March 27, 1984

A FLAWED TEST BAN TREATY

INTRODUCTION

In 1974, the United States and the Soviet Union negotiated and signed the Threshold Test Ban Treaty (TTBT), which limited underground nuclear testing to a maximum yield of 150 kilotons. Although the Treaty has never been approved by the U.S. Senate, the two countries pledged to observe the terms of the TTBT. The signing of the TTBT, and two years later, the Peaceful Nuclear Explosions Treaty, was heralded by many as the beginning of the process leading to the long sought-after comprehensive ban on all nuclear testing. However, Soviet violations of the terms of the TTBT, combined with the lack of any verification guarantees, have caused the Treaty to become a symbol of the flawed premise of entering into international arms control agreements before securing ironclad verification requirements.

The TTBT bans underground nuclear tests for weapons that have explosive yields greater than the equivalent of 150,000 tons of TNT--over ten times the power of the bomb dropped on Hiroshima. If nuclear testing were limited, the hope was that the development of Soviet nuclear weapons would be limited, thus increasing U.S. security.

These hopes have floundered, as President Reagan's recent report to Congress on Soviet violations of arms control agreements clearly showed. Soviet noncompliance with TTBT, the Anti-Ballistic Missile (ABM) Treaty, and the Strategic Arms Limitation Treaty (SALT) increases the possibility that Soviet nuclear weapons could overwhelm existing U.S. forces.

Even if effective verification procedures were accepted by Moscow, the Soviets have achieved military advantages that strongly suggest that ratification of the TTBT would be inimical to U.S. security interests. To redress the worsening strategic

balance, further testing is required to achieve a number of extremely important improvements in U.S. nuclear weapons technology. Testing at higher yields and the continued development of nuclear defensive systems are also required. The TTBT effectively prevents any of these necessary measures, and thus reduces U.S. security.

THE SOVIET TESTING RECORD

Since the TTBT was negotiated, it has been criticized alike by arms control apologists and by arms control skeptics. Arms control enthusiasts regard the 150-kiloton testing limit as much too high. Skeptics feel that the Treaty would freeze the great Soviet advantage in high-yield warheads, hinder U.S. efforts to undo the harm done by the "assured destruction" doctrine of the McNamara era,[1] and limit the U.S. to weapons not optimal for attacking hardened or protected military targets.

Skeptics also argue that the Treaty is basically unverifiable. The reason: a factor of two uncertainty exists concerning the method for estimating the yields of Soviet underground nuclear tests. Critics contend that, with current test measuring capabilities, a test at 150 kilotons would occasionally appear on the measuring instruments to be 300 kilotons, and more important, occasionally appear to be only 75 kilotons. Finally, the TTBT would prevent testing of nuclear weapons designed for the defensive purpose of attempting to minimize nonmilitary casualties and damage from a nuclear exchange.

When the first evidence of Soviet testing well above the TTBT limit came to light in 1976, the initial U.S. government response was to stop releasing reports of Soviet nuclear test yields to the public. The next step was a search for some scientific basis to cast doubt on the yield estimates themselves. In 1977, the Carter White House ordered the intelligence community to adopt a new methodology that in effect cut estimates of these yields in half. Within a year of this change, the Soviets nearly doubled the yields of their underground testing and again appeared to be in violation of the TTBT.

During this period there were press reports, since confirmed by the Reagan Administration, of Soviet tests with estimated yields (or central values, the middle of the range of estimates of possible yields) well above 150 kilotons.[2] The Carter Administration responded by withholding the facts and making misleading statements

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1 See infra., p. 9.

2 See, for example, Jack Anderson, "U.S. Can't Tell If Russia Cheats on Test Ban," The Washington Post, August 11, 1982, p. C15; and Harold Agnew, "Detection of Nuclear Tests," Science, Vol. 220, p. 142.

to the public. One explanation was: "There have been a number of Soviet tests of which the best estimate is that they are rather close to the 150-kiloton limit. Because there is almost a factor of two uncertainty in either direction, they could be bigger than 150 kilotons by quite a lot, or they could be smaller by quite a lot."[3] On the opposing side, Harold Agnew, former director of the Los Alamos Laboratory, stated that these "tests appeared to us to range as high as 400 kilotons, based on detection criteria in effect at the time of the initial agreement."[4]

The Reagan Administration is under pressure to ratify the TTBT. In May 1982, several U.S. Senators urged the President to ask for ratification of the TTBT.[5] In response, the White House dramatically revealed U.S. concern regarding Soviet compliance with the TTBT. Then in July of 1982, Eugene Rostow, director of the Arms Control and Disarmament Agency, stated, "Indeed, we have real concerns about the number of tests conducted by the Soviets since the TTBT and Peaceful Nuclear Explosions Treaty (PNET) agreements were signed."[6] In March 1983, President Reagan told a news conference that "we have every reason to believe there have been numerous violations" of TTBT. In January 1984, the President released a report to Congress on Soviet arms control treaty violations, which noted ambiguities in the available evidence, but concluded that some Soviet tests constituted likely violations of the TTBT.

The Administration's position on the TTBT remains that the U.S. should not ratify the treaty unless the Soviets agree to improve verification procedures. The U.S., meanwhile, continues to adhere to the 150-kiloton limit, despite Soviet rejection of any further negotiations on the subject.

THE TECHNIQUE OF VERIFICATION

Determination of a Soviet treaty violation is based upon interpretations of signals received thousands of miles away from

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3 Senate Armed Services Committee, Preview Budget Briefing Fiscal Years 1981-1985 Five Year Defense Program (Washington, D.C.: U.S. Government Printing Office, 1980), p. 37.

4 Harold Agnew, op. cit.

5 Rudy Abramson, "Senators Press Reagan on Two Nuclear Pacts," Los Angeles Times, May 26, 1982. Other prominent individuals and newspapers soon followed suit and urged ratification. See for example: Theodore C. Sorenson, "Test Ban and Epitaphs," New York Times, July 25, 1982; see also "Banning the Ban," The New Republic, August 16 and 23, 1982; "Nuclear Steps to Take Now," The Christian Science Monitor, August 6, 1982; "A Mistake on Nuclear Test-Ban Negotiations," The Minneapolis Tribune, July 25, 1982; and "The Tail of the Snake," The Boston Globe, July 23, 1982.

6 Prepared Statement before the Senate Foreign Relations Committee, (Washington, D.C.: ACDA, Mimeo, 1982). Mr. Rostow's concerns become ironic with his calling for the Treaty's ratification.

the Soviet test sites.[7] Seismic signals travelling such a long distance through the ground can be distorted substantially. This distortion is known as "path bias." Since the seismic waves from Soviet tests pass through geologic formations very different from those for U.S. tests, there is no assured basis for comparison. Any path bias assumption is at best an educated guess; there is no way of being confident that the estimate is accurate.

Seismic waves generated by different Soviet tests in the same area, however, would be subject to the same path bias, and thus can be compared to each other with great accuracy. This is significant because a pattern of Soviet testing at the same sites has developed that strongly suggests, in spite of the uncertainties inherent in U.S. estimation of Soviet yields, that the Soviets are in fact actually violating the TTBT. Most of the Soviet nuclear tests that appear to be over 150 kilotons occur in one area: the Shagan River test site in Eastern Kazakhstan in Central Asia.

Rather than directly challenge the Soviet Union, the Carter Administration decided in 1977 to introduce path bias assumptions into the calculations of Soviet test yields, thereby reducing their yield estimate[8] (see chart on page 5). Tests that had previously appeared to U.S. specialists to be in the range of 300 kilotons--a TTBT violation--were "corrected" by path bias and declared in compliance with the TTBT. In the words of one expert, "We [the U.S.] have normalized our criteria for detection in order to reconcile the seismic signals received to keep Soviet tests within the 150-kiloton limit."[9]

Within a year, the Soviets had begun testing at levels that again appeared to violate the TTBT by roughly a factor of two. Because these tests took place at the same test site, there was no doubt that the test yields had increased in a way that could be compared to previous tests. These tests had already been corrected for path bias and yet, again, appeared to be nearly twice the 150-kiloton TTBT limit.

The Soviet tests after 1978 are about twice as powerful as the tests conducted between 1976 and 1978. Thus, if the Soviet tests between 1976 and 1978 were in the 150-kiloton range, those after 1978 must be 300 kilotons or more--clearly in violation of the 150-kiloton limit.

If the post-1978 tests were under the 150-kiloton limit, the earlier tests must have been under 75 kilotons to account for the increased percentage. This would mean that the Soviet

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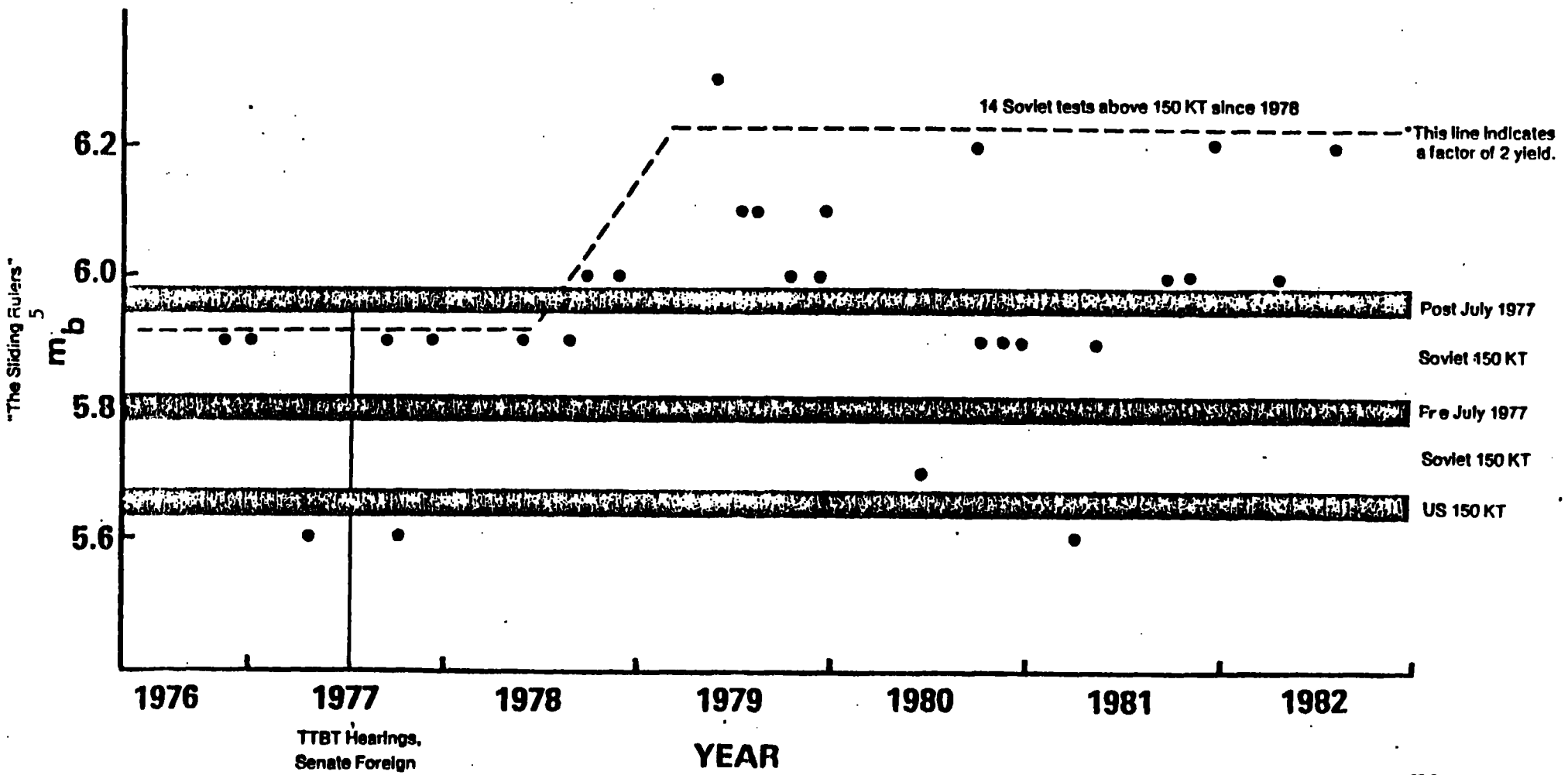
7 See "Soviet Violations of Arms Control Agreements: the TTBT," in The Congressional Record, May 19, 1983, pp. S7134-7139.

8 Prior to 1977, no path bias was assumed.

9 Harold Agnew, op. cit.

SOVIET NUCLEAR EXPLOSIONS
(SHAGAN RIVER TEST AREA)
GLOBAL MAGNITUDES (N.E.I.S.) VS TIME



"The Sliding Rulers" 5

Note: If the Soviets were testing up to the 150 KT limit of the TTBT in the first three years of the Treaty (as would be expected - the US certainly did), the Soviets are now testing up to 300 KT. Alternatively, if they are testing below 150 KT now, they must have restricted testing to below 75 KT during the first 2-1/2 years. This is an unrealistic assumption.

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Union for almost three years was testing at less than half the negotiated testing limit. Given the Soviet record of stretching arms control agreements to their limits and beyond, the contention that they tested at such a low level for such an extended period strains credulity.

In fact, Soviet military requirements provide a great incentive for testing at the Treaty maximum or beyond. In the late seventies, the Soviet Union introduced a new series of improved intercontinental ballistic missiles (ICBMs), including the SS-17, SS-18 Mod 4, and the SS-19 Mod 3.[10] The megaton range yields associated with these missile warheads strongly suggest that it would have been unlikely for the Soviets to deploy these weapons without testing well above 150 kilotons. The incentive for future Soviet testing above the Treaty limit is the development and deployment of a new generation of warheads designed specifically to destroy U.S.missile silos.

Although questions concerning compliance cannot be resolved completely with currently available technical data, informed and reasonable judgments can be made. The pattern of testing indicates that Moscow continues to test at levels far above the TTBT limit but within the factor of two uncertainty the U.S. believes it can assess. U.S. estimates of Soviet yields already have been "corrected" once for path bias. Thus the inescapable conclusion, from a TTBT verification standpoint, is that the uncertainty factor on yield verification must approach four if the Soviets are to be judged in compliance. This serious technical uncertainty, combined with the Soviets' powerful military incentives to violate the Treaty, must call into serious question the desirability of its ratification by the U.S.

IMPROVING TTBT VERIFICATION

The fundamental problem with the TTBT, as with most arms control agreements, is verification. First, underground testing by its very nature precludes collecting the information about nuclear design and yield that could be obtained by observing the explosion. Second, the TTBT is the only modern arms control treaty that does not ban deliberate concealment that would impede verification. Under the TTBT, it is perfectly legal to conceal everything about a nuclear test and engage in deliberate deception. For example, exploding a nuclear device in a cavity tends to reduce its seismic signal and makes the explosion and its yield appear smaller than they are. No improvement in seismic detection would reduce significantly the margin of uncertainty regarding yields of underground nuclear explosions. The verification

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[10] The Defense Department, Soviet Military Power - 1983 (Washington, D.C.: Government Printing Office, 1983), pp. 17-18.

problem lies not in recording the seismic signals but in interpreting what those signals mean.

It would not be possible to eliminate all the uncertainty about Soviet nuclear testing yields even if all U.S. verification proposals were accepted. Moscow could still cheat. But reduction of the current margin through cooperative verification procedures could reduce substantially the military significance of possible Soviet cheating under the TTBT.

It has been suggested that adequate verification might be achieved because the TTBT specifies exchanges of data following ratification. Yields of two past explosions in each designated "geophysically distinct" (undefined in the Treaty) testing area would be exchanged. However, the Soviet Union could provide false yields if they were testing at above the 150-kiloton limit. Thus, such yield information would change nothing. Data about certain elementary physical properties of the test sites would be a secondary part of this exchange. Knowledge of these properties, even if assumed to be accurate, would be of little help unless the Soviets provided detail far beyond that specified in the Treaty. This is highly unlikely, given past and current Soviet attitudes.

The data exchange mandated by the TTBT could even worsen matters because it would create a legitimized channel for Soviet misinformation. There would be no verification that the data concerning calibration shots were correct.[11] The yield data the Soviets provide in two tests could be false and intended to give the impression that all Soviet tests were of a lower yield.

What kind of agreement would improve yield estimation so that compliance with the TTBT could be verified? Clearly, it would be necessary to obtain independently verified data that allowed less ambiguous yield estimates. The specific U.S. proposal is for a direct yield measurement obtained by inserting a cable down the emplacement hole into the vicinity of the explosion. The cable would measure the speed with which the explosion energy travels out through the ground, allowing much more accurate yield estimates. U.S. personnel would be required at Soviet test sites, and Soviets would monitor U.S. tests. Moscow, however, has rejected this approach.

SOVIET COMPLIANCE WITH ARMS CONTROL AGREEMENTS

With adequate verification of the TTBT in doubt, the record of Soviet treaty noncompliance becomes even more relevant. It is no longer possible to doubt seriously Soviet violation and circumvention of existing arms control treaties. Said President Reagan,

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[11] See Judith Miller, "Experts Split on Flaws in Pacts Limiting Nuclear Tests," New York Times, July 26, 1982.

"I am sorry to say that there has been increasingly serious ground for questioning their compliance with arms control agreements that have already been signed and that we both have pledged to uphold."[12] Secretary of State George Shultz has characterized Moscow's behavior as a "...continuing practice of stretching a series of treaties to the brink of violation and beyond."[13] Nearly every agreement in this area has produced credible allegations of Soviet noncompliance.

When the Soviet Union apparently decided to conduct nuclear tests at yields that violated the TTBT, it did so after more than a decade of violations of the 1963 Limited Test Ban Treaty (LTBT). After an initial announcement by the Johnson Administration of a "technical violation" of the Treaty in 1964, the U.S. government neither insisted on Soviet compliance nor made any further announcements of additional LTBT violations. The Carter Administration refused to release any information concerning the Soviet venting of radioactive nuclear debris across its borders and even denied that such events violated the LTBT: "There have been venting cases in which radioactive nucleii have been detected outside the Soviet Union...again these are not clear violations. They are matters of stretching the limits of the agreement."[14]

The U.S. government, as early as the mid-1960s, signaled to the Soviet Union that it would not insist on strict Soviet compliance with arms control agreements. In addition, the Soviet Union saw the U.S. government rationalize a host of Soviet activities between 1973 and 1976 that either violated SALT I or circumvented its essential limitations. It would be understandable if the Kremlin concluded that the U.S. government would do nothing against Soviet testing above 150 kilotons. And indeed, the only U.S. responses were ineffectual démarches followed by predictable Soviet denials.

The Soviets soon may be able to deploy a new ICBM, contrary to SALT II Treaty limitations. It would have an advanced warhead, developed in violation of the TTBT, and would be defended by anti-ballistic missiles, in direct contradiction of the ABM Treaty. The lack of an American response to previous Soviet violations of arms control agreements enhances the possibility of this scenario.

THE TTBT AND U.S. SECURITY

Even if agreement could be reached assuring effective verification of the TTBT, serious questions arise as to the actual

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12 "Text of Remarks by the President to the Los Angeles World Affairs Council," (Washington, D.C.: The White House, March 31, 1983), p. 2.

13 "U.S.-Soviet Relations in the Context of U.S. Foreign Policy," Statement before the Senate Foreign Relations Committee (Washington: State Department Mimeo, June 15, 1983), p. 8.

14 Former Secretary of Defense Harold Brown, cited in Senate Armed Services Committee, op. cit.

utility of limiting testing in the manner called for by the Treaty. Donald Kerr, Director of the Los Alamos Laboratory, has pointed out that "nuclear tests are essential for determining the proper functioning of nuclear explosives; calculations do not suffice, and there is no way to experimentally simulate the performance of a nuclear design."[15]

Because the U.S. has limited itself to very small missile systems, one objective of nuclear testing is to increase yield-to-weight ratios--the amount of nuclear explosive yields obtained from any given weight. Nuclear weapons are also frequently removed at random from the existing stockpile and tested to prove that they will have a given yield. Over the years the U.S. has conducted about 40 such tests.

In addition, the U.S. tests nuclear devices to correct problems that develop in weapons that have previously been placed in the stockpile. By 1978, there had been a dozen instances in which weapons required a nuclear test to repair a problem. If a problem with a nuclear weapon required a test over 150 kilotons, it could not be repaired under the TTBT.

The TTBT also limits development of new weapons types. New designs are constrained by the Treaty's test ceiling, and options for developing systems exceeding the 150-kiloton limitation must utilize existing designs to insure Treaty compliance.

The negative impact on U.S. security is even greater when probable Soviet TTBT violations are taken into account. Since 1978 the Soviets have conducted 15 nuclear tests that appear on U.S. instruments to have yields substantially above the 150-kiloton TTBT ceiling. The argument that no Soviet violations have occurred is technically plausible in the sense that one cannot prove it in a purely scientific manner, but it is extremely unlikely in a practical sense when other factors are taken into account.

The limitations the TTBT places on nuclear testing must also be viewed in the context of historical nuclear strategies. The introduction of the mutual assured destruction doctrine in the early 1960s[16] resulted in the termination of most major weapons systems other than the Minuteman and Polaris programs. The development of small missile systems carrying small warheads, such as

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15 Dr. Donald Kerr, former Acting Assistant Secretary for Defense Programs, Department of Energy, current Director of Los Alamos Laboratory, testimony before the House Armed Services Committee, "Effects of a Comprehensive Test Ban on U.S. National Security Interests," (Washington, D.C.: Government Printing Office, 1978), p. 5.

16 A detailed explanation of MAD may be found in the "Statement of the Secretary of Defense Robert S. McNamara before the Senate Armed Services Committee on the Fiscal Years 1969-73 Defense Program and 1969 Defense Budget" (Washington, D.C.: Government Printing Office, 1968), pp. 41-69.

the Minuteman III and the Poseidon, produced a combination that does not have the yield and accuracy capability to destroy hardened military targets. This shortcoming has been exacerbated by the deployment of Soviet ICBMs with the ability to destroy hardened U.S. targets.

To counter this new threat to U.S. deterrence and nuclear stability, the Accelerated Test Program was begun in the U.S. during the 1970s. A primary objective of this program was to seek out and develop new options for higher yield weapons to destroy hardened Soviet targets. Testing of any of these new weapons would be precluded under the TTBT if their yields increased by a substantial amount.

Supporters of the TTBT have argued that testing new designs at the higher yields needed is no longer necessary because nuclear weapons development is at a technological plateau and further design improvements cannot be achieved. On the contrary, Robert Woodward, Associate Director of Nuclear Design, and W. F. Scanlon, Deputy Director of Military Applications at the Lawrence Livermore National Laboratory, point out that the so-called "plateau" is actually caused by the "imposed limits of the TTBT rather than the lack of anything technically new to be done."[17]

As a result of observing TTBT limitations, the U.S. has been forced to use older, less advanced designs for the MX and Trident II warheads because their tests were allowed at full yield only before the signing of the TTBT. There is a substantial risk in using these older plans. Very slight design changes often can improve dramatically the performance of nuclear weapons systems, rendering the older plans relatively obsolete. The warheads for the MX, Trident II, Mark 12A, the new bomb carried on the B-52, and the future B1-B bomber cannot be proof tested at full yield in their final deployed form under the TTBT. The MX, Trident II, and cruise missiles all have "options under research and development upon which nuclear testing has not been completed, and the U.S. would not certify them and place them into the strategic stockpile without having completed that nuclear testing."[18] Strategic deterrence systems have never been previously deployed with such uncertainties concerning their performance.

An additional problem facing the U.S. is the shortage of special nuclear materials, including plutonium and Uranium-235, which comprise the basic building blocks of nuclear weapons.[19]

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17 Letter to the Editor, The Washington Post, August 10, 1983.

18 Admiral R. R. Monroe, Director of the Defense Nuclear Agency, testifying before the House Armed Services Committee, "Current Negotiations on the Comprehensive Test Ban Treaty" (Washington, D.C.: Government Printing Office, 1978), p. 104.

19 See Arnold Kramish, "America's Plutonium Predicament," Strategic Review, Summer 1982, p. 48.

This shortage might be averted through the development and deployment of higher kiloton nuclear warheads that use lower levels of special material to achieve their design yields. However, TTBT limits prohibit the testing, and hence the development and deployment, of these weapons with yields of more than a few hundred kilotons--precisely the type most needed today. The problem of critical nuclear material shortages, then, is exacerbated by the TTBT, thereby limiting the U.S. ability to meet the growing Soviet threat.

Besides requiring the use of older and less efficient designs for multibillion dollar strategic weapons, the TTBT limits the response to future Soviet military hardening programs. Any such Soviet fortifications will require the U.S. to deploy megaton and multimegaton yield weapons to maintain a credible deterrent.[20] It becomes imperative to test higher yield weapons systems that can penetrate these hardened targets because "it is not possible... to always accomplish the same objective with greater accuracy of delivery."[21] Yet there is no viable option of testing in this yield range.

Improved air defenses in the Soviet Union, not limited by any treaty,[22] also contribute to the need for larger testing yields. Bombers and cruise missiles must travel longer distances to overcome these air defenses, reducing the accuracy of their payloads. This in turn requires an increased yield from the weapons carried in order to offset the decreased accuracy if a target is to be effectively destroyed. The best response to this combination of new defense and hardened targets, the development of higher yield weapons, is precluded under the TTBT.

The ABM Treaty and the TTBT limits also essentially preclude the development of advanced U.S. defensive weapons, such as the ABM program and the so-called X-ray laser.[23] Yet Soviet ABM-related activities--research, testing, and radar deployment--create a real threat of violation or "breakout" from the ABM

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20 The yields, for example, for the Poseidon and Minuteman III are only .04 megaton and .17 (or .335) megaton, respectively. Comparable Soviet weapons are in the megaton or multimegaton yield range. See Mark B. Schneider, "SALT and the Strategic Balance," Strategic Review, Fall 1974, p. 42; and Colin S. Gray, "Of Bargaining Chips and Building Blocks," International Journal, Spring 1973, p. 287.

21 Woodruff and Scanlin, ERDA, "Funding and Management Alternatives for ERDA Military Applications," p. 2.

22 Air defense systems against air-breathing weapons, such as the manned bomber and cruise missile, are not covered under the ABM Treaty.

23 The largest underground U.S. nuclear test was devoted to the development of an ABM warhead for the Spartan ABM. See Major General Edward B. Giller, "Nuclear Technology in Support of Our Strategic Options," Air University Review, November 1976, pp. 33.

Treaty. There are four references to this possibility in the bipartisan Scowcroft Commission Report on Strategic Forces.[24] By violating both treaties, the Soviets may be able to deploy effective strategic defensive weapons, while the U.S., limited to exploratory research and development, will lack this capability. One option for meeting this threat would be for the U.S. to develop new strategic warheads, putting a great premium on nuclear testing above 150 kilotons.

CONCLUSION

When the U.S. revised its testing methodology in 1977, the Soviets responded by increasing their testing yields to over 300 kilotons. The Soviet Union apparently had some tests as high as 350-400 kilotons.

Testing at these yields enables the Soviet Union to develop new and improved nuclear weapons systems for its seemingly unending series of new missiles. At the same time, the U.S. limits itself to testing at 150 kilotons and cannot develop weapons suitable for use on its MX, Trident II, or Midgetman ICBM unless it adapts existing, older designs. The only other available option entails the serious risk that major new strategic systems will be deployed with warheads that will not deliver their expected yield because of the lack of appropriate testing.

When combined with the features of the SALT I and SALT II Treaties that favor the USSR, the TTBT gives Moscow a significant military advantage. This undoubtedly will grow with time. The Soviets have, in effect, boosted the yields at which they test. The higher the yields tested by the Soviets, the more the U.S. revises its methodology to legitimize these tests. The Soviet Union has tested and will continue to test at slightly more than twice the maximum allowable yield calculated by the U.S. at any given time. Thus, if the U.S. takes action in the future to legitimize Soviet tests now estimated at 300 kilotons or more, the Soviets will be able to test at 600 kilotons.

The TTBT is not now verifiable and cannot be made verifiable by any procedure apparently acceptable to Moscow. The Soviets have rejected all negotiations concerning improved verification.

The United States, moreover, has sound national security reasons for not ratifying the TTBT. There is substantial evidence that the Soviet Union is cheating. The U.S. has clear military requirements for developing and testing weapons above 150 kilotons. If the current situation persists--in which the Soviets are probably testing at two to three times the Treaty limit--the U.S. will continue to fall behind the Soviet Union in strategic military power.

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[24] Report of the President's Commission on Strategic Forces, April 1983, Brent Scowcroft, Chairman, pp. 10, 12.