Policy Analysis

No. 330 January 15, 1999

THE COMPREHENSIVE TEST BAN TREATY

The Costs Outweigh the Benefits

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Executive Summary

The Comprehensive Test Ban Treaty (CTBT) is now before the U.S. Senate for its advice and consent. The treaty bans all explosive testing of nuclear weapons.

Advocates of the CTBT make several arguments in support of the treaty. The reasons reduce to two points: the ban will constrain the modernization and development of nuclear weapons by the nations that already possess them, and it will help prevent the spread of nuclear weapons to additional nations. Both objectives are set out in the CTBT's preamble.

Opponents of the CTBT are most concerned about one issue: in the absence of nuclear testing, U.S. nuclear weapons can be neither as safe nor as reliable as they should be. Those deficiencies will diminish the effectiveness of the U.S. nuclear deterrent. While the treaty will constrain the United States from modernizing and developing weapons, it will be possible for other nations to cheat with little or no risk of being caught because the CTBT cannot be verified.

To resolve safety and reliability questions, the Clinton administration has developed the U.S. Stockpile Stewardship Program (SSP). The SSP is intended to improve knowledge about nuclear weapons to such an extent that it will be possible to fix problems and design new weapons without nuclear testing. The SSP is extremely expensive and technologically very risky. Furthermore, it is unclear whether the SSP will accomplish its goal of attracting, training, and retaining scientists and engineers capable of fixing future problems with current weapons and designing new weapons.

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Introduction

The Comprehensive Test Ban Treaty (CTBT) was signed by the United States on September 24, 1996, and transmitted by President Clinton to the U.S. Senate almost one year later, on September 22, 1997. The CTBT is a treaty of unlimited duration that bans nuclear weapons test explosions and all other nuclear explosions. The treaty establishes an international organization, located in Vienna, Austria, that will have an executive council, a technical secretariat, and a conference of all the states that are party to the treaty. The organization will oversee the treaty's verification regime, called the International Monitoring System (IMS), and an International Data Center. The IMS consists of four types of monitoring, including seismological. Requests for on-site inspections will require approval by a vote of at least 30 of the treaty's 51-member Executive Council.

The CTBT will enter into force only when all 44 nations with nuclear power or research reactors, or both, have ratified it. If the CTBT has not entered into force by October 1999, nations that have ratified it may convene annually to consider ways to accelerate the ratification and entry into force of the treaty.

In the case of the United States, ratification requires that the U.S. Senate give its advice and consent. Because the CTBT is likely to have a profound impact on the reliability and future safety of the U.S. nuclear deterrent, the treaty's ratification is contentious.

This paper does not address the debate regarding abolition of nuclear weapons. It is now, and likely will continue to be, the policy of the United States to rely on nuclear deterrence for its security. President Clinton has stated,

> As part of our national security strategy, the United States must and will retain strategic nuclear forces sufficient to deter any future hostile foreign leadership with access to strategic nuclear forces from acting against our vital interests and to convince it that seeking a nuclear advantage would be futile. In this regard, I consider the maintenance of a safe and reliable nuclear stockpile to be a supreme national interest of the United States.[1]

Nuclear abolition is, however, at the heart of the CTBT debate. The preamble of the treaty clearly states

Table 1
Key Arguments in the CTBT Debate

Test Ban Advocates	Test Ban Opponents
Constrains modernization of nuclear weapons (modernization is bad)	Constrains modernization of nuclear weapons (modernization is vital)
Ends development of new nuclear weapons (new weapons are bad)	Ends development of new nuclear weapons (new weapons may be necessary)
Helps prevent proliferation	Has little or no impact on proliferation
Moves us toward nuclear disarmament (disarmament is good)	Moves us toward nuclear disarmament (disarmament is presently foolhardy)
A ban is verifiable (it freezes other nations' nuclear capabilities)	A ban is not verifiable (if other nations cheat, it does not freeze their nuclear capabilities)

that the purpose of ending nuclear testing is to move systematically toward nuclear disarmament. Most CTBT proponents in the United States, as well as abroad, view the treaty as a means of reducing the political and military usefulness of nuclear weapons because the cessation of testing will have two key effects: it will make modernization of weapons designs risky, and it will reduce confidence in the reliability of current weapons designs over time.[2]

This paper begins with a discussion of reasons why the CTBT--or any cessation of nuclear testing--would diminish confidence in the reliability and safety of U.S. nuclear weapons. It then outlines the reasons why a CTBT is not verifiable, why alternatives to nuclear testing are unproven and therefore risky, and why the CTBT will do little or nothing to prevent nuclear proliferation. (For a summary of those arguments, see Table 1.) It concludes with brief discussions of the extraordinary powers of the CTBT international bureaucracy and of U.S. public opinion on testing.

The CTBT Would Constrain Nuclear Modernization

A central purpose of the CTBT is to take a step toward nuclear disarmament by constraining the moderniza-

tion and development of nuclear weapons by the states that now have them. The preamble of the CTBT states that

> the cessation of all nuclear weapon test explosions and all other nuclear explosions, by constraining the development and qualitative improvement of nuclear weapons and ending the development of advanced new types of nuclear weapons, constitutes an effective measure of nuclear disarmament.[3]

Although some CTBT proponents in the United States do not view the treaty as leading inevitably to disarmament, there is no question that the abolition of testing will have the effect of constraining development and improvement of nuclear weapons. The directors of U.S. and Russian nuclear weapons laboratories have stated that they would not choose to introduce new warhead designs into their countries' stockpiles without nuclear testing.[4]

The important question to ask is whether constraining nuclear modernization is desirable. There are serious implications, as outlined below.

Modernization May Be Needed for New Requirements

Constraining modernization is risky because it seriously degrades the ability of the United States to tailor its arsenal to emerging or as yet unknown threats or to adapt it to changes in other nations' defensive technologies.

At present, the United States has no specific need for new nuclear weapons designs, but that may not always be the case. Desert Storm, for example, taught us that we need to be able to strike and destroy deeply buried targets such as underground bunkers. The United States has modified an existing nuclear weapon to satisfy this new mission.

Another emerging mission for which nuclear warheads might be the most effective weapon is destroying chemical and biological agents. If an offensive missile were intercepted by a defensive missile armed with a high-explosive warhead, the chemical or biological agent would probably not be destroyed. It would simply be further dispersed. If the offensive missile were intercepted with a low-yield nuclear warhead, however, the agent--even the hardiest agents such as anthrax--would be destroyed by the high heat generated by the nuclear explosion. If the pro-

liferation of missiles armed with chemical or biological agents becomes a more serious threat to the United States and its allies in the future, it may be prudent to include in the U.S. nuclear arsenal some warheads designed specifically for the mission of destroying such agents either in their storage areas or on incoming missiles.

Preserving the option of modernizing U.S. nuclear weapons is also important in the context of other nations' emerging defensive technologies. We cannot now know what means opponents may develop to render U.S. warheads or delivery vehicles obsolete. Such technological breakthroughs could necessitate a complete overhaul of U.S. delivery systems and nuclear warheads.

New Delivery Systems Can Require New Warheads

Nuclear warheads are designed to be mated with specific delivery systems. As aircraft and missiles age, they must be replaced. Furthermore, as adversaries develop countermeasures, U.S. delivery systems must be improved to ensure that they will be able to accomplish their missions. The newer systems are likely to have more advanced electronics, materials, performance criteria, and other attributes--all of which affect the optimal design of the weapons they deliver. (It is possible to reverse the process and to design delivery vehicles to the parameters of existing warheads, but that could be more expensive and might have a less than optimal outcome.)

It is possible to make some changes to warhead design without testing. However, for nuclear weapons to continue to be deliverable by newer systems, it may be necessary to change the weight, size, and shape of the warhead. Without testing, the ability to significantly change the parameters of U.S. nuclear warheads will be extremely limited.

Lack of Modernization Forecloses Safety Improvements

Think of the safety improvements to automobiles that have resulted from evolving technology over the past decade. Advances in materials science, electronics, and concept innovation have led to better crash proofing, air bags, design principles, and so on. Those improvements could not have been introduced without actual testing.

Similarly, we can assume that nuclear weapons technology will continue to advance and that new measures to make

nuclear weapons safer will be discovered. For example, it is possible that in the future researchers will invent less sensitive explosives. Because nuclear weapons are extraordinarily complex, testing would be required in most cases before such advances could be integrated into stockpile designs.

The argument for preserving the option of modernization for the sake of safety is rejected by some people who feel that existing nuclear weapons are safe enough. However, the U.S. government decided not to integrate some existing safety features--insensitive high explosives and fire-retardant pits--into some nuclear weapons in the U.S. arsenal because to do so would require nuclear testing. That proves the point that the inability to test forecloses safety improvements.

In summary, the CTBT will constrain nuclear weapons modernization, which will very likely have a negative effect on U.S. national security. Inability to modernize warheads will greatly complicate the task of designing and building more modern delivery systems, despite the fact that such upgrades may be necessitated by advancements in other nations' countermeasures. Lack of modernization may also prevent the United States from using nuclear weapons for new missions for which they could be the most effective and appropriate option. Evolution in technologies for safety, nuclear delivery systems, and enemy defenses may render the now-modern U.S. nuclear arsenal technologically obsolete or less safe.

The CTBT Would Reduce Confidence in the Reliability of U.S. Nuclear Weapons

Ensuring reliability of U.S. nuclear weapons means having high confidence that they will perform as intended. Reliability does not mean that every weapon of a given design must work correctly but rather that most will. To use another automobile industry analogy, a few lemons are tolerable--even expected--but a serious flaw that is common to all autos of a given type requires a recall. Ensuring reliability means that no "recall" will be warranted.

The premium placed on ascertaining the reliability of nuclear weapons is increasing because the size of the U.S. stockpile is declining, as is the mix of weapons designs within it. As noted by Jonathan Medalia of the Congressional Research Service, "A problem with one warhead type can affect hundreds or thousands of individual deployed warheads; with only nine types of warheads expected

to be in the stockpile in 2000, compared to 30 in 1985, a single problem could affect a large fraction of the U.S. nuclear force."[5]

As noted previously, some less advanced types of nuclear weapons designs do not require testing to ensure reliability. Such designs are relatively simple, and their performance can be calculated and modeled with high confidence. Advanced designs, such as those in the U.S. stockpile, are extremely complicated. They have many variables and several thousand components. Such sophisticated designs have been produced to make U.S. weapons very small and able to withstand rapid acceleration, heat, and impact. With the technology available today, there is no way to simulate nuclear detonation of the high-performance, complex designs in the U.S. stockpile.

Some CTBT proponents nevertheless contend that nuclear testing is unnecessary to ensure reliability of the U.S. stockpile. They make three arguments: there has been no decline in reliability since U.S. testing ceased in 1992; past testing has left a legacy of understanding sufficient to fix any future problems; and surveillance, nonnuclear testing, and rebuilding weapons will correct flaws. Evidence speaks to the contrary for each of those assertions.

Confidence in U.S. Nuclear Weapons Has Already Declined

There has indeed been a decline in the confidence in the U.S. stockpile since testing ceased in 1992. In 1997 the director of Los Alamos National Laboratory, Sig Hecker, wrote to Sen. Jon Kyl (R-Ariz.), stating that confidence in the U.S. stockpile had decreased since the last U.S. test in 1992. Hecker also said that several problems, some of them age related, had developed, which previously "we would have turned to a nuclear test in the kiloton range to resolve."[6]

In 1997 it was possible to fix the warhead problems and to certify the reliability of the stockpile with confidence--but not to achieve the high level of confidence that would come from a test. The 1958-61 test moratorium provides a relevant comparison. At that time, some stockpile problems were fixed, and there was confidence that the solutions worked. When the moratorium ended and testing resumed, the "fixes" were found to be inadequate.

A key reason for the confidence that allowed certification in 1997 was the presence of experienced scientists

and engineers: the people who designed the devices in the stockpile and participated in testing them were still on hand and provided solutions for the problems that were found. According to one expert, those scientists and engineers have been repeatedly humbled by creating designs in which they had the highest confidence, only to see a test make a mockery of their assumptions and calculations. The designers know the designs in the stockpile well. Their experience in testing and working with the designs over the years has enabled the designers to understand the subtleties of changes and their effects on the weapons.

The experience and understanding of the experts who designed the current U.S. nuclear weapons have not been well documented because the entire U.S. nuclear weapons program was predicated on the absolute need for and ability to conduct testing throughout the life of the design. Testing was viewed as essential to the development and proof of nuclear weapons designs, to ensuring the reliability of the stockpile, and to correcting any problems that occur. With such dependence on nuclear testing, extensive documentation was unnecessary. Although an effort is now under way to document and archive the experiences of designers, there is no way to be sure that all of their pertinent knowledge is recorded. Problems may also develop, particularly relating to the aging of weapon components, for which the designers' knowledge is of little or no help.

Of the 85 remaining nuclear weapons designers at Los Alamos and Livermore laboratories, only 35 have been lead designers on a nuclear test.[7] In the future, as those experts retire and die, there will be no nuclear weapons experts who have actually designed a stockpiled weapon or have gone through the rigors and learning processes of nuclear testing.

Data from Past Tests Are Inadequate

Once a design is tested, why can't that test history provide sufficient data and understanding to enable scientists to fix any problems that develop later? The answer is that past testing data can help but will not necessarily suffice. Some problems may develop for which no testing data are relevant. For example, the effects of aging on weapons components and materials is unknown. The heat from radioactive materials may make weapons parts brittle, an effect similar to the degradation of plastics under prolonged exposure to sunlight. Replacement parts are

likely to use new materials for which there are no testing data.

In addition, as noted above, past U.S. nuclear weapons testing did not focus on the tasks of building databases and tools to ensure reliability of U.S. weapons in the absence of testing. Testing was part of the cradle-to-grave process. Although some arms control advocates believe that all the original design flaws have been found and fixed, the specialists responsible for U.S. nuclear weapons know that is not true.

In October 1992, the U.S. nuclear weapons design laboratories were asked what types of tests they would conduct if they were allowed 15 more tests to prepare for a testing moratorium. They laid out a series of tests to address safety and reliability issues, to develop stockpile stewardship data and tools, and to validate processes for remanufacturing aging weapons. Those tests were not allowed by the Clinton administration. President Clinton, in his July 3, 1993, statement extending the U.S. moratorium, said, "Additional nuclear tests could help us prepare for a CTB and provide additional improvements in safety and reliability. However . . . these benefits would be outweighed by the price we would pay in conducting the tests now--through undercutting our nonproliferation goals."

Weapons Surveillance and Rebuilding May Fail to Find Problems

Why can't measures other than nuclear testing--surveillance of the stockpiled weapons, nonnuclear testing of materials and components, and rebuilding of aging weapons--reveal problems and provide high-confidence solutions? To some extent, they can and already have. However, we have learned from experience that weapons in the U.S. stockpile can have design flaws or problems that are introduced as a result of field handling. A particularly difficult problem to address is what U.S. nuclear testing experts call the "unknown unknown"--the unanticipated problem that is exposed only by the extreme stresses encountered in the environment of a full-scale nuclear test. Many times in the past, U.S. nuclear weapons designers were surprised by the results of nuclear tests, which revealed problems the designers had not imagined. The tests showed them that they had not understood conditions and technologies as well as they had thought. Thus, while some defects have been discovered through surveillance of the stockpile and nonnuclear testing, other problems with U.S. nuclear weapon

designs have been identified solely as a result of a nuclear test.[8]

A key question for the future is what the effects of aging will be on U.S. nuclear weapons. Some weapons parts may become weaker as they age, but nonnuclear testing may indicate that individually they are still functional. If they were subjected to a nuclear test, however, it might be revealed that their collective weaknesses could cause a weapon failure.

It would seem that rebuilding warheads regularly to replace their parts and materials would correct age-related problems that develop in nuclear warheads. Indeed, Russia's approach to ensuring reliability depends on rebuilding; it produces thousands of weapons per year to replace aging warheads in its inventory.

In the case of the U.S. arsenal, rebuilding warheads to ensure reliability is not currently an option. Some components and materials are no longer available, and there is no way to duplicate them. The U.S. weapons-production infrastructure has been allowed to decay and has been purposefully cut to such a degree that the United States no longer has facilities and trained personnel to produce key weapons components. There are plans, thus far insufficiently budgeted, to restore the production infrastructure. However, the United States is presently unable to produce complete warheads for the active stockpile.[9] Some components could not be duplicated even if facilities and personnel were available because environmental and safety standards for manufacturing have evolved, making some old processes unsafe or illegal, or both. Creating substitute parts is a risky undertaking. It may not be possible to determine, in the absence of nuclear testing, what the functional equivalent of a particular component or material is. And there is a Catch-22: Even when new U.S. production capabilities are built, it will be impossible, absent nuclear testing, to validate the new plants, processes, and people. Nuclear tests are the only known means of demonstrating that new production lines produce functionally identical products.

In summary, CTBT opponents agree with proponents' contention that the treaty will constrain the development and modernization of nuclear weapons. However, opponents view that as a negative effect because unforeseen circumstances could require significant changes in U.S. weapons that would require testing. Proponents also argue that it will not matter that the United States is constrained, because Russia, China, and other nations will be similarly con-

strained. Opponents disagree, saying that cheating under the CTBT can go undetected.

The CTBT Is Not Verifiable

Throughout the history of test ban negotiations, U.S. policy consistently stated that the United States would not sign any treaty unless it were effectively verifiable. The reason for this position is that any adversary that covertly tests--while the United States forgoes testing--can gain significant military advantage. Testing both allows nuclear weapons modernization and confirms stockpile reliability.

Effective verification is generally accepted to mean high confidence that militarily significant cheating will be detected in a timely manner. In the case of the CTBT, this would mean that the United States would have high confidence that it would be able to detect, within hours or a few days of the event, any nuclear test that would provide the testing nation with militarily significant weapons information. Two key questions must therefore be addressed: what is the minimum yield of a nuclear test that can provide militarily significant information, and can the CTBT verification system detect tests at that level?

Testing at 500 Tons of Yield or More Provides Militarily Significant Data

Testing at any yield, regardless of how low it is, may provide militarily significant information to a proliferator and, perhaps, to an advanced nuclear weapons state. In the case of the United States, the lowest possible yield to accomplish new designs, as well as ensure safety and reliability, depends upon warhead requirements. Most designs could be adequately tested at yields between 1 and 10 kilotons.[10] A yield of only 500 tons would be sufficient for testing the reliability of U.S. nuclear weapons, but a higher yield would be needed to certify any new design that departed significantly from already tested designs. Therefore, it is reasonable to assume that 10-kiloton tests would be militarily significant--meaning that they could prove the reliability of weapons--and that tests down to a level of 500 tons might also fit into this category.[11]

The IMS Cannot Detect Militarily Significant Nuclear Testing

It is quite feasible to conduct militarily significant testing with little or no risk of detection. Nuclear testing could be masked by other explosive activities. Also, testing could be conducted in the ocean, where identifying the origin of the device may be impossible.

The most likely cheating scenario may be an underground nuclear explosion in a cavity. That would muffle the energy, reducing the blast signal by as much as a factor of 70.[12] Thus, a 1-kiloton explosion could be made to look seismically like a 14-ton explosion; a 5-kiloton explosion could look like a 70-ton explosion.[13]

The IMS of the CTBT is expected to provide the ability to detect, locate, and identify nonevasive nuclear testing of yields of 1 kiloton or greater. It will not be able to detect, with any significant degree of confidence, nuclear testing below 1 kiloton. If the test is evasively conducted, the system will not detect a test of several kilotons.

CTBT proponents say that supplemental data from U.S. national technical means will fill the gap. This argument is not entirely accurate. The United States has stated that its objective is to have the capability of identifying and attributing with high confidence evasively conducted nuclear explosions of about a few kilotons yield in broad areas of the globe. At present, the capability does not exist. Furthermore, the U.S. intelligence community has acknowledged that this is a complex task that will require much effort, time, and resources to achieve. For the present, even with a fully functional IMS supplemented with data from U.S. national technical means, it is possible that a militarily significant test could be evasively conducted without detection.

CTBT proponents argue that, once the IMS is operating, the technology will continue to improve and may make it possible someday to detect low-yield events with certainty. Even if so, however, there would still be virtually insurmountable problems. One is that, at very low yields, the whole world becomes a potential test site. For example, tests in the tons can be done in old mines or underground cavities, and tests in the pounds can be done almost anywhere.[14] Russia is so large that we will never know if it is conducting such low-level tests, even if the verification regime entails full test-site transparency.

Another problem will be the serious difficulty of identifying explosions as nuclear tests. At lower yields, the number of nonnuclear events of similar size increases (e.g., mining explosions and earthquakes on land, explosions for geophysical exploration, volcanoes at sea, meteorite impacts in the atmosphere). Nonnuclear events increase the total number of events to be processed by a verification system, and a small percentage of them generates signals similar to those expected from nuclear explosions. This, too, increases the difficulty of identification.

In addition to its technical limitations, the IMS has other problems. The fact that stations monitoring some nations will be within their own borders offers the possibility that IMS data could be manipulated, or that the stations could be shut down during a test--just as Pakistan turned off a key seismic station within its borders when it conducted a nuclear test in May 1998. Some of the stations monitoring China will be within China; some monitoring Russia are within Russia. Hypothetically, either nation could ensure that the station or stations would not be working during the time of a test, thus depriving the IMS of key data. Shutdowns would not necessarily appear unusual because, inevitably, there will be times when the stations are not functioning properly.

The technical problems with CTBT verification are complicated by another difficulty that will not be addressed in detail here: the problem of gaining political consensus for a response when noncompliance with the treaty is suspected. In the case of the current nuclear testing moratorium, there have been indications that Russia may have conducted low-yield nuclear tests. Yet there have been no U.S. protests or inquiries. Shortly after an incident in January 1996, former secretary of defense William Perry told Congress that there had been suspicious activity at the Russian test site, but there was no follow-up of consequence.[15] There are numerous possible explanations for the lack of concern, including fear of setting the stage for resumption of U.S. testing, fear of embarrassing President Yeltsin, and fear of upsetting the then-ongoing negotiations on the CTBT. Regardless of the reason, it is clear that challenging nations suspected of illegal behavior can be politically very difficult.

Other Nations May "Legally Cheat"

The inability to verify the CTBT is complicated by yet another factor: the CTBT does not define what consti-

tutes a nuclear test. If other nations chose to apply a less restrictive definition than does the United States, they could conduct very low-yield tests in which the nuclear energy released was less than, for example, a four-pound equivalent of high explosives--what the United States refers to as hydronuclear testing. Hydronuclear tests can offer significant advantage to other nuclear weapons states by helping them to improve their understanding of fundamental nuclear weapons physics; develop new weapons concepts; ascertain existing weapons' reliability; and exercise the skills of scientists, engineers, and technicians.

Very low-yield tests would almost certainly go undetected. But, even if such tests were exposed by some means, the nation conducting the tests could simply argue that they are legal under the treaty. And that nation would have the historical CTBT negotiating record on its side. Drafts of the CTBT before the Clinton administration allowed for low-yield "permitted experiments."

Despite the fact that the CTBT does not define what constitutes a nuclear test, the Clinton administration adopted a formal, unilateral U.S. interpretation that the test ban outlaws any tests or experiments unless they are "zero yield." This interpretation prevents the United States from conducting hydronuclear experiments, which had previously been used to assess the safety of U.S. nuclear weapons and have played an important role in maintaining U.S. nuclear weapons expertise and test readiness.[16] Simulations cannot substitute for such low-level experiments.[17]

In summary, the verification regime of the CTBT increases international capabilities to detect nuclear tests at yields higher than 1 kiloton nonevasively conducted, and up to 70 kilotons evasively conducted. This means that militarily significant testing can be conducted with little or no risk of detection by either the IMS system or the current supplemental capabilities of U.S. technical means. The verification problems associated with the CTBT are complicated by the fact that the treaty includes no definition of what constitutes a nuclear test.

President Clinton's Safeguards Are Insufficient

The Clinton administration recognized that the CTBT would diminish confidence in the safety and reliability of U.S. nuclear weapons and that the CTBT has serious verifi-

cation deficiencies. To address those problems, President Clinton announced a series of so-called safeguards.

The White House stated in August 1995 that its support of the CTBT is conditioned on the following safeguards:

- A: The conduct of a Science Based Stockpile Stewardship program to insure a high level of confidence in the safety and reliability of nuclear weapons in the active stockpile, including the conduct of a broad range of effective and continuing experimental programs.

- B: The maintenance of modern nuclear laboratory facilities and programs in theoretical and exploratory nuclear technology which will attract, retain, and ensure the continued application of our human scientific resources to those programs on which continued progress in nuclear technology depends.

- C: The maintenance of the basic capability to resume nuclear test activities prohibited by the CTBT should the United States cease to be bound to adhere to this treaty.

- D: Continuation of a comprehensive research and development program to improve our treaty monitoring capabilities and operations.

- E: The continuing development of a broad range of intelligence gathering and analytical capabilities and operations to ensure accurate and comprehensive information on worldwide nuclear arsenals, nuclear weapons development programs, and related nuclear programs.

- F: The understanding that if the President of the United States is informed by the Secretary of Defense and the Secretary of Energy--advised by the Nuclear Weapons Council, the Directors of DOE's nuclear weapons laboratories and the Commander of the US Strategic Command--that a high level of confidence in the safety or reliability of a nuclear weapon type which the Secretaries consider to be critical to our nuclear deterrent could no longer be certified, the President, in consultation with Congress, would be prepared to withdraw from the CTBT under the standard "supreme national interest

clause" in order to conduct whatever testing might be required.

The safeguards establish a Stockpile Stewardship Program (SSP) to enhance confidence in the reliability and safety of U.S. nuclear weapons in the absence of testing, as well as a program for research on verification measures. The United States must maintain the capability to conduct a nuclear test, and in case SSP does not work, an "escape clause" exists for withdrawal from the treaty if a test is needed. There are major problems with the safeguards, and they may not work.

Success of the SSP Is Highly Uncertain

The Clinton administration's SSP will attempt to attract and train weapons scientists and to conduct research that will increase understanding of nuclear weapons physics and phenomena. Administration officials hope that this understanding, when coupled with advanced computational capabilities and nonnuclear testing, will be sufficient to ensure high confidence in the reliability of the U.S. stockpile. They also hope that these capabilities will enable the United States to modernize its stockpile, should new designs be required.[18]

CTBT opponents are unwilling to bet U.S. national security on the possibility that the SSP might succeed as a replacement for nuclear testing. They point out a number of weakness associated with the planned SSP, including the following:

- The technologies of the SSP are unproven. There is no certainty that those technologies will work as intended or that the SSP will enable scientists to understand weapons physics well enough to replace the knowledge previously gained through testing.

- The SSP facilities will not be completed for a decade, perhaps longer. In the interim, the stockpile could erode seriously because the United States would have inadequate capabilities to detect and fix the problems that arise.

- The funding for the program, $4.5 billion per year for 10 years, will be highly controversial. The sum must be defended in light of other pressing priorities and annually agreed to by Congress. A budget for testing weapons is likely to be much more readily

understood than one for a diverse set of projects to develop diagnostic tools.

• The SSP is designed to address research and development needs; it does not include a program for rebuilding U.S. nuclear weapons. The U.S. nuclear weapons production complex must itself be rebuilt and validated--a lengthy, costly process.

• Support from the arms control community for the SSP is lukewarm at best. Many advocates of the CTBT say that they will reconsider their support for the SSP in the future--after the CTBT is ratified.

• SSP managers are likely to limit the types of experiments they are willing to undertake because of fear of adverse reaction from anti-nuclear activists. This could make the SSP less relevant to nuclear weapons design.

• The credibility of the U.S. nuclear deterrent may erode regardless of the SSP's success because the reliability and viability of the U.S. arsenal will not be demonstrated regularly.

In summary, SSP--as a "substitute" for testing--faces serious challenges and may fail.

The Capability to Test Quickly Cannot Be Maintained under the CTBT

The directors of the two U.S. nuclear weapons laboratories gave their support to a test ban conditioned on two criteria: a fully funded SSP and the ability to test if there were a need to do so. President Clinton's safeguard F allows for making the political decision to test, and safeguard C requires maintaining the capability to test. In the absence of testing, however, the capabilities to test cannot be maintained. In addition, safeguard F sets an enormously difficult standard to be met before a test can proceed.

The ability to test requires more than just having a test site. It requires people with high levels of expertise and specialized skills, as well as unique and complex equipment. As Hecker has stated,

> Merely preserving facilities and support infrastructure at NTS [the Nevada Test Site] will not provide readiness. In spite of our best

> efforts, some special skills such as test containment reside in only a few individuals today, and some of the special equipment is no longer maintained or available from private industry.[19]

It should be noted that the United States previously learned the hard lesson of not being ready to conduct a nuclear test. President Kennedy's address to the American people in March 1962 summed up the U.S. experience with the 1958-61 moratorium:

> On September 1 of last year, while the United States and the United Kingdom were negotiating in good faith at Geneva, the Soviet Union callously broke its moratorium with a two-month series of more than 40 tests. Preparations for these tests had been secretly underway for many months. . . . Some may urge us to try it [a moratorium] again, keeping our preparations to test in a constant state of readiness. But in actual practice, particularly in a society of free choice, we cannot keep top-flight scientists concentrating on the preparation of an experiment which may or may not take place on an uncertain date in the future. Nor can large technical laboratories be kept fully alert on a stand-by basis waiting for some other nation to break an agreement. This is not merely difficult or inconvenient. We have explored this alternative thoroughly, and found it impossible of execution.[20]

Although that quotation is decades old, it makes a point pertinent today: keeping highly skilled, knowledgeable people at hand will be virtually impossible absent testing. At present, the United States is two years or more away from being able to conduct a nuclear test. This lack of readiness will inevitably worsen as skilled experts retire and die, equipment ages or becomes obsolete, and financial support erodes.

A Decision to Test Would Be Extraordinarily Difficult

President Carter consistently maintained a policy that any CTBT must be of limited duration, such as three years. His purpose was to ensure that testing could resume when the treaty expired. Not only would cadres of scientists and technicians be kept together and functioning, but, more important, there would be the domestic and international expectation that testing could resume. The test

ban could and would be extended only if it could be proven that testing was unnecessary for the security of the United States. Thus, the onus would be on test ban proponents to prove that the ban should continue. In contrast, the unlimited duration of the Clinton CTBT requires testing advocates to prove that the treaty should be abrogated.

The implications of unlimited duration are many, but the most important is that it will be extremely difficult politically to resume testing--even if it appears warranted from a technical standpoint. Abrogating the CTBT would likely bring on more negative reactions from the international community than would refusing to ratify the treaty. In addition, President Clinton set an extraordinarily difficult standard that must be met before the United States would resume testing under the CTBT (safeguard F).

For a host of reasons, a decision to resume testing would not likely ever be made under the conditions set forth in safeguard F. Several people with differing motives and perspectives must agree to undertake a contentious action. They must agree that there is a problem, that it must be fixed, how it is to be fixed, and whether a test is vital to ensuring that the remedy works. "High level of confidence" cannot be defined, so there will always be grounds for disagreement over the importance of testing. And, the critical phrase, "of a nuclear weapon type which the Secretaries consider to be critical to our nuclear deterrent," offers an escape. There are nine designs in the enduring U.S. arsenal, each of which has unique characteristics. Despite the need to maintain the diversity of U.S. weapon types, a decision to retire the weapons of any design that develops a problem--by labeling that design as not critical to the deterrent--would be politically easier to make than the difficult decision to break a test ban.

Even those who would wish to fix any problems that develop with U.S. weapons may hesitate to break a test ban once it is in place. They might be legitimately concerned that taking such a drastic action as treaty abrogation would send a dangerous signal to adversaries that the problems with the U.S. nuclear weapons stockpile were extremely serious. That action could signal weakness and invite aggression.

The above sections address the first argument on behalf of the CTBT--that it will constrain the development and modernization of nuclear weapons. The conclusion here is that such constraint is disadvantageous to the United

States because the need for new or different nuclear weapons may evolve and because today's verification technology cannot give us high confidence that other nations will not cheat. Furthermore, the safeguards designed to enable the United States to retain its nuclear weapons design and testing capabilities are extremely risky.

The following sections will address the second principal argument on behalf of the CTBT--that it will constrain the spread of nuclear weapons to additional countries. The notions that the treaty will help "save" the Nuclear Non-Proliferation Treaty and will create an international norm against nuclear testing will also be addressed.

The CTBT Does Little or Nothing to Prevent Nuclear Proliferation

A proliferator may want to test its nuclear weapons for political reasons, as India and, particularly, Pakistan did in 1998. However, nuclear testing is not a prerequisite to acquiring a workable, reliable arsenal. It is well known that some single-stage fission designs are relatively simple and that nations would not need to test them to have sufficiently high confidence that they will work. The bomb dropped on Hiroshima was a design that had never been tested. South Africa built six nuclear weapons without testing.

Furthermore, the CTBT would not confine new proliferators to simple designs. Today, without testing, relatively sophisticated weapons (nonboosted, implosion-type devices) may also be designed with high confidence. The level of complexity of the nuclear design that can be attained without testing depends on the technological sophistication of the nation concerned and on that nation's access to foreign nuclear weapons expertise.

The technical need for testing increases with the complexity and performance requirements of the nuclear weapon. The United States and Russia have focused on the ability to strike one another's military sites--which entails pinpoint accuracy against small targets such as silos--rather than larger targets such as cities. That emphasis dictates the need for high-performance delivery systems, which, in turn, require tight parameters on allowable weight, size, shape, safety measures, and yield. In addition, U.S. and Russian interest in the destructive effects of warheads on military equipment is high.[21] And both nations have high standards for the reliability of their weapons.

By comparison, proliferators are likely to target cities, not silos. Their delivery vehicles may be ships, barges, trucks, or Scud-type missiles. Proliferators may not care whether they obtain an exact yield, may not face the tight restrictions imposed by advanced delivery systems or safety standards, are unlikely to use highly complex designs, and may not care about weapons' effects on equipment. Furthermore, proliferators may have an entirely different standard for reliability. In other words, a nation may quite feasibly develop devices that will work, as long as knowing the exact yield does not matter and no exacting specifications are required.

In summary, the CTBT will not create a significant or meaningful obstacle to nuclear proliferation. A nation may quite feasibly design, build, and stockpile effective nuclear weapons without nuclear testing.

The Non-Proliferation Treaty Is at Risk, Regardless of a CTBT

The Clinton administration argues that U.S. ratification of the CTBT is essential to ensure extension of the Nuclear Non-Proliferation Treaty (NPT)--a treaty to prevent the spread of nuclear weapons--when the NPT is next reviewed by its parties in 2000. In reality, NPT parties will not be satisfied with CTBT ratification. The NPT conference in 2000 will be highly contentious, regardless of CTBT ratification, because the CTBT has been falsely represented as a commitment to nuclear disarmament. Some background on the NPT-CTBT linkage is necessary to understand why.

There has long been a conflict between two sets of nations that are party to the NPT--those that have nuclear weapons and those that do not. The latter group has contended that the nuclear weapons states are not fulfilling their treaty obligation, contained in article VI of the NPT, to work in good faith toward total nuclear disarmament. Increasingly, the nonnuclear states have demanded concrete steps toward zero nuclear weapons, as well as a timetable according to which disarmament will be achieved. The nuclear weapons states, however, have refused to give up nuclear weapons and have argued that disarmament is a long-term rather than a near-term goal.

By advocating a CTBT, the United States has sought to satisfy the demands for disarmament while continuing to rely on nuclear deterrence. During negotiations at the Conference on Disarmament in Geneva, U.S. representatives

portrayed the CTBT as a step toward disarmament, saying that it would halt vertical proliferation--the improvement of nuclear arsenals by those states that possess them. Most NPT parties have been led to believe that the United States and other nuclear weapons states would be unable to test under a CTBT. This prohibition would erode confidence in the reliability of the nuclear stockpile and, ultimately, make the use of such weapons less likely. The Geneva negotiating record makes it clear that other nations have been convinced that the CTBT is a step in the process by which the United States and other nations will abandon nuclear deterrence and reduce nuclear stockpiles to zero.

The truth, however, is that the United States has no intention of giving up its nuclear weapons and has the stated policy of retaining them for as long as it is in U.S. security interests to do so. The United States and other nuclear weapons states are establishing programs designed to ensure that their stockpiles will remain safe and reliable--and therefore usable--despite the testing ban. Thus, "nuclear erosion," the goal set for a CTBT by many nations around the world, is effectively undermined by a successful SSP. As a result, many nations and non-governmental groups have already declared that the CTBT does little or nothing to fulfill the NPT article VI obligation to abandon nuclear deterrence and reduce nuclear stockpiles to zero. Because non-nuclear-weapons states are likely to perceive that the CTBT is not the disarmament measure they anticipated, they probably will try to use the threat of unraveling the NPT as leverage to terminate the SSP and equivalent programs in Russia, China, France, and the United Kingdom. Already, for example, Japan has called for new discussions to focus on terminating zero-yield experiments--the type of experiments that is integral to the SSP.

The willingness of some NPT parties to use that treaty as an expendable tool is influenced by the decline in relevance of the NPT to nations' sense of security. The decline has nothing to do with the presence or absence of nuclear testing by the first five nuclear weapons states.[22] Rather, the NPT's diminished significance stems from a host of other phenomena such as the violations of the NPT by North Korea and Iraq, the spread of chemical and biological weapons, growth in missile proliferation, and the nuclear weapons capabilities of nations not party to the NPT--Israel, India, and Pakistan. Those factors will continue to erode the relevance of the NPT, regardless of whether there is a CTBT.

The "International Norm" Argument Is Meaningless

CTBT proponents contend that the test ban will constrain even those who are not party to the agreement from conducting nuclear tests because the treaty will create an international norm against testing. While law-abiding nations may hesitate to break a norm, history demonstates that some nations readily dismiss treaty norms. The NPT norm against the pursuit of nuclear weapons has been broken repeatedly, both by the treaty's parties and by non-parties. The norm was established when the treaty went into effect in 1970. The list of states that have broken or are thought to have broken the norm includes Argentina, Brazil, India, Iran, Iraq, Israel, North Korea, Pakistan, South Africa, South Korea, and Taiwan. North Korea, for example, produced plutonium in direct violation of the NPT and continues to be in noncompliance with treaty requirements.

Another example of the failure of an international norm is provided by the history of nonadherence of some parties to the Biological and Toxin Weapons Convention (BTWC) of 1972, which outlawed the possession of biological weapons. Iraq had signed but not acceded to the BTWC; then it proceeded secretly to produce massive quantities of biological agents. The Soviet Union, and later Russia, violated not only the norm but the treaty--a fact admitted publicly by President Yeltsin.

In summary, the CTBT will not act as a significant barrier to the spread of nuclear weapons to other countries. Testing is not needed to acquire nuclear weapons; the CTBT does little to bolster the nonproliferation regime; and the international norm the CTBT would create is as meaningless as similar norms created by some other arms control treaties.

In addition to the serious security ramifications of the CTBT for the United States, there may be political downsides to the treaty as well. The treaty creates an international bureaucracy with a charter that includes a carte blanche to pursue additional measures in support of nuclear disarmament.

The Clinton CTBT Gives Extraordinary Powers to the International CTBT Organization

Comprehensive test ban negotiations under the Carter administration sought a trilateral treaty among the United States, the United Kingdom, and the Soviet Union. The

Clinton administration's CTBT is a multilateral treaty involving more than 150 nations. As such, it entails a very large UN-style multinational bureaucracy and ascribes significantly more power to that bureaucracy than was envisioned in previous U.S. presidents' versions of a test ban. For example, the Clinton administration's CTBT creates an executive council with extensive and extraordinary powers.

The Executive Council comprises 51 member states, each of which is elected to the council by the Conference of All the States Parties (all states that are party to the treaty). Seats on the council are allocated by region--10 from Africa, 7 from Eastern Europe, 9 from Latin America and the Caribbean, 7 from the Middle East and South Asia, 8 from Southeast and East Asia, and 10 from North America and Western Europe. The treaty does not guarantee the United States a seat. Conceivably unforeseen political events may someday deny U.S. representation.[23] Decisions of the council require a two-thirds majority for matters of substance; procedural issues require a simple majority.

One of the most extraordinary powers of the Executive Council is its charter to conclude and supervise implementation of agreements or arrangements with states that are parties, other states, and international organizations. The council may unilaterally conclude agreements or arrangements that relate to verification; all others must be made with the prior approval of the Conference of All the States Parties.

Although two words are used--"agreements" and "arrangements"--the Clinton administration has stated that the functionality of the two words is the same.[24] Both words are used because "agreements" are legally binding conclusions that, in the case of the United States, might very well need congressional approval. An "arrangement" would probably not be submitted for approval, but under this treaty, the United States would still be bound by it.

The danger exists that the Executive Council may use its power to conclude arrangements that have significant political or economic repercussions, or both, and that would legally bind the United States--all without the approval of the U.S. Congress. Providing such power to an international organization is unprecedented.

Another potentially controversial power given by the CTBT to the Executive Council is the responsibility to recommend proposals for "promoting the object and purpose of this treaty."[25] Most nations that have signed the

treaty, and some officials within the U.S. government as well, believe that the object and purpose of the CTBT is to help achieve total nuclear disarmament. Their view is bolstered by several sentences in the CTBT preamble stating that the goal of a test ban is nuclear disarmament. Therefore, it is possible that the Executive Council will use its authority to pursue additional steps toward disarmament, including measures unrelated to nuclear testing. By funding the CTBT organization, the United States would be financing an international bureaucracy with a charter that includes responsibility for pressuring the United States to give up its nuclear deterrent.

If a majority of the Executive Council undertakes to "negotiate" additional nuclear disarmament measures, it will be assisted in its efforts by a third extraordinary power granted the council by the CTBT: the power to order all treaty parties to convene. Thus, the Executive Council can call conferences, for example, to consider resolutions or actions in support of nuclear disarmament. Only a two-thirds majority of the treaty parties present and voting would be required to act on the Executive Council's proposals.

The likelihood that the Executive Council will engage in activities not directly related to the implementation of verification measures is increased by the fact that it is a permanent body. Unless there are frequent accusations that nuclear tests are being conducted, there will be little for the Executive Council to do once the International Monitoring System is set up. International bureaucrats, most of whom will be strong supporters of disarmament, may be inclined to seek new ways to use the powers of the Executive Council to pursue their objectives.

In summary, the CTBT is more than a simple ban on nuclear testing. Its bureaucracy and charter create the option for continuing pressure and action on behalf of the goal of nuclear disarmament. Yet nuclear disarmament is not a goal that the American public supports.

The American Public Supports Both the U.S. Nuclear Deterrent and a CTBT

The University of New Mexico Institute for Public Policy conducted a nationwide, objective poll in 1997 to probe U.S. public perceptions on a variety of nuclear-related issues.[26] One of the key findings is that the U.S. public strongly supports the U.S. nuclear deterrent and is

willing to spend tax dollars to ensure that U.S. nuclear weapons are reliable.

In the poll, respondents were asked how important it is for the United States to retain nuclear weapons today. A majority, 73 percent, believe it is important. Of those who believe it is important to retain nuclear weapons, 30 percent said that it is extremely important.

One of the best ways to determine the degree of public support for an idea is to inquire whether people would be willing to spend money on it. Thus, the poll asked whether respondents thought that the government should increase, decrease, or keep the same the amount of spending to maintain nuclear weapons in reliable condition. Fifty-seven percent of the respondents advocated increased spending, 15 percent would keep spending the same, and 28 percent would decrease spending.

The poll also found that the public does not support nuclear testing. One question asked how respondents felt about the United States participating in a treaty that bans all nuclear test explosions. Seventy-three percent supported such a treaty, 7 percent were unsure, and 21 percent opposed it.

The questions in the poll did not inform respondents of details about the CTBT. For example, the respondents were not told that the treaty would be unverifiable or that confidence in the reliability of the U.S. stockpile would decline without testing. If such information were provided to the public, it would probably substantially increase opposition to the CTBT.

If the United States were to reject the CTBT and resume nuclear testing, the opposition from anti-nuclear activists would be extremely strong. Thus, before testing is resumed--if indeed that option is chosen--it is imperative that the public be better infomed on the relationship between testing and retaining a strong nuclear deterrent.

An Alternative

From a purely technical standpoint, it would be most prudent for the U.S. Senate to reject the CTBT and to allocate funds for resumption of U.S. testing and for reconstruction of the U.S. nuclear weapons production infrastructure. However, it may be politically desirable to undertake some limitations on testing. The question is, What specific measure should be taken? Perhaps the

most acceptable solution both politically and technically is to pursue a test ban with two key features: it would enable the United States to conduct testing at yields sufficient to ensure the safety and reliability of its nuclear weapons, and it would be effectively verifiable. The CTBT pursued by all presidents before President Clinton included both of those features. Past U.S. negotiating positions on the CTBT allowed for so-called permitted experiments, that is, very low-yield tests below the detection level. Past presidents' negotiating positions on the CTBT required that only those tests that could be detected with high confidence be disallowed under a test ban.

Some observers may believe that the Senate should simply not act on the CTBT. That is unwise because it allows the state of limbo--not testing--to continue eroding confidence in the reliability and safety of U.S. nuclear weapons. It also allows continuing deterioration of U.S. capabilities across an array of specializations--nuclear weapons design, engineering, computer code development, testing, and materials science.

Conclusion

The first of two principal arguments for CTBT ratification is that the treaty will be a step toward total nuclear disarmament because it will constrain the modernization and development of nuclear weapons. The second argument is that the CTBT will stem nuclear proliferation. While it is true that modernization and development will be constrained, some opponents of the treaty view that as a negative outcome for the United States. Further, they fear that other nations may continue to modernize and develop nuclear weapons despite the treaty because CTBT verification measures will not likely detect evasive testing. The notion that the CTBT will stem proliferation is clearly untrue. Nations can acquire workable nuclear arsenals without testing.

The substitutes for testing devised by the Clinton administration may not be successful. The SSP is politically and technologically risky, and the money is by no means guaranteed. Maintenance of the capability to resume underground testing quickly is not possible absent testing. The nuclear weapons production complex is not fully functional and must be rebuilt.

In conclusion, the limited political benefits of the CTBT are not worth the high cost to U.S. national securi-

ty. Given the importance of ensuring that U.S. nuclear weapons are as safe and reliable as possible, nuclear testing at low yields--an amount identified by the design laboratories' directors as the lowest possible--should be undertaken to achieve three essential goals:

- To guarantee that the SSP will work. Facilities should be operational and technologies proven. Predictions generated by the SSP should be validated with actual tests.

- To validate the processes and tools of a working, effective nuclear weapons production complex and to demonstrate that the weapons rebuilt by the complex are safe and reliable.

- To ensure with high confidence that U.S. nuclear weapons are as safe and reliable as possible during the time in which SSP facilities are being constructed and its technologies proven and the U.S. production complex is being rebuilt.

Notes

1. "Message from the President of the United States Transmitting the Comprehensive Nuclear Test Ban Treaty to the U.S. Senate," September 23, 1997, p. iv.

2. White House, Office of the Press Secretary, "Fact Sheet on the Comprehensive Test Ban," September 10, 1996; and Coalition to Reduce Nuclear Dangers, "Ten Reasons for a Comprehensive Test Ban Treaty," Issue Brief 2, no. 4 (October 21, 1997).

3. "Message from the President," p. 122. Passage quoted is in the preamble to the CTBT.

4. See, for example, Bruce Tarter, director, Lawrence Livermore National Laboratory, Letter to Sen. Jon Kyl, September 29, 1997, as entered into the record of a hearing before the Subcommittee on International Security, Proliferation, and Federal Services of the Senate Committee on Governmental Affairs, October 27, 1997 (S. Hrg. 105-267), p. 77.

5. Jonathan Medalia, Nuclear Weapons Production Capability Issues (Washington: Congressional Research Service, June 8, 1998), p. 34.

6. Sig Hecker, director, Los Alamos National Laboratory, Letter to Sen. Jon Kyl, September 24, 1997, as entered into the record of a hearing before the Subcommittee on International Security, Proliferation, and Federal Services of the Senate Committee on Governmental Affairs, October 27, 1997 (S. Hrg. 105-267), p. 81.

7. Vic Reis, assistant secretary, U.S. Department of Energy, Written responses to questions for the record from Sen. Thad Cochran, April 1998.

8. Ibid.

9. The number of weapons production plants has fallen from 14 to 8, and the personnel have been reduced from 57,935 in 1990 to 24,384 in 1997. See Medalia, pp. 7-8.

10. Senator Kyl asked, "What yield of testing would be the lowest possible to accomplish new designs as well as safety and reliability?" Bruce Tarter, director of Lawrence Livermore National Laboratory, replied, "If we were to resume testing, the lowest useful test for safety issues would be a few pounds, and for a reliability test around 500 tons." Tarter, p. 27. Sig Hecker, in answer to the same question, replied, "I believe that most designs could be tested at yields between 1 and 10 kilotons." Hecker, p. 84.

11. An argument could be made that yields even smaller than 500 tons could be militarily significant in some scenarios. For example, some nations testing a device with an extremely low yield might be satisfied simply because they demonstrated that their warhead designs worked.

12. The effects of "decoupling" are well documented. For example, the United States conducted two nuclear tests in the Tatum salt dome located at Chilton, Mississippi. Sterling, the test conducted on December 3, 1966, had a yield of 380 tons. The apparent seismic yield was only 5.3 tons, a reduction by a factor of 71.7.

13. Experts' opinions vary on the size of the largest explosion that could be easily decoupled. Ten kilotons is probably the upper limit.

14. Testing with a few pounds of yield is useful for ascertaining nuclear weapon safety. Testing the reliability of complex U.S. nuclear designs can be done at subkiloton levels. However, other nations, such as Russia, may use different types of designs whose reliability could be

tested at very low nuclear yields--perhaps even at the level equivalent to a few pounds of explosive.

15. Bill Gertz, "US Officials Suspect Russia Staged Nuclear Test This Year," Washington Times, March 7, 1996, p. A3; and Bill Gertz, "Perry Cites Evidence of Russian Nuke Test," Washington Times, March 8, 1996, p. A8.

16. Hydronuclear experiments enable the development of testing baselines, methodologies, tools, and procedures and provide a focus for nuclear weapons designers to work directly with engineers, technicians, and other specialists.

17. Simulations cannot be substituted because they are not always capable of predicting one-point safety. One-point safety exists when there is less than one chance in a million that an accidental detonation will have more than four pounds of yield.

18. The need to be able to design new weapons was acknowledged in the Clinton administration's Nuclear Posture Reiew. In the opinion of the Clinton administration, the CTBT does not prohibit either the development or the improvement of existing nuclear weapons. See "Message from the President," p. 2.

19. Hecker, p. 84.

20. John F. Kennedy, Address of March 2, 1962, reprinted in United States Arms Control and Disarmament Agency Publication 19, November 1963, p. 74.

21. For example, they wanted to know the effects of the electromagnetic pulse--generated by a nuclear blast--on sophisticated communications systems.

22. The term "first nuclear weapons states" will be used instead of "declared nuclear weapons states" because the latter term lost much of its relevance following the tests and declarations of nuclear weapons status by India and Pakistan in May 1998. The first five declared nuclear weapons states, whose weapons were openly acknowledged at the time of the NPT's entry into force, are the United States, the Soviet Union (now Russia), China, the United Kingdom, and France.

23. The United States has received nonbinding assurances from members of the North American and Western European Group, of which it is a member, that it will serve contin-

uously on the Executive Council once the treaty enters into force.

24. "Message from the President," p. 17.

25. Ibid., p. 132. Passage cited is the Comprehensive Test Ban Treaty, article II, C, 38 (c).

26. Kerry G. Herron and Hank C. Jenkins-Smith, "Public Perspectives on Nuclear Security," University of New Mexico Institute for Public Policy, June 1998, p. 79.

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