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PEACE Research Centre

WORKING PAPER NO. 122

A Comprehensive Nuclear Test Ban: Post-Cold War Prospects

by

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Canberra
September 1992

National Library of Australia

Cataloguing-in-Publication Entry

Findlay, Trevor, 1951 - .
A comprehensive nuclear test ban : post-Cold War prospects

ISBN 0 7315 1456 4.

ISSN 0817-1831

1. Nuclear arms control. 2. Nuclear weapons - Testing. I. Australian National University. Peace Research Centre. II. Title. (Series : Working paper (Australian National University. Peace Research Centre) ; no. 122.)

327.174

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Abstract

This paper considers the prospects for a comprehensive nuclear test ban treaty (CTB) following the end of the Cold War and the nuclear arms race between the United States and the Soviet Union. After analysing the history of nuclear test limitations, the paper examines the evolution of the CTB as an arms control measure: its declining value as an early indicator of nuclear capability, its increasing political importance, its improving verifiability and the changing arguments in favour of continued nuclear testing. Finally the paper looks at the prospects of a CTB being agreed before the NPT Review Conference in 1995 and the implications of a nuclear test ban for the Asia/Pacific region.

A shorter version of this paper was presented at the Peace Research Centre's conference on 'Arms Control in the Post-Cold War World: With Implications for the Pacific and Indian Ocean Regions', held from 25-26 June 1992 in Canberra and from 29-30 June 1992 in Perth.

Biographical Note

Trevor Findlay is Acting Head of the Peace Research Centre. From 1986 to 1988 he was the first Foreign Affairs Disarmament Fellow appointed to the Centre by the Department of Foreign Affairs and Trade. Formerly an Australian diplomat, he was from 1980 to 1984 a member of the Australian delegation to the Conference on Disarmament in Geneva and to other disarmament forums, including the UN Disarmament Commission and the First Committee of the UN General Assembly.

He is the author of *Nuclear Dynamite: The Peaceful Nuclear Explosions Fiasco* (Pergamon Australia, Sydney, 1990) and editor of *Chemical Weapons and Missile Proliferation* (Lynne Rienner Inc., Boulder, Colorado, 1991). He is also the editor of the Peace Research Centre's quarterly periodical, *Pacific Research*.

Introduction

Nuclear testing is currently in an unusual transitional period unimaginable a few years ago. Worldwide, nuclear testing has dropped to its lowest level since the mid-1950s (excluding the 1958-61 moratorium).[1] Russia and France have declared unilateral nuclear testing moratoria until the end of 1992.[2] The two nuclear test sites of the former Soviet Union have been effectively shut down. One of them, at Semipalatinsk, is no longer in the nuclear successor state to the Soviet Union - Russia - but in Kazakhstan, a state that has pledged itself to non-nuclear weapon status in seven years. The other, at Novaya Zemlya in the Arctic, can only be operated for a few months during the northern summer. The United States has cut its nuclear testing back to historically low levels. China, apparently running contrary to the general trend, has just conducted one of its largest nuclear tests (between 300 kilotons and one megaton), although some observers interpret this as a last-ditch testing effort prior to a nuclear test ban.[3]

These developments are taking place at a time when the principal arms control measure designed to end all nuclear testing - a comprehensive test ban or CTB - confronts four longer-term trends:

(1) the potential value of a CTB in halting nuclear proliferation, both horizontal and vertical, has declined markedly

(2) the political value of a CTB is (arguably) increasing

(3) the verifiability of a CTB has become less problematic and

(4) the technical justifications for nuclear testing are narrowing and are decreasingly persuasive.

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1 Robert S. Norris and William M. Arkin, 'Known Nuclear Tests Worldwide, 1945 to December 31, 1991', 'Nuclear Notebook', *Bulletin of the Atomic Scientists*, April 1992, p.49.

2 *Trust and Verify*, No.28, May 1992, p.1.

3 George Leopold, 'Experts Suggest China May Accede to Ban on Nuclear Tests', *Defense News*, 22-28 June 1992, p.12.

History of Nuclear Test Limitations

A complete ban on nuclear testing is the most persistent of all the items on the traditional arms control agenda. Originally subsumed under proposals for comprehensive nuclear disarmament made during the 1940s, a CTB emerged as a discrete arms control goal only after a particularly disastrous US hydrogen bomb test in the Pacific in 1951. The test deposited radioactive fallout on the unlucky crew of the *Lucky Dragon*, a Japanese trawler, and on the nearby Marshall Islands. Thereafter, calls for a halt to all nuclear tests were heard from such luminaries as Indian Prime Minister Nehru, Nobel Prize winner Linus Pauling and the Pope. Enthusiasm for a CTB was driven both by environmental and arms control concerns.

Opposition to a CTB came not only from those who regarded nuclear testing as necessary for the continued refinement of nuclear weapons and the alleged enhancement of nuclear deterrence, but also from those who believed a CTB to be unverifiable. While nuclear testing in the atmosphere and under water was assumed to be readily monitorable, underground testing could allegedly escape detection.

Public pressure for a test ban eventually led the United States to propose the convening of a conference on the verification question. Called the Conference on the Discontinuance of Nuclear Tests, it was held in Geneva from 1958 to 1962 and involved scientists from the three existing nuclear weapon states (the United States, the Soviet Union and the United Kingdom), plus Canada, France, Czechoslovakia, Poland and Romania. Since underground nuclear tests produce shock waves in the same way that earthquakes do, the conference spent most of its time considering the seismic detection of such tests. The initial findings, based on a single American underground nuclear test, were sanguine: the experts concluded that it was possible to establish an effective seismic system to detect nuclear tests down to magnitude 4.75, the equivalent of 5 kilotons (the Hiroshima bomb was approximately 13 kilotons). In the meantime the Soviets, British and

Americans declared unilateral moratoria on their nuclear testing, lasting from 1958 to 1961.

Negotiations on a CTB commenced in Geneva. Numerous factors prevented early optimism about verification being translated into the negotiation of a treaty. First, further studies produced less favourable assessments of the capabilities of seismic detection. Second, possible evasion scenarios, such as conducting nuclear tests in underground cavities to muffle the seismic shock waves, began to gain currency. Third, the possible solution to such problems, on-site inspection (OSI), was opposed by the Soviets as being tantamount to spying. Fourth, the US Administration was internally divided on the merits of a CTB, with the US Atomic Energy Commission and key nuclear scientists vocally opposed. Finally, the shooting down of Gary Powers' U-2 spy plane over the Soviet Union in 1960 made the negotiation of a CTB politically inopportune. In 1961 the Soviets abruptly resumed nuclear testing with a huge 58 megaton explosion, an event that coloured for decades the United States' attitude towards unilateralism in arms control.

The 1962 Cuban missile crisis eventually restored the political impetus to the test ban negotiations. President Kennedy by-passed the Geneva talks, sending a delegation to Moscow to negotiate the 1963 Partial or Limited Test Ban Treaty (PTBT or LTBT). This agreement, concluded by the US, the UK and the Soviet Union, banned nuclear tests in the three environments in which they were judged to be satisfactorily monitorable - in the atmosphere, in outer space and under water. Underground testing was permitted provided that vented radioactivity from such tests did not cross an international frontier. Being only partially verifiable, this requirement subsequently led to disputes between the US and the Soviet Union. The PTBT was opened to accession by all states. It currently has 118 parties.[4] Although China and France have remained non-parties, they now also conduct all their tests underground.

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[4] *SIPRI Yearbook 1991*, Oxford University Press for the Stockholm International Peace Research Institute (SIPRI), Oxford, 1991, p.668.

By driving nuclear testing underground, out of sight, the PTBT had a lulling effect on public pressure for a complete ban on nuclear tests - a phenomonon Paul Boyer calls the 'Era of the Big Sleep'.[5] It was not until 1974 that additional treaty constraints were placed on nuclear testing. This time it was not due to public clamour, but the need for President Nixon to have an arms control agreement to sign with General Secretary Brezhnev at their Moscow summit. The treaty, known as the Threshold Test Ban Treaty (TTBT), banned underground nuclear tests over 150 kilotons. Its companion treaty, the Peaceful Nuclear Explosions Treaty (PNET) took another two years to negotiate. It placed the same yield limit of 150 kilotons on so-called 'peaceful nuclear explosions' (PNEs) - those carried out for 'planetary engineering' purposes such as the excavation of canals or the formation of underground storage cavities. The aim of the PNET was to prevent the parties obtaining weapons-related benefits from those PNEs with higher yields than weapon tests.[6]

While the 150 kiloton limit prevented the United States and the Soviet Union from testing their more powerful nuclear weapons at full yield, the TTBT and PNET did not appreciably slow the modernisation of nuclear weapons or lead to a decline in the number of tests. Indeed the TTBT was criticised for setting the permitted yield level well above that which would significantly affect the weapon testing program of either party. The PNET, meanwhile, was criticised for giving credence to the idea that there was a difference between nuclear weapon tests and PNEs. This argument was dramatically vindicated in 1974 when India declared that its nuclear weapon test was a 'peaceful nuclear explosion'.

Neither the TTBT nor the PNET entered into force until December 1990. Ratification was delayed initially because of the Soviet invasion of Afghanistan and then because of the Reagan Administration's purported concern over the

[5] Paul Boyer, *By The Bomb's Early Light: American Thought and Culture at the Dawn of the Atomic Age*, Pantheon Books, New York, 1985, p.355.

[6] See Trevor Findlay, *Nuclear Dynamite: The Peaceful Nuclear Explosions Fiasco*, Pergamon Australia, Sydney, 1991.

treaties' alleged verification shortcomings. The claim that the Soviets had violated the TTBT's 150 kiloton ceiling was added to the Reagan Administration's long list of supposed Soviet arms control transgressions. This was despite scientific evidence that the size of Soviet tests was being systematically overestimated because their geologically older test sites were propagating seismic waves more efficiently than the Americans' geologically younger Nevada Test Site.[7]

The real purpose of the Reagan Administration's insistence that the verification provisions of the TTBT and PNET be renegotiated was revealed in 1989 by US Assistant Secretary for Defense Frank Gaffney:

> The thinking goes like this: the more time is wasted on discussions and experimentation of monitoring techniques irrelevant to the verification of an environment in which there are no legal tests, the easier it will be to stave off demands for [a] comprehensive test ban.[8]

The fuss over the TTBT was deliberately designed to forestall the negotiation of a CTB.

Unlike the Reagan Administration, the Carter Administration which preceded it had genuinely tried to negotiate a CTB with the Soviet Union and the United Kingdom, in the so-called trilateral negotiations from 1977 to 1980. Some progress was made and a draft treaty substantially completed. One breakthrough was Soviet agreement to forgo the development and use of PNEs for the duration of a CTB, in effect instituting a perpetual ban on such explosions. Agreement was also reached on the principle of on-site inspections and the deployment of in-country

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[7] See Lynn R. Sykes, 'Present capabilities for the detection and identification of seismic events' in Jozef Goldblat and David Cox (eds), *Nuclear Weapon Tests: Prohibition or Limitation?*, Oxford University Press for the Canadian Institute for International Peace and Security (CIIPS) and the Stockholm International Peace Research Institute (SIPRI), Oxford, 1988, pp.151-155.

[8] *Pacific Research*, August 1989, p.17, quoting *Geneva Monitor*, 5 April 1989.

seismic monitoring stations. Substantial differences remained however over the details of the OSI regime and the number of seismic stations each party would be expected to host. The Soviet Union insisted for instance that the United Kingdom have 10 stations like the two much larger superpowers.

However it was not substantive differences which caused the talks to fail, but the lack of political capital available to President Carter. Opposition from nuclear weapon designers and the Defense Department proved too strong for a President preoccupied with the negotiations of the Strategic Arms Limitation Treaty (SALT) and other domestic and foreign policy issues. The Soviet invasion of Afghanistan was the last straw. The incoming Reagan Administration formally ended the talks and relegated a CTB to a 'long-term objective' of US arms control policy.

Henceforth a CTB, according to US policy, was only to be contemplated as part of a comprehensive nuclear arms reduction package involving deep cuts and confidence-building measures. For the United States at least, a CTB had returned to its roots, enmeshed in a comprehensive disarmament program that was unlikely ever to be fulfilled. Since 1980 there have been continuing futile attempts to have the Conference on Disarmament in Geneva commence negotiations on a CTB, but these have been blocked by the United States and the United Kingdom.

The Changing Arms Control Value of a CTB

The arms control rationale for a CTB has changed considerably since it was first mooted in the 1950s. Originally a complete ban on nuclear tests was seen as a means of:

. preventing the emergence of new nuclear weapon states by stopping them crossing the nuclear threshold with a nuclear test, and

. preventing nuclear modernisation by the existing nuclear weapon states, thereby slowing the nuclear arms race.

Today the first aim has evaporated. Due to the widespread diffusion of knowledge about nuclear weapons, a non-nuclear weapon state is able to develop a first-generation fission weapon of the type dropped on Hiroshima or Nagasaki - an A-bomb - and have reasonable confidence in its reliability, without nuclear testing. As former head of the Los Alamos National Laboratory, J. Carson Mark, puts it:

> It is no longer necessary for anyone, anywhere, ever to conduct a test to ascertain again that an assembly which is supercritical with prompt, fast neutrons will produce an explosion.[9]

A non-nuclear weapon state could even develop a complete arsenal of 1950s-style fission weapons, including warheads of various sizes, yields and delivery

[9] J. Carson Mark, 'The Purpose of Nuclear Test Explosions' in Goldblat and Cox (eds), pp.32-33.

requirements, without a single nuclear test.[10] The case of Israel, which has acquired a nuclear arsenal reportedly numbering in the hundreds, but has not conducted a nuclear test, is the obvious example.[11] While political and/or military leaders might demand a test before placing faith in the reliability of such weapons, such a demonstration is technically unnecessary.

The experts appear to agree however, that nuclear tests are required for development of sophisticated fission warheads, so-called 'boosted' weapons, or fusion weapons (H-bombs).[12] As William van Cleave puts it:

> A test programme would be required for the continued development of warheads, if advanced sophistication and versatility are to be obtained, or certainly if a two-stage thermonuclear device were desired.[13]

A CTB, universally adhered to, would therefore prevent the emergence of new H-bomb-capable states, but not new nuclear weapon states per se.

The second traditional aim of a CTB - to slow the growth and modernisation of existing nuclear weapon states' arsenals - does retain some validity. While the effects of a CTB on modernisation would have been more dramatic had it been in

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10 Quoted in Donald R. Westervelt, 'The Role of Laboratory Tests' in Goldblat and Cox (eds), p.51.

11 See Seymour M. Hersh, *The Sampson Option: Israel, America and the Bomb*, Faber & Faber, London, 1991.

12 Israel may be the great exception here. Such is the capability of its nuclear establishment and so great the amount of assistance it has received from France and even the United States, that some observers believe it also has produced hydrogen bombs without a test. Alternatively, the flash of light detected over the South Atlantic in 1979 may have been a joint South African/Israeli H-bomb test.

13 Quoted in Westervelt, p.51.

force since the 1960s, a CTB today would still have a marked effect on the ability of the nuclear weapon states to further modernise their nuclear weapons. It would not however bring about nuclear disarmament, nor prevent the manufacture of additional nuclear weapons based on proven designs. Hence a CTB is not a panacea for the quantitative nuclear arms race, but only some of its qualitative dimensions.

The potential impact of a CTB, in the sense of halting an activity that contributes to the nuclear arms race, is in any event eroding as nuclear testing continues to decline. A *de facto* CTB is possible. Only 14 nuclear tests were conducted in 1991, fewer than in any year since 1954, excluding the 1958-61 moratorium. In the first half of 1992 only 3 tests have been conducted, 2 American and 1 Chinese.[14] US Energy Secretary Watkins has said the US will conduct 4 more this year.[15] If no other states conduct tests, the total for 1992 is likely to be the lowest since 1950.

Moreover, for the vast majority of states a CTB is irrelevant to their conduct, since as parties to the Nuclear Non-Proliferation Treaty (NPT) and/or equivalent regional agreements, they are prohibited from acquiring a nuclear device, much less testing one. The number of states that have not renounced the acquisition of nuclear weapons is now minuscule and includes, in addition to the nuclear weapon states, only three states of significance: Israel, India and Pakistan. The

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[14] Based on data from the Australian Seismological Centre, Canberra.

[15] *Trust and Verify*, No.28, May 1992, p.1.

rest are lesser states like Burma and Vanuatu which are unlikely ever to be able to construct a nuclear device.

The only other states of concern would be those NPT parties whose commitment to their non-nuclear status is suspect. These currently are North Korea, Iran, Iraq and Libya. While as parties to a CTB they would be subject to an additional treaty constraint, this is unlikely to prevent them testing if they had already decided to violate the NPT by acquiring a nuclear weapon in the first place.

In sum, if adherance to a CTB is universal, the treaty will materially affect the actual behaviour of fewer than ten significant states.

The Growing Political Importance of a CTB

Yet, notwithstanding its declining value as an arms control 'choke-point', the political symbolism of a CTB remains without parallel in what Alva Myrdal called the 'game of disarmament'.[16] The principle reason is its connection with the NPT. From the outset a CTB has been regarded by the non-nuclear weapon states as the single most important way for the nuclear powers to demonstrate their commitment to nuclear disarmament. Such a commitment is loosely set out in Article VI of the NPT, although a CTB is not specifically mentioned.

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16 Alva Myrdal, *The Game of Disarmament: How the United States and Russia Run the Arms Race*, Pantheon Books, New York, 1976.

The non-nuclear weapon states also see a ban on nuclear testing by **all** states as partially redressing the discriminatory nature of a nonproliferation treaty which divides the world into nuclear 'haves' and 'have-nots'. Such is the symbolic power of a CTB that no amount of nuclear disarmament - possibly not even the dramatic post-START reductions announced in June 1992 by Presidents Bush and Yeltsin - is likely to assuage the non-nuclear weapon states in their demand for a CTB.

The reasons why the non-nuclear weapon states should be so adamant about a CTB are complex. One reason is that a CTB is an issue that the international community feels belongs to it, partly because most states are parties to the 1963 Partial Test Ban Treaty (PTBT), which in its preamble calls for a ban on all nuclear tests. Seismic verification technology and capability is widespread and the cooperation of most states will be required for the establishment of a global verification system. By contrast the START and SALT processes are regarded by the nuclear weapon states as being their sole preserve, to be verified only by them.

Another factor is that a CTB, like a nuclear freeze, is easily comprehensible. It can fire the imagination of politicians and publics and can be intelligently debated and negotiated by the representatives of non-nuclear weapon states. This stands in stark contrast to the SALT and START processes, which are politically and technically more complex.

Cynical political considerations are also at work. States like Mexico and India undoubtedly see a CTB as a way of clipping the wings of the great powers at little expense to themselves. Indeed for most states a CTB would be cost-free - as contrasted with, for instance, conventional disarmament, which would cause problems for everyone.

Another factor is diplomatic lethargy and the glacial pace at which the agenda of the multilateral arms control community evolves. A nuclear test ban has been the number one item on the program of work of the Conference on Disarmament for so long that it is almost inconceivable that it should be removed or relegated.

It is also a matter of sunk costs. So many states have invested so much political and diplomatic energy into a CTB - Australia among them - that they would be reluctant to let it go. In any event, if for instance Australia and New Zealand dropped their annual CTB resolution at the UN General Assembly, another country - probably Japan or Canada - would certainly take it up.

The political importance of a CTB is growing in the lead-up to the 1995 NPT Review Conference, where the parties will consider whether to extend the treaty and for how long. Those states which are adamant that a CTB is a prerequisite to their agreement to an extension of the NPT are in a position to hold the treaty to ransom. The greatest danger is that the NPT, an existing arms control agreement with over 140 parties, which has contributed substantially (if imperfectly) to constraining nuclear proliferation, might be sacrificed for the sake of a nonexistent treaty which will affect only a small number of states and have a marginal effect on stopping nuclear proliferation.

The Increasing Verifiability of a CTB

Another trend facing a CTB is that the verifiability of compliance with such a treaty is improving markedly. The traditional argument against a CTB was that it was unverifiable: that due to inherent uncertainties in seismic detection capabilities and possible evasion techniques, there could never be complete certainty that all nuclear tests would be detected and identified. While true, such a bald statement ignores several subtleties.

Verification by its very nature can never claim 100% effectiveness, since it involves proving a negative: the absence of treaty violations. As former ACDA official Amron Katz colourfully put it, 'We have never found anything that the Soviets had successfully hidden'.[17] The question then becomes: what degree of verifiability is politically required by each treaty party? This depends, among other things, on:

. the existing level of trust between the parties

. the military significance of a violation, and

. the ability of any party to redress any disadvantage from a violation.

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[17] Quoted in W.F. Rowell, *Arms Control Verification: A Guide to the Policy Issues for the 1980s*, Ballinger, Cambridge, Mass., 1986, p.53.

In the case of a CTB, the question of trust has principally been posed in terms of the United States being unable to trust the former Soviet Union. Today however the level of trust between the United States and Russia is so high as to warrant a less demanding approach to verification, as Presidents Bush and Yeltsin have recently acknowledged. The more open nature of Russian society reinforces the case.

The question of trust may perhaps still be relevant in regard to other potential CTB parties such as China. But for the overwhelming majority of parties a CTB verification system will be unnecessary. Hence while the system must, for political reasons, be global and non-discriminatory, in practice attention will be directed at a handful of states, most of them easier to monitor than Russia or China. For most parties the verification system will be a confidence-building measure, not a device to catch or deter treaty violators.

As for the military significance of an undetected CTB violation, a single illicit nuclear test will not, by itself, affect the military security of any CTB party. As the Scowcroft Commission stated in 1983:

> The essential test of an effective verification system is that it will detect with a high degree of confidence any *set* [emphasis added] of violations which would have a significant impact on the strategic balance.[18]

[18] Quoted in *Energy & Technology Review*, August 1986, p.24.

Even a series of clandestine tests under a CTB by a nuclear weapon state would not necessarily have military significance, especially given the size and sophistication of current nuclear weapon state arsenals. Steve Fetter summarises the situation as follows:

> ...nuclear tests with yields less than 0.01 kiloton are not militarily significant. A series of tests with yields of 0.01 to 1 kiloton might be significant since it would allow the proof-testing of some old tactical warheads, development and testing of some new tactical warheads, and somewhat limited nuclear-effects testing, but it is unlikely that these developments would change the military balance. A single test of 5 to 15 kilotons could be important since it would allow the most important features of an aged or slightly modified weapon to be evaluated. A series of tests at yields at or above a few kilotons would be significant because it would permit the development of new boosted fission weapons. Such a testing program could support the development of new strategic weapons and the exploration of new weapon concepts.[19]

Moreover, even if a successful series of clandestine tests resulted in the deployment of a new type of nuclear weapon by an existing nuclear weapon state, it is doubtful that this would radically affect the nuclear balance, especially since such a deployment would itself probably be detected even if the tests had not been. Since nuclear weapons are a mature technology investigated thoroughly in almost fifty years of nuclear testing, it is difficult to see what revolutionary development might emerge from a few, necessarily small, clandestine nuclear tests that would be sufficient to endanger nuclear deterrence.

Naturally, the greater the size of a clandestine underground nuclear test and/or the more tests that are conducted, the greater the likelihood of detection. Once a

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[19] Steve Fetter, *Toward A Comprehensive Test Ban*, Ballinger, Cambridge, Massachusetts, 1988, p.112.

clandestine nuclear test program has been detected and identified then other states may take corrective action such as conducting their own nuclear tests.

How Verifiable Is A CTB?

Since seismic monitoring is the principal means for verifying compliance with a CTB, the verification debate often focuses - often misleadingly - solely on the capabilities of seismology. Often described as more an art than a science, seismology confronts several difficult challenges in relation to a CTB:

. detection is complicated by the fact that the smaller the size of the nuclear test, the more its seismic signal is hidden in the background 'noise' of natural and man-made earth movements, including earthquakes, chemical explosions and even urban noise (this is a classic scientific problem of the signal-to-noise ratio)

. nuclear tests must not only be detected, but identified, that is distinguished from other types of earth movement

. seismic signals from nuclear tests are transmitted differently depending on the type of rock in which the tests are conducted; a test in hard, wet rock produces a stronger signal than a test in dry alluvium

. evasion scenarios are theoretically possible; the most plausible (but still highly unlikely) involve hiding a test in an earthquake or chemical explosion, or muffling or decoupling a test's seismic signal by conducting it in a large cavity.

Since 1976 the Conference on Disarmament's *Ad Hoc* Group of Scientific Experts (GSE) has been planning the establishment of a global seismic network using existing seismic stations and the communications system of the World Meteorological Organisation (WMO). The Group has conducted two full-scale tests of the system, the most recent being in April/May 1991. Australia and New Zealand, on the basis of the latest trial, claim that the existing global network would have a 90% chance of detecting an event in most geological environments somewhat below the equivalent of 10 kilotons in the northern hemisphere and of 10 kilotons and above in the southern hemisphere.[20]

Below 10 kilotons however there remains scientific controversy as to how effective a global seismic verification network might be. Lynn Sykes of Columbia University claims that 'a comprehensive test ban treaty or a low-yield threshold treaty is verifiable with high confidence down to explosions of very small size, approximately 1 kt'.[21] Dennis Fakley, former Deputy Leader of the British CTB delegation, on the other hand asserts that, 'it is clear that a verification performance down to 1kt could not yet be provided'.[22] Why are these assessments so different and what is the layperson to make of them?

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[20] Australia and New Zealand, 'Verification of a Comprehensive Test Ban', Conference on Disarmament document CD/1081, 11 June 1991.

[21] Lynn R. Sykes, 'Present Capabilities for the Detection and Identification of Seismic Events' in Goldblat and Cox (eds), p.145.

[22] D.C. Fakley, 'Present Capabilities for the Detection and Identification of Seismic Events' in Goldblat and Cox (eds), p.167.

Part of the difficulty in assessing the optimal capability of an international seismic verification system is that it does not yet exist. As seismologists Basham and Dahlman put it, 'in principle, a seismological system can be developed to meet any political requirements'.[23] It depends on the finance and resources devoted by the international community to such a system. Basham and Dahlman propose a 3-tiered system comprising:

1. a global network of 50 or more 'primary' stations to provide uniform global coverage
2. networks of 'secondary' stations drawn from national earthquake-monitoring networks to provide improved capabilities on the territories of CTB parties
3. special networks of 'in-country' stations and other arrangements for the territories of existing nuclear weapon states.[24]

In regard to the **first tier**, there will undoubtedly continue to be improvements in the global network, both as a result of national initiatives and the CD's work. The GSE has long recognised the need for improvements in coverage of the southern hemisphere, especially Africa, Latin America and Antarctica. Some are already occurring. It should be noted however that most countries of concern under a CTB regime will be in the northern hemisphere.[25]

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23 Peter Basham and Ola Dahlman, 'International Seismological Verification' in Goldblat and Cox (eds), p.187.

24 *Ibid.*

25 Zaire is being assisted by Belgium to upgrade its seismic capabilities. Now that it has renounced nuclear weapons by joining the NPT, South Africa can also contribute to monitoring the Southern Hemisphere. The US and Russia have plans for joint seismic stations in Antarctica,

The **second tier** will benefit from regional seismic networks and arrays established by states particularly advanced in seismology and/or well placed geographically. These include Norway, Sweden, Canada, Australia, the United Kingdom and the United States. Such stations are likely to used advanced seismological methods such as high-frequency wave detection.

Spectacular gains have been made by the new high-frequency Norwegian regional array (NORESS) in detecting nuclear tests in the former Soviet Union. Soviet explosions at yields of only a fraction of a kiloton were detected reliably at distances as great as 2600 miles (or 4160 kilometres).[26] The Swedish array has similar capabilities.[27] NORESS even provides improved detection of French tests in the South Pacific.[28] Norway has proposed that NORESS-type regional arrays be used as the standard for stations comprising the basic global network.

High-frequency waves are also useful in countering evasion scenarios. According to Lynn Sykes, high-frequency waves distinguish nuclear tests from earthquakes so well that the attempt to hide tests by simultaneously detonating them during an earthquake becomes infeasible.[29] Similarly, it has been discovered that high-

where Australia already has a station.

[26] Sykes, p.147.

[27] *Ibid.*, p.150.

[28] Frode Ringdal, 'Verifying Compliance with a CTBT' in *Towards A Comprehensive Test Ban Treaty*, Royal Norwegian Ministry of Foreign Affairs, Oslo, May 1992, p.115.

[29] Sykes, pp.147-149.

frequency waves are not subject to as much muffling or decoupling when an explosion is conducted in an existing cavity.

The **third tier**, of 'in-country' seismic stations, particularly in the nuclear weapon states, would comprise tamper-proof unmanned stations which relay data direct to satellites linked to the global system. Such systems, developed by the US, allow the detection threshold to be lowered and also help counter evasion scenarios.

Great strides have been made in recent years in mutual bilateral seismic monitoring by the United States and the former Soviet Union. The US Natural Resources Defense Council (NRDC) and the former Soviet (now Russian) Academy of Sciences have jointly established a permanent in-country network of 13 stations in the former Soviet Union and a comparable number in the US. These are intended to transmit continuous seismic data between the two countries. In addition, two seismic arrays of approximately 10 seismic instruments each are being installed, one in Armenia and one in Kirghizia. Plans call for an eventual 20-25 stations.[30] Charles Archambeau of the University of Colorado estimates that at least one station in a network of 26 internal seismic arrays within the territory of the former Soviet Union could detect 1-kt decoupled explosions anywhere in that territory and that at least 4 stations would detect explosions in 95% of the territory.[31]

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30 Gregory E. van der Vink, 'Verifying a Comprehensive Test Ban', *Arms Control Today*, November 1990, pp.19-20.

31 This assumes a low-frequency decoupling factor of 200 and that frequencies up to 30 Hz could be detected. See Fetter, p.116.

Identification

One challenge in identifying nuclear tests is that the identification threshold is higher than the detection threshold; that is, it is easier to detect a nuclear test than identify it. Seismographs often register different patterns for earthquakes and tests due to the fact that explosions are point sources of energy, while earthquakes result from the slipping of faults over large distances.[32] Seismologists disagree however about the precise capability of seismology to always provide this differentiation. In addition nuclear explosions must also be distinguished from chemical explosions.

The use of so-called discriminants, such as location and depth, eases the problem. Large areas of the earth can be ruled out as possible sites of nuclear tests, including oceanic and coastal areas, those with large population densities and those close to international frontiers. Under a CTB one could also rule out old nuclear testing sites, since these would be very closely monitored. In addition, vast uninhabited areas without roads, airstrips or other human activity can be ruled out, particularly through the use of satellite and aerial reconnaissance.

The location problem in relation to former Soviet territory has been eased considerably by the fact that its successor state, Russia, has shrunk. Russia's newly-independent neighbours are extremely unlikely to host clandestine Russian nuclear tests or conduct their own.

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[32] Fetter, p.118.

A second discriminant is depth. While most underground nuclear explosions are conducted at depths of 300 to 600 metres, with the deepest being 2.6 kilometres, most earthquakes are much deeper.[33]

A CTB treaty can itself improve the situation by requiring states to notify large chemical explosions and permit on-site inspection as required.

National (Seismic) Technical Means

The capability of the global seismic network under a CTB would be supplemented by so-called 'national technical means'. The national seismic capabilities of the US and the former Soviet Union are difficult to assess because of the secrecy that surrounds some of them. For instance the US Air Force Technical Applications Centre (AFTAC) operates a secret Atomic Energy Detection System, including seismographs and atmospheric radioactivity detectors, at 92 sites (mostly military bases and diplomatic missions) in more than 35 countries.[34]

Evasion Techniques

Clearly, assumptions about the verifiability of a CTB turn in part on assessments of the likelihood of evasion techniques and the means available to counter them.

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[33] *Ibid.*, p.118.

[34] Robert S. Norris and William M. Arkin, 'Nuclear Notebook', *Bulletin of the Atomic Scientists*, July/August 1987, p.63.

The most commonly cited evasion scenario involves detonating a nuclear device in a large cavity, either pre-existing or specially constructed. There are a number of reasons why a state is unlikely to attempt such an evasion. First is the difficulty of constructing such a cavity. The most promising material for such decoupling is salt. Such areas are relatively rare and could be the target of special monitoring. Gregory van der Vink points out that a cavity with a diameter of at least 86 metres - larger than the Statue of Liberty - would be required to fully decouple a 5 kiloton explosion in salt.[35] In crystalline rock, a volume of material the size of the largest Egyptian pyramid would need to be excavated.[36]

In addition a cavity probably needs to be roughly spherical to maximise the decoupling effect. The construction work required would be detectable by satellites, as would the instrumentation facilities unless extraordinary (and costly) precautions were taken. This is especially so since clandestine nuclear tests are likely to be conducted in uninhabited regions.

In addition there is always the possibility of the cavity collapsing, especially if used for more than one explosion. Radioactivity leakage may also occur even if the cavity does not collapse.

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35 Van der Vink, p.22.

36 Jeremy Leggett, 'Techniques to Evade Detection of Nuclear Tests' in Goldblat and Cox (eds), p.216.

The CTB treaty can ease the decoupling problem by requiring parties to register the location of all large underground cavities, including those created by previous nuclear explosions, and the location of large salt deposits. In any event Jeremy Leggett reports that a reexamination of the seismic data on decoupling has caused revisions in the estimates of the maximum decoupling effect likely to be achieved.[37]

Many scientists remain entirely sceptical about the likelihood of any state attempting evasion of a CTB by such methods. One American physicist goes as far as saying that 'it could be that the big hole [theory] was originally designed for the purpose of containing the CTB, and that may well end up being its only use'.[38]

A second evasion scenario commonly cited is the 'hide-in-earthquake' scenario. Quite apart from the advances in high-frequency signal detection, this scenario is fraught with improbabilities. Clearly the earthquake would have to be predicted in advance, the device ready to go and the diagnostic equipment in place. These factors preclude a rapid sequence of nuclear tests necessary for a weapons development program. The areas where such an evasion might be attempted are also limited. In the case of the former Soviet Union, half the shallow earthquakes occur in areas that now lie outside Russia, probably the only former Soviet

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37 *Ibid.*, p.216.

38 *Ibid.*, p.210.

republic capable of any evasion techniques, while the other areas are probably too close to Mongolia, China and Japan to be useful.[39]

The key question in considering evasion scenarios is whether any state could rationally conclude that the benefits to be gained from a few expensive, small, clandestine nuclear tests would outweigh the international opprobrium and possible countermeasures resulting from being detected. A far cheaper method, sanctioned by international law, would be to leave the treaty altogether after giving the required period of notice.

Non-Seismic Means

One reason why some seismologists are more pessimistic than others about the verifiability of a CTB is that they fail to consider non-seismic means of verification. While not as powerful as seismology, there are several tools available that enhance verifiability and complicate the life of any would-be violator.

Atmospheric Monitoring

A CTB treaty will establish a dedicated, improved system for monitoring atmospheric radioactivity from atmospheric tests or venting from underground tests. Such venting was quite common at both the Soviet and American test sites despite these states' extensive nuclear test experience. A country attempting to test a

39 Fetter, pp.128-9.

weapon underground for the first time risks such tell-tale emissions of radioactivity. The Soviets admitted that as recently as February 1989 one of their tests vented radioactive gas.[40]

Satellite Surveillance

The United States, Russia and France operate satellites which can detect, through photo-reconnaissance, preparations for nuclear tests, such as excavations, laying of instrumentation and evacuation of people (as India did prior to its 1974 test). Both Soviet and US photographic surveillance satellites reportedly detected preparations for a South African nuclear test in the Kalahari desert in August 1977.[41] Brazil's excavation of a test shaft was presumably detected by the same means.

US Defense Support Program (DSP) early warning satellites and NAVSTAR navigation satellites carry nuclear detection sensors, the most advanced of these being launched in 1991. Part of the US Integrated Operational Nuclear Detonation Detection System, these sensors can detect nuclear explosions in the atmosphere and outer space by such varied means as nuclear particle detectors, gamma-ray and x-ray sensors, visible light bhangmeters, and electromagnetic pulse (EMP) sensors.[42]

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40 *Washington Times*, 6 July 1989.

41 Stockholm International Peace Research Institute (SIPRI), *World Armaments and Disarmaments: SIPRI Yearbook 1987*, Taylor & Francis, London, 1978, pp.73-9.

42 Desmond Ball, 'A Comprehensive Test Ban Treaty: A Role For Australia', Working Paper No.6, Peace Research Centre, Australian National University, Canberra, 1986, p.47. It should be noted however that the detection of a flash by an old Vela satellite off the southern coast of Africa

Open Skies

The Open Skies treaty, signed in March 1992 by most members of the Conference on Security and Cooperation in Europe (CSCE) - including the US, Canada and Russia - will greatly assist the verification of a CTB by being able to detect nuclear test site preparations and subsidence from tests already conducted. This will supplement data available from satellites. The treaty establishes annual quotas of unarmed observation flights over the territory of all parties, from Vancouver to Vladivostok.[43] Aircraft may be equipped with photographic, radar and infrared sensors. Under a CTB radioactivity sensors could be added.[44]

Other Technical Means[45]

Other techniques which have been investigated include ionospheric disturbance detectors;[46] microphone arrays for monitoring very-low-frequency waves propagated into the upper atmosphere by nuclear explosions;[47] hydroacoustic sensors on the sea floor to detect acoustic waves propagated through the ocean;[48] and marine sampling to detect accumulated plutonium or other

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in September 1979 failed to provide positive identification of a nuclear explosion.

43 For the US and Russia the quota is 42.

44 US Information Service, *East Asia and Pacific Wireless File*, 20 March 1992, p.12.

45 For details see 'Conclusion' in Trevor Findlay (ed.), *Verifying A Test Ban*, Monograph No.4, Peace Research Centre, Australian National University, Canberra, 1988.

46 'Ionospheric Detection of Explosions', *Energy & Technology Review*, May 1983, p.39.

47 *Washington Post*, 10 August 1985.

48 Robert S. Norris and William M. Arkin, 'Nuclear Notebook, *Bulletin of the Atomic Scientists*, July/August 1987, p.63.

radioactive substances in marine life[49]. A number of advanced techniques are available to help analyse the enormous amounts of data produced by a CTB verification system. These include the computer-based knowledge engineering systems and expert systems.[50]

On-Site Inspection (OSI)

While OSIs are often touted as the ultimate verification tool, in the case of a CTB they are totally reliant on other verification techniques, such as satellites and aerial surveillance, providing precise information on a possible clandestine test site. Otherwise inspectors seeking surface evidence of a test site or underground radioactivity could be faced with searching huge areas. Unless there had been radioactive venting, OSI might also require back drilling into a suspected detonation cavity.

Nonetheless, making provision for mandatory OSIs under a CTB is important since the human element involved in OSIs adds to the uncertainty of a potential violator and may thereby act as a deterrent.

Intelligence

Nuclear testing generates large quantities of communications traffic, the detection of which may prove extremely useful in detecting and identifying actual or

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49 'Marine Sampling for the Detection of Clandestine Nuclear Explosions', *Energy & Technology Review*, August 1986, p.26.

50 See Shane Ingate, 'Capabilities of the Present Global Seismic Network' in Findlay (ed.), pp.39-43.

potential violators of a CTB. Desmond Ball reports that a US SIGINT station in Cyprus intercepted a teletype message from Moscow to the Caucasus in August 1961 revealing a Soviet decision to resume nuclear testing.[51] In 1974 the Director of Australia's Joint Intelligence Organisation (JIO) reported that Australian SIGINT activities had made 'a substantial contribution to our total information...[on] French nuclear-testing activities and pre-knowledge of detonations'.[52]

The Verification 'Uncertainty Principle'

A fully operational verification system for a CTB will be replete with redundancies and synergies, all of which will give a potential violator pause. While one could not be absolutely certain that all clandestine nuclear tests would be detected, such uncertainty works two ways. Just as the verifiers of a test ban can never be absolutely certain that they have detected all tests, a potential violator can never be certain that its violations will go undetected. Uncertainty can be a powerful deterrent - especially when the odds of detecting clandestine tests rises with the number attempted.

Seismological monitoring itself can be more powerful than expected. In a phenomenon that Gregory van der Vink calls 'sweet spots', some seismological stations can detect nuclear tests that in theory they should not be able to.[53] In 1991 a Soviet seismologist revealed that one of the principal Soviet stations, at

51 Ball, pp.25-6.

52 *Ibid.*, p.49.

53 Van der Vink, p.20.

Borovoye in northwest Kazakhstan, regularly detected US nuclear tests in the sub-kiloton range.[54] In January 1988 the National Resources Defence Council announced it had discovered evidence of 71 small, previously secret nuclear tests at the Nevada Test Site after examining old seismic records at the California Institute of Technology.[55] On the other hand US seismologists have learned of a series of small Soviet tests at Novaya Zemlya that they failed to detect.[56]

Evolving Arguments for Nuclear Testing

While the verification argument has gradually weakened to the point where it is no longer a serious objection to a CTB, other arguments in favour of nuclear testing have been waxing and waning.

Modernisation

The United States argued in the past that nuclear testing was necessary for the modernisation of its nuclear forces in order to preserve and enhance nuclear deterrence vis-a-vis the former Soviet Union. This was a particular argument of the Reagan Administration, which had come to power convinced that arms control had weakened the US nuclear deterrent and opened a 'window of vulnerability'

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[54] *Trust and Verify*, No.19, April/May 1991.

[55] *Canberra Times*, 18 January 1988, p.4.

[56] *Pacific Research*, May 1991, p.20.

which had to be closed through a major upgrading of the US nuclear arsenal and the deployment of strategic defences.

It is arguable however whether nuclear testing was required even for the Reagan Administration's ambitious plans. The most significant advances in nuclear weaponry in the past two decades have related to delivery vehicles and guidance systems rather than warheads. According to Steve Fetter, 'nearly all US weapon systems deployed over the last two decades could have used warheads that were already in the stockpile', rather than custom-built models.[57] For example the MX missile could have used the warhead developed for the Minuteman III, the Trident II could have used the Trident I missile. As physicist Richard Garwin colourfully puts it, when the US sent John Glenn into space it did not reconfigure him: 'Instead, we *packaged* him, so that he would be protected against the vacuum, cold, heat and shock of the flight'.[58]

If the arguments for nuclear testing to achieve modernisation ever had any force, in current circumstances they are completely irrelevant. The US and Russian nuclear forces are no longer growing or modernising, but shrinking. For the first time since the nuclear age began, no new US or Russian nuclear weapons are being developed and none will be needed if the new nuclear arms agreements and initiatives are implemented. Similarly, the Star Wars program is faltering and

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57 Steve Fetter, 'Reasons for Nuclear Testing' in *Towards A Comprehensive Test Ban Treaty*, Royal Norwegian Ministry of Foreign Affairs, Oslo, 1992, p.10.

58 'Perspectives for a Future Comprehensive Test-Ban Treaty (CTBT), in *Towards a Comprehensive Test Ban Treaty*, Royal Norwegian Ministry of Foreign Affairs, Oslo, 1992, p.129.

evolving in non-nuclear directions that will not require nuclear tests. The nuclear directed-energy weapons (NDEW) program, which included the nuclear-pumped x-ray laser, has been cancelled. Production of plutonium and highly-enriched uranium for weapons purposes has ended in both Russia and the United States.

Stockpile Reliability

As the verification and modernisation arguments against a CTB have faded, a new argument has gained prominence: that nuclear tests are needed to ensure confidence in the reliability of the US nuclear arsenal.

The argument has partly turned on past reliability problems detected by nuclear testing. Fourteen of the 41 types of nuclear weapons introduced into the US stockpile after 1958 developed stockpile confidence problems. Of these, 75% were discovered and/or corrected by nuclear testing. These figures are however misleading. Most of the problems detected were the result of incomplete nuclear testing programs interrupted by the 1958-1961 moratorium.[59] Today's stockpiled weapons have been thoroughly tested through their development stages.

Since they contain reactive materials such as plutonium and high explosives, nuclear weapons would experience ageing and deterioration under a CTB. Steve Fetter notes however that the normal stockpile surveillance program, which consists of careful disassembly, inspection, and testing of components, is more

[59] Fetter, *Toward A Comprehensive Test Ban*, pp.72-76.

effective than nuclear testing.[60] A single successful stockpile test gives little information about the reliability of all weapons of that type. To be 95% sure that a weapon of a particular design is 95% reliable would require nearly 60 nuclear tests.[61]

Under a CTB, if problems are identified in stockpiled weapons as a result of non-nuclear tests, the remedy would be to remanufacture the weapon to precise original standards. Some weapons designers argue that this would be problematic because changes in materials and techniques occur over time and designer skills would be lost. Rebuilding the 1950s television set is cited as the example. It is hard to believe however that a technological giant like the United States could not remanufacture anything made in the past, given sufficient time and resources, especially if national security was judged to be at stake. A 1990 Energy Department report concluded that for three recently developed warheads, 'no issues were found that would preclude replication'.[62]

Under a CTB all nuclear weapon states would, unlike at present, need to plan for the accurate remanufacture of existing nuclear weapon designs, including a vigorous non-nuclear testing program, possibly stockpiling critical materials and offering incentives to weapons designers to retain their skills. This seems hardly

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60 Richard Garwin claims there is '*technical* agreement between those in the weapons laboratories and those outside that a vigilant program of stockpile inspection and non-nuclear test [s] will suffice to reveal potential problems' (Garwin, p.130).

61 Fetter, *Toward A Comprehensive Test Ban*, p.89.

62 Tom A. Zamora, 'Put a Safety Cap on Testing', *Bulletin of the Atomic Scientists*, March 1992, p.29.

beyond the capabilities of the country that brought us the Manhattan Project and the moon walk. Indeed since 1982 US weapons laboratories have been obliged to maximise warhead lifetime and their own ability to replicate the warhead in future and incorporate it into other delivery systems.[63]

Moreover, as in the case of the Partial Test Ban Treaty, the US Senate is likely to make ratification of a CTB dependent on guarantees that stockpile reliability will be maintained, that the weapons laboratories will be adequately funded and staffed, and that preparations for resuming nuclear testing be made.

It is also important to consider what a loss of reliability would mean. In technical terms, since deterioration is a random process, the entire nuclear arsenal is unlikely to be affected simultaneously.[64] Moreover, many ageing problems are likely to result in a reduced yield, not a complete failure. The concept of 'reduced yield' in a nuclear weapon fired in anger would appear both immoral and irrelevant. It is certainly irrelevant to the inhabitants of a city whether the device they are hit with yields 300 kilotons or 100 kilotons. In the context of what could go wrong in a nuclear exchange - especially the communications and delivery systems - the reliability of nuclear explosives themselves is probably of least concern.

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[63] Fetter, *Toward A Comprehensive Test Ban*, p.101.

[64] *Ibid.*, pp.88-89.

Finally, as a result of current cuts in nuclear forces, it is the older systems (in theory the most unreliable) that are being withdrawn, raising the average reliability and modernity of the remaining arsenals.

There is an argument of course that deteriorating confidence is beneficial to nuclear deterrence - that if the deterioration affects all nuclear weapon states equally, the incentives to use them will grow. This is however a difficult argument to sell to a military and political leadership whose natural inclination is to demand that weapons perform as advertised. It may also give rise to the view that US weapons, being closer to their 'technological edge', are more vulnerable to deterioration than robust former Soviet weaponry.

Safety and Security

Another argument that is perhaps overtaking the stockpile reliability argument relates to the improved safety and security of nuclear weapons. It is argued that nuclear testing is necessary to ensure continuing improvements in mechanisms designed to prevent nuclear weapons detonating unintentionally (safety) and to prevent unauthorised use either by terrorists or armed forces personnel (security).

Safety mechanisms include:

. 'one-point safety', which prevents a nuclear explosion occurring as a result of a detonation at one point in the high explosive, such as might occur if the weapon were dropped or hit with a sharp object

. environmental sensing devices (ESDs) which prevent weapons from detonating unless they sense acceleration and altitude

. Fire-Resistant Pits (FRPs) where the plutonium pit is covered with high-melting point metal shells

. insensitive high explosive (IHE) to prevent accidental detonation of the conventional explosive.

As a result of the withdrawals and retirement of nuclear weapons announced in the past year, most of the US weapons without these features will disappear. The Energy Department has told the US Congress that 'we are confident that we can achieve modern safety in the stockpile by the year 2000'.[65]

The chief exception are submarine-launched ballistic missiles (SLBMs), which do not include IHE. According to Ray Kidder of the Lawrence Livermore National Laboratory, an estimated 10-20 tests would be needed to design versions of the Trident II warheads using IHE.[66] Alternatively the Trident II could be adapted to carry the MX warhead, which has IHE, and which is no longer to be deployed as a result of the post-START nuclear cuts agreed by Presidents Bush and Yeltsin in June 1992.[67]

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[65] Zamora, p.27.

[66] *Ibid.*, p.28.

[67] Fetter, 'Reasons for Nuclear Testing', p.15.

As to the security of US weapons, most of them are closely guarded by military personnel and fitted with permissive action links (PALs), which require the proper authorisation code to be entered to permit use. Again, SLBMs are an exception. However nuclear tests are not absolutely essential for the fitting of PALs to nuclear weapons.[68]

The End of the Cold War and Prospects for a CTB

With the utility of the central strategic nuclear balance between the United States and Russia itself under question, the issue of whether nuclear testing contributes to its stability seems even more arcane than ever before. Nuclear testing is increasingly irrelevant in a situation where no new nuclear systems are being developed;[69] where there are massive cuts in strategic nuclear weapons (particularly the older and more destabilising varieties); and where the geographic spread of nuclear weapons has shrunk markedly (because of withdrawal of Soviet weapons back into Russia, US weapons from Korea and Europe; and the withdrawal of both their short-range and tactical systems from deployment at sea).

The single most important determinant of whether a CTB is negotiated and implemented is US policy. US agreement to a CTB would lock in all the other

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68 *Ibid.*, pp.19-20.

69 US Secretary of Energy Watkins has said additional nuclear tests will be necessary to ensure the safety of new warheads using recycled plutonium pits from dismantled weapons (*Defense News*, 10 February 1992, p.12).

non-nuclear weapon states. France has declared that it will stop testing if others do, while the United Kingdom would be forced to follow the US lead since it tests at Nevada. Despite Boris Yeltsin's alleged appeasement of his military wing by ordering preparations for resumed testing at Novaya Zemlya, Russia would join a CTB tomorrow. According to Chinese physicist Shen Dingli, China is also serious about joining a CTB if other states do.[70]

Ever since the Reagan Administration reviewed US CTB policy in 1980, the United States has relegated a CTB to a 'long-term objective', to be contemplated only as part of a comprehensive nuclear arms reduction package involving deep cuts and confidence-building measures. The United States, supported by the United Kingdom, has repeatedly opposed attempts by the CD to commence CTB negotiations and has vetoed a plan to convert the Partial Test Ban Treaty into a CTB.

The Bush Administration continues to argue that nuclear testing is necessary as long as nuclear weapons exist, claiming that safety and reliability are even more important as the nuclear stockpile shrinks. Russian proponents of nuclear testing have used similar arguments.[71] The President has authorised 'only a small number of tests, mainly with relatively small yields' focusing on these issues.[72]

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70 George Leopold, 'Experts Suggest China May Accede To Ban On Nuclear Tests', *Defense News*, 22-28 June 1991, p.12.

71 Tom A. Zamora, 'Moruruoa-torium', *Bulletin of the Atomic Scientists*, June 1992, p.13.

72 Jacquelyn S. Porth, 'Nuclear Testing Ban Won't Aid Arms Control', US Information Service, *East Asia and Pacific Wireless File*, 15 July 1992, p.20.

There are however harbingers of change. Congressional pressure is growing for a moratorium, although this cannot force a change in US policy because of the Presidential veto.[73] Opinion within the Administration is divided, with the State Department, the Energy Department and National Security Advisor Brent Scowcroft supportive of concessions, while the Department of Defence, the Arms Control and Disarmament Agency (ACDA) and the nuclear weapons laboratories are opposed.[74] Democratic Presidential nominee Bill Clinton supports a 2-stage process towards a CTB - further reductions in the thresholds and numbers of tests before a full-scale CTB - while his running-mate Al Gore has traditionally strongly supported a CTB outright.[75]

The nuclear weapons laboratories, Los Alamos and particularly Livermore, have been instrumental at critical moments in US history in heading off a CTB. It is they who stand most to lose from such a ban. As anthropologist Hugh Gusterson has put it, nuclear tests are 'the core rituals through which the culture of the laboratory is consolidated and reproduced. [Tests] are the rites of passage by which new scientists are initiated into a community [and] designers and their subordinates acquire their reputations'.[76] George Perkovich notes that 'By default, the weapons laboratories and their consultants have been allowed to

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[73] On 4 June 1992 the House passed an amendment to the fiscal 1993 Defense Authorization Bill supporting a US testing moratorium for a year. A similar Senate Bill is due to be voted on in late July (*Bulletin of the Atomic Scientists*, July/August 1992, p.7).

[74] *Trust and Verify*, No.28, May 1992, pp.1-2.

[75] *Arms Control Today*, March 1992, p.6.

[76] George Perkovich, 'Weapons Complexes V. Democracy', *Bulletin of the Atomic Scientists*, June 1992, p.17.

define and largely decide' the CTB issue. 'These individuals and institutions', he says, 'have promoted their special interest as if it were the public interest'. The solution lies therefore in a democratisation of the decision-making process on the CTB issue. The possible amalgamation of the two nuclear weapons laboratories - with Livermore having been more consistently pro-testing - may assist this process.

Clearly a key date is 1995, when the NPT comes up for renewal. It behoves the US Administration to consider the impact that a CTB would have on that process and whether - in view of its renewed enthusiasm for nonproliferation[77] - surrendering the nuclear testing option might not a worthwhile trade-off.

Should the US consider that additional nuclear testing is genuinely required for reliability, safety and security, it could conduct the small number of tests required before 1995. Democratic Chairman of the House Science, Space and Technology Committee, George Brown, puts the number required at only 10.[78] If such a plan were announced in advance by the United States it would serve notice on other nuclear weapon states and enable them to make comparable preparations for a CTB. While this may result in a short-term renewed bout of nuclear testing, it would be worthwhile if the end result was the long sought-after CTB.

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[77] See President Bush's 'Plan to Bolster Nonproliferation Efforts' of 15 July 1992 in which he announced a formal end to US production of plutonium and highly-enriched uranium for weapons purposes (US Information Service 'Official Text', 15 July 1992).

[78] *Trust and Verify*, February/March 1992.

Among the non-nuclear weapon states, support for a CTB has recently increased. For instance Argentina, Brazil and South Africa no longer have nuclear pretentions that might require a nuclear test. The most recent Australia/New Zealand CTB resolution, at the 1991 session of the General Assembly, received the highest vote ever (147/2/4).[79] The United States and France voted against, while only China, Israel, the UK and the Federated States of Micronesia (under US guidance) abstained. Of the 147 voting in favour, only India and Pakistan may not accede to a CTB if eventually concluded, but they would be under enormous pressure to do so, as would Israel.

Implications for Asia/Pacific

For Asia/Pacific the implications of the current decline in nuclear testing are good; a CTB would be even better. French nuclear testing in the South Pacific has long been a source of tension and dissatisfaction among regional countries, not only the members of the South Pacific Forum but Latin American states as well. For France, an end to testing would usher in a new era in its relations with the South Pacific, not least with Australia, New Zealand and Greenpeace. It would also permit France to accede to the protocols of the South Pacific Nuclear Free Zone. For Australia and New Zealand, the achievement of a CTB would be the culmination of a long and at times diplomatically costly campaign.

[79] Information provided by Department of Foreign Affairs and Trade, Canberra.

It should be noted however that the inhabitants of French Polynesia have mixed feelings about the prospect of an end to French testing. As one observer has put it, '20% of the population is worried about nuclear testing's effect on health and the environment, and 80% is worried about the social and economic effects of its departure'.[80]

An end to Chinese nuclear testing would have similar benefits for Asia/Pacific. It would reassure Japan and South Korea of China's desire to participate fully in global arms control arrangements. It would also relieve pressure on Kazakhstan not to renege on its undertaking not to become a nuclear weapon state.

A CTB would put pressure on India and Pakistan - the former to forswear additional tests, the latter not to test at all. By fulfilling a major demand of the non-nuclear weapon states party to the NPT, a CTB would at least partly meet Indian and Pakistani allegations that the treaty was discriminatory and unfulfilled by the nuclear weapon states. For India not to do so would be the ultimate in hypocrisy. While Indian and Pakistani adherance to a CTB would not roll back or prevent further nuclear proliferation on the subcontinent, it would constrain them from developing the full range of nuclear capabilities, especially the H-bomb.

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[80] Sarah Walls, 'Islanders Force French to Face Up to Risks in the Business of the Nuclear Bomb', *Sydney Morning Herald*, 28 October 1989, p.19.

Conclusion

The time would appear ripe for the conclusion of a comprehensive nuclear test ban treaty. The nuclear arms race has ended, the number of would-be nuclear states has dropped dramatically, the verification problem has been adequately addressed, and there are environmental gains to be had. This long sought-after arms control measure would ensure a continuation of the Nuclear Non-Proliferation Treaty and be a fitting complement to the massive cuts in nuclear forces envisaged for the beginning of a new century.