¹²⁸ Hafemeister, “Progress in CTBT Monitoring Since Its 1999 Senate Defeat,” p. 171.

reply that InSAR is of value if it helps deter evasion, and that it may reduce the value and increase the difficulty of clandestine tests by forcing a would-be evader to dig deeper and use smaller nuclear devices in order to avoid detection by InSAR.

Detecting collateral evidence. A nuclear test requires much preparation. The testing nation must survey the site to determine if the geology is suitable, bring drilling and diagnostic equipment to the site, drill the shaft, set up the diagnostic equipment with its many cables, emplace the device, seal the shaft, and so on. While IMS does not detect pre-test activities, national technical means of verification could. Satellite photography and communications intercepts, CTBT supporters argue, can detect such activities, and Article IV(D) of the treaty permits use of national technical data as well as IMS data as grounds for requesting an inspection. CTBT opponents recognize that satellites might detect preparations for a clandestine test, but argue that some activities may appear normal, such as mining in a mining area, other activities may be hidden, land lines can prevent access to communications, etc.

On-site inspections (OSIs): Procedural aspects. The treaty and a protocol provide for OSIs, in which international inspectors would travel to the site of a suspected nuclear explosion to search for conclusive evidence of such explosion. For example, if the inspection team is able to drill into the cavity formed by a nuclear explosion, it would have conclusive proof that a test occurred, and radiochemical analysis (such as the ratio of different isotopes) could provide its approximate date. The treaty and protocol go into extensive detail on OSIs, specifying procedures by which the Executive Council would authorize the start and continuation of an inspection, the timeline for an inspection, the number of team members, and equipment they may and may not use. These procedures represent a compromise between those who wanted highly intrusive inspections that could be conducted quickly and those who feared that such inspections would reveal military secrets.

Contending views. Much of the Senate debate on OSIs in 1999 involved the ease of securing Executive Council permission for an OSI. According to Article II of the treaty, once a state party has requested an OSI, 30 of 51 members of the Executive Council would have to approve to order the inspection. Ambassador Jeane Kirkpatrick questioned the competence of the council to make technical decisions related to the treaty. Each member of the council would have one vote. Since the council would be based on geographic representation, many nations on it would have little or no nuclear experience. Further, “there will be a technical support group ... chosen by the same executive council ... which is chosen by people the overwhelming majority of whom do not themselves have any experience or competence with nuclear questions, much less nuclear weapons.”¹²⁹ She also noted, “U.N. bodies are very highly political bodies.”¹³⁰ Senator Richard Shelby said that it would be hard to obtain the 30-vote supermajority needed for an OSI to go forward,¹³¹ while Senator Joseph Biden provided an analysis of likely council voting and concluded that “it

¹²⁹ *SFRC CTBT hearing, 1999*, pp. 10-11.

¹³⁰ *SFRC CTBT hearing, 1999*, p. 48.

¹³¹ *SFRC CTBT hearing, 1999*, p. 55.

seems to me pretty darned easy to get to 30 votes, not because 30 nations love us, but because it is in their naked self-interest.”¹³²

Another contentious topic is how the provisions of the treaty and its protocol specifying procedures for OSIs might affect the success of inspections. Opponents assert that many of these provisions impair the technical effectiveness of an inspection. Some such provisions are listed here, along with a few comments made in 2007 by the State Department:

- The protocol limits the inspection team to 40 members except when it is drilling, and limits an inspection to 130 days. The State Department observes, “the availability of acceptable, technically qualified and trained inspectors and inspection assistants, operating as a cohesive team, is a factor affecting the adequacy of the OSI timeline.”¹³³
- The treaty requires the team to submit a progress report within 25 days of the council’s approval of the OSI; the inspection will continue unless a majority of the council votes not to do so. But according to the State Department, “there is no guarantee that the Executive Council will consider ‘progress’ (not defined) to be sufficient to justify the OSI entering the continuation phase of the inspection.”¹³⁴
- The protocol permits specified inspection techniques but does not provide for the adoption of new ones. This omission may become more significant as new technologies emerge.
- The protocol permits one overflight that may last at most 12 hours and may only use field glasses, passive location-finding equipment, video cameras, and hand-held still cameras, unless the state being inspected agrees to more overflights and the use of other equipment. The State Department observes, “a State Party that conducts a test will most likely employ all available means to evade initial detection and, following approval of an OSI, restrict to the maximum extent the use of technologies and techniques that might otherwise result in detection.”¹³⁵
- The inspected state has “[t]he right to make the final decision regarding any access of the inspection team ...,” apparently referring to areas within the area to be inspected that the inspected state deems sensitive. To protect them, the inspected state may shroud sensitive

¹³² *SFRC CTBT hearing, 1999*, p. 96.

¹³³ “Response to Medalia Questions.”

¹³⁴ “Response to Medalia Questions.”

¹³⁵ “Response to Medalia Questions.”

equipment and restrict radionuclide measurements and the taking of samples to those relevant to the inspection.

- The inspection team may gain access to sensitive facilities if “the inspection team demonstrates credibly to the inspected State Party that access to buildings and other structures is necessary to fulfil the inspection mandate.” Opponents doubt that the inspected state would agree that any such demonstration was credible.

The treaty’s supporters recognize that the inspection provisions represent a compromise between the ability to find evidence of a clandestine test and the ability of inspected states to protect sensitive facilities and guard against espionage. Supporters observe that these provisions protect the United States as well as other nations. They note that many provisions of the Protocol facilitate inspections.

- Inspectors may inspect an area of 1,000 square kilometers; supporters argue that this is large enough given the ability of monitoring technologies to limit the area to be inspected.
- Inspectors shall be chosen “on the basis of their expertise and experience”; supporters note that other possible criteria, such as representing regional groupings of states, were not used.
- The protocol permits many technologies to be used, including visual observation, video and still photography, multi-spectral imaging, measurement of radioactivity, environmental sampling, passive seismological monitoring for aftershocks.
- Unless the Executive Council disapproves by a majority vote a request to continue the inspection, it may also use active seismic surveys and magnetic and gravitational field mapping.
- If the council approves, inspectors may drill for samples.
- Subject to certain limitations, the inspection team has the right to collect, remove, and analyze samples. Supporters note that a nuclear explosion would create many forms of evidence, and that techniques for analysis of samples are highly sensitive.
- While the Executive Council may terminate an inspection after 25 days, supporters of the treaty see that outcome as unlikely given that 30 of 51 members of the council had to approve the inspection, and argue that the evidence needed to gain approval by a supermajority would necessarily have been compelling.

OSIs: technical aspects. While the 1999 debate considered procedural aspects of OSIs, it made little reference to their technical aspects. Yet that issue has been raised for a half-century. For example, in 1960 testimony, a witness pointed to clues of value for an OSI. A nuclear explosion may produce very different surface phenomena than an earthquake. If there are no signs of human activity in the area,

an explosion can be ruled out. There are dozens of signatures of a nuclear test, such as disrupted vegetation, radioactivity, melted snow, pebbles in bushes, and road and fence displacement. The witness pointed out difficulties as well. The most conclusive evidence of a nuclear test is radioactive debris obtained by drilling into the radioactive zone left by a nuclear explosion. Yet, he calculated, the radius of the radioactive zone of a 1.7-kiloton explosion is about 60 feet, and it would be necessary to drill 63 holes to have a 100 percent chance of finding this zone in an area 500 feet in radius.¹³⁶

Contending views. Technical capability to support OSIs has improved over the years. Satellite imagery could reveal human activity. Seismologists have developed techniques to extract more information from seismic data, helping to distinguish earthquakes from explosions and more precisely locating the epicenter of an explosion. Radioactive isotopes of noble gases might be discovered at the test site even if they were in such low concentration that they could not be detected at a distance. InSAR could greatly narrow the search area.

It may, however, be difficult for an OSI to find the most conclusive proof of a clandestine test, drilling into the cavity created by an underground explosion and retrieving radioactive debris. A 10-kiloton test would produce a cavity some 60 meters in diameter;¹³⁷ depending on geology and depth of burial; a lower-yield device would produce a smaller cavity. The test might or might not result in a crater on the Earth's surface. Such craters are caused when a cavity collapses and the overburden above it collapses into the resulting void all the way up to the surface. Deeper burial and careful attention to the geology of the test area would reduce but not eliminate the risk of crater formation or of some signs of a test appearing at the surface. OSIs could encounter practical problems. According to a prediction based on an experiment, xenon-133 and argon-37 "would be detectable, respectively, about 50 and 80 days after the detonation" for a 1-kiloton explosion.¹³⁸ By that time, an OSI might be completed. Livermore presents another problem with detecting argon-37:

There is another "smoking gun" in lieu of drilling. That is argon-37. This is a noble gas isotope produced by bombardment of calcium with neutrons. It gets formed during an underground explosion, has a fairly long half life and is unique to an underground test (i.e. the background is low to nonexistent). The only problem is that it is difficult to detect and measure because you have to shield the sample from ambient background to a high degree (i.e. put the sample in a lead-lined chamber of some kind to do the measurements). The procedure discussed in OSI circles has been to take extensive air samples from surface cracks at the suspected site, separate the noble gases from the air, remove the

¹³⁶ "Statement of Richard M. Foose, Chief, Department of Earth Sciences, Stanford Research Institute," in U.S. Congress. Joint Committee on Atomic Energy. Special Subcommittee on Radiation and Subcommittee on Research and Development. *Technical Aspects of Detection and Inspection Controls of a Nuclear Weapons Test Ban*. Hearings, 86th Congress, 2nd Session, 1960, pp. 282-305.

¹³⁷ Information provided by Lawrence Livermore National Laboratory, personal communication, August 31, 2007.

¹³⁸ C.R. Carrigan et al., "Trace Gas Emissions on Geological Faults as Indicators of Underground Nuclear Testing," p. 528.

radon, and then measure for argon-37. This would be difficult to do in the field.¹³⁹

CTBT advocates claim that OSIs, by offering proof of a clandestine nuclear test, would act as a deterrent. If a nation fears that it would get caught, the reasoning goes, it would be less likely to conduct a nuclear test. Further, supporters argue, the deterrent effect would be magnified because evaders would not know the thresholds at which various U.S. and international monitoring capabilities could detect various test signatures, so they would have to compensate by deeper burial, great efforts at containment, lower yield, and the like. Moreover, it is argued, evaders with little or no test experience would have little confidence in their ability to predict yield or to contain nuclear explosions, forcing them to take still more conservative measures to evade detection. Such measures, it is argued, could make testing so difficult, costly, and risky as to be not worthwhile.

CTBT critics respond that careful attention to evasion would defeat OSIs and would deter other nations from requesting them. If a nation were not sure that it could locate a test with an OSI, or even that a test had taken place, it would be reluctant to risk its credibility by requesting an OSI. Further, in this view, while the U.S. monitoring system, USAEDS, may be able to detect faint signatures that IMS cannot, the United States may be unwilling to use this evidence to make the case for an OSI to avoid revealing capabilities. Thus an evader would not need to worry about the maximum capability of USAEDS. At the same time, a prospective evader could learn the capabilities of IMS because states parties to the CTBT receive IMS data. It could, for example, conduct a large mining explosion and see how it registers with IMS. As a result, the treaty's opponents maintain, the prospect of OSIs would merely force an evader to pay close attention to evasion techniques, something it would do anyway. Perversely, then, the CTBT's provision for OSIs would allow evaders to use the absence of a request for an OSI, or the conduct of an unsuccessful OSI, as evidence that it was not evading.

CTBT critics challenge the validity of debating technical issues of monitoring, verification, and evasion on an unclassified basis. Robert Monroe, former Director of Defense Nuclear Agency, said:

Verification cannot be usefully addressed in unclassified documents. Verification is a two-sided game. On the one hand, many of those around the world who are working to improve verification are operating in an unclassified environment, and the arms control community trumpets every advance in sensor locations, sensitivity, networks, etc. On the other hand, our adversaries or potential adversaries who wish to develop or improve their nuclear weapons while maintaining test deniability, are working with highest priority to improve their evasion techniques. They are working in absolute secrecy, taking every precaution against being detected. The only organization the U.S. has to counter them is the intelligence community, and every scrap of its information collected on evasion improvements is highly classified. Therefore an unclassified study

¹³⁹ Information provided by Lawrence Livermore National Laboratory, personal communication, August 31, 2007. "Noble gases" are chemically inert; they include helium, neon, argon, krypton, xenon, and radon.

will acquire a great deal of information on verification improvements and almost nothing on evasion improvements. This could lead the unwary to conclude that we are now able to verify a CTBT. My own impressions, based upon many decades of close involvement with nuclear weapons, are exactly the opposite. I believe the evaders have an easier problem to solve, that they are now in a comfort zone for undetected testing, and that they expect their advantage to improve in the future.¹⁴⁰

On the other hand, as Senator J. William Fulbright once said, “the mere fact that information has been classified does not make it necessarily true.”¹⁴¹ Similarly, the treaty’s supporters would note, the fact that information is unclassified does not make it invalid. Supporters argue that advances in monitoring capability, many of which are unclassified, are likely to reveal clandestine testing or preparations for it. Having unclassified information, such as from thousands of seismometers around the world, publicly and promptly available increases the number of people who may find evidence of testing. While technical monitoring cannot provide information that human intelligence can on motivations, plans, and budgets, human intelligence can be misleading because of disinformation, misinterpretation, reliance on unreliable sources, and incomplete information. Basing conclusions on the absence of evidence it is argued, may be hazardous. Former Secretary of Defense Donald Rumsfeld reportedly said, “the absence of evidence is not evidence of absence.”¹⁴² However, the absence of evidence cannot be construed as evidence. Clearly, the Senate would consider classified information in any future debate on the treaty, but classified details of evasion techniques would have to be balanced against classified monitoring capabilities, and both would be only two of many elements of a net assessment.

Additional Evasion Scenarios. For decades, supporters of nuclear testing treaties have argued that monitoring capability is good enough to permit effective verification, while critics have responded in part by setting forth scenarios that, they maintained, would defeat verification. This report discussed one scenario, decoupling, earlier and now turns to two others.

Testing without attribution. One scenario envisions conducting one or more tests that would be detected but could not be attributed. Robert Barker, former Assistant to the Secretary of Defense for Atomic Energy, postulates a scenario that

involves conducting a test in a remote ocean area long after identifiable national vessels had left the scene. The testing nation would expect the international monitoring system to detect the test and announce the yield, and by virtue of its participation in the monitoring community the testing nation would have access to any debris collected, for its own analysis of performance. It would be impossible to positively attribute the test to a nation if the testing nation took care to ensure that materials were not used in the test such that debris could be

¹⁴⁰ Personal communication, November 5, 2007.

¹⁴¹ U.S. Congress. Senate. Committee on Foreign Relations. Subcommittee on International Organization and Disarmament Affairs. *Strategic and Foreign Policy Implications of ABM Systems*. Hearings, 91st Congress, 1st Session, 1969, p. 183.

¹⁴² Walter Pincus, “Report Details Errors Before War,” *Washington Post*, September 9, 2006, p. 12.

uniquely traced back to the testing nation. Indeed, a clever cheater would place materials that are unique to different nations in close proximity to the bomb so that the debris might look Israeli or Indian or even U.S.¹⁴³

The National Academy of Sciences study stated,

Attribution is likely to be more problematic for an underwater or atmospheric test, since a nation with a nuclear explosive could detonate it on a ship or a plane and the effects on the surrounding media would be more ephemeral. Though such a test would likely be detected and located, it might be attributed only with difficulty to the nation responsible. ... To confidently evade attribution, a tester would need to believe that the United States, working with other nations, did not have the capability to track ships and planes in the vicinity of the test location, and would not intercept communications relating to the test.¹⁴⁴

Arguments on this scenario can be played out at length. Donald Barr, a retired Los Alamos radiochemist, states,

It is virtually impossible to disguise (spoof) the signatures of a nuclear explosive detonation. This is because of the broad range of fission product and actinide radionuclides which are produced instantaneously and then evolve with time according to well-known radioactive decay laws. Any attempt to tamper with either or both of these distributions would produce a discordance of the radiochemical data suite. The likely nature of such an attempted spoof would become apparent through comparison of the radiochemical data with the extensive data base of U.S. tests coupled with ever-improving model calculations of nuclear explosives.¹⁴⁵

Critics state that attribution depends on matching a sample of radioactive material with a sample from an archive of such materials. If the sample does not match any in the archive, this method provides no basis for attribution. Supporters counter that detection of debris from a nuclear test would trigger an immediate, all-out effort by the United States, other nations, and the CTBTO to attribute the test. The list of potential testers would be quite small, easing the task, and debris could reveal information about weapon design, providing further clues as to the testing nation. Supporters argue that a nation would probably need a test series to have confidence in a warhead design, increasing the odds of attribution; opponents reply that one successful test might suffice to confirm a simple implosion design, and an unsuccessful test might not be detected.

Evading multiple sensors. While many signatures could reveal a test, it might be possible to conceal them all by conducting a nuclear test in a large cavity excavated in a mining complex deep underground. A large cavity would permit decoupling. Excavating the cavity deep underground, especially in rock, would guard against a depression in the Earth's surface that could be detected by standard or InSAR satellite photography. Deep burial would arguably trap noble gases and

¹⁴³ Personal communication, April 28, 2007.

¹⁴⁴ *NAS report*, pp. 38-39.

¹⁴⁵ Personal communication, November 29, 2007.

particles; the open literature has much information on how to contain underground explosions.¹⁴⁶ Use of a mine would provide a cover story for human activity and would hide much of that activity. Material removed during excavation could be placed, unseen by satellites, in unused tunnels. Access to IMS data, a right of all states signatory to the treaty, would help a would-be evader improve evasion techniques and gather data on some types of evasive tests.

CTBT supporters see evasion as difficult. Containment, while harder for a nation with no test experience, can fail nonetheless because of unknown aspects of test site geology, as the U.S. “Baneberry” test showed.¹⁴⁷ Satellite photography might reveal suspicious human activity. An evader would not know capabilities of U.S. monitoring systems. Technical progress in monitoring and a growing archive of background noise, it is argued, reduce the threshold below which an evader could feel confident of success. An evader with little nuclear test experience would not have a precise estimate of weapon yield, forcing it to lower the yield, and value, of a test. Human intelligence might reveal a test. Supporters assert that the treaty would make evasion harder. Secretary Albright argued that, while the United States cannot be absolutely certain to detect very low yield tests with or without the treaty, “by improving our capacity to monitor, we are much more likely under the treaty to detect such tests and consequently to deter them.”¹⁴⁸

Would Clandestine Testing Confer Military Advantages?

A concern that arose in the 1999 CTBT debate was that clandestine testing could increase the threat to the United States. As Senator John Warner said,

I am also concerned that the treaty’s zero yield test ban is not verifiable. It is difficult, if not impossible, to detect tests below a certain level. If a nation is determined to conceal their non-compliance with this treaty, there are certain levels below which we simply cannot detect. The equipment is not there.

Testing at yields below detection levels may allow certain countries, such as Russia, to develop a new class of nuclear weapons.¹⁴⁹

Some argued then that undetected testing, even at low yield levels, would confer military advantages. Six former Secretaries of Defense said, “it is impossible to verify a ban that extends to very low yields.... Tests with yields below 1 kiloton can

¹⁴⁶ See, for example, Office of Technology Assessment, *The Containment of Underground Nuclear Explosions*.

¹⁴⁷ “Baneberry,” a 10-kiloton test, spewed a radioactive cloud that was tracked to the Canadian border. See Office of Technology Assessment, *The Containment of Underground Nuclear Explosions*, pp. 31-33; and U.S. Department of Energy. National Nuclear Security Administration. Photo and description of *Baneberry* test, at [<http://www.nv.doe.gov/library/photos/photodetails.aspx?ID=846>].

¹⁴⁸ *SFRC CTBT hearing*, 1999, p. 76.

¹⁴⁹ *SASC CTBT hearings*, 1999, p. 5.

both go undetected and be militarily useful to the testing state.”¹⁵⁰ C. Paul Robinson, Director of Sandia National Laboratories, said, “I believe that nuclear testing in the subkiloton range could have utility for certain types of nuclear designs.”¹⁵¹ A 1995 report by the JASON defense advisory group noted the value of half-kiloton tests: “For the U.S. stockpile, testing under a 500 ton yield limit would allow studies of boost gas ignition and initial burn, which is a critical step in achieving full primary design yield.”¹⁵² Bruce Tarter, then Director of Lawrence Livermore National Laboratory, stated in 1997, “If additional tests were to be allowed, then 500 tons would be the minimum nuclear test yield that would be of value for validating experimental and computational tools used to assess weapon performance. For purposes of helping to validate models for assessing weapon safety, nuclear test yields of a few pounds would be of value.”¹⁵³

CTBT opponents hold that low-yield weapons can have much more value for new or current nuclear powers now than was the case decades ago, even within the 1 to 2 kilotons that the NAS report uses as the upper limit on effective decoupling. Kathleen Bailey and Robert Barker write, “One to two kilotons can be militarily and politically significant to any proliferator; with today’s commercially available guidance technology one to two kilotons accurately delivered against a major city or a major military installation will create massive damage. Today, proliferators don’t need high-yield, thermonuclear weapons to threaten their neighbors.”¹⁵⁴ John Foster writes,

Low yield underground tests of devices with yields of tons to hundreds of tons can provide high confidence that such devices can be scaled up to strategic yields. Right now we have little confidence that we could detect such low yield tests with high confidence if evasive techniques were used. Such tests, if conducted by potential adversaries and not by the United States, could adversely affect our overall security posture. For example, the US has provided a nuclear umbrella to a number of its allies, such as South Korea, Japan, and Turkey, to deter attacks by hostile nations and to reduce their need to develop their own nuclear capabilities. However, recently a number of Russian sources have stated that Russia has developed and is deploying low yield “clean” (that is, with

¹⁵⁰ Letter from James Schlesinger, Richard Cheney, Frank Carlucci, Caspar Weinberger, Donald Rumsfeld, and Melvin Laird to The Honorable Trent Lott, Majority Leader, United States Senate, and The Honorable Tom Daschle, Democratic Leader, United States Senate, in *SASC CTBT hearings, 1999*, p. 58.

¹⁵¹ “Prepared Statement by Dr. C. Paul Robinson,” in *SASC CTBT hearings, 1999*, p. 132.

¹⁵² Sidney Drell, Chair, et al., *Nuclear Testing: Summary and Conclusions*, JASON report JSR-95-320, the MITRE Corporation, August 3, 1995, p. 3.

¹⁵³ “Response to Questions Regarding Comprehensive Test Ban Treaty (CTBT) for Senator Jon Kyl from C. Bruce Tarter, Director, University of California, Lawrence Livermore National Laboratory,” September 29, 1997, in U.S. Congress. Senate. Committee on Governmental Affairs. Subcommittee on International Security, Proliferation, and Federal Services, *Safety and Reliability of the U.S. Nuclear Deterrent*, Senate hearing 105-267, 105th Congress, 1st Session, 1997, p. 75.

¹⁵⁴ Bailey and Barker, “Why the United States Should Unsign the Comprehensive Test Ban Treaty and Resume Nuclear Testing,” p. 135.

reduced fission to reduce residual radiation) nuclear weapons, including some “clean” earth penetrator weapons. Russian development of clean nuclear devices for peaceful uses, similar to the U.S. “Plowshare” program of the 1960s and 1970s. China may also be developing new low-yield weapons. In contrast, current U.S. nuclear weapons, which date from the Cold War, are largely high yield, high fission, dirty weapons. If a crisis were to develop between Russia and a U.S. ally, a Russian inventory of low yield tactical nuclear weapons, and the asymmetry with U.S. weapons, could call into question the credibility of the U.S. nuclear umbrella. Even without explicit threats, the asymmetry could lead to nuclear nonproliferation by pressuring U.S. allies to develop their own nuclear weapons.¹⁵⁵

The treaty’s supporters reject the idea that low-yield weapons would make much difference to the strategic balance, given the many nuclear weapons, of various yields, that this nation has. They point to an article reporting on an interview with General James Cartwright, USMC, then Commander of U.S. Strategic Command:

Theoretically, if a “grave” threat to the United States emerged that could be deterred only by a low-yield nuclear weapon, the general might be persuaded to support its development, [Cartwright] said. However, to date, “I haven’t seen anything that approaches that,” Cartwright said. ... “My priority is not reduced yield,” Cartwright told a reporter in April 2005. “It’s to take the accuracy to the point where conventional can substitute for nuclear. That’s my first priority.”¹⁵⁶

Various evasion scenarios, opponents argue, might be linked into a weapons development program, with each step providing data and experience for the next step. Extremely low yield tests could provide data on nuclear physics, nuclear testing, test containment, instrumentation, and data retrieval; the data could be used to develop and validate computer models for weapons design. Decoupled tests could provide data for design of an unboosted fission weapon, or perhaps a boosted fission weapon.¹⁵⁷ One or a few atmospheric tests conducted in a remote ocean area might suffice to develop a higher-yield weapon while arguably avoiding attribution.¹⁵⁸ Alternatively, the NAS report states, if a nation were given the design of a weapon,

¹⁵⁵ Personal communication, November 2, 2007.

¹⁵⁶ Elaine Grossman, “Senior U.S. General Sees High Nuclear Threshold,” *Global Security Newswire*, October 22, 2007.

¹⁵⁷ In “boosting,” a mixture of deuterium and tritium gases are injected into a hollow pit (typically made of plutonium). When the pit is imploded, the heat and pressure cause the deuterium-tritium gas mixture to undergo fusion, thereby releasing a great many neutrons that fission more plutonium. The significance, according to a Livermore report, is that “[b]oosting increases the yield by a large amount.” R.E. Kidder, *Maintaining the U.S. Stockpile of Nuclear Weapons During a Low-Threshold or Comprehensive Test Ban*, Lawrence Livermore National Laboratory, UCRL-53820, October 1987, p. 5.

¹⁵⁸ For example, disagreement remains even about whether an event in the South Atlantic in September 1979 that registered a certain nuclear test signature on a U.S. satellite designed to detect nuclear explosions was caused by a nuclear test or a meteoroid, let alone which nation conducted the possible test. See Jeffrey Richelson, ed., “The Vela Incident: Nuclear Test or Meteoroid?”, National Security Archive, Electronic Briefing Book No. 190, May 5, 2006, [<http://www.gwu.edu/~nsarchiv/NSAEBB/NSAEBB190/index.htm>].

“A single full-yield test would validate both the legitimacy of a blueprint and success in reproducing the object, but that test might be of yield too high to be concealed.”¹⁵⁹

Supporters argue that nations could not develop thermonuclear weapons under a CTBT, and see very low yield tests as of little value for weapons development. According to Richard Garwin, hydronuclear tests “will provide little useful knowledge,” and tests of 0.1 kiloton “would have little value in the development of nuclear weapons.”¹⁶⁰ According to the NAS report, tests up to 1 to 2 kilotons are concealable in some circumstances, and could be used to improve unboosted fission weapons or, with difficulty, for proof tests of weapons of 1 to 2 kilotons. Tests up to 20 kilotons are unlikely to be concealable; they could be used to proof-test 20-kiloton fission weapons, or for “eventual development & full testing of some primaries & low-yield thermonuclear weapons.” Finally, tests above 20 kilotons could not be concealed; they could be used to develop and test boosted fission weapons and thermonuclear weapons.¹⁶¹ Thus both the value of tests and the risk of being caught are thought to increase with yield. At the same time, there is general agreement that a nation could develop a simple gun-type or implosion weapon, with a yield of perhaps 10 to 20 kilotons, without testing, thereby avoiding the need for evasion.

The NAS report observes that nations with more test experience could make more progress in a weapons program through covert testing, but that “the threats these countries can pose to U.S. interests with the types of nuclear weapons they already have tested are large. What they could achieve with the very limited nuclear testing they could plausibly conceal would not add significantly to this.”¹⁶² CTBT supporters hold that the United States has lived with the prospect that Russia or China could gain an advantage through clandestine testing since the U.S. moratorium began in 1992. Russia, at least, has apparently taken a different approach to its nuclear weapons program than has the United States, so that the programs are not strictly comparable. For example, the NAS report states, “Russian nuclear weapons are remanufactured on a 10-year cycle,”¹⁶³ which contrasts with the current U.S. policy of extending the service lives of existing warheads for many years. Nonetheless, CTBT supporters argue that the United States has advanced in its nuclear capability significantly through SSP. In their view, it would be instructive to ask the current directors of the three U.S. nuclear weapons laboratories if they would rather be in the position of the Russian or Chinese nuclear weapons programs, even including the possibility of testing at very low yields, or the U.S. enterprise with the scientific tools made available by SSP but without testing. The NAS report summarizes the value of clandestine testing as follows:

Very little of the benefit of a scrupulously observed CTBT regime would be lost in the case of clandestine testing within the considerable constraints imposed by the available monitoring capabilities.... The worst-case scenario under a no-

¹⁵⁹ *NAS report*, p. 66.

¹⁶⁰ *SFRC CTBT hearing*, 1999, p. 117.

¹⁶¹ *NAS report*, p. 68.

¹⁶² *NAS report*, pp. 68, 77.

¹⁶³ *NAS report*, p. 70.

CTBT regime poses far bigger threats to U.S. security interests — sophisticated nuclear weapons in the hands of many more adversaries — than the worst-case scenario of clandestine testing in a CTBT regime, within the constraints posed by the monitoring system.¹⁶⁴

What Risks Does a Nation Run if It Is Caught Cheating?

Any nation that ratified the CTBT, and then sought to cheat, would have to evaluate the risks and benefits of clandestine testing. In the 1999 debate, attention focused on the feasibility of successful cheating and the military gains that such tests might or might not confer, but virtually no attention was paid to the risks of being caught. Nonetheless, the question merits consideration because the answer could be crucial to a would-be evader's calculus. Possible alternative cases are sketched here; further research would be of use. It could be argued that there would be few consequences. In this view, the Conference of States Parties to the CTBT, pursuant to Article V of the treaty, "may recommend to States Parties collective measures which are in conformity with international law." Further, "[t]he Conference, or alternatively, if the case is urgent, the Executive Council, may bring the issue, including relevant information and conclusions, to the attention of the United Nations." The U.N. might take little action, or it might delay. In particular, if evidence of clandestine testing were not conclusive, there might be few or no penalties. Another possibility is that the U.N., fearful that an unpunished violation could lead to the unraveling not only of the CTBT, but also of U.S. willingness to take further steps toward nuclear disarmament, could impose meaningful sanctions. Yet another possibility is that some nations could take actions outside the U.N. framework.

Instead of attempting to conduct clandestine tests, a nation wishing to conduct one or more nuclear tests might simply withdraw from the treaty. The case for so doing is that it might want to conduct a test with a yield that could not be hidden; it might believe that even a low-yield test could be detected, especially if it had little or no experience with nuclear testing and test containment; and it might want to announce its nuclear capabilities to the world. But clandestine testing offers advantages: an open weapons development program could spur rivals to launch their own program, so a nation wanting to develop nuclear weapons might prefer to keep its intent unknown; a nation that withdrew from the treaty would lose access to IMS data, which could help it evade detection; a nation that withdrew from the treaty to conduct nuclear tests might face the same penalties as one that conducted clandestine tests and was caught cheating; and a nation might prefer to stay in good standing with the international community for as long as possible in order to delay any sanctions.

¹⁶⁴ *NAS report*, p. 78.

The CTBT, Nuclear Nonproliferation, and Nuclear Disarmament

There is widespread agreement among experts within and outside the government that nuclear proliferation, especially if it leads to terrorists obtaining nuclear weapons, is one of the greatest security threats facing the United States.

The nuclear nonproliferation regime is a decades-long attempt to hold nuclear proliferation in check. This regime is an array of treaties, agreements, nuclear weapon free zones, restrictions on exports of nuclear-related equipment, controls of nuclear materials, and national laws, with the Nuclear Nonproliferation Treaty (NPT) at its core.¹⁶⁵ The NPT entered into force in 1970. It represents a bargain in which nuclear weapon states could have nuclear weapons, non-nuclear weapon states agreed not to acquire them, and both agreed, in Article VI, “to pursue negotiations in good faith on effective measures relating to cessation of the nuclear arms race at an early date and to nuclear disarmament, and on a Treaty on general and complete disarmament under strict and effective international control.”

Many see this regime as being in danger.¹⁶⁶ North Korea conducted a nuclear test in 2006.¹⁶⁷ Iran is embarked on a nuclear program that many fear is, or will become, a nuclear weapons program.¹⁶⁸ Many nations are expected to begin nuclear power programs, which would make fissile materials and nuclear expertise more widely available. There are concerns about unsecured nuclear weapons in Pakistan¹⁶⁹ and elsewhere, and about whether another proliferation network such as that operated by A.Q. Khan will emerge, or if another one still exists undiscovered. Another concern is the threat of terrorists armed with nuclear weapons. Some fear a cascade of nuclear proliferation. For example, if Iran develops nuclear weapons, that could put pressure on Egypt and Saudi Arabia to do likewise, and a continued North Korean nuclear weapons program could lead Japan and South Korea to follow suit.¹⁷⁰

¹⁶⁵ See CRS Report RL31559, *Proliferation Control Regimes: Background and Status*, by Sharon Squassoni, Steve Bowman, Steven Hildreth, and Jill Marie Parillo.

¹⁶⁶ See CRS Report RL31559, *Proliferation Control Regimes: Background and Status*, by Mary Beth Nikitin, Paul Kerr, Steve Bowman, and Steven Hildreth.

¹⁶⁷ See CRS Report RL33709, *North Korea’s Nuclear Test: Motivations, Implications, and U.S. Options*, by Emma Chanlett-Avery and Sharon Squassoni; CRS Report RL34256, *North Korea’s Nuclear Weapons: Latest Developments*, by Mary Beth Nikitin; and CRS Report RL33590, *North Korea’s Nuclear Weapons Development and Diplomacy*, by Larry Niksch.

¹⁶⁸ See CRS Report RL32048, *Iran: U.S. Concerns and Policy Responses*, by Kenneth Katzman.

¹⁶⁹ See CRS Report RL34248, *Pakistan’s Nuclear Weapons: Proliferation and Security Issues*, by Paul Kerr and Mary Beth Nikitin.

¹⁷⁰ See U.S. Department of State. International Security Advisory Board. *Report on Discouraging a Cascade of Nuclear Weapons States*, October 19, 2007, 25 p. + app., at [<http://belfercenter.ksg.harvard.edu/files/ISAB%20-%20Nuclear%20Cascade%20Report.pdf>].

At issue is how to protect this regime and thwart nuclear proliferation. A major argument by supporters on behalf of the CTBT is that the treaty would promote nonproliferation. Some CTBT supporters favor the treaty by itself as a means to slow proliferation, while other supporters see the treaty as a step toward nuclear disarmament. Opponents argue that the treaty would weaken deterrence and that nonproliferation and disarmament are not linked. Some opponents would resume testing promptly to restore confidence in existing weapons, develop new ones, and train weapons designers, while other opponents would resume testing only under more limited circumstances, such as if a problem developed with an existing warhead that could only be fixed through testing. Greg Mello, executive director of the Los Alamos Study Group, offers the following view:

The nonproliferation value of U.S. CTBT ratification depends on other U.S. policies, some connected to the treaty and some not. If those other policies build on and implement the CTBT as a disarmament treaty, as the text of the treaty proclaims it to be, it could have significant nonproliferation value. On the other hand, a CTBT that aims to “ban the bang, but not the bomb,” and that the United States ratifies and implements on that basis, may have little if any nonproliferation value. In that case it would be widely and correctly seen as furthering a world order based on a nuclear double standard. For example, ratifying the CTBT while making long-term investments to maintain and improve a leaner U.S. nuclear arsenal would make a mockery of this treaty in the eyes of most of the world.

Merely having a CTBT is not enough of a goal to provide real improvement in the foreign relations of the United States. Freedom from the threat of nuclear attack, i.e. freedom from nuclear deterrence, would be such a goal, with the CTBT one means to it. In contrast, should a situation arise in which a world led by nuclear-armed, rich states enforced a future CTBT regime by threat of military force or by economic sanctions that cause widespread suffering, that situation would not be much different than the one we have today prior to ratification and entry into force.¹⁷¹

Another possible position is that the CTBT would make little difference one way or the other. In this view, the extent of proliferation is about what it would be had the United States ratified the CTBT; this nation has made progress on nuclear nonproliferation despite not having ratified the treaty; the weapons labs have supported 12 annual assessments that nuclear weapons remain safe and reliable despite the lack of testing; and the strategic balance favors this nation whether or not Russia or China has tested clandestinely. Thus, neither the worst fears of those who opposed the treaty on grounds that deterrence would collapse without testing, nor of those who supported it on grounds that U.S. failure to ratify would accelerate nuclear proliferation, have been realized. This position has received little if any support.

The Treaty’s Technical Contributions to Nonproliferation

CTBT supporters hold that the treaty would make specific technical contributions to nuclear nonproliferation. Richard Garwin, IBM Fellow Emeritus, testified,

¹⁷¹ Personal communication, January 28, 2008.

It is possible to build simple nuclear weapons without nuclear explosion tests. But there will always be a nagging doubt whether or how well they perform. The Hiroshima and Nagasaki bombs each weighed about 9,000 pounds, with a yield of 15 to 20 kilotons.... these must be compared with a two-stage thermonuclear bomb, tested in 1957, 12 years later, that weighed some 400 pounds, with a yield of 74 kilotons. Its diameter was a mere 12 inches, with a length of some 42 inches. That is what you can do by testing. That is what other people cannot do without testing.¹⁷²

General John Shalikashvili (USA, Ret.), former Chairman of the Joint Chiefs of Staff, in a 2001 report on the CTBT, noted the importance of such limitations imposed by the treaty:

A ban on nuclear explosions would also place technical constraints on countries that already have nuclear weapon capabilities. Test Ban Treaty signature by India or Pakistan would not close off their nuclear options, but it would rule out certain developments and help prevent a destabilizing nuclear arms race in South Asia. China would not be free to test explosively a post-production sample of a more advanced warhead than is in its current arsenal. This would, for example, impede China from placing multiple warheads on a mobile missile.¹⁷³

Treaty supporters argue that the treaty would reduce the risk of nuclear proliferation in other ways. They state that IMS, which would complement U.S. monitoring systems by placing seismic stations in areas that would be closed to a U.S. national system, and OSIs, which could be conducted only if the treaty were to enter into force, would help detect and deter nuclear tests. Garwin argued that China would have to test to develop certain new weapons: “if secret information regarding thermonuclear weapons has been acquired by others or may be so acquired in the future, as has been alleged in regard to China, this information cannot be turned into a deployable weapon without tests forbidden by the CTBT.”¹⁷⁴

“Nuclear Umbrella,” New Weapons, and Nonproliferation

CTBT opponents see a strong and robust nuclear force as essential to nonproliferation. In this view, the U.S. “nuclear umbrella,” that is, a U.S. willingness to use nuclear weapons to defend friends and allies from attack, contributes to nonproliferation by reassuring them so they do not need nuclear weapons of their own. Opponents stress the importance that many nations attach to the nuclear umbrella. One report finds, “The United States has extended security assurances to 31 countries — the 26 nations of NATO, Australia, Japan, South Korea, Taiwan, and Israel.”¹⁷⁵ While the North Atlantic Treaty does not reference nuclear weapons, the

¹⁷² *SFRC CTBT Hearing*, 1999, p. 114.

¹⁷³ General John Shalikashvili, USA, Ret., Special Advisor to the President and Secretary of State, *Findings and Recommendations Concerning the Comprehensive Nuclear Test Ban Treaty*, January 2001, (n.p.), at [http://www.armscontrol.org/act/2001_01-02/ctbtreport.asp].

¹⁷⁴ *SFRC CTBT hearing*, 1999, p. 113.

¹⁷⁵ Kathleen Bailey et al., *White Paper on the Necessity of the U.S. Nuclear Deterrent*,” (continued...)

United States kept many nuclear weapons in Western Europe during the Cold War, and a 1999 NATO document states, “The supreme guarantee of the security of the Allies is provided by the strategic nuclear forces of the Alliance, particularly those of the United States....”¹⁷⁶ Regarding Japan, after a meeting between Secretary of State Condoleezza Rice and Japanese Foreign Minister Taro Aso shortly after the 2006 North Korean nuclear test, Secretary Rice said, “I reaffirmed the President’s statement of October 9th that the United States has the will and the capability to meet the full range — and I underscore full range — of its deterrent and security commitments to Japan.” Minister Aso said, “There is no need to arm ourselves with nuclear weapons either. For Japan’s own defense we have this Mutual Defense Treaty with [the] United States ... and that commitment has been reconfirmed by Secretary Rice.”¹⁷⁷ And regarding a U.S.-South Korean Mutual Defense Treaty that entered into force in 1954, Secretary of Defense Donald Rumsfeld said, “The United States reaffirms its firm commitment to the Republic of Korea, including continuation of the extended deterrence offered by the U.S. nuclear umbrella, consistent with the Nuclear [sic] Defense Treaty.”¹⁷⁸

CTBT opponents maintain that the nuclear umbrella must be kept credible, which requires ongoing effort. As Robert Barker said, “The credibility of our nuclear deterrent can only be sustained if we, ourselves, are confident it will work.... We, especially in our open society, cannot sustain the credibility of deterrence for long if we lose confidence in the actual performance of the weapons.”¹⁷⁹ To maintain credibility, opponents believe, the U.S. nuclear deterrent must respond to changing conditions. Threats change over time, and U.S. forces must change as well to continue to hold at risk assets that adversaries value highly. But, opponents fear, the deterrent cannot remain credible under current conditions. As noted earlier, John Foster raised concerns about SSP. And Robert Monroe, former Director of Defense Nuclear Agency, said,

We’ve let every aspect of our nuclear weapons program deteriorate for the past sixteen years. We have not transformed our nuclear strategy from one of massive retaliation against the Soviets to the surgical needs of today’s distributed threats. Our stockpile of high-yield, dirty nuclear weapons, designed for the Cold War, is aged and becoming more irrelevant by the day. The nation’s nuclear

¹⁷⁵ (...continued)

update of August 15, 2007, p. 3. For a version of July 30, 2007, through the National Institute for Public Policy, see [<http://www.nipp.org/Adobe/Deterrence%20Paper%20-%20final.pdf>].

¹⁷⁶ NATO, “The Alliance’s Strategic Concept, Approved by the Heads of State and Government participating in the meeting of the North Atlantic Council,” Washington D.C., April 23 and 24, 1999, at [<http://www.nato.int/docu/pr/1999/p99-065e.htm>].

¹⁷⁷ U.S. Department of State. “Remarks [by Secretary of State Condoleezza Rice] with Japanese Foreign Minister Taro Aso After Their Meeting,” Tokyo, Japan, October 18, 2006, at [<http://www.state.gov/secretary/rm/2006/74669.htm>].

¹⁷⁸ U.S. Department of Defense. “DoD News Briefing with Secretary Rumsfeld and South Korean Minister of National Defense Yoon Kwang-Ung at the Pentagon,” October 20, 2006, at [<http://www.defenselink.mil/transcripts/transcript.aspx?transcriptid=3763>].

¹⁷⁹ *SASC CTBT hearings*, 1999, p. 173.

infrastructure has seriously deteriorated. Our advanced nuclear technology R&D effort is practically nonexistent. We've designed no new nuclear weapons, tested no weapons, and produced no new weapons. Our Defense Department has virtually "denuclearized" itself.... In sum, states under our nuclear umbrella may be worried over both our capability and our will to protect them.¹⁸⁰

In this view, since the main risk to the nonproliferation regime flows from a lack of confidence in the U.S. nuclear deterrent, the only way to restore that confidence is to test. Testing would permit development of new weapons, training of nuclear designers and other personnel, and exercising of the nuclear weapons complex, all of which would, in this view, make the nuclear umbrella more credible and reduce the risk of proliferation. According to Robert Monroe,

Our arsenal is still composed of aging Cold War "massive retaliation" weapons, with moderate accuracy, very high yields, and "dirty" radiation outputs. They are virtually irrelevant today for deterring our proliferating adversaries. These rogue states have buried their nuclear weapons facilities deep underground, frequently locating them near deliberately exposed civilian populations. Any U.S. nuclear weapons that do not have high accuracy, very low yields, reduced collateral damage, and reduced residual radiation will not be credible of use, and our attempted deterrence will fail. To be effective deterrents, these new weapons also need tailored outputs (earth penetration, neutralization of chem-bio agents, etc.). All these new capabilities will require nuclear testing.¹⁸¹

CTBT supporters reject the emphasis on new weapons as creating major problems for nuclear nonproliferation. Former Senator Sam Nunn testified,

On the RRW [reliable replacement warhead] itself, if Congress gives a green light to this program in our current world environment — and I stress in our current world environment — I believe that this will be misunderstood by our allies, exploited by our adversaries, complicate our work to prevent the spread and use of nuclear weapons ..., and make resolution of the Iran and North Korea challenges all the more difficult.¹⁸²

Former Secretary of Defense Harold Brown, though not a supporter of the CTBT in its current form, wrote about

the ill-advised push by elements in the current administration to field new, low-yield nuclear weapons and new nuclear designs of penetrating "bunker busters." They would provide further excuses for aspiring nuclear-weapon states and alienate those whose cooperation is sought while providing no significant and

¹⁸⁰ Robert Monroe, "Nonproliferation, Deterrence, and Nuclear Strategy," Center for Security Policy, Occasional Papers no. 27, October 2007, pp. 3-4.

¹⁸¹ Robert Monroe, "Nuclear Testing Realities," *Washington Times*, December 4, 2007, p. 16.

¹⁸² U.S. Congress. House. Committee on Appropriations. Subcommittee on Energy and Water Development. Hearing on nuclear weapon activities, March 29, 2007, transcript by CQ Transcriptions.

perhaps negative security gains. Shaking the U.S. nuclear stick at adversaries probably encourages proliferators.¹⁸³

The CTBT and the NPT's "Grand Bargain"

While some CTBT supporters favor the treaty on its own merits as restricting nuclear weapons programs of nuclear weapon states (NWS), other supporters take a broader view of the treaty's contribution to nonproliferation. They assert that the United States agreed, in Article VI of the NPT, to a "grand bargain" in which the NWS would move toward nuclear disarmament while the non-nuclear weapon states (NNWS) would forgo nuclear weapons and support nuclear nonproliferation measures. They see a world without nuclear weapons as the best defense against proliferation, and progress in this direction as needed to enlist the world's support on behalf of this goal. As a result, it is argued, steps toward disarmament are essential for nonproliferation.

CTBT opponents, however, see no logical linkage between nonproliferation and disarmament. They believe that by claiming Article VI of the NPT makes this link, supporters are trying to shape it to say something it does not. According to Stephen Rademaker, former Assistant Secretary of State, "It is impossible to discern from this language [Article VI] a binding legal obligation on the U.S. and the other four nuclear-weapon states to give up nuclear weapons. The operative legal requirement is to 'pursue negotiations in good faith on effective measures relating ... to nuclear disarmament....'" Further, the NPT "does not assume that nuclear disarmament must be a prerequisite to general and complete disarmament. To the contrary, one of the treaty's introductory paragraphs spells out the expectation of the parties that actual 'elimination from national arsenals of nuclear weapons' would take place not prior to, but 'pursuant to a Treaty on general and complete disarmament.'"¹⁸⁴

Supporters reply that Article VI is only part of the picture, and that the CTBT is a necessary first step toward nonproliferation and disarmament. They note that the United States, along with other NWS, committed to the CTBT in 1995 and 2000.

- The NPT provides for review conferences every five years. Article X provides that the 25-year conference, held in 1995, would "decide whether the Treaty shall continue in force indefinitely, or shall be extended for an additional fixed period or periods. This decision shall be taken by a majority of the Parties to the Treaty." The 1995 conference decided to extend the treaty indefinitely through a package of decisions that, because it was so controversial, was adopted without a vote.¹⁸⁵ The package included Principles and Objectives for Nuclear Non-Proliferation and Disarmament that

¹⁸³ Harold Brown, "New Nuclear Realities," *Washington Quarterly*, Winter 2007-08, p. 20.

¹⁸⁴ Stephen Rademaker, "Blame America First," *Wall Street Journal*, May 7, 2007, p. 15; ellipses in original.

¹⁸⁵ For a brief description of this process, see Stephen Young and Daniel Plesch, "A Permanent Non-Proliferation Treaty," *Basic Reports*, June 1, 1995, pp. 1-3.

stressed the importance of completing “negotiations on a universal and internationally and effectively verifiable Comprehensive Nuclear-Test-Ban Treaty no later than 1996.”¹⁸⁶

- In a joint statement to the 2000 NPT review conference, the NWS said, “No effort should be spared to make sure that the CTBT is a universal and internationally and effectively verifiable treaty and to secure its earliest entry into force.”¹⁸⁷ The conference’s final document, adopted by consensus, included 13 steps to implement Article VI; the first was “The importance and urgency of signatures and ratifications, without delay and without conditions and in accordance with constitutional processes, to achieve the early entry into force of the Comprehensive Nuclear-Test-Ban Treaty.”¹⁸⁸

Supporters argue that these commitments were instrumental in securing indefinite extension of the NPT and a successful outcome of the 2000 review conference. They conclude that this nation should honor its commitments

Supporters note that the international community overwhelmingly favors the CTBT. As of March 2008, 178 nations had signed the treaty, and 144 of them had ratified. On December 5, 2007, by a vote of 176 for, 1 against (United States), and 4 abstentions, the U.N. General Assembly adopted resolution A/RES/62/59 stressing the importance of achieving the earliest entry into force of the CTBT. Further, the international community overwhelmingly links the treaty to nuclear nonproliferation and disarmament. For example, Japan’s representative at the 2007 conference on the treaty’s entry into force stated, “Japan supports the CTBT, which underpins the international nuclear non-proliferation regime founded on the NPT, as a practical and concrete measure for realizing a nuclear-free world.”¹⁸⁹ Nigeria’s representative said, “We believe that the universal adherence to the Treaty, including by the five nuclear weapon States, would contribute towards the process of nuclear disarmament and nuclear non-proliferation and, therefore, towards the enhancement of international

¹⁸⁶ U.N. Conference of the Parties to the Treaty on the Non-Proliferation of Nuclear Weapons. “Principles and Objectives for Nuclear Non-proliferation and Disarmament.” NPT/CONF.1995/32 (Part I), Annex. Available at [<http://disarmament2.un.org/wmd/npt/1995dec2.htm>].

¹⁸⁷ “Statement by the Delegations of France, the People’s Republic of China, the Russian Federation, the United Kingdom of Great Britain and Northern Ireland, and the United States of America,” statement to the 2000 NPT Review Conference, May 1, 2000, at [<http://canberra.usembassy.gov/hyper/2000/0502/epf207.htm>].

¹⁸⁸ 2000 Review Conference of the Parties to the Treaty on the Non-Proliferation of Nuclear Weapons, “Final Document,” adopted May 19, 2000.

¹⁸⁹ Japan. Permanent Mission of Japan to the International Organizations in Geneva. “Statement by H.E. Mr. Hitoshi Kimura, Senior Vice-Minister for Foreign Affairs of Japan, at the 5th Conference on Facilitating the Entry into Force of the Comprehensive Nuclear-Test-Ban Treaty, Vienna, 17 September 2007.”

peace and security.”¹⁹⁰ The final declaration of the conference stated: “We reiterate that the cessation of all nuclear weapon test explosions and all other nuclear explosions ... constitutes an effective measure of nuclear disarmament and non-proliferation in all its aspects.”¹⁹¹

Gen. John Shalikashvili, former Chairman of the Joint Chiefs of Staff, argued that the CTBT and nuclear nonproliferation were closely linked:

Non-ratification [of the CTBT] has also complicated U.S. efforts to strengthen the International Atomic Energy Agency safeguards that non-nuclear weapon state parties to the NPT must have on their civilian nuclear programs. Many countries are reluctant to accept new obligations while the United States is unwilling to approve the Test Ban Treaty.... Once we ratify the Test Ban Treaty, which the rest of the world views as vital for non-proliferation, we will be better able to enlist cooperation on export controls, economic sanctions, and other coordinated responses to specific problems.¹⁹²

Former Secretary of State George Shultz, former Secretary of Defense William Perry, former Secretary of State Henry Kissinger, and former Senator Sam Nunn argued the need to link the goal of disarmament and specific steps to achieve it:

Reassertion of the vision of a world free of nuclear weapons and practical measures toward achieving that goal would be, and would be perceived as, a bold initiative consistent with America’s moral heritage.... Without the bold vision, the actions will not be perceived as fair or urgent. Without the actions, the vision will not be perceived as realistic or possible.

One of the eight steps they recommend is “Initiating a bipartisan process with the Senate, including understandings to increase confidence and provide for periodic review, to achieve ratification of the Comprehensive Test Ban Treaty, taking advantage of recent technical advances, and working to secure ratification by other key states.”¹⁹³

By the same token, some CTBT supporters contend that U.S. failure to observe the disarmament end of the bargain will inevitably undermine the willingness of other nations to cooperate on nonproliferation. Margaret Beckett, former U.K. Secretary of State for Foreign and Commonwealth Affairs, said,

¹⁹⁰ “Nigeria’s Statement Delivered by Dr. F. Erepamo Osaisai, Director-General/Chief Executive, Nigeria Atomic Energy Commission, at the Article XIV Conference of the CTBT, 17th -18th September 2007, Vienna, Austria,” p. 3.

¹⁹¹ “Final Declaration and Measures to Promote the Entry into Force of the Comprehensive Nuclear-Test-Ban Treaty,” as adopted on 18 September 2007 at the Conference on Facilitating the Entry into Force of the Comprehensive Nuclear-Test-Ban Treaty and annexed to the Report of the Conference (CTBT — Art.XIV/2007/6).

¹⁹² Shalikashvili, *Findings and Recommendations Concerning the Comprehensive Nuclear Test Ban Treaty*, n.p.

¹⁹³ Shultz et al., “A World Free of Nuclear Weapons.”

our efforts on non-proliferation will be dangerously undermined if others believe, however unfairly, that the terms of the grand bargain have changed, that the nuclear weapon states have abandoned any commitment to disarmament.

The point of doing more on disarmament, then, is not to convince the Iranians or the North Koreans. I don't believe for a second that further reductions in our nuclear weapons would have a material effect on their nuclear ambitions. Rather the point of doing more is this: because the moderate majority of states, our natural and vital allies on non-proliferation, want us to do more. And if we do not, we risk helping Iran and North Korea in their efforts to muddy the water, to turn the blame for their own nuclear intransigence back onto us. They can undermine our arguments for strong international action in support of the NPT by painting us as doing too little too late to fulfill our own obligations.¹⁹⁴

CTBT opponents dismiss this seeming international support. According to a 2007 study by the International Security Advisory Board, a federal advisory committee for the State Department,

the NPT is too important to be left to the NPT “professionals.” These “professionals,” perhaps more aptly termed “groupies,” are an association of government representatives, NGOs, and anti-war, anti-nuclear activists. They often carry agendas far beyond the views of their senior government leaders and are quite disconnected from world realities and from the original intention of the NPT. It is generally believed that the success in the 2000 review was the result of diplomatic approaches by the Clinton Administration directly to internationally influential government leaders.¹⁹⁵

CTBT opponents state that many nations do not need their own nuclear weapons because they rely on the U.S. nuclear umbrella. They hold that supporters misread the relationship between nuclear weapons and nonproliferation because the NNWS are the main beneficiaries of the NPT. As Robert Monroe said, “the real winners from this inequality [between NWS and NNWS] are the NNWS. They're overwhelmingly better off by not having to fear nuclear-armed neighbors and by being relieved of the staggering expense of maintaining a nuclear arsenal.”¹⁹⁶ As the International Security Advisory Board states,

There is clear evidence in diplomatic channels that U.S. assurances to include the nuclear umbrella have been, and continue to be, the single most important reason many allies have foresworn nuclear weapons.... The ISAB is convinced that a lessening of the U.S. nuclear umbrella could very

¹⁹⁴ Margaret Beckett, Secretary of State for Foreign and Commonwealth Affairs, United Kingdom, “A World Free of Nuclear Weapons?” address to Carnegie International Nonproliferation Conference, June 25, 2007, Washington, DC, p. 4, at [<http://www.carnegieendowment.org/static/npp/2007conference/transcripts/keynote.pdf>].

¹⁹⁵ U.S. Department of State. International Security Advisory Board. *Report on Discouraging a Cascade of Nuclear Weapons States*, October 19, 2007, p. 14.

¹⁹⁶ Personal communication, November 7, 2007.

well trigger a cascade [of nuclear proliferation] in East Asia and the Middle East.¹⁹⁷

Opponents, seeing U.S. nuclear forces as contributing strongly to nuclear nonproliferation, reject the claim that the CTBT is essential for it. They note that the United States has taken a great many steps to counter proliferation, many since 1999. These include the Proliferation Security Initiative, a multinational partnership to interdict WMD shipments; U.N. Security Council Resolution 1540, under which all nations are to “adopt and enforce appropriate effective laws which prohibit any non-State actor” from acquiring WMD; continued efforts to secure nuclear weapons in Russia and fissile materials in former Soviet republics and elsewhere; the Global Initiative to Combat Nuclear Terrorism; the Six-Party Talks with North Korea to roll back its nuclear program; the successful rollback of Libya’s nuclear weapons program; and breaking the A.Q. Khan nuclear smuggling ring. Opponents therefore argue that Senate rejection of the CTBT has not hindered U.S. nonproliferation efforts.

The CTBT and Nuclear Disarmament

CTBT opponents also note that the United States has taken many steps toward disarmament. The State Department states, “U.S. actions over the past 20 years have established an enviable record of Article VI compliance.” Accomplishments include dismantlement of over 13,000 nuclear weapons since 1988, elimination of 350 heavy bombers and 28 ballistic missile submarines, conversion of about 60 tons of fissile material irreversibly for fuel in civil reactors, cooperative threat reduction assistance to the former Soviet Union resulting in elimination of 1,000 Soviet/Russian ballistic missiles and 27 ballistic missile submarines, and continuing the nuclear test moratorium.¹⁹⁸ A U.S. official said, “One wonders how such progress can be overlooked.”¹⁹⁹ CTBT opponents conclude that these efforts can continue without U.S. ratification of the CTBT because they are in the interests of almost every nation.

Beyond these specific steps, opponents see the concept of nuclear abolition as unrealistic. There are many thousands of these weapons in the world, and they

¹⁹⁷ U.S. Department of State. International Security Advisory Board. *Report on Discouraging a Cascade of Nuclear Weapons States*, p. 23.

¹⁹⁸ U.S. United States Mission to International Organizations in Vienna. “U.S. Implementation of Article VI and the Future of Nuclear Disarmament.” December 21, 2005, 3 p., available at [http://vienna.usmission.gov/_unvie/media/speeches_and_related_documents/Fact_Sheet_US_Implementation_of_NPT_Article_VI_Dec_21_05.doc]. See also John Harvey, “U.S. Nuclear Weapons Programs: Implications for Nonproliferation,” Remarks at NATO Conference: “NATO and the Future of the NPT,” NATO Defense College, Rome, Italy, September 12, 2006 (as revised November 27, 2006).

¹⁹⁹ U.S. Department of State. U.S. Mission to the United Nations in Geneva. “Statement by Christina Rocca, Permanent Representative of the United States to the Conference on Disarmament on the General Debate on Disarmament and International Security Agenda Items in the First Committee of the General Assembly,” press release, October 9, 2007, available at [<http://geneva.usmission.gov/Press2007/1009AmbRoccaUNAG.html>].

cannot be “disinvented.” Former Secretary of Defense Harold Brown and former Director of Central Intelligence John Deutch wrote,

the goal, even the aspirational goal, of eliminating all nuclear weapons is counterproductive. It will not advance substantive progress on nonproliferation; and it risks compromising the value that nuclear weapons continue to contribute, through deterrence, to U.S. security and international stability.... at present, there is no realistic path to a world free of nuclear weapons.²⁰⁰

The CTBT’s opponents see the treaty as not enforceable. They argue that the “international community” is long on talk but short on action, and point to Bosnia, Rwanda, and Darfur as examples, as well as difficulties in imposing meaningful sanctions on Iran for its nuclear activities. They would be unwilling to rely on the U.N. to enforce the CTBT. Further, disarmament would require some means of knowing, as a baseline, how many warheads China and Russia possessed at some point in time. Since there is no technical means of gaining this data, it is argued, the United States would not know their remaining stocks even if they were to destroy a substantial number.

Supporters see this concern over lack of enforceability as misplaced. Norms and sanctions, they argue, have an effect. South Africa, Argentina, and Brazil gave up nuclear weapon programs; Ukraine, Kazakhstan, and Belarus gave up nuclear weapons on their soil when they became independent states; and North Korea seems to be in the process of giving up its nuclear weapons program. Supporters see nuclear disarmament as a very long term goal, not one that can be implemented any time soon. For example, the United Kingdom, which ratified the CTBT, plans to continue its submarine-based nuclear deterrent. As Prime Minister Tony Blair explained, “the risk of giving up something that has been one of the mainstays of our security since the War ... is not a risk I feel we can responsibly take. Our independent nuclear deterrent is the ultimate insurance.”²⁰¹ Nonetheless, they believe it is important to set disarmament as a goal and to take steps toward it, notably the CTBT.

Beyond that, supporters believe a resumption of U.S. nuclear testing would be disastrous to the nonproliferation regime, setting off a proliferation cascade. In this scenario, Russia would feel compelled to test, if only to demonstrate that it would keep up with the United States. China would seize the opportunity to test to perfect lighter warheads that, it is argued, might be designed using U.S. weapons information allegedly gained through espionage.²⁰² With the testing option open, Iran could

²⁰⁰ Harold Brown and John Deutch, “The Nuclear Disarmament Fantasy,” *Wall Street Journal*, November 19, 2007, p. 19.

²⁰¹ U.K. Prime Minister. “PM Outlines Plans for Nuclear Deterrent.” December 4, 2006, available at [<http://www.pm.gov.uk/output/Page10532.asp>].

²⁰² Regarding allegations of espionage, see U.S. Congress. House. Select Committee on U.S. National Security and Military/Commercial Concerns with the People’s Republic of China. *U.S. National Security and Military/Commercial Concerns with the People’s Republic of China*. H.Rept. 105-851, 105th Congress, 2nd Session, 1999, Volume 1, Chapter 2, “PRC (continued...) ”

conduct nuclear and ballistic-missile tests; the potential threat to Israel could lead that nation to expand its alleged nuclear weapons program and conduct tests. Saudi Arabia and Egypt might feel the need for nuclear programs, whether to deter Iran or Israel. In this environment, North Korea might test again, leading Japan and South Korea to begin nuclear weapon programs. India and Pakistan might conduct tests. The risk of nuclear war would grow exponentially, with many nations threatened from multiple directions and none of the new nuclear powers having the strict command and control of the United States and Russia. With nuclear weapons, fissile material, and expertise in so many hands, in this scenario, the risk of nuclear terrorism would rise sharply.

Supporters question the link between the nuclear umbrella and testing. They note that Japan, South Korea, all members of the European Union, and all members of NATO except the United States have ratified the CTBT.²⁰³ Their ratification, it is argued, calls into question whether they would exit the treaty to develop nuclear weapons of their own should there be some doubt about the reliability of U.S. nuclear forces. Instead, supporters claim, nonproliferation and the CTBT are tightly linked. A Carnegie International Nonproliferation Conference document stated:

Nearly every speaker emphasized that the CTBT is the most salient indicator of whether the core nuclear nonproliferation bargain can be sustained. ... The CTBT indicates whether states are willing to uphold their commitments to reduce the role of nuclear weapons. Its implementation would stop the steep plunge in international confidence in the nonproliferation regime. U.S. ratification of the treaty would pressure other states that also have not ratified to clarify their nuclear policies to the rest of the world — including China, India, Egypt, Israel, and Iran.²⁰⁴

Moratorium and Entry into Force

Opponents respond that the U.S. moratorium on nuclear testing is an example of compliance with Article VI of the NPT, especially as this moratorium has been in effect since 1992, and so should be seen as supporting nonproliferation. They prefer the moratorium to the treaty, believing that, in the event of a problem with a nuclear weapon that could only be fixed through testing, it would be politically more difficult to exit the moratorium than the treaty.

Supporters reply that the moratorium is insufficient. The WMD Commission, an independent organization funded by the Swedish government that seeks proposals to reduce the dangers of WMD, stated in a report of 2006:

²⁰² (...continued)

Theft of U.S. Thermonuclear Weapons Design Information,” pp. 59-95.

²⁰³ For list of European Union nations, see [http://europa.eu/abc/european_countries/index_en.htm]. For NATO members, see [<http://www.nato.int/cv/hsg/cv-hos.htm>]. For CTBT ratifications, see [<http://www.ctbto.org/>].

²⁰⁴ Carnegie Endowment for International Peace, 2007 Carnegie International Nonproliferation Conference, “Top Ten Results,” August 2007, at [<http://www.carnegieendowment.org/files/toptenresults2007.pdf>].

The Commission believes that a US decision to ratify the CTBT would strongly influence other countries to follow suit. It would decisively improve the chances for entry into force of the treaty and would have more positive ramifications for arms control and disarmament than any other single measure. While no nuclear-weapon tests have been carried out for many years, leaving the treaty in limbo is a risk to the whole international community. The United States should reconsider its position and proceed to ratify the treaty. Only the CTBT offers the prospect of a permanent and legally binding commitment to end nuclear testing.²⁰⁵

Similarly, the final declaration of the 2007 Conference on Facilitating the Entry into Force of the Comprehensive Nuclear-Test-Ban Treaty stated, “Continuing and sustained voluntary adherence to a moratorium is of the highest importance, but does not have the same effect as the entry into force of the Treaty, which offers the global community the prospect of a permanent and legally binding commitment to end nuclear weapon test explosions or any other nuclear explosions.”²⁰⁶ Supporters note that the treaty’s entry into force would bring into operation the treaty’s on-site inspection provisions, as inspections can only occur pursuant to the treaty, not the moratorium. They believe that the CTBT would provide a visible barrier between nuclear power and nuclear weapons programs that some would be unwilling to cross, and this barrier, by reducing confidence in a weapons program, might dissuade some nations from undertaking such a program.

Opponents note that even if the United States were to ratify the CTBT, it would still not enter into force, so they see the attempt to gain Senate advice and consent as an exercise in futility, especially given that the Senate rejected the treaty in 1999 by a vote of 48 for, 51 against, and one present — far short of a two-thirds majority. Of the 44 “Annex 2” states, those that must, pursuant to Annex 2 of the treaty, ratify the treaty for it to enter into force, six have signed but not ratified (China, Egypt, Iran, Israel, Indonesia, and the United States), and three (India, North Korea, and Pakistan) have not signed. While Colombia and Indonesia might be induced to ratify the treaty, opponents question whether the others would do so.

David Hafemeister, professor emeritus of physics at California Polytechnic State University, sees a path to entry into force.

It is generally assumed that the process begins with the United States. If the US ratifies, it is generally assumed that China will follow. With China and the US acting together, it is generally assumed that North Korea will ratify. ... Indonesia, a significant CTBT player, will probably ratify. The next step would be the most difficult, as it necessitates a Middle-East Grand Bargain, which would obtain ratifications from Israel first and then

²⁰⁵ Weapons of Mass Destruction Commission, *Weapons of Terror: Freeing the World of Nuclear, Biological, and Chemical Arms*, Stockholm, Sweden, 2006, p. 107, at [http://www.wmdcommission.org/files/Weapons_of_Terror.pdf].

²⁰⁶ “Final Declaration and Measures to Promote the Entry into Force of the Comprehensive Nuclear-Test-Ban Treaty,” September 18, 2007.

Egypt and Iran. With China committed to a test ban, India could follow China. Pakistan has stated that it would ratify if India did.²⁰⁷

Opponents reply that this scenario hinges on many assumptions, the failure of any one of which could prevent entry into force. Would China ratify the treaty? What basis is there to assume that North Korea would ratify? Why would India agree to the treaty simply because China did? India's main rival is Pakistan, and India might be unwilling to foreclose the option to improve its nuclear weapons through testing given the prospect of instability in Pakistan. India's stated unwillingness to block entry into force could be taken to mean that Pakistan must ratify the treaty before India, which seems unlikely. A Middle East bargain between Egypt, Iran, and Israel would be difficult to achieve, especially if, as has been the case since 1970, Israel is unwilling to ratify the NPT as a non-nuclear weapon state. Given the many other outstanding Middle East issues, CTBT ratification would seem low on the agenda of these three nations.

Even if not all 44 Annex 2 states do not ratify the treaty, supporters see value in U.S. ratification. It would give the United States leverage to press others to join the treaty. Senator Carl Levin said, "If we are not willing to ratify the Comprehensive Test Ban Treaty, what standing do we have to urge India, Pakistan, or any country to stop testing?"²⁰⁸ Some supporters hold that U.S. ratification would help secure international cooperation with the United States by symbolizing a U.S. turn toward multilateralism. Randy Rydell of the U.N. Office for Disarmament Affairs said, "I believe the CTBT does have enormous symbolic importance, regardless of the limits of its ability — alone — to 'stop' proliferation or 'prevent' the improvement of existing arsenals. It stands for the rule of law in disarmament, for the need for binding commitments, for multilateralism, for verification, and for transparency."²⁰⁹ Even if a few of the 44 Annex 2 states do not ratify the treaty, the international community could press non-members of CTBT not to test, and could impose sanctions if they test. According to Richard Garwin, "U.S. ratification of the treaty would legitimize and mobilize support for U.S. and international action against nations that test, whether or not they are party to the treaty; indeed, the prospect of such support might deter nations from testing."²¹⁰ It might be possible to find a way to bring the treaty into force without all 44 Annex 2 states, but not, in the view of the treaty's supporters, without the United States.

In 1982, President Reagan set forth a series of conditions under which the United States could proceed with the CTBT.

U.S. policy continues to endorse a Comprehensive Test Ban as a long-term objective. This is to be achieved in the context of broad, deep, and

²⁰⁷ David Hafemeister, "Entrance-Into-Force of CTBT," *Forum on Physics and Society*, American Physics Society, January 2008, vol. 37, no. 1, at [<http://units.aps.org/units/fps/newsletters/2008/january/article-hafemeister.cfm>].

²⁰⁸ *SFRC CTBT hearing*, 1999, pp. 58-59.

²⁰⁹ Personal communication, July 26, 2007.

²¹⁰ Personal communication, September 26, 2007.

verifiable arms reductions, expanded confidence building measures, improved verification capabilities that would justify confidence in Soviet compliance with a Comprehensive Test Ban; and at a time when a nuclear deterrent is no longer as essential an element, as currently, for international security and stability.²¹¹

CTBT supporters assert that these conditions have been met, so it is time for the United States to ratify the treaty. If not now, they ask, when?

The treaty's opponents take a different view. While there have been verifiable reductions in missile silos, bombers, and submarines, the Moscow Treaty (Strategic Offensive Reduction Treaty) does not provide for verification, and there has been no verifiable reduction in numbers of nuclear warheads. While many programs since 1982 have built confidence with Russia, as has the disappearance of the Soviet Union, Russia continues to modernize its nuclear forces, and concerns remain about China, Iran, and others. Opponents argue that there are ample opportunities for Russia to conduct clandestine tests that would give it a military advantage, given limitations on monitoring capability and extensive data on testing and evasion gained from Soviet tests. While deterrence of a Russian attack may be less salient now than was deterrence of a Soviet attack in 1982, opponents point to many potential threats, to the importance of the nuclear umbrella for deterrence and nuclear nonproliferation, and to new sources of international instability, such as rogue states, nuclear smuggling rings, and the prospect of nuclear terrorism, that have arisen since the collapse of the Soviet Union. Instead of building confidence, it is argued, these developments reduce it. In this environment, they argue, the United States must maintain a robust nuclear deterrent that evolves to meet actual or anticipated threats. This deterrent, they conclude, is the best guarantee against nuclear proliferation, and maintaining it requires nuclear testing.

Conclusion: Alternatives, Packages, and a Net Assessment

Some have suggested modifying the CTBT in order to gain acceptance by the U.S. Senate. One possibility is a treaty that would permit withdrawal after 10 years with no reason required, but no nation other than the United States supported this position in negotiations for the treaty.²¹² Another is a ban permitting very low yield tests, but the nuclear weapon states could find no threshold to which all could agree other than zero and the nonnuclear weapon states pressed for zero.²¹³

A third possibility would be to conduct some tests before ratifying a zero-yield, indefinite-duration CTBT. Indeed, the Hatfield-Exon-Mitchell amendment to the FY1993 Energy and Water Development Appropriations Act (P.L. 102-377, Section 507) provided for some tests from July 1993 to September 1996 under certain

²¹¹ Quoted in *SASC CTBT hearings, 1999*, p. 16.

²¹² *SFRC CTBT Hearing, 1999*, p. 24.

²¹³ *SFRC CTBT Hearing, 1999*, p. 17.

conditions, though the tests were not conducted. For the United States, this approach would accomplish many things that the treaty's critics favor. Testing would:

- indicate whether LEPs had maintained existing weapons sufficiently and, if not, would validate fixes;
- indicate whether RRW designs were effective;
- provide experimental data to validate computer models and data drawn from nonnuclear experiments;
- provide nuclear test experience for a new generation of weapons designers and others; and
- benefit from advances made by SSP, which would guide the tests to gather key pieces of data, and from technical advances made in the broader economy since the last test in 1992.

On the other hand, U.S. testing could lead to testing by Russia and China, which would enable them to maintain and improve their weapons and develop new ones, undermining U.S. security, and could lead other nations to test as well, in a proliferation cascade. Nonnuclear weapon states might grudgingly have accepted some U.S. testing in 1993-1996; indeed, China and France conducted several tests in this period, though accompanied by international protests. At present, however, critics of this approach believe that with the U.S. moratorium in effect for over 15 years and the treaty ratified by over 140 nations, resumed U.S. testing — even if limited in number and duration and presented as a way to secure U.S. ratification — could well lead to the demise of the CTBT. In any future debate on the treaty, the Senate may wish to examine whether any of these three alternatives merits consideration.

Even if these alternatives are rejected, others might be considered that are not inconsistent with the treaty. CTBT supporters might offer new safeguards in addition to those set forth by President Clinton in 1995, but the 45-year history of safeguards indicates that they are all but certain to be a part of any future resolution of ratification of the CTBT and so may offer little leverage on behalf of the treaty. As another alternative, CTBT supporters might offer an RRW-CTBT package to secure Senate advice and consent to ratification. Yet RRW appears an insufficient inducement. Some CTBT opponents hold that the United States could not have confidence in RRW without nuclear testing, and RRW has only modest political support as evidenced by the fact that Congress eliminated FY2008 funds for it.

Therefore, if the treaty were to come up again for Senate consideration, it might have to be considered on its own merits. In every arms control treaty, each state party gives up something in the expectation that the risks of so doing are outweighed by gains from what it can give up (such as expensive weapons or programs), what the other parties give up, and what threats it averts. This argues for a net assessment rather than accepting or rejecting a treaty based on one criterion in isolation. There are many criteria to consider in this assessment:

- Can the United States maintain the safety and reliability of its nuclear weapons, and the health of the nuclear weapons enterprise, well enough over the long term without nuclear testing? And what constitutes “well enough”?
- Are new nuclear weapons needed for deterrence, or do existing weapons, coupled with conventional forces, suffice? Will new weapons require testing?
- What is the current balance between monitoring and evasion? Given that monitoring technology will continue to improve, and that evasion capability may improve, but in ways that are generally classified and may well be unknown, how is the monitoring-evasion balance likely to shift over time?
- How confident can an evader be in its ability to succeed, given the many and improving monitoring techniques and the difficulties that could cause an evasion attempt to fail? How confident can monitors be in their ability to detect and identify a clandestine or an unattributable test in light of the many scenarios that have been set forth and the vast information on monitoring capabilities available in the open literature and available through the IMS to states parties to the treaty?
- How likely are Russia and China to cheat, and to gain a strategic advantage thereby?
- How likely are other nations to cheat, and how would that affect deterrence, regional stability, and nuclear proliferation?
- Would the international community impose severe consequences on a CTBT member that conducted clandestine tests? Would it impose such consequences on a state not party to the CTBT that conducted tests, whether clandestine or not?
- Would U.S. ratification of the treaty make nuclear proliferation more or less likely? What specific steps would entry into force of the CTBT lead nonnuclear weapon states to take in order to rein in nuclear proliferation? Would these states take these steps only if the treaty enters into force?
- Is U.S. movement toward nuclear disarmament, as exemplified by the CTBT, essential for nuclear nonproliferation, as some suggest, or do the many U.S. steps toward disarmament and nonproliferation taken to date provide a firm basis for further nonproliferation efforts?
- Is the U.S. moratorium on nuclear testing a reasonable long-term balance between those who demand that the United States ratify the CTBT and those who urge a return to testing?

- Is the United States likely to exit the moratorium if a problem arises that calls for a test? Is this nation less likely to exit the CTBT under that circumstance?
- How likely is the CTBT to enter into force if the United States ratifies it and works to secure ratification by all Annex 2 states? Could the treaty be brought into force if the United States and China ratified it but a few Annex 2 states did not?
- Do technical and geopolitical developments since 1999 warrant a reconsideration of the treaty?

One's net assessment depends on the importance one attaches to these and other criteria, and the degree and probability of adverse consequences resulting from an incorrect judgment. The assessment is complicated by the accretion of criteria over the course of test ban debates over the past half-century. While arguments over each criterion necessarily shift over time, it also appears that new criteria are added but old ones never leave the debate. Beyond that, perceptions on broader issues influence judgment: the likelihood of malevolent actions by China, Russia, Iran, and North Korea; the value of treaties and regimes for restraining or halting nuclear proliferation; the balance between obtaining security through military capability or diplomacy, and how the two are linked; and the value of U.S. nuclear weapons for influencing the behavior of other nations. In the case of the CTBT, there is no more agreement on the direction of these assessments than there is on judgments on individual criteria. As a result, Members of Congress, Secretaries of Defense and State, and Chairmen of the Joint Chiefs of Staff have often arrived at opposed assessments.

Appendix A. History of Nuclear Testing, Test Bans, and Nonproliferation

Efforts toward a CTBT date from the dawn of the nuclear age. In 1946, Representative Louis Ludlow introduced H.Con.Res. 146, declaring the sense of Congress that an atomic bomb test be canceled, “that the manufacture of atomic bombs shall cease,” and that U.S. officials should seek “a definite postwar agreement by the United Nations to ban the atomic bomb forever as an instrument of war.”²¹⁴ A scholarly study, analyzing a 1952 report, stated, “Perhaps convinced by the failure to control the A-bomb that there was no possibility for international control once a weapon had been tested, the Oppenheimer Panel recommended approaching the Soviets on control before testing the H-bomb.”²¹⁵ In 1954, Prime Minister Jawaharlal Nehru of India proposed “Some sort of what may be called ‘standstill agreement’ in respect, at least, of these actual [nuclear] explosions.”²¹⁶ President Dwight Eisenhower and Soviet Chairman Nikolai Bulganin began a correspondence in 1957 on a nuclear test ban, and discussions and negotiations continued in various fora toward a CTBT for several years.²¹⁷ The two nations were often deadlocked over on-site inspections, which the United States claimed were needed to assure that the Soviets were not cheating and which the Soviets claimed were a means to introduce spies into the country.

The Cuban Missile Crisis of October 1962 added impetus to these negotiations. On July 15, 1963, in the wake of this crisis, negotiations between the Soviet Union, United Kingdom, and United States began in Moscow. The United States initially sought a CTBT, but Soviet negotiators ruled this out. Instead, the negotiators quickly worked out a ban on nuclear testing in the atmosphere, in space, and under water. The result was the Limited Test Ban Treaty (LTBT), which was signed on August 5 and which President Kennedy submitted to the Senate on August 8. While the treaty did not limit underground tests because of the difficulty of monitoring them, the Preamble noted that the U.S., U.K., and Soviet governments were “Seeking to achieve the discontinuance of all test explosions of nuclear weapons for all time, determined to continue negotiations to this end, and desiring to put an end to the contamination of man’s environment by radioactive substances.”

In Senate hearings on the LTBT, the Joint Chiefs of Staff recognized gains from the treaty, but expressed concern that the treaty could lead the United States to let

²¹⁴ U.S. Congress. *Congressional Record*, vol. 92, 79th Congress, 2nd Session, 1946, pt. 3, pp. 4023-4024, and pt. 13, p. 674.

²¹⁵ Benjamin Greene, *Eisenhower, Science Advice, and the Nuclear Test-Ban Debate, 1945-1963*, Stanford, CA, Stanford University Press, 2007, p. 36.

²¹⁶ “Statement by the Indian Prime Minister (Nehru) to Parliament Regarding Nuclear Tests,” April 2, 1954, reprinted in U.S. Department of State. Bureau of Public Affairs. Historical Office. *Documents on Disarmament, 1945-1959*, Volume I, 1945-1956. Department of State publication 7008, released August 1960, p. 410.

²¹⁷ For a detailed history of the test ban negotiations from 1957 through 1963, see Harold Karan Jacobson and Eric Stein, *Diplomats, Scientists, and Politicians: The United States and the Nuclear Test Ban Negotiations*, Ann Arbor, University of Michigan Press, 1966.

down its guard on nuclear matters. Accordingly, they conditioned their support for the treaty on four “safeguards,” or measures the United States could take unilaterally within the treaty to maintain U.S. nuclear capabilities: Safeguard A, an aggressive underground nuclear test program; Safeguard B, technology facilities and programs to attract and retain scientists; Safeguard C, maintenance of the ability to resume atmospheric testing promptly; and Safeguard D, improvement of monitoring capability.²¹⁸

Owing to concerns about the balance of risks and benefits of the treaty, Senate Majority Leader Mike Mansfield and Senate Minority Leader Everett McKinley Dirksen met with President Kennedy to discuss the matter. The President sent them a letter on September 10 providing “unqualified and unequivocal assurances” on the treaty. These assurances included the safeguards set forth by the Joint Chiefs (though differently worded), and provisions regarding Cuba, East Germany, and peaceful nuclear explosives.²¹⁹ These assurances were instrumental in securing Senator Dirksen’s support, and that of the Senate. The Senate gave its advice and consent to ratification on September 24, and it entered into force on October 10, 1963.

The Nuclear Nonproliferation Treaty (NPT) involved a bargain between the nuclear weapon states (NWS — China, France, Soviet Union, United Kingdom, and United States) and the nonnuclear weapon states (NNWS). In 1959, the U.N. General Assembly adopted a resolution calling for barring states not having nuclear weapons from acquiring them, and in 1961 another General Assembly resolution supporting such a treaty passed unanimously.²²⁰ The treaty was signed in July 1968. The Senate gave its advice and consent to ratification in March 1969. The United States ratified it in November 1969, and it entered into force in March 1970. The central bargain was that NWS would retain nuclear weapons but would not aid NNWS in acquiring nuclear weapons, and NNWS would not acquire nuclear weapons. NNWS were concerned that these provisions would permit the NWS to have nuclear weapons indefinitely, so they insisted on a provision, Article VI, making clear that the intent was the opposite: “Each of the Parties to the Treaty undertakes to pursue negotiations in good faith on effective measures relating to cessation of the nuclear arms race at an early date and to nuclear disarmament, and on a Treaty on general and complete disarmament under strict and effective international control.” This provision has been at the heart of disputes over nuclear disarmament between NNWS and NWS, especially the United States, ever since. Other provisions include “safeguards” to verify compliance with the treaty (Article III), “the inalienable right of all the Parties

²¹⁸ Testimony of General Maxwell Taylor, Chairman, Joint Chiefs of Staff, in U.S. Congress. Senate. Committee on Foreign Relations, *Nuclear Test Ban Treaty*, hearings on Executive M, 88th Congress, 1st Session, 1963, pp. 274-275.

²¹⁹ Letter from President John Kennedy to Hon. Mike Mansfield and Hon. Everett McKinley Dirksen, in address by Senator Dirksen on the Nuclear Test Ban Treaty, U.S. Congress. *Congressional Record*, September 11, 1963, p. 16790-16791.

²²⁰ George Bunn, “The Nuclear Nonproliferation Regime and Its History,” in George Bunn and Christopher Chyba, *U.S. Nuclear Weapons Policy: Confronting Today’s Threats*, Center for International Security and Cooperation, Stanford University, and Brookings Institution Press, Washington, 2006, p. 76. This chapter contains a detailed history of the NPT and other nuclear nonproliferation arrangements.

to the Treaty to develop research, production and use of nuclear energy for peaceful purposes,” aided by exchange of equipment, materials, and information for that purpose (Article IV), the benefits of peaceful nuclear explosions would be made available to all parties to the treaty (Article V, which has become a dead letter as such explosions have not been conducted for decades and would be barred by the CTBT), a conference to review the treaty every five years (Article VIII), and a conference 25 years after entry into force “to decide whether the Treaty shall continue in force indefinitely, or shall be extended for an additional fixed period or periods” (Article X). These conferences, and especially the 25-year conference, provided further leverage for the NNWS to press the NWS for nuclear disarmament. While the treaty did not ban nuclear testing, its Preamble recalled “the determination expressed by the Parties to the 1963 Treaty banning nuclear weapon tests in the atmosphere, in outer space and under water in its Preamble to seek to achieve the discontinuance of all test explosions of nuclear weapons for all time and to continue negotiations to this end.”

The Threshold Test Ban Treaty (TTBT) was signed in 1974, and the Peaceful Nuclear Explosions Treaty (PNET) was signed in 1976. (These treaties did not enter into force until 1990, as discussed below.) Both were between the United States and Soviet Union, and both contained verification protocols. The TTBT banned underground nuclear weapon tests having a yield greater than 150 kilotons; the PNET extended this limit to peaceful nuclear explosions to preclude weapon tests under the guise of explosions for peaceful purposes. The Preamble of the TTBT recalled Article VI of the NPT and the determination expressed in the Preamble of the LTBT “to seek to achieve the discontinuance of all test explosions of nuclear weapons for all time, and to continue negotiations to this end.” Article I provided that both sides would undertake to observe the 150-kiloton threshold beginning March 31, 1976.

When the LTBT was negotiated in 1963, the United States had limited experience with underground tests. The first contained underground test was conducted in 1957,²²¹ and the extent to which underground testing would prove adequate for weapons development was unclear. As a result, Safeguard C as set forth by the Joint Chiefs of Staff called for “The maintenance of the facilities and resources necessary to institute promptly nuclear tests in the atmosphere should they be deemed essential to our national security or should the treaty or any of its terms be abrogated by the Soviet Union.”²²² After eight years of experience with testing conducted solely underground, the value of such testing had become clear. In 1971, Carl Walske, Assistant to the Secretary of Defense for Atomic Energy, stated,

the test program since 1963 has made the difference between having fairly reliable knowledge about vulnerability [of warheads], both during the launch and reentry phases, and not having it; between having the Poseidon and Minuteman III [missile] systems, and having systems which at best

²²¹ U.S. Department of Energy. Nevada Operations Office. *United States Nuclear Tests, July 1945 through September 1992*, DOE/NV-209, Rev. 15, December 2000, pp. 8-11. The first test with a nuclear explosive emplaced below the ground surface was conducted in 1951 to study cratering, and another such test was conducted in 1955; both were at shallow depth.

²²² Senate Foreign Relations Committee, *Nuclear Test Ban Treaty*, p. 275.

could be a fraction as effective in terms of effects on defended targets; and between the possibility of an effective ABM [antiballistic missile], and most likely, no such possibility.²²³

With the need for atmospheric testing having diminished, President Ford decided in January 1976 to redefine Safeguard C as “The maintenance of the basic capability to resume nuclear testing in the atmosphere should that be deemed essential to national security.” It was understood that “atmosphere” included all prohibited environments.²²⁴ The other safeguards were retained.

President Carter pursued a CTBT rather than seeking Senate advice and consent to ratification of the TTBT and PNET. According to a Senate report, “In mid-1978, the Administration concluded that a push to gain Senate consent to ratification of the TTBT and PNET could stir up a fight which would jeopardize the prospects for a complete ban.”²²⁵ Instead, the United States, United Kingdom, and Soviet Union conducted negotiations on a CTBT. By 1979, almost all issues were resolved or seemed resolvable. However, strong opposition within the Administration to a CTBT led to a U.S. position that the treaty should expire after three years unless renegotiated. Further, in 1979 and 1980, the SALT II ratification debate overshadowed the CTBT negotiations, which continued at a low level until the end of the Carter Administration.²²⁶

President Reagan declined to reopen negotiations for a CTBT, and cited concerns about U.S. ability to monitor the TTBT and PNET. Meanwhile, in 1986, the House and Senate included provisions limiting nuclear testing in their FY1988 defense authorization bills. The House included a one-year moratorium on nuclear tests over 1 kiloton, while the Senate version contained a non-binding provision that called for ratification of the two treaties and resumption of CTBT talks. A conference committee considered these provisions as President Reagan left for a summit meeting with President Gorbachev in October 1986. Again according to the Senate Foreign Relations Committee report,

To break the impasse on the Defense bill and to leave the President free to deal with General Secretary Gorbachev, a compromise was reached.

²²³ “Answers to Questions Subsequently Submitted to Dr. Walske,” in U.S. Congress. Senate. Committee on Foreign Relations. Subcommittee on Arms Control, International Law and Organization. *Prospects for Comprehensive Nuclear Test Ban Treaty*, hearings, 92nd Congress, 1st Session, 1971, p. 131.

²²⁴ “Memorandum of Understanding Between the Department of Energy and the Department of Defense for Planning and Support for Safeguard C and Conducting Nuclear Weapons Tests Outside North American Continental Limits,” signed September 4, 1984, by Richard Saxer, Lieutenant General, USAF, Director, Defense Nuclear Agency, and September 24, 1984, by Maurice Katz, Acting Director of Military Applications, Department of Energy; available at [<http://worf.eh.doe.gov/ihp/chron/H17.pdf>].

²²⁵ U.S. Congress. Senate. Committee on Foreign Relations. *Threshold Test Ban and Peaceful Nuclear Explosions Treaties*. Report to accompany Ex. N, 94-2, 100th Congress, 1st Session, Exec. Rept. 100-1, 1987, p. 4.

²²⁶ This paragraph is based on *ibid.*, pp. 4-5.

The Congress accepted the Senate provision in exchange for Presidential assurances which were contained in an October 10 letter from President Reagan to Chairmen [Senator Barry] Goldwater and [Representative Les] Aspin. The President agreed as follows:

To take two important steps toward limiting nuclear testing. First, I intend to inform General Secretary Gorbachev in Reykjavik that as a first order of business for the 100th Congress, if the Soviet Union will, prior to the initiation of ratification proceedings in the Senate next year, agree to essential TTBT/PNET verification procedures which could be submitted to the Senate for its consideration in the form of a protocol or other appropriate codicil, I will request the advice and consent of the Senate to ratification of the TTB and PNE treaties. However, if the Soviet Union fails to agree to the required package of essential procedures prior to the convening of the 100th Congress, I will still make ratification of these treaties a first order of business for the Congress, with an appropriate reservation to the treaties that would ensure they would not take effect until they are effectively verifiable. I will work with the Senate in drafting this reservation.

Second, I intend to inform the General Secretary in Reykjavik that, once our verification concerns have been satisfied and the treaties have been ratified, I will propose that the United States and the Soviet Union immediately engage in negotiations on ways to implement a step-by-step parallel program — in association with a program to reduce and ultimately eliminate all nuclear weapons — of limiting and ultimately ending nuclear testing.²²⁷

Negotiations began on the verification protocols for the TTBT and PNET in November 1987;²²⁸ as noted, these treaties had been signed in 1974 and 1976, respectively. On June 1, 1990, the United States and Soviet Union signed these protocols, which replaced protocols initially submitted with the treaties.²²⁹ The Senate gave its advice and consent to ratification of both treaties by a vote of 98-0 on September 25, 1990, and they entered into force December 11, 1990. The Senate's resolutions of ratification²³⁰ were "subject to — The declaration that to ensure the preservation of a viable deterrent there should be safeguards ..." These safeguards were (a) the conduct of a continuing nuclear test program, (b) the

²²⁷ Ibid., pp. 6-7.

²²⁸ U.S. Department of State. Bureau of Verification, Compliance, and Implementation. "Treaty Between The United States of America and The Union of Soviet Socialist Republics on the Limitation of Underground Nuclear Weapon Tests (and Protocol Thereto)," [<http://www.state.gov/t/ac/trt/5204.htm>].

²²⁹ Ibid., p. 1.

²³⁰ U.S. Congress. *Congressional Record*. September 25, 1990, p. S13767.

maintenance of modern laboratory facilities and nuclear technology programs to attract and retain nuclear scientists, (c) “maintenance of the basic capability to resume nuclear test activities prohibited by treaties ...,” (d) improved treaty monitoring capabilities, and (e) improved intelligence capabilities. The resolutions of ratification were also subject to a second declaration:

mindful of the commitment of the United States, the Soviet Union and Great Britain in the Limited Test Ban Treaty of 1963 and in the Non-Proliferation Treaty of 1968 to seek the discontinuance of all test explosions of nuclear weapons for all time and of the commitment which shall be legally binding on the Parties upon ratification of the Treaty on the Limitation of Underground Nuclear Weapons Tests [the TTBT] to ‘continue their negotiations with a view toward achieving a solution to the problem of the cessation of all underground nuclear weapon tests,’ the United States shares a special responsibility with the Soviet Union to continue the bilateral Nuclear Testing Talks to achieve further limitations on nuclear testing, including the achievement of a verifiable comprehensive test ban.

In 1992, following the end of the Cold War and the dissolution of the Soviet Union, Congress attached an amendment by Senators Mark Hatfield, James Exon, and George Mitchell to the FY1993 Energy and Water Development Appropriations Act, which President George H.W. Bush signed into law (P.L. 102-377) in October 1992. The amendment, Section 507, barred underground nuclear tests between September 30, 1992, and July 1, 1993; permitted fewer than 20 tests between July 1993 and September 1996 under certain conditions, including an absence of congressional disapproval of such tests; and halted U.S. nuclear tests after September 1996 unless another nation conducted a test after that date. It called for the President to submit “[a] plan for achieving a multilateral comprehensive ban on the testing of nuclear weapons on or before September 30, 1996.” The last U.S. test was held September 23, 1992; none have been held since.

The following year, in the FY1994 National Defense Authorization Act (P.L. 103-160, Section 3138), Congress established the Stockpile Stewardship Program (SSP) “to ensure the preservation of the core intellectual and technical competencies of the United States in nuclear weapons.” SSP elements included enhanced computing capabilities to better simulate nuclear weapon detonation, experiments not involving nuclear explosions, and new experimental facilities. The legislation required the President to submit an annual report to Congress noting “any concerns with respect to the safety, security, effectiveness or reliability of existing United States nuclear weapons ...,” and actions taken or to be taken to address such concerns.

Also in P.L. 103-160, Congress modified Safeguard C, barring in Section 3137 the use of any funds “to maintain the capability of the United States to conduct atmospheric testing of a nuclear weapon.” According to the conference report, “The

conferees agree that the United States no longer needs to maintain the capability to resume the atmospheric testing of nuclear weapons.”²³¹

In November 1993, the United Nations General Assembly unanimously approved a resolution calling for negotiation of a CTBT. The Conference on Disarmament (CD), a U.N.-affiliated organization that is “the single multilateral disarmament negotiating forum of the international community,”²³² conducted the negotiation. The CD’s 1994 session began in January, with negotiation of a CTBT its top priority. This priority resulted at least in part from the NPT Review and Extension Conference scheduled for April and May of 1995, at which time the states parties to the NPT would decide whether to extend the treaty indefinitely, as the United States wanted, or for one or more fixed periods. The decision would be binding on the states parties to the treaty.

The 1995 NPT conference was contentious. NNWS parties to the NPT saw attainment of a CTBT as the touchstone of good faith on matters of disarmament. They argued that the NWS failed to meet their NPT obligations by not concluding a CTBT. They saw progress on winding down the arms race as inadequate. They assailed the NPT as discriminatory because it divided the world into nuclear and nonnuclear states, and argued for a nondiscriminatory NPT regime in which no nation would have nuclear weapons. The CTBT, in their view, was the symbol of this regime because, unlike the NPT, the NWS would give up something tangible, the ability to develop sophisticated new warheads. Some NNWS saw NPT extension as their last source of leverage for a CTBT: once they agreed to a permanent extension of the NPT, they could not pressure the NWS to achieve a CTBT. Other NNWS saw the NPT as in the interests of all but would-be proliferators and felt that anything less than indefinite extension would undermine the security of most nations. This position saw the NPT as too important to put at risk as a means of pressuring the NWS for a CTBT.

The Review and Extension Conference extended the NPT indefinitely. Extension was accomplished by a package of decisions that, because it was so controversial, was adopted without a vote.²³³ The package included decisions on indefinite extension of the NPT, strengthening the treaty’s review process, a resolution on the Middle East, and Principles and Objectives for Nuclear Non-Proliferation and Disarmament. The latter set forth goals on universality of the NPT, nuclear weapon free zones, etc., and stressed the importance of completing “the negotiations on a universal and internationally and effectively verifiable

²³¹ U.S. Congress. Committee of Conference. *National Defense Authorization Act for Fiscal Year 1994*. Conference report to accompany H.R. 2401, 103rd Congress, 1st Session, H.Rept. 103-357, 1993, p. 841.

²³² U.N. United Nations Office at Geneva. “Disarmament: An Introduction to the Conference [on Disarmament].” Available at [[http://www.unog.ch/80256EE600585943/\(httpPages\)/BF18ABFEFE5D344DC1256F3100311CE9?OpenDocument](http://www.unog.ch/80256EE600585943/(httpPages)/BF18ABFEFE5D344DC1256F3100311CE9?OpenDocument)].

²³³ For a brief description of this process, see Stephen Young and Daniel Plesch, “A Permanent Non-Proliferation Treaty,” *Basic Reports*, June 1, 1995, pp. 1-3.

Comprehensive Nuclear-Test-Ban Treaty no later than 1996.”²³⁴ This explicit CTBT-NPT linkage lent urgency to CTBT negotiations.

Meanwhile, President Clinton extended the Hatfield-Exon-Mitchell nuclear test moratorium several times, beginning in 1993, and his administration debated whether to pursue a CTBT or another type of test ban, such as one permitting very low yield nuclear tests. In August 1995, the President announced his “decision to negotiate a true zero yield comprehensive test ban” (i.e., a CTBT that permitted no nuclear yield).²³⁵ A White House fact sheet accompanying the President’s statement conditioned a CTBT on six safeguards, including the SSP, modern laboratory facilities and nuclear technology programs to attract and retain scientists, the “basic capability to resume nuclear test activities,” continued R&D to improve the ability to monitor compliance with the treaty, continued improvement of intelligence capabilities to provide information on nuclear weapons programs worldwide, and the understanding that if a key nuclear weapon type could no longer be certified as safe or reliable, “the President, in consultation with Congress, would be prepared to withdraw from the CTBT under the standard ‘supreme national interests’ clause in order to conduct whatever testing might be required.”²³⁶

The CD completed work on a draft CTBT in August 1996, though objections by India prevented the CD, which operates by consensus, from submitting the treaty to the U.N. General Assembly as a CD document. The General Assembly adopted the treaty in September 1996, and it was opened for signature on September 24, 1996. President Clinton and others signed it on that date. President Clinton submitted it to the Senate in September 1997. On October 13, 1999, the Senate declined to give its advice and consent to ratification by a vote of 48 for, 51 against, and 1 present; a two-thirds majority was required.

The international community has continued to press for the CTBT and has linked it to nuclear nonproliferation and the NPT. In a joint statement to the 2000 NPT review conference, the NWS said, “No effort should be spared to make sure that the CTBT is a universal and internationally and effectively verifiable treaty and to secure its earliest entry into force.”²³⁷ The final document of the conference, which was adopted by consensus, reaffirmed that “the cessation of all nuclear weapon test explosions or any other nuclear explosions will contribute to the non-proliferation of

²³⁴ U.N. Conference of the Parties to the Treaty on the Non-Proliferation of Nuclear Weapons. “Principles and Objectives for Nuclear Non-proliferation and Disarmament.” NPT/CONF.1995/32 (Part I), Annex. Available at [<http://disarmament2.un.org/wmd/npt/1995dec2.htm>].

²³⁵ “Remarks Announcing a Comprehensive Nuclear Weapons Test Ban,” August 11, 1995, in U.S. National Archives and Records Administration. Office of the Federal Register. *Weekly Compilation of Presidential Documents*, August 14, 1995, p. 1432.

²³⁶ U.S. White House. Office of the Press Secretary. “Fact Sheet: Comprehensive Test Ban Treaty Safeguards.” August 11, 1995, p. 1.

²³⁷ “Statement by the Delegations of France, the People’s Republic of China, the Russian Federation, the United Kingdom of Great Britain and Northern Ireland, and the United States of America,” statement to the 2000 NPT Review Conference, May 1, 2000, at [<http://canberra.usembassy.gov/hyper/2000/0502/epf207.htm>].

nuclear weapons”; called on all States, especially those that must ratify the CTBT for it to enter into force, “to continue their efforts to ensure the early entry into force of the Treaty”; and agreed, as a practical step toward disarmament, “An unequivocal undertaking by the nuclear-weapon States to accomplish the total elimination of their nuclear arsenals leading to nuclear disarmament to which all States parties are committed under Article VI” of the NPT.²³⁸

In 2002, a DOD official spelled out the position of the Bush Administration: “We are continuing the current administration policy, as I said, which is we continue to oppose ratification of the CTBT; we continue to adhere to a test moratorium.”²³⁹ Secretary of State Condoleezza Rice reiterated this position in 2007: “the Administration does not support the Comprehensive Test Ban Treaty and does not intend to seek Senate advice and consent to its ratification. There has been no change in the Administration’s policy on this matter.”²⁴⁰

The 2005 NPT review conference was widely seen as ending in failure. The United States focused on Iranian and North Korean nuclear issues, and on steps to counter proliferation,²⁴¹ while, according to one report, “nonnuclear states insisted that the United States and other nuclear powers focus on radically reducing their nuclear armaments,” and some wanted agreement on the CTBT.²⁴²

In keeping with the Bush Administration’s policy, the United States has resisted international pressure to ratify the CTBT. Five conferences have been held pursuant to Article XIV of the CTBT to facilitate the treaty’s entry into force. The most recent conference was held in September 2007. One hundred and six nations participated; the United States did not send a delegation.²⁴³ In September 2006, to mark the tenth anniversary of the CTBT’s opening for signature, 59 foreign ministers issued a statement on the treaty that reaffirms that the CTBT “would contribute to systematic

²³⁸ 2000 Review Conference of the Parties to the Treaty on the Non-Proliferation of Nuclear Weapons, “Final Document,” adopted May 19, 2000.

²³⁹ U.S. Department of Defense. News transcript: “Special Briefing on the Nuclear Posture Review,” presented by J.D. Crouch, Assistant Secretary of Defense for International Security Policy, January 9, 2002. Available at [<http://www.defenselink.mil/Transcripts/Transcript.aspx?TranscriptID=1108>].

²⁴⁰ Letter from Condoleezza Rice, Secretary of State, to The Honorable Pete V. Domenici, United States Senate, June 25, 2007.

²⁴¹ U.S. Department of State. U.S. Mission to the United Nations. “Closing Statement by Ambassador Jackie W. Sanders, Special Representative of the President for the Non-Proliferation of Nuclear Weapons to the 2005 Review Conference of the Treaty on the Non-Proliferation of Nuclear Weapons (NPT),” USUN press release 107 (05), May 27, 2005.

²⁴² David Sanger, “Nonproliferation Conference Ends in Failure,” *International Herald Tribune*, May 28, 2005.

²⁴³ Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization, Conference on Facilitating the Entry into Force of the Comprehensive Nuclear-Test-Ban Treaty, “List of Participants at the Conference on Facilitating the Entry into Force of the Comprehensive Nuclear-Test-Ban Treaty,” CTBT — Art.XIV/2007/INF.4, October 10, 2007, at [http://www.ctbto.org/reference/article_xiv/2007/CTBT-Art.XIV-INF_4.pdf].

and progressive reduction of nuclear weapons and the prevention of nuclear proliferation,” and “[calls] upon all States that have not yet done so to sign and ratify the Treaty without delay, in particular those whose ratification is needed for its entry into force.”²⁴⁴ By wide margins, the U.N. General Assembly passed several resolutions supporting the CTBT that the United States opposed. For example, one such resolution, in 2007, passed by a vote of 176 for, 1 against (United States), and 4 abstentions.

As of March 2008, the treaty had been signed by 178 nations and ratified by 144, including 35 of the 44 whose ratification is required for the treaty to enter into force.²⁴⁵ Among the nuclear weapon states, France, Russia, and the United Kingdom have ratified; China and the United States have signed but not ratified.

²⁴⁴ “Joint Ministerial Statement on the CTBT,” New York, September 20, 2006, at [http://www.armscontrol.org/pdf/20060920_CTBT_Joint_Ministerial_Statement.pdf#search=%22%20%22joint%20ministerial%20statement%20on%20the%20ctbt%22%22].

²⁴⁵ For status of signatures and ratifications, see the website of the Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization at [<http://www.ctbto.org>].

Appendix B. Abbreviations

AFTAC	Air Force Technical Applications Center
CD	Conference on Disarmament
CTBT	Comprehensive Nuclear-Test-Ban Treaty
CTBTO	Comprehensive Nuclear-Test-Ban Treaty Organization
DOD	Department of Defense
DOE	Department of Energy
IDC	International Data Center
IMS	International Monitoring System
LEP	Life Extension Program
LTBT	Limited Test Ban Treaty
NAS	National Academy of Sciences
NNSA	National Nuclear Security Administration
NNWS	Non-nuclear weapon states
NPT	Nuclear Nonproliferation Treaty
NWS	Nuclear weapon states
OSI	On-Site Inspection
PNET	Peaceful Nuclear Explosions Treaty
RRW	Reliable Replacement Warhead
SSP	Stockpile Stewardship Program
TTBT	Threshold Test Ban Treaty
USAEDS	U.S. Atomic Energy Detection System
WR1	Designation of first RRW design