Implementing the Comprehensive Test Ban
New Aspects of Definition, Organization and Verification

Stockholm International Peace Research Institute

SIPRI is an independent institute for research into problems of peace and conflict, especially those of arms control and disarmament. It was established in 1966 to commemorate Sweden's 150 years of unbroken peace.

The Institute is financed mainly by the Swedish Parliament. The staff and the Governing Board are international. The Institute also has an Advisory Committee as an international consultative body.

The Governing Board is not responsible for the views expressed in the publications of the Institute.

Governing Board

Director

sipri

Stockholm International Peace Research Institute
Pipers väg 28, S-170 73 Solna, Sweden
Cable: SIPRI
Telephone: 46 8/655 97 00
Telefax: 46 8/655 97 33

Implementing the Comprehensive Test Ban

New Aspects of Definition, Organization and Verification

SIPRI Research Report No. 8

Edited by
Eric Arnett

OXFORD UNIVERSITY PRESS
1994

Oxford University Press, Walton Street, Oxford OX2 6DP
Oxford New York
Athens Auckland Bangkok Bombay
Calcutta Cape Town Dar es Salaam Delhi
Florence Hong Kong Istanbul Karachi
Kuala Lumpur Madras Madrid Melbourne
Mexico City Nairobi Paris Singapore
Taipei Tokyo Toronto
and associated companies in
Berlin Ibadan

Oxford is a trade mark of Oxford University Press

Published in the United States
by Oxford University Press Inc., New York

British Library Cataloguing in Publication Data
Data available

Library of Congress Cataloging in Publication Data
Implementing the Comprehensive Test Ban / edited by Eric Arnett
— (SIPRI research report: no. 8) Includes index
1. Nuclear weapons—testing. I. Arnett, Eric H. II. Series.
U264.I47 1994 355.8´25119—dc20 94–19853
ISBN 0–19–829188–4
ISBN 0–19–829187–6 (pbk.)

Typeset and originated by Stockholm International Peace Research Institute
Printed in Great Britain
on acid-free paper by
Biddles Ltd, Guildford and King's Lynn

Contents

Preface

The decision of the nuclear powers in August 1993 to charge the Geneva Conference on Disarmament to negotiate a comprehensive nuclear test ban (CTB) was a crucial contribution to international peace and security. It now seems possible that the CTB will be concluded in the near future, and that it will enjoy the support of nuclear and non-nuclear weapon states alike. Nevertheless, even in a representative forum like the Conference on Disarmament, it is all too easy for the advanced industrialized powers to overlook the concerns of their counterparts from the developing world in the give and take over their own interests, as they sometimes did during the negotiations on the 1993 Chemical Weapons Convention. This report, the first publication from the SIPRI study, 'Nuclear Weapons after the Comprehensive Test Ban: Implications for Modernization, Implementation and Proliferation', seeks to ensure that these views are aired and taken into account in the pursuit of a fair treaty that can be concluded quickly. The conclusions of the contributors are summarized in chapter 1.

The non-proliferation goals of the CTB will require a different way of thinking about verification, as described in chapter 2. For example, during the cold war specialists sought primarily to ensure that even small, decoupled tests in the USSR could be detected and identified reliably, but the new goals might require that preparations to test in any country be detected before a test takes place, as discussed in chapter 3. The CTB will require a new level of co-operation between public and private methods of monitoring compliance with a cost-effective additional multilateral capability created by the treaty, as described in chapter 4. After the initial period, verification activities are likely to be sporadic but intense, so there is a danger that the implementing authority created by the treaty will be under-funded and understaffed. The specific needs of such an organization are judged in chapter 5.

Finally, once achieved, the long-sought CTB may suffer the disappointment all-too-often associated with high expectations if steps are not taken to assure that it fulfils promises made on its behalf. The introduction of new nuclear weapons into the known nuclear arsenals after the treaty is concluded could undermine the hoped-for effect of the treaty in strengthening norms against proliferation. These concerns are

briefly addressed in the report's introduction and executive summary, and will be taken up again in a related forthcoming book, which will identify programmes, deployments, and strategies that could have this undesirable effect, as well as additional steps that can strengthen the nuclear stigma or otherwise contribute to positive developments affecting nuclear weapons in the developing world.

SIPRI has assembled an international team of technical experts to address the key issues in the CTB negotiations: Eric Arnett, the leader of SIPRI's Project on Military Technology; Patricia Lewis, the Director of the Verification Technology Information Centre; and Annette Schaper, senior research associate at the Frankfurt Peace Research Institute. They were given invaluable advice by SIPRI researchers Ragnhild Ferm, Trevor Findlay, Shafqat Ali Khan and Rick Kokoski, who spent a generous amount of their time discussing the authors' contributions and offering support that considerably strengthened this report's final form. Information and suggestions from Katherine Magraw and Rebecca Johnson were also especially helpful. SIPRI would also like to thank Harald Müller, Jürgen Altmann and George Bunn for assistance and encouragement in the preparation of chapter 2 by Annette Schaper. The manuscripts were discussed at a seminar, which could not have been held but for the able efforts of Jaquelin Cochran, Anna Helleday, Bibbi Henson, Marianne Lyons and Monica Rasmussen. The transformation of ragged drafts into the current volume can be attributed to the work of no fewer than three of SIPRI's justly esteemed editors, Billie Bielckus, Eve Johansson and Connie Wall. SIPRI gratefully acknowledges the financial support of the W. Alton Jones Foundation and the John D. and Catherine T. MacArthur Foundation.

Adam Daniel Rotfeld
Director of SIPRI
August 1994

Acronyms

AEDS	Atomic Explosion Detection System
AFTAC	US Air Force Technical Applications Center
AHF	Advanced Hydrotest Facility
ARPA	Advanced Research Projects Agency
CD	Conference on Disarmament
CTB (T)	comprehensive test ban (treaty)
CWC	Chemical Weapons Convention
GSE	Group of Scientific Experts
HDE	hydrodynamic experiment
HNE	hydronuclear experiment
HUMINT	human intelligence
IAEA	International Atomic Energy Agency
ICF	inertial confinement fusion
ICJ	International Court of Justice
IRIS	Incorporated Research Institutions for Seismology
MTM	multinational technical means
NPT	Non-Proliferation Treaty
NTM	national technical means
OPCW	Organisation for the Prohibition of Chemical Weapons
PNE	peaceful nuclear explosion
PNET	Peaceful Nuclear Explosions Treaty
PTBT	Partial Test Ban Treaty
SIGINT	signals intelligence
SNM	special nuclear material
START	Strategic Arms Reduction Treaty
TNT	trinitrotoluene
TTBT	Threshold Test Ban Treaty
UNSCOM	United Nations Special Commission on Iraq
USGS	US Geological Survey
WEU	Western European Union
WMO	World Meteorological Organization
WWCA	War Weapons Control Act
WWL	War Weapons List

1. Introduction and executive summary

Eric Arnett

I. Introduction

After 12 years of stonewalling and one of soul-searching, the USA reversed its policy on nuclear weapon testing in 1993 and paved the way for the Conference on Disarmament (CD) to revitalize the moribund Nuclear Test Ban talks.[1] Having accepted its new mandate on 10 August 1993,[2] the CD in January 1994 formally opened talks intended to achieve a comprehensive test ban (CTB) treaty at an early date.

Despite the mandate, there is disagreement between those who would like the treaty to be completed soon and those who see no reason to hurry. Possible deadlines put forward by the fast-track proponents include the Non-Proliferation Treaty (NPT) Review and Extension Conference (to be held 17 April to 12 May 1995); the presidential elections in France (May 1995), after which an anti-CTB government is expected to take power; and the date set by the US Congress in the Hatfield Amendment (30 September 1996), after

[1] The members of the CD are Algeria, Argentina, Australia, Belgium, Brazil, Bulgaria, Canada, China, Cuba, Egypt, Ethiopia, France, Germany, Hungary, India, Indonesia, Iran, Italy, Japan, Kenya, Mexico, Mongolia, Morocco, Myanmar, the Netherlands, Nigeria, Pakistan, Peru, Poland, Romania, Russia, Sri Lanka, Sweden, the United Kingdom, the United States, Venezuela and Zaire. The nuclear test ban, or NTB as it has been known in CD discourse, has long been on the CD's agenda, but only now is there a negotiating mandate. Previous CTB negotiations were conducted in other forums.

[2] Conference on Disarmament document CD/1212, 10 Aug. 1993. The full text is as follows:

The Conference on Disarmament, Taking note of initiatives regarding the negotiation of a comprehensive test ban treaty (CTB), Convinced that, to contribute effectively to the prevention of the proliferation of nuclear weapons in all its aspects, to the process of nuclear disarmament and therefore to the enhancement of international peace and security, a CTB should be universal and internationally and effectively verifiable, Convinced further that, in order to achieve this goal, it is important that a CTB be multilaterally negotiated, Stressing that, as the sole multilateral disarmament negotiating forum of the international community, it is the appropriate forum for negotiating a CTB, Deciding to give its Ad Hoc Committee on a Nuclear Test Ban a mandate to negotiate a CTB; Requests the Chairman of its Ad Hoc Committee on a Nuclear Test Ban to make the necessary arrangements to conduct consultations during the period between 3 September 1993 and 17 January 1994 on the specific mandate for, and the organization of, the negotiation.

which nuclear weapon testing will be illegal in the USA.[3] In 1996 there will also be presidential elections in Russia and the USA, both of which might result in governments less committed to the CTB than those in power at present. None of these dates has been identified as an official negotiating goal, but Russia and the 'Group of 21' formerly non-aligned countries in the CD[4] have called for completion of an agreed draft in 1994. China's position is that the treaty should be completed no later than 1996. In the meantime, negotiators expect to assert that substantial progress has been made on the CTB treaty at the NPT Review and Extension Conference, whether the treaty has been completed or not. France and the UK have indicated officially they will not sign the CTB treaty before that conference.

Some observers fear that if a CTB is not concluded before these dates pass it will become bogged down unless another target date is identified. Others worry more that rushing negotiations and not specifying implementation procedures carefully or securing consensus will lead to a harried period during preparation for entry into force similar to that being experienced under the 1993 Chemical Weapons Convention (CWC), if not more serious problems of interpretation. They note that the CD has been given a mandate and that members are committed to completing the treaty quickly, even without a formal deadline. One of the major goals of this report is to identify areas in which careful treaty language is especially important and distinguish them from those in which reasonable simplicity, if not ambiguity, will provide for acceptable, if not preferable, means of implementation.

Another question is what is meant by a *finished* treaty. A treaty can be considered finished when its text is agreed and key parties have signed, but it might also be considered essentially finished when most of the brackets denoting text that has not been agreed have been removed from a working draft or so-called rolling text. In the case of the CTB, no rolling text is expected until late 1994 at the earliest. Most lawyers would not accept that a treaty was finished until it had

[3] Fiscal Year (FY) 1993 Energy and Water Development Appropriations Act, reproduced in *Congressional Record*, 24 Sep. 1992, p. H9424; 'US Congress nuclear testing limits', Institute for Defense and Disarmament Studies, *Arms Control Reporter* (IDDS: Brookline, Mass.), sheet 608.D.1–2, Oct. 1992; and Lockwood, D., 'Nuclear arms control', *SIPRI Yearbook 1993: World Armaments and Disarmament* (Oxford University Press: Oxford, 1993), p. 562.

[4] The members of the Group of 21 (G-21) are Algeria, Argentina, Brazil, Cuba, Egypt, Ethiopia, India, Indonesia, Iran, Kenya, Mexico, Mongolia, Morocco, Myanmar, Nigeria, Pakistan, Peru, Sri Lanka, Venezuela and Zaire. Originally, this grouping, an artefact of the cold war, included Sweden and Yugoslavia but not Mongolia.

been ratified by key countries and entered into force, an event that might not occur until a few years after the text is agreed. In the case of the CTB treaty, the verification system created by the treaty might not be complete even at entry into force (as discussed in chapter 4), suggesting still another standard of completion.

This introductory chapter summarizes the conclusions of the report in the context of the full range of issues under negotiation. It previews SIPRI's findings on the principal unresolved issues—defining the term 'nuclear weapon test', monitoring preparations to test, verification and establishing an implementing authority—and describes a number of related political issues.

II. Contentious issues

Although the technical goal of the CTB negotiations is simple—an end to nuclear explosions—and the treaty has been under negotiation in one form or another for more than three decades, there remain several areas of disagreement among the negotiators.

Definition

One of the most important questions concerns the scope of the treaty. Which technical and scientific activities shall be included in the ban and which shall be permitted? What constitutes a nuclear weapon test? Although the questions seem trivial at first glance, they become complicated if the term 'comprehensive' is to be taken seriously. Too narrow a definition would effectively create another Threshold Test Ban Treaty (TTBT),[5] albeit at a much lower yield threshold, and so fail to achieve some of the aims of a CTB. There are several types of ambiguous activity which can serve some of the essential functions of unambiguous nuclear weapon tests and have been mentioned as potentially within the scope of the CTB, including peaceful nuclear explosions, inertial confinement fusion, hydrodynamic experiments, hydronuclear experiments and computer simulations.

[5] The Treaty between the USA and the USSR on the limitation of underground nuclear weapon tests (Threshold Test Ban Treaty, TTBT), was signed in 1974. The text is reproduced in Goldblat, J. and Cox, D. (eds), SIPRI, *Nuclear Weapon Tests: Prohibition or Limitation?* (Oxford University Press: Oxford, 1988), pp. 350–52.

Peaceful nuclear explosions

Technically, peaceful nuclear explosions (PNEs) cannot be distinguished from military nuclear explosions. A definition which allows either testing of PNEs or their use in non-military applications but not military nuclear explosions leaves a direct and simple means of circumventing the treaty. A CTB treaty must therefore ban PNEs as well. Fortunately, PNEs are no longer a significant problem, since a consensus has emerged that the civilian benefits are slight in comparison with the costs and environmental disadvantages. At present, no states conduct PNEs. Although Algeria, China, Iran and Russia have expressed some interest in reserving the option to conduct PNEs (a position Algeria and Russia have since revised and China has reiterated), such an exemption is not desirable and these countries are unlikely to block consensus on the treaty over this issue.

Inertial confinement fusion

Inertial confinement fusion (ICF) is an experimental technique which uses lasers or particle beams to produce a short-lived, extremely dense and highly energetic plasma. The physical principle of creating the plasma is similar to that of the hydrogen bomb and, in effect, ICF can be thought of as a laboratory-scale hydrogen-bomb explosion and is well suited to simulating the physical conditions in a nuclear explosion. The development of some new types of nuclear weapon, especially those of the third generation, would require such experiments. It would be impossible, however, to design third-generation nuclear weapons on the basis of ICF experiments alone or without nuclear weapon tests.

ICF is technologically complex, costly and can only be mastered by the advanced industrialized countries. For most developing countries, the technological hurdle is prohibitively high and will remain so for several decades. Because there are several civilian uses for ICF, a ban on this technique is unlikely. Since civilian facilities can easily be employed for military purposes, there are no technical parameters from which military uses can be distinguished from their civilian counterparts. Nevertheless it is worth considering whether all ICF experiments should be open to international co-operation, as is the standard in civilian scientific endeavours. Such a provision should not be part of the CTB treaty, since it would needlessly delay completion.

Hydrodynamic experiments

A hydrodynamic experiment (HDE) is an explosive test in which the plutonium or highly enriched uranium (special nuclear material, or SNM) is replaced by a passive material (natural uranium or depleted uranium). Implosion and compression take place in exactly the same way as in a nuclear weapon test, but no chain reaction results. A series of HDEs can help designers to perfect symmetric and stable compression. In principle, this suffices for the development of an unboosted fission weapon and guarantees that it will function, but HDEs alone cannot establish the yield of a weapon. In short, HDEs are relevant for horizontal and, to a limited degree, also for vertical proliferation.

Given their significance for nuclear weapon development, a ban on HDEs is attractive to some observers. The non-nuclear weapon states parties to the NPT are not permitted to conduct HDEs, since their possession of a nuclear device is prohibited. There are no formal provisions to monitor compliance with this ban. In fact, verification provisions for a ban on HDEs would be quite intrusive and might still not detect a violation. Yet even if negotiators were willing to overlook the problem of verification, a ban on HDEs still would not be negotiable because of the significance of these experiments for weapon stockpile reliability and safety tests.

Hydronuclear experiments

A hydronuclear experiment (HNE) is a test in which only part of the SNM in a nuclear device is replaced by passive material. Upon detonation a chain reaction is initiated, but its rate is much slower than in the explosion of a complete device. The explosion blows the device apart before much nuclear energy has been released.[6]

HNEs leave unambiguous traces of SNM. One can therefore clearly prove that HNEs have taken place after the fact through on-site inspections. A ban on HNEs would therefore be simpler to verify effectively than a ban on HDEs, although detecting the site of an HNE will be difficult, barring the use of intelligence means or an accident

[6] A test yield of the order of 1 kg TNT equivalent is typical of the publicly known HNE projects in the nuclear weapon states, but only of the order of 10^{-2} to 10^{-3} kg is fission yield. Test yields are typically measured in terms of their explosive power in comparison with trinitrotoluene (TNT).

in which a much higher fission yield is produced. The latter would be unlikely in a nuclear weapon state and only somewhat more likely in a state with little testing experience.

HNEs provide the same information as HDEs about the quality of compression. In addition, HNEs furnish designers with information on the nuclear behaviour of the material used. More important technical issues in the development of new nuclear weapon designs cannot be addressed through HNEs. Although some argue that the existing arsenals must be tested for reliability or safety through HNEs, HDEs are completely sufficient for this purpose. HNEs are therefore properly seen as a method of maintaining nuclear weapon design expertise, not the stockpile itself, in the nuclear weapon states.

Although the arguments are stronger for banning HNEs than HDEs or ICF, the nuclear weapon states and threshold states not party to the NPT[7] can be expected to resist any effort explicitly to include HNEs in the CTB treaty or to let the negotiating record stand as an implicit but nevertheless unambiguous ban on HNEs.[8] On the other hand, the non-nuclear weapon states parties to the NPT may well see any attempt to exempt HNEs from the CTB as an affront and block consensus. Mexico's Miguel Marin Bosch, who is in the chair of the negotiations, has made clear that he will not interfere with the wishes of those who oppose such a ban. So while a ban on HNEs is arguably desirable and feasible, the decision on whether to press for one is a matter for political judgement.

Computer modelling

Computer modelling is an important aspect of every nuclear weapon programme. Appropriate software, when combined with data from HDEs or HNEs, can replace underground tests completely for the development of fission weapons, but if a computer model cannot be validated by nuclear weapon tests (or in some cases ICF), then there is a factor of uncertainty which limits the further development of

[7] China, France, Israel, Russia, the UK and the USA are known to have nuclear weapons and are referred to as 'nuclear weapon states' in this report. Israel has not signed the NPT or officially acknowledged that it has nuclear weapons, and therefore is also considered a 'threshold state', along with India and Pakistan, which are not publicly known to have nuclear weapons.

[8] Interpretations of treaty language and provisions in the negotiating record are binding as long as they are not ambiguous or contradicted by other passages of the record. A statement regarding the CTB's coverage of HNEs will be a part of its negotiating history, if not its text.

nuclear weapon designs. In any case, verification provisions for a ban on computer simulations would be so intrusive as to be unacceptable to most potential signatories.

Pre-test monitoring and inspections

The Swedish draft CTB treaty prohibits 'preparing . . . any nuclear explosion', but its verification protocol only provides explicitly for the detection and identification of the explosions themselves, not preparations.[9] Some argue that the word 'preparing' should simply be deleted from the relevant passage. Others see the prohibition of preparations as a crucial tool for stopping a test before it is carried out, since the actual explosion might do more damage to the regime of which the treaty is a part than the preparatory activities discovered—better to nip the problem in the bud. This prohibition is argued by some to be implicit in the treaty, its negotiating history and the principle of international law that the treaty be negotiated in good faith, even if the word 'preparing' is deleted from the basic obligations. Some in this second group argue that the treaty must explicitly provide for verification measures that would ensure that preparations to test could be detected confidently and quickly enough that diplomatic steps could be taken to prevent an actual test.

Although the Swedish draft does not provide for special measures to detect preparations, it does allow states parties to use national technical means (NTM) 'to assist in interpretation of any event that may be of relevance to the Treaty' and to 'request an on-site inspection . . . for the purpose of ascertaining compliance with this Treaty'.

Preparatory activities that might be detected include creating and maintaining an organization for the purpose of manufacturing and testing nuclear explosives, drawing up and discussing plans for a nuclear explosion, manufacturing and assembling an explosive device, preparing a test site (perhaps by digging a shaft or tunnel, or installing appropriate equipment), and delivering the explosive device to the test site and installing it. Some of these activities are ambigu-

[9] All references to 'the Swedish draft' in this report refer to Conference on Disarmament document CD/1232, CD/NTB/WP.33, 6 Dec. 1993. References to 'the Australian draft' refer to CD/NTB/WP.49, 30 Mar. 1994 and its associated official commentary, WP.50. These documents are not official drafts and the actual treaty may have little in common with either of them. They are meant to serve as a basis for discussion. These draft treaties are appended to this report.

ous, especially for states that have already conducted tests and will continue to possess and manufacture nuclear weapons. All can be detected by different verification means—including satellite imagery, signals intelligence (SIGINT) and human intelligence (HUMINT)—but not always reliably. In addition, the NPT provides for routine inspections of nuclear facilities in non-nuclear weapon states parties and has recently sought to broaden its inspection mandate. These provisions act as a first line of defence against states parties to the CTB that might attempt to violate it.

While the Swedish draft's verification provisions might not catch every attempt to prepare for a nuclear weapon test, the inclusion of preparation among the activities forbidden by the treaty arguably gives states parties an important tool. When there is evidence of preparation, they can take steps to avert an actual test. This possibility acts as a deterrent to states that cannot be sure that their activities will not be detected or publicized, whether by another state's NTM or some more mundane means. General verification provisions such as those in the Swedish draft treaty are therefore adequate in any plausible scenario, whether an explicit ban on preparations is included or not. Indeed, even if preparations were explicitly excluded from the scope of activities banned by the treaty, it is likely that the regime embodied in the CTB would lead the international community to put pressure on any state found to be preparing a nuclear weapon test, whether or not it was a state party, much as China was pressured not to test in 1993 and again in June 1994.

Further, the scenario on which the argument for special pre-test verification measures is built is far-fetched. It is difficult to conceive circumstances in which a state party decides to prepare a test covertly, knowing it will most likely be made public upon detonation, but is dissuaded from testing by international pressure. If states parties withdraw from the CTB treaty and regime, it is much more likely to be for political reasons that will make them less likely to hide their preparations and make it difficult to stop testing. There is no case in which additional treaty provisions for verification of pre-test activities improve the security of a potential state party by improving its confidence in compliance.

The prohibition on preparing to test is an important political tool, whether an explicit or implicit part of the treaty or, preferably, simply a norm that is strengthened as another part of the regime of which the

treaty is also a part. The best approach to verifying compliance with the norm of not preparing to test is to rely on existing International Atomic Energy Agency (IAEA) safeguards and national, multinational and private means of verification. Anything more is likely to block consensus, especially provisions for suspected preparations to trigger inspections, as both nuclear weapon states and threshold states not party to the NPT are unlikely to find such provisions acceptable.

National, multinational and private monitoring

Monitoring compliance with a CTB has been one of the most thoroughly discussed problems in the arms control and verification literature. It is clear that a CTB can be effectively verified. The states with testing experience are either open societies or closely observed by national, multinational and private means of verification. The states without testing experience or access to it cannot hope fully or reliably to exploit the techniques necessary to keep tests covert, because their designs will be for nuclear explosive devices with yields of over 10 kt and they have no experience with the technologies relevant to evading detection. Further, the more likely scenario for any state resuming nuclear weapon testing for the foreseeable future is not a risky attempt to test covertly, but an open flouting for political reasons of the norms embodied in the CTB. Even the most elaborate verification system is inconsequential in this scenario.

National intelligence means are the bedrock on which any treaty verification regime is built. These include NTM and other means states use to collect intelligence which are not necessarily legal and not recognized or protected by treaty (as NTM often are). To an increasing extent, the public has been furnished with information bearing on treaty compliance from private (that is, non-governmental) sources. This is particularly true with regard to nuclear weapon testing. Still, the CD's negotiating mandate specifies that the treaty should be verified not just 'effectively' but also 'internationally',[10] that is, other states parties should not have to rely too heavily on Russia and the USA, the two states with the greatest across-the-board capabilities for NTM.

[10] See note 2.

This broad range of capabilities will strengthen the treaty in a number of ways. First, of course, they will detect attempts to test covertly and distinguish them from other phenomena that might resemble tests, for example, industrial explosions associated with mining. Second, the very existence of a vast array of verification means acts as a deterrent to any state considering the option of covert testing. Third, the combination of sensitive national means and publicly accessible national, multinational and private means ensures that data will be available to demonstrate that a state party is either non-compliant or strongly suspected. Proof that can be examined independently strengthens the cause of those who would respond strongly to suspected or confirmed non-compliance, whether by enforcing the obligation for a state to submit to challenge inspections or to marshal support for a stronger response in national and international forums. Finally, a robust verification capability increases the confidence of governments, legislatures and publics, improving the chances that more states will sign and ratify the treaty.

An effective verification regime should be able to detect and identify tests with yields as low as 1 kt, the yield of current tactical nuclear weapons and primaries (the fission bomb that ignites a thermonuclear secondary explosion in a fusion bomb), conducted by any of the six countries with extensive testing experience or access thereto: China, France, Israel, Russia, the UK and the USA. Other states are unlikely to test at yields so low, except as the culmination of a testing programme begun at higher yields.

National intelligence means

National intelligence means comprise all the sources of information directly available to any state's government, including NTM and HUMINT, without the co-operation of the states being monitored. Teleseismic (long-range seismic) techniques are now such that explosions of roughly 1-kt yield can be detected reliably anywhere in Russia, as long as those explosions are not muffled or decoupled (i.e., conducted in a large cavity or soft medium). A similar standard can be set globally with a network of 50–100 stations. There is a scientific consensus that even decoupled tests can be detected reliably to roughly 5 kt through teleseismic measurements. Explosions with yields smaller than 1 kt have also been detected, so a cheater could not be confident that a lower-yield test would not be detected tele-

seismically. High-frequency (short-range) arrays are able to detect even decoupled explosions of 1-kt yield at a distance of 1500 km or more under some conditions. Reliable seismic detection at any lower level will be quickly overwhelmed by false alarms, that is, events that will have to be investigated by other means. France, Italy, the UK and the USA (and probably Russia) operate networks of seismic stations in co-operation with friendly governments (thus properly termed 'international' networks) in addition to stations on their own territories.

Seismic means of verification are complemented by national and international capabilities for atmospheric monitoring of radionuclides, satellite surveillance, hydro-acoustic monitoring and SIGINT and HUMINT. The contribution these verification methods will make to judgements about compliance with a CTB are often underestimated. The USA has suggested that infrasound, ionospheric and optical monitoring and techniques for detecting electromagnetic pulse might make a contribution to verifying compliance with the CTB.

Private means

Before considering ways in which national and international means can be supplemented by multinational means tailored to the CTB, it is important to recognize the role of private data-gathering methods in any assessment of treaty compliance. Most private technical means of verification have the advantage of being available to the public, including the governments of states not endowed with advanced NTM or sufficient access to HUMINT. Seismic stations are operated by a number of universities and other private organizations. Although they are often sponsored by governments, they retain their independence and their data are available to the public. Many of these are involved in the network administered by Incorporated Research Institutions for Seismology (IRIS), a consortium of about 80 research institutes. When augmented by data from the 2000 stations around the world contributing data to the US Geological Survey's open list of events, the threshold for reliable detection through private means is roughly magnitude 4 on the logarithmic Richter scale (roughly equivalent to a fully coupled 1-kt explosion) for most locations. Private organizations can also undertake atmospheric monitoring and have access to satellite imagery.

Remaining requirements for multinational means

The CD's negotiating mandate specifies that the CTB must be effectively and internationally verifiable. In practical terms, this should mean simply that any state party can be confident that no other state party will be able to violate the treaty without its knowledge and having means to demonstrate non-compliance in order to redress its grievance.[11] However, the obligation to negotiate international verification has been interpreted by some as necessitating an elaborate and costly network of multinational technical means (MTM). The analysis in this report demonstrates that the treaty is better off without provisions for elaborate MTM (although some MTM are a good idea), and should instead recognize that national, multinational and private means are both effective and sufficiently international.

An implicit assumption among the proponents of elaborate MTM is that the Russo-US oligopoly on the most advanced NTM will prevent some states parties from getting access to information that might incriminate the security partners of Russia and the USA. This supposition neglects the internal political dynamics of both countries.

The core of the multinational verification system will be an 'Alpha' network of about 60 state-of-the-art seismic stations reporting directly to an International Data Centre. Given the open nature of national, multinational and private stations, the need for the implementing authority to take over the financing and operation of so many stations as recommended in the Swedish draft, is difficult to demonstrate. While it is desirable for the Alpha network to be completed, its construction should not be seen as a prerequisite for entry into force or effective verification. Since most recent and future stations are digital, all their data will be available to the CTB implementing authority. Although they have been suggested by various observers, additional multilateral capabilities for atmospheric, hydro-acoustic and infrasound monitoring and satellite surveillance are unnecessary for effective, international verification of the CTB, given national, multinational and private capabilities.

[11] In practice, this may require that the state party has confidence that the implementing authority is impartial and has the required wherewithal.

On-site inspections

The CTB treaty must provide for two general types of inspection, which can be categorized as routine inspections and challenge inspections. Routine inspections allow the states parties to monitor permitted activities regularly through the implementing authority in order to assure themselves that violations are not being masked by legitimate activities, and challenge inspections are intended to provide the states parties with an opportunity through the implementing authority to collect additional information regarding suspicious events. The possibility of a challenge inspection provides an additional deterrent to any organization considering the option of covert nuclear weapon testing.

The Swedish draft provides for routine inspections of all explosions in excess of 500 t (0.5 kt) TNT equivalent and random inspections of sites where explosions in excess of 100 t TNT equivalent are detonated frequently. The International Data Centre would catalogue all explosions in excess of 100 t TNT equivalent. These provisions simplify the problem of distinguishing between covert nuclear weapon tests and industrial explosions, but it is not clear that they are cost effective. They are omitted from the Australian draft.

A second type of routine inspection would be required if hydronuclear experiments were explicitly banned by the treaty and if compliance with that ban were meant to be monitored effectively. Unless hydrodynamic experiments were banned as well, an unlikely prospect, facilities in several countries at which HDEs or similar experiments are regularly conducted would have to be inspected regularly to assure other states parties that none of the HDEs was an HNE. Such an inspection regime would be expensive, intrusive and would only deter non-compliance at the sites inspected, not at covert sites. For many observers, avoiding such an inspection regime (or a series of challenge inspections that had the same effect) would be the main reason not to include an explicit or implicit ban on HNEs in the CTB treaty. Threshold states not party to the NPT and seeking to protect the carefully cultivated ambiguity surrounding their nuclear programmes are likely to be at least as uncomfortable with such inspections as the openly nuclear weapon states.

Challenge inspections in the context of the CTB must be seen as primarily political in nature. Airborne and ground-based sampling in a region identified by other means could provide evidence consistent

with a nuclear weapon test, including air and soil samples and measurements of earth and ground-water displacements, but such evidence would not necessarily resolve lingering uncertainties or be compelling to a sceptical or hostile audience.

China, Israel and the USA, among others, have expressed concern about abuse of challenge inspections to harass the nuclear weapon states, collect intelligence or interfere in a state party's internal affairs. Similar concerns informed the CWC negotiations, which form the basis of the relevant passages in the Australian draft, and will no doubt affect the structure and decision protocols of the implementing authority. In the CWC, a challenge inspection must be based on a reasonable suspicion and can be blocked if 31 of the 41 members of the Executive Council consider the inspection request 'frivolous, abusive or beyond the scope of the treaty'.[12] Further, if the inspection reveals evidence that the request was abusive, the requesting party may be penalized. Some CD members and observers see even this as creating too strong an obligation to submit to inspections and would prefer a process of consultations that might result in an invited inspection to resolve lingering doubts.

Providing for verification in the treaty

If every additional increment of verification capability supports the treaty's technical goals of detecting, deterring and demonstrating noncompliance, the issue is less clear when it comes to the treaty's political goal of securing signatures and ratifications. Including what are arguably unnecessary multilateral capabilities does help governments assure themselves, their publics and legislators that the treaty can be verified effectively, but may also put them in the position of having to foot their share of the bill for what might be seen as an unduly expensive treaty. Presenting this trade-off will be a particularly thankless job if refining the verification provisions delays the conclusion of the treaty beyond the immediate negotiating goals offered by the NPT Review and Extension Conference and the Hatfield Amendment's US testing cut-off. From this perspective, additional investments in multinational technical means beyond a modest role in the international

[12] Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction, Article IX, para. 17. The text of the Convention is reproduced in SIPRI, *SIPRI Yearbook 1993: World Armaments and Disarmament* (Oxford University Press: Oxford, 1993), pp. 735–57).

seismic network to complement national, multinational and private capabilities and an international data centre with some collection and analysis capabilities are difficult to justify.

More importantly, the inspection regime must not be so intrusive that key states, in particular the three threshold states not party to the NPT, are reluctant to sign and ratify it for fear of endangering their postures of nuclear ambiguity. India and Pakistan are unlikely to allow the CD to come to consensus on such a treaty, even if the states openly possessing nuclear weapons do. Israel, which is not a member of the CD, is unlikely to sign or ratify such a treaty. Without Israel in the regime, it is unlikely that the states already critical of its exceptional position in the region would sign, including several other states of proliferation concern. For this reason, provisions for on-site inspections must be drawn conservatively, and it would seem desirable to make clear in the negotiating record that suspected HNEs will not be considered sufficient cause for intrusive inspections.

Organizing for effective implementation

Effective implementation of the CTB treaty will be critically dependent on a number of organizational aspects of the treaty. In order for implementation of the treaty to be considered effective, it must be effectively and internationally verifiable, and procedures for deciding when to inspect and how to solve problems and settle disputes must also be multilateral and non-discriminatory. Effective verification may also require timely decision making to ensure that inspection teams can reach sites related to suspected non-compliance quickly, preferably within two to four weeks. While all of these are desirable, CTB negotiators are increasingly sensitive to the cost of implementation. Anything that can be done to speed up the negotiating process without damaging the long-term effectiveness of the implementing authority would also be an advantage. Finally, some potential states parties might be concerned that aspects of the organization or its procedures might take a toll on their security if they are seen as too intrusive or discriminatory in a way that can be manipulated by their enemies.

The CTB implementing authority

The CTB can most effectively be implemented if its administration is more centralized and independent than might have been possible during the pre-Gorbachev era, when prospects for inspections were remote. Under this form of organization, the CTB treaty would create an authority with greater responsibility for implementation than was possible until fairly recently. The Swedish draft envisages what might be seen as a minimally centralized authority, responsible for little more than collecting and disseminating data and conducting inspections, although the ability of the IAEA as the implementing authority to analyse data might be exploited. In explicit contrast, the Australian draft provides for the implementing authority to analyse data as well as to collect and disseminate them and conduct inspections, allowing all states parties to compensate for any lack of relevant expertise.

The IAEA as implementing authority. Under the provisions of the Swedish draft, the IAEA would be required to co-ordinate the monitoring regime, including the analysis and exchange of seismic and other data. If questions were to arise, the IAEA would request additional data from the states parties. If there were still no resolution of the discrepancy, the IAEA would carry out a challenge inspection.

The technical expertise of the IAEA has some overlap with the needs of the CTB verification regime. In the area of monitoring airborne radioactivity, for example, the IAEA has experience as well as expertise. The IAEA uses the World Meteorological Organization (WMO) for its Emergency Notification System, a 24-hour global information service. It also has some limited expertise in seismic measurements for determining the safe positioning of nuclear facilities in the Mediterranean region, studies of local earthquake monitoring and recruitment of seismologists. The IAEA has extensive experience in photo- and video-image analysis which may have some application to verification of a CTB treaty, but little experience with satellite imagery. The IAEA has strengths in laboratory analysis relevant to assessing samples retrieved during challenge inspections, although its capability would need to be expanded for the CTB. The IAEA has wide-ranging experience in conducting inspections, from that of single inspectors for routine inspections to that of the 30-strong team for inspections in Iraq, in co-operation with the UN Special

Commission on Iraq (UNSCOM) following the 1991 Persian Gulf War.

Aside from some demonstrated competencies, the financial and administrative implications, especially the ability to put the elements of the regime in place upon completion of the treaty, are the most attractive aspects of accepting the IAEA as the implementing authority. The IAEA already exists; it has a building and a working infrastructure. There would be no negotiations over premises like those that have bedevilled the start-up of the Organisation for the Prohibition of Chemical Weapons (OPCW). The incremental costs for the IAEA are likely to be less than the start-up costs of a new organization.

On the other hand, critics of such a role for the IAEA point out that it has little experience with seismic data interpretation and none on the scale required for monitoring the CTB. There are also problems with the IAEA's primary mission, as specified in its statute: promoting nuclear power. This mission, the culture of secrecy surrounding safeguards, the IAEA's role in the NPT, and varying views of its role in the Iraqi and North Korean crises have undermined its credibility in the eyes of many observers, including negotiators and potential states parties to the CTB. Although Sweden still stands by its recommendation, the option of entrusting the IAEA with the CTB has lost much of the support it had from other states in the first months of 1994.

The IAEA as a subcontractor. An alternative proposed in the commentary accompanying the Australian draft would establish 'a small separate CTBT Organization, collocated in Vienna with the IAEA, which would be able to contract out certain technical and administrative and conference support tasks to the IAEA'. The intent was to capture the advantages offered by the IAEA while avoiding the disadvantages. This approach is gaining support.

The Australian approach to centralization

The Australian draft not only addresses the concerns that many have over the IAEA but also takes into account the lessons of the OPCW. It provides for the implementing authority to analyse seismic, radionuclide and other data, rather than simply facilitate the exchange of data between states parties. In contrast with the Swedish draft, it envisages the implementing authority co-ordinating the activities of

monitoring stations, but not financing or running them, on a case-by-case basis, primarily to save money. It also assumes that the CTB is unlikely to require routine inspections, so there is no need for a large cadre of permanent inspectors to be recruited and employed by the CTBT Organization. The implementing authority would simply maintain a roster of experts made available by states parties for inspections.

Under the Australian modification of the CWC procedure for handling ambiguous events, any state can request an inspection. During the following 12 hours, the Director-General must ascertain that the request is not obviously frivolous or abusive and the Executive Council, made up of an as yet unspecified number of states parties, will convene. If the Director-General or three-fourths of the members of the Council judge that the request is patently frivolous or abusive, it will be blocked. Otherwise, it will be carried out by the Technical Secretariat, with the inspection team to arrive as soon after the expiration of the 12 hours as is feasible. States parties' confidence that they will not be subject to inappropriate inspections thus depends as much on the judgement of the individual chosen as Director-General and the composition of the Council as on treaty provisions and procedures. States with few allies may find it difficult to arrange a three-quarters blocking majority unless the inspection requested would set an equally unpopular precedent.

For these reasons, the power of the Director-General and the composition of the Executive Council have been controversial. Almost without exception, negotiators see the office of the Director-General as exclusively administrative, with very little latitude for making judgements about requests for inspection. A strong personality in the office might strengthen that role under favourable political circumstances, however. While many negotiators see it as desirable, if not inevitable, that the five declared nuclear weapon states sit permanently on the Council, there are problems with such a provision. Since some members of the CD object to what they see as the discriminatory nature of the NPT and the UN Security Council, neither of these can be used as the basis for creating permanent seats on the CTBT Executive Council. On the other hand, simply specifying that states possessing nuclear weapons would be permanent members of the Council would touch on the delicate issue of Israel's status as a nuclear weapon state and contested candidate for CD membership.

Some negotiators feel so strongly that the very idea of an Executive Council entails irresolvable biases and complexities that they would rather do away with it altogether and refer all questions to the Conference of States Parties.

Qualms about centralization

The reluctance of some CD members and observers to submit to the CTB procedures, especially inspections, appears to be moving the negotiations towards a somewhat less centralized approach. Although it seems likely that the treaty will provide for a multinational seismic and atmospheric monitoring network and an International Data Center to collect, analyse and disseminate information to all states parties, provisions for inspections will likely reflect some negotiators' sense of unease. An influential Israeli working paper on consultation and clarification[13] appears to have struck a resonance with several states' discomfort at the prospect of being inspected themselves and the belief of some that a state party not complying with the treaty's other provisions would be unlikely to accept a requested inspection. The Israeli paper provides for an open-ended process that might result in an invited inspection, but there would be no obligation for a state party to submit to a request for inspection.

Settlement of disputes

The Australian draft's treatment of the methods for settling disputes is lifted nearly verbatim from the CWC, which states that in the event of 'a dispute . . . relating to the interpretations or application of [the] Treaty, the parties concerned shall consult together with a view to . . . expeditious settlement . . . by negotiation or by other peaceful means . . . including referral to the International Court of Justice [ICJ]'.[14] The Swedish draft is similar but lists more explicitly the methods for settlement: negotiation, inquiry, mediation, conciliation, arbitration or any other peaceful means. The Swedish draft also specifies that disputes can be referred to the ICJ.

Ultimately, any state party may lodge a complaint with the UN Security Council about another state party acting in breach of its treaty obligations, as reflected in the Swedish draft. In the interest of

[13] CD document CD/NTB/WP.102, 7 June 1994.
[14] See also the CWC (note 11), Article XIV, para. 2.

creating a progression of responses short of referring disagreements to the ICJ or the Security Council, the protocol to the Australian draft takes a different line. The first response envisaged is the Conference of States Parties taking 'the necessary measures to ensure compliance with [the] Treaty and to redress and remedy any situation which contravenes [its] provisions', upon referral from the Executive Council. The draft treaty suggests punitive measures might include 'rights and privileges under the Treaty [being] restricted or suspended . . . [or] collective measures . . . in conformity with international law', including sanctions. The UN Security Council would remain as a court of last resort if these measures failed to rectify the situation, leaving states parties with strong partners among the five permanent members in a somewhat better position to resist possible punitive actions than those without.

Other issues

Membership in the CD

Another proposal would expand the membership of the CD to include those states with a nuclear weapon capability or of proliferation concern that are not members.[15] Iraq, Israel, North Korea, South Korea, Libya and Ukraine are already observers.[16] Giving these states a formal role in the creation of the treaty is said to ensure that they will join. Opponents of this proposal see it as needlessly time-consuming: the procedure for increasing the size of the CD will delay negotia-

[15] Expansion of the CD is not part of the CTB negotiations, but the issue has been informally linked to the negotiations on the insistence of several members.

[16] There is no public evidence that all of these states intend to produce or are capable of producing nuclear weapons, but all have been accused by at least one member of the CD. A total of 50 states have applied to be members of the CD since 1983, and the special coordinator recommended in Aug. 1993 that a 'phased approach' should be 'reviewed', beginning in 1994. As many as 23 states could be admitted in 1994, including Austria, Bangladesh, Belarus, Cameroon, Chile, Colombia, Finland, Iraq, Israel, North Korea, South Korea, New Zealand, Norway, Senegal, Slovakia, South Africa, Spain, Switzerland, Syria, Turkey, Ukraine, Viet Nam and Zimbabwe. Others that have applied for membership are Albania, Bolivia, Costa Rica, Croatia, the Czech Republic, Denmark, Ecuador, Ghana, Greece, the Holy See, Ireland, Jordan, Kuwait, Libya, Malaysia, Malta, Mauritius, Oman, Philippines, Portugal, Qatar, Singapore, Slovenia, Thailand, Tunisia, the United Arab Emirates and Uruguay. 'Conference on Disarmament', *1993 United Nations Handbook* (Wright and Carman for the Ministry of Foreign Affairs and Trade: Wellington, New Zealand, 1993), pp. 44–45.

tions, which in turn will be more complicated with more members.[17] Further, Iran opposes allowing Israel to join the CD, and the USA opposes participation of any state subject to Chapter VII of the UN Charter, a condition applying only to Iraq, but is prepared to allow Iraq to join the CD with its membership suspended. Other members say countenancing the precedent of this criterion would give the UN Security Council an undesirable ability to suspend the participation of any state in any UN body. To emphasize their position, Iran cites UN resolutions of which Israel is arguably in violation. Similar conditions for participation might be applied to a number of other members. In any case, members are not unaware of the concerns of the observers or indeed states that are not observers.[18] Observers have played important roles in negotiating treaties before, as Finland did for the CWC, for example, and as Finland and Norway have done on the subject of verifying the CTB. Their only disadvantage is that they cannot block consensus and thereby veto treaty provisions of which they do not approve.

Entry into force

The issue of when the treaty will enter into force is contentious on two grounds. In the Swedish draft, the treaty would enter into force after 45 states including the five nuclear weapon states, as defined in the NPT, have signed and ratified it.[19] Opponents of this proposal would prefer that the treaty be universal before entering into force, or at least be ratified by all the states with nuclear weapon capabilities or of proliferation concern. Another alternative would require ratification by all members of the CD. Those who would like the treaty implemented quickly are reluctant to give a veto to any state, or at least certain states. The Australian draft remains agnostic on the

[17] Each additional member will have a veto over the treaty, as all members have, whereas members of the UN General Assembly, which must endorse the treaty, simply have a vote. On the unwieldy nature of the CD generally, see Gati, T. T. and Piasecki, E. T., 'The United Nations and disarmament', *Encyclopedia of Arms Control and Disarmament* (Charles Scribner's Sons: New York, 1993).

[18] Discussion of these concerns is the subject of a companion volume to this report: Arnett, E. (ed.), SIPRI, *Nuclear Weapons After the Comprehensive Test Ban: Implications for Modernization and Proliferation* (Oxford University Press: Oxford, forthcoming). In this book, researchers and officials write about the implications for the negotiations, treaty goals and implementation of the nuclear policies of Algeria, China, France, India, Iran, Iraq, Israel, North Korea, Libya, Pakistan, Russia, Ukraine, the UK and the USA.

[19] In contrast, the CWC will enter into force after 65 signatories have ratified it (but not before 13 Jan. 1995). Other numbers of ratifications have also been mooted.

question, but the accompanying commentary opposes creating such a veto.

Other states oppose the Swedish draft on the grounds that it legitimizes the NPT definition of nuclear weapon states, those that 'manufactured or exploded a nuclear device prior to 1 January 1967'.[20] While all five of the nuclear weapon states, thus defined, support the CTB (despite differences over timing and conditions for entry into force) and are expected to sign, a number of other states that support the CTB as an egalitarian arms control measure would prefer not to see it linked in any way with the NPT, which they see as discriminatory.

Duration and review

In the Australian and Swedish drafts, the CTB would be of indefinite duration and reviewed every five years. Some critics would prefer that the CTB provide for an extension conference as does the NPT, in order to provide some incentive for further steps consonant with what they see to be the goals of the treaty. Further steps mentioned in the Australian and Swedish drafts include 'further effective measures against proliferation of nuclear arms', 'prompt implementation of [START I and START II] and other . . . agreements', and 'further reduction of tactical and strategical [*sic*] nuclear weapons and their delivery systems'. A Chinese working paper containing a draft preamble also identifies 'early attainment of a complete ban on, and total destruction of, nuclear weapons [and] dispelling the danger of the use or threatened use of nuclear weapons [including] international agreements guaranteeing against the use or threatened use of nuclear weapons against non-nuclear weapon states or nuclear-free zones, and guaranteeing that they will not be the first to use nuclear weapons against each other.'[21] Others worry that an extension process like that of the NPT might create a period during which a few tests could be conducted, even if the treaty were ultimately extended.

[20] Treaty on the Non-Proliferation of Nuclear Weapons, 1 July 1968, Article IX, para. 3. The Treaty text is reproduced in Müller, H., Fischer, D. and Kötter, W., SIPRI, *Nuclear Non-Proliferation and Global Order* (Oxford University Press: Oxford, 1994), pp. 210–13.

[21] CD document CD/NTB/WP.124, 20 June 1994, pp. 1–2. China 'would welcome' the inclusion of such security assurances in the CTB treaty, but is not expected to block consensus over the issue. CD document CD/NTB/WP.122, 20 June 1994, p. 2.

Financing

Although disagreements over implementation, particularly verification, that will determine the cost of the CTB treaty remain unresolved, the fiscal burden is already the subject of controversy.[22] If, as envisioned in the Swedish draft, the IAEA is to implement the treaty, costs could be incorporated in the Agency's budget and additional funds raised among IAEA member states by the usual procedure. The draft specifies, however, that funds should be raised by the standard UN method (that is, roughly proportional to gross national product). In any case, as discussed above, most observers expect another implementing authority to be created and funded by the CTB parties.

It is likely that at least some states with little interest in the CTB will sign the treaty. In fact, the states most interested in the CTB can be expected to cajole indifferent states into signing in order to strengthen the case that not testing has become a global norm subject to customary law that therefore binds even non-signatories. These indifferent signatories cannot be expected to pay much to support the implementation of the treaty, especially if they are poor and do not have neighbours of proliferation concern.[23] If dues are assessed against them, they may not pay them.[24] Some members of the CD see the nuclear weapon states as the primary beneficiaries of the CTB, if not the creators of the problem to be solved by it, and argue that they should pay for it.

[22] The direct costs of the CTB to its implementing authority are expected to be of the order of $100 million the first year and $60–80 million in following years. On 13 Dec. 1993, John Holum, Director of the US Arms Control and Disarmament Agency, identified resources as one of the two issues (along with verification) still being examined in detail by the USA, suggesting US concerns about the likely cost of the treaty. Holum, J. D., *Arms Control Today*, Jan./Feb. 1994, p. 5.

[23] Some of these states have signalled informally that they are willing to use arms control, which is not high on their national agendas, to secure concessions on economic development, which is much higher. These states may not only refuse to pay for implementation of the CTB, but also require some form of compensation, either outside the treaty or inside it, in the form of otherwise unneeded monitoring stations or headquarters.

[24] This is already a problem for the CWC. Stock, T., 'The Chemical Weapons Convention: institutionalization and preparation for entry into force', *SIPRI Yearbook 1994* (Oxford University Press: Oxford, 1994), pp. 686–711.

III. Conclusion

With so many issues to address and so many points of view, completing the CTB has become a complex political and technical undertaking. Nevertheless, the task of resolving outstanding disagreements quickly should not distract negotiators, their governments and researchers from the broader goals and spirit of the treaty: halting nuclear modernization and inhibiting nuclear weapon proliferation.

Nuclear weapon modernization continues in several of the nuclear weapon states, and indeed, the ability to modernize without testing will be a condition for some of them to sign the treaty.[25] China and France have gone so far as to assert their need to conduct several final tests—as many as 20 for France, fewer than 4 for China[26]—before the treaty enters into force. China, France and Russia are thought to be developing new nuclear weapons or delivery systems, while the UK and the USA continue older nuclear modernization programmes that are near completion (Trident missiles and B-2 bombers). British, French, Russian and US officials and commentators discuss possible new 'requirements' for nuclear weapons tailored to hypothetical regional contingencies. Only the US Government has unequivocally ruled out any new requirements, designs or tests. Yet even the USA insists on maintaining a large nuclear weapon design bureaucracy engaged in nuclear weapon research, has committed itself to funding a facility for HDEs, and admits to having the capability to design new nuclear weapons of some sophistication without testing.[27] Little is known publicly about Israeli plans for nuclear weapon modernization.

Among the non-nuclear weapon states, the behaviour of Iraq and North Korea stands out. Although other states are suspected of having nuclear weapon development programmes, only these two have acceded to the NPT and then flouted it by attempting to manufacture nuclear weapons (Iraq) or reneging on treaty commitments to allow

[25] Labbé, M-H., 'France' and Lewis, P. M., 'The United Kingdom' in Arnett (note 18). France has suggested that the transfer of information that would allow French designers to design advanced nuclear weapons without testing under the Palen programme might also be a requirement before they sign and ratify the treaty. Most of the 10–20 tests which officials claim France needs would support Palen by validating computer models and validate a variable yield warhead for the M-5 strategic ballistic missile.

[26] China has already excavated tunnels for three more tests and is expected to conduct a second test in 1994.

[27] 'Perry sounds note of caution over USA's foreign policy', *Jane's Defence Weekly*, 26 Mar. 1994, p. 18.

inspections (North Korea). Iraq's remaining nuclear infrastructure—primarily scientific and technical expertise—is bound to remain heavily regulated from abroad for the foreseeable future, however.

The performance of other non-nuclear weapon states, whether or not they are parties to the NPT, has been more promising. Argentina, Brazil and South Africa have discontinued or reversed their nuclear weapon programmes, while India and Pakistan have not exploited their nuclear options. Pakistan has capped its programme and appears to have stepped back from deploying nuclear weapons, offering public commitments to that effect. Japan and South Korea have forsworn the possibility of acquiring nuclear weapons, even if North Korea goes ahead with its suspected weapon programme. Despite a barrage of accusations, Algeria, Iran and Libya deny any interest in nuclear weapons and there is no public evidence that they have active programmes. Algeria, like Argentina, has indicated that it will accede to the NPT before the 1995 Review and Extension Conference and has opened its reactor to IAEA inspection. Iran has twice—in 1992 and 1993—allowed the IAEA to inspect any site on its territory at any time to prove that it is not attempting to manufacture nuclear weapons, an unprecedented step not required by Iran's treaty commitments. All of these developments augur well and support the CTB's goal of preventing further proliferation.

2. The problem of definition: Just what is a nuclear weapon test?

Annette Schaper

I. Introduction

One of the most important questions in the CTB negotiations concerns the coverage of the treaty. Which technical and scientific activities shall be included in the ban and which shall be permitted? What constitutes a nuclear weapon test? Although the questions seem trivial at first glance, they becomes complicated if the term 'comprehensive' is to be taken seriously. A 'comprehensive' ban must prohibit all tests, even those at such low levels that they might escape verification by technical means.[1] Too narrow a definition would effectively create another TTBT, albeit at a much lower threshold, and so fail to achieve the aims of a CTB.

There are several types of ambiguous activity which can serve the essential purposes of nuclear weapon tests. Fortunately, an arms control treaty need not be restricted to activities seen as *verifiable* from the narrowest interpretation of that term. Other agreements have successfully prevented activities that arguably are not verifiable. An important example is the NPT, under which almost all the non-nuclear weapon states have renounced aspects of nuclear research, including weaponization,[2] the production of non-nuclear parts of a nuclear weapon.[3]

[1] Technical means include but are not limited to seismic monitoring and remote sensing. Technical means of monitoring supplement information gathered through HUMINT. Verification of testing is discussed in chapter 4, and monitoring of preparations for testing in chapter 3.

[2] Bunn, G. and Timerbaev, R., *Nuclear 'Weaponization' Under the NPT: What is Prohibited, What can be Inspected, Who Should do it?* (Program for the Promotion of Nuclear Nonproliferation: Washington, DC, 1994).

[3] For a description of the parts of an implosion design see Cochran, T. B., Arkin, W. M. and Hoenig, M. M., *Nuclear Weapons Databook, Vol. I. US Nuclear Forces and Capabilities* (Ballinger, for the Natural Resources Defence Council: Cambridge, Mass., 1984), p. 26. See also Schaper, A., 'Forschung und Entwicklung für Kernwaffen der ersten und zweiten Generation' ['Research and development for nuclear weapons of the first and second generation'], eds E. Müller and G. Neuneck, *Rüstungsmodernisierung und Rüstungskontrolle* ['Arms modernization and arms control'], (Nomos-Verlag: Baden-Baden, 1991/92), p. 71 (in German).

Section II of this chapter considers the questions that must inform any attempt to formulate a working definition of the term 'nuclear weapon test' for the purposes of the treaty. In section III, a number of ambiguous activities are examined. For each of them the following questions are discussed: Should this activity be banned under the CTB treaty? What difficulties arise if it is included? What technical aspects must be understood for the formulation of an effective definition? In section IV, several possible definitions of the term 'nuclear weapon test' are evaluated and judgements made on the basis of the criteria, including: maximum clarity, minimum ambiguity, and prompt and smooth negotiability.

II. Relevant questions about ambiguous activities

Can the activity make an important contribution to the design of new nuclear weapons?

This question addresses a primary technical objective of the CTB treaty: providing a tool for containing the arms race by ending further vertical proliferation. Activities that offer the possibility of substituting for nuclear weapon tests by enabling significant research and development for new types of nuclear weapon would undermine the spirit of the CTB if they are not ruled out by the letter of the treaty, and should be included in the ban.[4] They would also have to maintain the technical expertise that would perpetuate the functioning of nuclear weapon complexes.

Is the activity necessary to maintain the existing arsenals?

As long as global nuclear disarmament has not been achieved, the nuclear weapon states will maintain some of their existing warheads. A significant number of nuclear weapon tests has been devoted to this goal, and a CTB will only be acceptable to these states if a replacement for reliability testing is provided. Since early success is an important negotiating goal, the members of the CD not possessing

[4] For a detailed analysis of the potential of tests for the development of new types of nuclear weapon, especially third-generation weapons, see: Fenstermacher, D. L., 'The effects of nuclear test-ban regimes on third generation weapon innovation', *Science and Global Security*, vol. 1 (1990), p. 187.

nuclear weapons should not provoke unnecessary opposition from important constituencies in the nuclear weapon states, especially the organizations responsible for maintaining and certifying the reliability of nuclear weapons. Since the implications of this second question are at odds with those of the first, a compromise must be found in order to bring the negotiations to a timely close.

Can the activity provide important design information to threshold countries?

Another goal of the CTB is stemming horizontal proliferation. If a threshold country that is not a party to the NPT has no legal possibility of testing, another obstacle to proliferation is created. Again, it is desirable to ban activities that could replace underground tests. The technical requirements for vertical proliferation (developing new generations of nuclear weapons) and horizontal proliferation (acquiring a first- or second-generation design) are not necessarily the same, since different aspects of the technology are involved.

Are the activities already forbidden to non-nuclear weapon states party to the NPT?

In contrast to the NPT, the CTB treaty should be ‘non-discriminatory’, that is, it should apply the same provisions to nuclear weapon states and to non-nuclear weapon states. The CTB is seen by the latter as an important means towards the goal of a less discriminatory regime for regulating activities involving nuclear weapons. The history of the NPT negotiations set a legally binding understanding of the term ‘manufacture . . . of nuclear explosive devices’ that includes much more than simply the final assembly of a device.[5] If activities forbidden to non-nuclear weapon states by the NPT are also banned by the CTB treaty, the international nuclear non-proliferation regime (of which the NPT is only a part) will become less discriminatory. In addition, key threshold states not party to the NPT will be brought into the regime if they join the CTB, even if they do not accept it fully. This is especially important, since India, Israel and Pakistan accept most of the norms embodied in the NPT, and oppose only certain decisions made in the drafting of the treaty.

[5] Bunn and Timerbaev (note 2).

Can the activity be confused with legitimate civilian or conventional military activities?

This question is important for the negotiability of a ban on any ambiguous activity and also the false-alarm rate of the verification provisions. If an activity has significant civilian applications, interested states are unlikely to support a ban. If it can be confused with conventional military activities, verification will of necessity be either intrusive or prone to false alarms (and thus triggering intrusive challenge inspections).

Can compliance with a ban on the activity be monitored effectively?

This question is of great importance in any negotiation. Verification has political as well as technical aspects, since there is always a degree of technical uncertainty that is dependent on political processes, including the degree of trust the parties have in one another. If compliance with a ban on an activity is difficult to monitor effectively, negotiators are less likely to proscribe that activity in the treaty if they hope for an early conclusion. This consideration does not necessarily rule out banning an activity which is otherwise important to include in the treaty's scope, but doubts about verification (including its cost and intrusiveness) will work against such a provision.

Is nuclear energy released?

Since a nuclear explosion releases nuclear energy, as do some of the activities discussed in the sections below, it might be important to use this criterion in formulating an appropriate definition.

III. Activities that might be banned under the CTB

Peaceful nuclear explosions

Technically, peaceful nuclear explosions cannot be distinguished from military nuclear explosions.[6] A definition which allows PNEs but not military nuclear explosions leaves a direct and simple means

[6] Findlay, T., *Nuclear Dynamite: The Peaceful Nuclear Explosions Fiasco* (Brassey's Australia: Sydney, 1990).

of circumventing the treaty. A CTB treaty must therefore ban PNEs as well. Fortunately, PNEs are no longer a significant problem, since a consensus has emerged that the civilian benefits are slight in comparison with the costs and environmental disadvantages. At present, no states use PNEs. The recent suggestion of a Russian firm that weapon-grade plutonium or chemical weapons be disposed of by means of PNEs has not garnered serious interest. Although Algeria, China, Iran and Russia have expressed some interest in reserving the option to conduct PNEs in the negotiations (a position Algeria and Russia have since revised and China reiterated), such an exemption is not desirable and these countries are unlikely to block consensus on the treaty over this issue.

Hydrodynamic experiments

HDEs, explosive tests in which the plutonium or highly enriched uranium (special nuclear material, or SNM) is replaced by a passive material (natural uranium or depleted uranium), are central to the development of nuclear weapons. Although the SNM is replaced, all the other components of the device remain otherwise unaltered. Implosion and compression take place in exactly the same way, with the one difference that no chain reaction results. The process is recorded with high-speed X-ray flash cameras which provide a sequence of pictures of the compression. A series of HDEs can help designers to perfect symmetrical and stable compression. In principle, this suffices for the development of a nuclear weapon and guarantees that it will function. HDEs are therefore of enormous relevance to horizontal proliferation.

HDEs alone cannot establish the yield of a weapon design, and additional computer programs are needed to calculate the course of the chain reaction together with the release, distribution and diffusion of energy and expansion of the plasma. Writing such programs is difficult, but with the help of open literature on several parameters (such as cross-sections of fission or opacities of hot plasmas) it is possible for the determined proliferator to do so. In fact, an HDE can be used to predict yields precisely enough to develop the primary of a hydrogen bomb. HDEs are not sufficient to produce a finished device and cannot contribute significantly to the development of qualitatively new devices, such as very low-yield or third-generation nuclear

weapons. In short, HDEs are relevant for horizontal and, to a limited degree, also for vertical proliferation.

HDEs are also used to test the reliability of existing arsenals, especially the functioning of the detonators. They can be used to test for one-point safety, that is, to ensure that an accidental detonation started by an unintended shock-wave in the conventional explosive surrounding the SNM will not produce a nuclear yield. During the CTB debate of the 1980s, when the safety of the existing US arsenal was a contentious issue, CTB proponents offered HDEs as an alternative to full-yield underground nuclear weapon tests.[7]

HDEs involve conventional high explosives (typically of the order of 10 kg), and can be conducted in the open or in reinforced buildings or underground cavities. As the possibility of a CTB being concluded has become more real, the US Department of Energy has become more interested in HDEs. The construction of a new facility, the $1.5-million Advanced Hydrotest Facility (AHF) for HDEs, has begun at the Los Alamos National Laboratory.[8] Under certain circumstances, depending on previous intelligence information, test sites or facilities like the AHF can be observed by aircraft or satellite. Subsequent on-site inspections can in principle reveal whether conventional explosions have taken place.[9]

Unfortunately, while there are no civilian uses for HDEs, there are several civilian or conventional military applications in which high explosives are used in similar ways in comparable amounts, for example, mining, metal-working, conventional munitions involving shape-charges (for anti-tank and anti-ship missions) and new types of high-current generator for scientific experiments. The only difference is the form of the metal to be compressed; only HDEs use spherical explosions. In principle, the shape of the explosion might be checked by X-raying covered experiments without revealing more sensitive information, but since conventional military experiments are quite frequent the costs of such a procedure are probably enormous. In prin-

[7] Kidder, R., *Maintaining the US Stockpile of Nuclear Weapons During a Low-Threshold or Comprehensive Test Ban*, Report UCRL-53820, Lawrence Livermore National Laboratory, Livermore, Calif., Oct. 1987; Kidder, R., 'How much more nuclear testing do we need?', *Arms Control Today*, Sep. 1992, p. 11.

[8] Magraw, K., 'The United States of America', ed. E. Arnett, SIPRI, *Nuclear Weapons after the Comprehensive Test Ban: Implications for Modernization and Proliferation* (Oxford University Press: Oxford, forthcoming).

[9] The CTB treaty may provide for routine inspections of explosions at higher yields, but not less than 100 t of TNT equivalent. See chapter 4 of this report.

ciple, a notification procedure for all conventional experiments with a few random inspections might be possible, but the bureaucratic effort and therefore cost would be high and the probability of discovering cheating through this provision low.[10]

HDEs are forbidden to non-nuclear weapon states party to the NPT,[11] and the histories of several non-nuclear weapon states suggest that they have complied with this ban, although no formal verification provisions were included in the treaty.[12] Using the NPT precedent, it might be possible to ban HDEs under the CTB despite the low probability of discovering violations without intrusive inspection. This would apply the same standard of behaviour to the nuclear weapon states and the non-nuclear weapon states not party to the NPT.

Given their significance for nuclear weapon development, a ban on HDEs is attractive to some observers, even without special verification provisions. Yet even if negotiators were willing to overlook the problem of verification and the inherent ambiguity of conventional military activities, a ban on HDEs still would not be negotiable because of the significance of these experiments for reliability and safety tests.

[10] In the cases of the democratic nuclear weapon states, the intention to conduct HDEs might be detected in open-source publications (executive and congressional documents and press reports). See chapter 4 of this report.

[11] This provision does not appear explicitly in the treaty, but is evident in the negotiating record. Bunn and Timerbaev (note 2).

[12] The Swedish programme to maintain the option of deploying nuclear weapons and to conduct defensive research on possible bomb designs of potential enemies involved HDEs, but was abandoned. Wallin, L., 'Sweden', ed. R. Cowen Karp, SIPRI, *Security with Nuclear Weapons? Different Perspectives on National Security* (Oxford University Press: Oxford, 1991), p. 365. FR Germany conducted experiments in the 1960s, some of which were very close to HDEs. They stopped when the FRG signed the NPT in 1975. Schaper, A., 'The transferability of sensitive nuclear weapon knowledge from civil science to military work', Paper prepared for the 5th International Summer Symposium on Science and World Affairs, Boston, July 1993. A published result of these experiments is Kleinhanß, H.-R., 'Untersuchungen über die Wechselwirkung von Sprengstoffen verschiedener Detonationsgeschwindigkeit zur Auslösung gerichteter konzentrischer Detonationswellen' ['Investigations of the interaction of explosives of different detonation velocities producing directed concentric detonation waves'], Dissertation (University of Düsseldorf: Düsseldorf, 1970) (in German). Mirza Aslam Beg, formerly Pakistan's Army Chief of Staff, claimed that Pakistan has conducted HDEs, but subsequently retracted his claim. Beg, A., 'Benazir part of troika decision and capping', *Strategic Digest*, Mar. 1994, p. 412. US intelligence suggests that North Korea may have conducted HDEs.

Hydronuclear experiments

HNEs are tests in which only part of the SNM in a nuclear weapon is replaced by passive material. Upon detonation, a chain reaction is initiated, but its rate is much slower than in the explosion of a complete device. The explosion blows the device apart before much nuclear energy has been released, stopping the chain reaction. HNEs are sometimes called 'zero-yield' or 'subcritical' tests, although they actually contain slightly more than a critical mass of SNM and have a small nuclear yield (less than 1 kg TNT equivalent).[13]

The quantity of energy released is related exponentially to the *multiplication factor* (represented by the symbol *k*). The multiplication factor is a measure of how much the number of neutrons increases during a nanosecond (10^{-8} s). Exponential dependence implies that a very small change in the independent variable (*k*) can result in a very large change in a dependent variable (the amount of energy released). The multiplication factor depends on the rate and extent of compression, mass, uniformity of compression, composition and thickness of the reflector, and the isotope mixture. It is also variable over time, because compression and subsequent expansion are part of a dynamic process. Calculating *k* from these factors is a complicated procedure and involves a series of material constants which can be measured only with great difficulty.[14] Rough estimates for qualitative purposes, by contrast, are relatively easy to make.

The multiplication factor for an HNE with a high explosive yield of 1 kg TNT equivalent differs only marginally from that of a full-yield nuclear weapon test with all of its SNM. In fact, a considerable amount of SNM—of the order of one-quarter of that necessary for a full-yield nuclear explosion—is required for an HNE with a high explosive yield of 1 kg. In an HNE, only a fraction of the SNM undergoes fission, in contrast to a full-yield nuclear explosion.

For this reason, HNEs leave unambiguous traces of nuclear material, in large part SNM but also a very small quantity (less than one part per million) of fission products. There are no civilian or conventional military uses which could leave the same kinds of traces. One

[13] Thorn, R. N. and Westervelt, D. R., *Hydronuclear Experiments*, Report LA-10902-MS (Los Alamos National Laboratory: Los Alamos, N. Mex., 1987), pp. 5, 6.

[14] Iraqi scientists, for example, had begun to work on such a programme, but had not yet integrated its different parts in 1991. See appendix of the Sixth IAEA on-site inspection in Iraq, Nov. 1991: 'Ministry of Industry and Industrialization: Petrochemical Project', p. 5/17.

can therefore clearly prove such experiments to have taken place after the fact through on-site inspections. A ban on HNEs would therefore be simpler to verify than a ban on HDEs, but still very difficult. Co-operative verification activity (inspections) can take place after a suspicious activity and produce unambiguous evidence. Unfortunately, without intelligence on the location of a test from some other source, detecting the site of an HNE will be difficult, barring an accident in which a much higher fission yield is produced.[15] Although HNEs can only be carried out in reinforced buildings or underground for safety reasons, they might remain undetected.

HNEs are known to have been conducted at the Nevada Test Site by the Los Alamos National Laboratory during the US–Soviet moratorium from 1958 to 1961 and by the UK in Australia before the Partial Test Ban Treaty (PTBT) was opened for signature in 1963.[16] The US goal was said to be increasing one-point safety,[17] but the personnel involved were no doubt eager to test the potential of such experiments for other applications. HNEs provide the same information as HDEs about the quality of the compression. In addition, HNEs furnish designers with information on the nuclear behaviour of the material used, from which they can make deductions about the initiation of nuclear ignition and hydrodynamic behaviour, for example, the spatial distribution of the compression, a major concern of nuclear weapon designers. HNEs are most important for horizontal proliferation, since they provide results of fundamental importance for programmes which are in their infancy. In threshold states, HNEs might be quite dangerous because of the increased probability that the yield would be much higher than planned because of the lack of experience and modelling. It is therefore more important to include HNEs in a CTB for their effect on horizontal proliferation of nuclear weapons to states not party to the NPT, and the risk of accident and attendant discovery

[15] A small increase in compression would result in a much larger increase in the value of k and release a much larger amount of energy as a consequence. The steel containers proposed for the US AHF are designed to withstand explosions up to a yield of 10 kg. It is US policy that HNEs are too risky to conduct at sites like the ATF, because 'simple physics mitigates against such approaches', but this does not mean that it would not be possible or that such sites would be above suspicion. Thorn and Westervelt (note 13), pp. 5, 6.

[16] Arnold, L., *A Very Special Relationship: British Atomic Weapon Trials in Australia* (Her Majesty's Stationery Office: London, 1987).

[17] A one-point safety test that revealed shortcomings in the weapon design could produce a yield of the order of several tonnes of TNT equivalent. One-point safety tests are therefore conducted in the same way as full-yield tests, in underground shafts or tunnels. Thorn and Westervelt (note 13), pp. 3, 5–6.

of the programme, though slight, should make those states less likely to attempt to conduct covert HNEs.

In the USA, most of what can be learned from HNEs is probably already known. Additional information that might be gained from HNEs for vertical proliferation would involve higher compression (and thereby smaller critical masses), a relatively minor concern. More important technical issues in the development of new nuclear weapon designs cannot be addressed through HNEs. Boosting, for example, which is a characteristic of all modern nuclear explosive devices,[18] only takes place when a sufficient energy density has been produced in the core. Since it is exactly this which is prevented by reducing the amount of SNM in an HNE, an HNE is of no more use for boosting research than an HDE.

More important uses of HNEs in the nuclear weapon states are in maintaining the expertise of laboratory personnel and training younger designers to maintain the existing stockpile. Reducing the level of design expertise (even while retaining some ability to maintain an effective nuclear stockpile) may, however, be desirable as part of the CTB.

In the US testing and CTB debate, many test supporters have lobbied consistently for test yield thresholds rather than a comprehensive ban.[19] At various stages of the negotiations over the years, thresholds of 1 kt, 1 t and finally 1 kg TNT equivalent have been discussed. The goal of many of those who propose thresholds is to reserve the right to conduct—if not legitimize—HNEs below those thresholds. It can be expected that any attempt to include HNEs in the CTB definition of nuclear weapon testing will run up against considerable resistance from nuclear weapon designers acting as lobbyists in the nuclear weapon states and from those states' negotiators at the CD. Although some argue that the existing arsenals must be tested for reliability or safety through HNEs, HDEs are completely adequate for this purpose. HNEs are therefore properly seen primarily as a method of maintaining nuclear weapon design expertise, not the stockpile itself, and some movement on the issue might therefore be forthcoming.

[18] The principle is explained in Cochran *et al.* and Schaper (note 3).

[19] von Hippel, F., 'A one-kiloton test limit instead of a comprehensive test ban?', Memo, 2 May 1993. von Hippel, F. and Zamora-Collina, T., 'Nuclear junkies: testing, testing, 1, 2, 3—forever', *Bulletin of the Atomic Scientists*, July/Aug. 1993, p. 28. Tests and PNEs with yields greater than 150 kt are already banned under the 1974 TTBT and the 1976 Peaceful Nuclear Explosions Treaty (PNET).

A more complex situation obtains in the threshold countries not party to the NPT. India and Pakistan can be expected to try and thwart the effort to include HNEs in the CTB, and Israel (not a member of the CD, but an observer, and therefore unable to block consensus) would be less likely to sign. These countries might depend more on HNEs than those with nuclear weapon testing experience, since they will in future also not be able to match that experience without violating or withdrawing from the treaty. Their nuclear ambitions would be limited by a ban on HNEs.[20] They would have greater difficulty finding an official reason for resistance to such a ban under a regime embodied in the CTB, since it would not be as discriminatory as the NPT. A ban on HNEs would therefore be an effective means of preventing future horizontal proliferation. This is in the interest of not only non-nuclear weapon states, but also the nuclear weapon states.

Inertial confinement fusion

ICF is an experimental technique which uses energy sources (lasers or particle beams) to produce a short-lived, extremely dense and highly energetic plasma.[21] Depending on the material used, ICF can produce nuclear fusion and nuclear fission reactions in the laboratory and be used to measure the properties of materials under extreme conditions (pressure, temperature, radiation transport parameters).[22] The physical principle of creating the plasma is similar to that of hydrogen bombs. In both cases a cavity is heated to extremely high temperatures until it is filled with black-body radiation in the X-ray range, but the dimensions of the set-ups differ significantly. In hydrogen bombs, a nuclear device ignites material inside a relatively large cavity (of the order of decimetres), whereas in ICF, high energy beams are directed through small holes in the shell around a tiny cavity (of the order of

[20] Although there have been reports that Israel has conducted HDEs and HNEs in the Negev Desert, such reports and similar ones implicating other countries cannot be corroborated. India may also have conducted HNEs. Miller, M., 'Israel', in Arnett (note 8).

[21] Schaper, A., 'Arms control at the stage of research and development? The case of inertial confinement fusion', *Science & Global Security*, vol. 2 (1991), p. 279. A plasma is a gas in which particles have been completely or partially ionized, that is, consisting of positive or negative ions. As a consequence of the high energy densities in nuclear explosions and also in ICF experiments all particles are ionized many times over.

[22] Equations which describe the relationship between pressure and temperature are called 'equations of state'. It is possible to investigate not only fusion but also fission plasmas. Schaper, A., *ICF-Experiment und kernwaffenähnliche Materialien* [*ICF experiments and nuclear weapon materials*], (IANUS: Darmstadt, 1989) (in German).

millimetres). In both cases, an outer layer of the material to undergo fusion in the cavity is heated and explodes because of the high energy density. As a consequence, the rest of the material is compressed until the extreme conditions necessary for fusion are achieved in the centre. In effect, ICF can be thought of as a laboratory-scale hydrogen-bomb explosion and is well suited to simulating the physical conditions in a nuclear explosion.

The development of some new types of nuclear weapon, especially those of the third generation, would require such experiments. It is also possible to do research on basic physical principles, for example, the possible uses of new laser materials which can only be pumped at extremely high energy densities, or equations of state for materials under the conditions of a nuclear explosion. It would be impossible, however, to design third-generation nuclear weapons on the basis of ICF experiments alone or without nuclear weapon tests. ICF can also be used to test the effects of radiation from nuclear explosions on equipment.[23] In the USA, ICF already plays an important role in attracting new, qualified scientists to work at the weapon laboratories, and would play an even more important role in keeping nuclear weapon expertise alive under the CTB if it is permitted. As a result, it holds some potential for vertical proliferation by contributing to planning for war involving nuclear explosions and maintaining nuclear weapon design expertise.

ICF is technologically complex and costly and can only be mastered by the advanced industrial countries. Appropriate experimental facilities suited to measuring nuclear weapon-related parameters—for example, equations of state for hot, dense hydrogen, uranium or plutonium plasmas—are known to exist in China, France, Israel, Japan, Russia and the USA. For most developing countries, the technological hurdle is prohibitively high and will remain so for several decades. In any case, a nuclear weapon programme is much simpler than the construction of a functional ICF experimental facility, which would not contribute much to the efforts of less experienced designers anyway. The potential for horizontal proliferation is therefore quite limited.

There are various potential civilian uses for ICF. Not all of them have yet been realized, and some are unlikely ever to be achieved. The major civilian goals are generation of electricity with fusion reac-

[23] On weapon effects testing, see Arnett, E., *The Comprehensive Test Ban Debate* (American Association for the Advancement of Science: Washington, DC, 1989).

tors, simulation of the cores of stars, cell holography, research on X-ray lasers (once seen as a potential third-generation nuclear weapon) and space propulsion (the least likely to be realized). Because of the potential civilian uses for ICF, especially fusion reactors, a ban on ICF is unlikely. In Germany and Japan there is a strong, purely civilian interest in ICF. Civilian facilities can easily be employed for military purposes, and there are no technical parameters by which military uses can be distinguished from their civilian counterparts.[24] The major differences reside in part with the experiments themselves and the materials upon which they focus. Uranium or plutonium plasmas, for example, are rather uninteresting for fusion reactors but important for military applications. In the final analysis, these differences can be judged only by the experts who participate in the experiments.

This suggests the possibility of providing for transparency in ICF research. In the civilian area, especially in the non-nuclear weapon states, all research and development takes place within a context of international co-operation and exchange, as is standard in science. In contrast, military research in the nuclear weapon states is shrouded in secrecy, although in democratic states it would be difficult to hide from public attention the existence of an ICF facility capable of producing militarily relevant results, since such projects are technically complex and costly. Although a ban on ICF cannot be expected, it is worth considering whether all ICF experiments or preparatory work should be subject to international inspection if not international co-operation. It remains to be seen whether China, France, Israel, Japan, Russia and the USA would be willing to agree to such regulation, but all states would profit from international co-operation and have an interest in transparency. Unfortunately, this seems rather unlikely. For the sake of the completion of the treaty (so that it will not be blocked by Russia and the USA) and its entry into force (so that Israel will be more likely to sign and ratify it) at an early date, it is preferable not to mandate international co-operation in all ICF facilities in the treaty.

[24] One distinction can be made: a fusion reactor driven by high-energy lasers is in all likelihood impossible. Therefore the scientific contributions from a laser-driven ICF facility for this goal are rather limited. In contrast, a reactor driven by high-energy heavy ion beams seems to be possible in principle but is still decades from being realized (if it is feasible at all). Because it is at an early stage of development at present, ICF driven by heavy ions is only useful to a limited degree in any application, be it civilian or military. See Schaper (note 21).

Various other sources of radiation

Several common sources of radiation can simulate forms of energy released during a nuclear explosion, including X-ray flash machines, neutron sources, radiation sources, plasma experiments and electromagnetic pulse simulators. They are used mainly to test the effects of nuclear weapons on military equipment, and their relevance to proliferation, horizontal or vertical, is slight. Nevertheless, components of nuclear weapons are tested with these methods and the testing of weapon effects can contribute to planning to fight a nuclear war. In this respect almost any source of radiation can play a role in the development of nuclear weapons, but in comparison to the other elements which are necessary to a development programme their role is a subordinate one. The proliferation of these relatively unsophisticated technologies cannot be controlled, and the end of the cold war has further reduced their importance.

High-yield non-nuclear explosions

In 1993, the US Department of Energy detonated a conventional explosive that released a quantity of energy comparable to that of a nuclear explosion, about 1 kt, in a verification experiment. Similar experiments at somewhat lower yields have been used to measure the effect of nuclear explosions on missile silos and command centres. Such conventional explosions are not relevant to nuclear weapon development, and banning them would have no arms control rationale.

High-temperature and high-pressure experiments

There are no other methods of producing pressures and temperatures as high as those produced by ICF and nuclear weapon tests. The highest pressures and temperatures which can be produced by any other method—for example, in the production of industrial diamonds—are several magnitudes lower. High-temperature and high-pressure experiments are of little or no significance and asking for a ban on them would only delay the negotiations.

Computer modelling

Computer modelling is an important aspect of every nuclear weapon programme. Appropriate software, when combined with data from HDEs or HNEs, can replace underground tests completely for the development of fission weapons. The computers used in the Manhattan Project to design first-generation weapons were not up to the performance of even the cheapest modern personal computers, but they were sufficient to produce a simple nuclear weapon (which did not need to be tested). A personal computer would have done the job for Iraqi designers if they had developed a sufficiently precise computer model and their project had not been stopped by international intervention.

The organizations responsible for designing nuclear weapons in the nuclear weapon states have comprehensive modelling programs, and computer simulations play an important role in the development of new nuclear weapon designs. US research on X-ray lasers in the 1980s, for example, consisted largely of computer simulations, and the weapon programme stumbled when a physical example had to be produced and did not perform as expected. Simulation programs rely on data, some of which have been public for decades. If a computer model cannot be validated by means of nuclear weapon tests or ICF, there is a factor of uncertainty which limits the further development of nuclear weapon designs. In sum, the relevance for horizontal proliferation is significant, if less so than for vertical proliferation.

Computers and programming activities are characteristic of all scientific projects. Most of the programming methods and principles are universal and can be equally applied to civilian or military projects. The broad availability and further development of high-performance computers together with programming projects cannot be stopped. It is also most unlikely that existing simulation programs in nuclear weapon states would be destroyed, and verification provisions for such a ban would be so intrusive as to be unacceptable to most potential signatories.[25]

[25] The CWC provides for personnel at suspect sites to shut down their computers before a challenge inspection. If similar provisions are not made in the verification protocols of the CTB treaty, sensitive design information might be accessible to hostile nuclear weapon states and non-nuclear weapon states alike.

Summary

In the CD negotiations, it will be necessary to draw a boundary between permitted and banned activities. The spirit of the treaty requires that this boundary be chosen in a way that minimizes further proliferation, both horizontal and vertical. In the abstract, this would imply in the absence of other considerations that the number of scientific activities to be banned should be maximized. On the other hand, if some states' negotiators insist on attempting to draw the boundary too strictly, none of the CTB's non-proliferation benefits will be realized, because the treaty will not be concluded quickly—or perhaps ever.

To summarize the activities that might be banned under a truly comprehensive test ban: there is little doubt that PNEs will be banned without much additional diplomatic trouble, while a ban on computer simulations is simply untenable. A ban on HDEs would have its greatest effect on threshold states that have not conducted them already and are not party to the NPT, and would strengthen the NPT by making universal its ban on HDEs in the non-nuclear weapon states party to it. Such a ban would be costly and intrusive to verify, however. It would interfere with the nuclear weapon states' programmes to maintain the reliability of their arsenals and so is unlikely to be included in the treaty. In contrast, a ban on HNEs is simpler to verify, because HNEs require more distinctive facilities than do HDEs and leave unambiguous traces once they have been conducted. HNEs contribute little to stockpile stewardship that cannot be accomplished with HDEs, so banning HNEs in the CTB treaty might be feasible if an appropriate definition can be formulated. It is also desirable in principle to mandate international co-operation at all ICF facilities in order to ensure transparency, but providing for such a measure in the CTB treaty would needlessly delay completion and entry into force.

IV. Defining the term 'nuclear weapon test' in the treaty

A definition of the concept 'nuclear weapon test' must precisely delimit the boundary between allowed and prohibited activities, that is, banning unambiguous nuclear weapon tests and perhaps HNEs while allowing HDEs, ICF and other processes that release explosive energy or radiation. A problem might arise since efforts to formulate

an explicit definition might further complicate and delay the negotiations, as has been shown by the histories of several arms control treaties.

For this reason, George Bunn and Roland Timerbaev suggest doing without a definition altogether: 'A CTB should simply ban the testing of "nuclear explosive devices" without defining them in the treaty, relying instead on the negotiating history of the NPT and the new CTB to define the coverage of the treaty.'[26] They defend this suggestion by reference to the history of the NPT negotiations, in which the participants wrestled with definitions of 'nuclear explosive device' and 'manufacture' for a long time. Although in the end the text of the Treaty did entirely without definitions, in the course of the negotiations criteria were developed which are now generally accepted as binding. 'Manufacture', for example, is interpreted more broadly than simply the final assembly of a complete nuclear weapon.[27] According to the understanding accepted by the parties to the Treaty, the NPT prohibits non-nuclear weapon states from conducting HDEs, HNEs and other preparatory experiments, in so far as they serve the purpose of acquiring nuclear weapons. It was also determined at the Review Conference in 1975 that ICF experiments are not in fact nuclear explosions in the sense intended by the NPT. Bunn and Timerbaev assume that a similar understanding will develop for the CTB without it being negotiated explicitly.

There is a danger in this, however, that an understanding would emerge in a form which allows activities in the nuclear weapon states that are banned in the non-nuclear weapon states. The consequence would be a weaker CTB and a more discriminatory regime than might otherwise be achieved. There would then be some residual risk not only that the organizations responsible for designing nuclear weapons in the nuclear weapon states would continue to perform relevant work behind closed doors, but also that their counterparts in threshold countries which have not signed the NPT and are less open in their political processes than some of the nuclear weapon states would pursue similar options, even if they sign the CTB treaty.

[26] Bunn, G. and Timerbaev, R., 'Avoiding the "definition" pitfall to a comprehensive test ban', *Arms Control Today*, May 1993, p. 15.

[27] Especially the so-called 'Foster Criteria', which stipulate that the purpose of any ambiguous manufacturing activity is the key to determining whether it is permitted. Bunn and Timerbaev (note 2), p. 17.

The demand for strictly binding understandings or supplementary protocols can be expected to encounter resistance in some circles in the nuclear weapon states, but there are also influential groups in those states which oppose any threshold whatsoever, no matter how low. In addition, some of the non-nuclear weapon states may not accept such a weakness in a CTB without protest, and may even go so far as to block consensus. On the other hand, reports to the effect that Mexico's Miguel Marin Bosch, now in the chair of the negotiations, prefers quick and widespread acceptance of the treaty at the expense of including HNEs among the activities banned by the treaty suggests that the path of less resistance is generally preferred by the non-nuclear states.

Previous approaches

Thresholds

In the TTBT, the category of nuclear explosion to be banned is defined in terms of the amount of energy that it releases, that, is, in terms of a threshold: 'underground nuclear weapons test[s] having a yield exceeding 150 kilotons'. The provisions of the Treaty 'do not extend to underground nuclear explosions carried out by the Parties for peaceful purposes'.[28] In most of the other arms control agreements which regulate nuclear weapons, it is also implicitly assumed that nuclear explosions involve the release of large amounts of energy. The concept is not further specified.[29]

If the goal is a comprehensive test ban and not simply a very low-yield threshold test ban treaty, however, the definition cannot be based on the quantity of energy released. This would rule out an alternative suggested by two analysts at the Los Alamos National Laboratory: 'a specific fission energy release that is comparable to or greater than that of [the] high explosive itself, about one kilocalorie per

[28] Threshold Test Ban Treaty, Article I, para. 1 and Article III. The text of the Treaty is reproduced in Goldblat, J. and Cox, D. (eds), SIPRI, *Nuclear Weapon Tests: Prohibition of Limitation?* (Oxford University Press: Oxford, 1988), pp. 350–52.

[29] Other examples include the 1963 Treaty Banning Nuclear Weapons Tests in the Atmosphere, in Outer Space and Under Water (or Partial Test Ban Treaty, PTBT): 'any nuclear weapon test explosion, or any other nuclear explosion'; the 1968 Treaty on the Non-Proliferation of Nuclear Weapons (NPT): 'nuclear weapons or other nuclear explosive devices'; and the 1971 Seabed Treaty: 'nuclear weapons'.

gram'.[30] This is an attempt at a definition of a test threshold and would serve to legitimize HNEs. A similar proposal that explicitly allows HNEs was made by Fenstermacher, albeit at a time when the realization of a CTB had not yet become as likely as today: 'For the purposes of this paper, a "comprehensive" test ban is taken to refer to all nuclear explosions except those small enough to be contained in aboveground vessels surrounded by permanently occupied research facilities'.[31]

Duration

An obvious alternative approach to a threshold is to measure the duration of the energy release: 'A nuclear explosion is the release of nuclear energy over a short period by artificial means'. The specification 'short period' is problematic, however, because several civilian activities also release nuclear energy in a period of time that might be termed short, for example, reactions in accelerators and plasma experiments, from the Tokamak fusion reactor to the so-called 'z-pinch'. This definition would ban all nuclear weapon tests, HNEs and some ICF experiments. It does not cover HDEs and all those ICF experiments which produce only hot plasmas without nuclear reactions, including those useful for research on nuclear-pumped X-ray lasers.

If the negotiators wanted to use this definition to ban HNEs and military ICF, they could adopt a *civil clause*, like the one in the German War Weapons Control Act: 'All apparatus, parts, equipment, installations, substances and organisms, which are used for civilian purposes for scientific, medical and industrial research in the fields of pure and applied science shall be excluded from this definition'.[32] This leaves the definition of the terms 'civilian' and 'military' to be clarified and a new grey area might be created. Grey areas can be defined or otherwise addressed in national law by means of constitutional legal judgements, but this is more difficult to accomplish in international law. For example, it is worthwhile recalling the nuclear explosion of 1974 which the Indian Government termed 'peaceful', a claim that could have been supported (if there had been a legal basis

[30] Thorn and Westervelt (note 13).

[31] Fenstermacher (note 4), p. 189.

[32] Preamble of the definition of 'war weapons' in the War Weapons List, Annex to the War Weapons Control Act as amended by the law of 5 Nov. 1990. English translation in: *The Export of Embargo Goods—Handbook of German Export Control* (Federal Export Office: Eschborn, 1 Mar. 1993).

to challenge it) by the civilian applications of nuclear explosives developed in the Soviet Union and the USA.[33]

If the definition were limited to nuclear fission, excluding fusion in order to side-step the complications associated with civilian plasma physics, almost all ICF experiments would be permitted. Since inclusion of ICF is not feasible or apparently negotiable, this clause might be helpful.[34] Such a definition would be costly and intrusive to verify, and a ban on fission that reserved the right to conduct fusion experiments would appear as or more discriminatory than the NPT.

Control

The only arms control treaty which includes an explicit definition of what constitutes a nuclear weapon is the 1967 Treaty of Tlatelolco, which was created by non-nuclear weapon states and will create a nuclear weapon-free zone in Latin America when it enters into force: 'For the purposes of this Treaty, a nuclear weapon is any device which is capable of releasing nuclear energy in an uncontrolled manner, and which has a group of characteristics that are appropriate for use for warlike purposes'.[35] For a definition of a nuclear explosion this would become: 'The release of nuclear energy in an uncontrolled manner by a device which has a group of characteristics that are appropriate for warlike purposes'.

A problem of interpretation arises from the term 'uncontrolled'. It can be understood to imply the lack of a control system such as that present in nuclear reactors, but nuclear explosions are controlled in another sense. Nuclear explosions release their energy more quickly than reactors, but ICF and some other plasma experiments are even faster. The interpretation of 'uncontrolled' as meaning 'fast and high energy' creates the problem of a threshold once again: How high would the energy be? ICF will soon be capable of releasing up to 1 t of TNT equivalent.

[33] Findlay (note 6).

[34] Theoretically, even Edward Teller's hypothetical 'clean bomb', a nuclear weapon that released its energy through fusion alone, would fall outside the definition. Since such a device probably cannot be built, the risk to the treaty of implicitly permitting it would be slight.

[35] Treaty for the Prohibition of Nuclear Weapons in Latin America (Treaty of Tlatelolco), 14 Feb. 1967, Article 5. The Treaty text is reproduced in Müller, H., Fischer, D. and Kötter, W., SIPRI, *Nuclear Non-Proliferation and Global Order* (Oxford University Press: Oxford, 1994), pp. 201–209.

Content, design or capability

The German War Weapons Control Act (WWCA) states:

> Nuclear weapons . . . are: 1. any weapons which contain, or are especially designed to contain or use, nuclear fuel or radioactive isotopes and which are capable of mass destruction, massive injury or mass poisoning; 2. parts, devices, assemblies or substances especially designed for use in a weapon described in item 1 above.[36]

This definition is repeated almost verbatim in the War Weapons List (WWL) that is attached to the WWCA, with the difference that to the expression 'especially designed' is appended the expression 'or those which are essential'. The definition in the WWL is therefore much broader than that in the WWCA itself.[37] This broader definition, which was adopted from the 1954 Protocols to the 1948 Treaty of Brussels of Collaboration and Collective Self-Defence among Western European Union (WEU) States, was designed to serve as a guideline in the writing of export laws and other legislation affecting nuclear activities, especially in Germany. It is not well suited for the definition of a nuclear explosion, since it also bans radiological weapons (a subject of separate negotiation at the CD) and the expression 'explosion of' is obviously applicable only to the first part. If the second part were removed, both HDEs and HNEs would fall outside the definition. The expression 'massive injury' leaves negotiators or judges with the task of defining another threshold, that between 'massive' and something less. If instead the expression 'experiments with' were introduced and applied to both parts, then all experiments and activities concerned with the safety and servicing of the existing arsenal would be included, and the definition would be too broad to be acceptable. In other words, the definition from the WWCA would be suitable only if nuclear weapons were completely banned.

[36] War Weapons Control Act (note 32), para. 17 (2).

[37] Müller, H., Dembinski, M., Kelle, A. and Schaper, A., *From Black Sheep to White Angel? The Reform of the German Export Control System* (Peace Research Institute Frankfurt: Frankfurt, 1994). A definition of the term 'nuclear fuel', involving both fission and fusion, is also included.

A compromise formulation

It is possible to formulate a definition that avoids setting a threshold and allows civilian experiments and maintenance of the existing nuclear arsenals: 'A nuclear explosion is the release of nuclear energy by means of a nuclear explosive device, or by means of parts, devices or assemblies belonging to a nuclear explosive device.'

The concept 'nuclear explosive device' can be understood in terms of international law in the traditional sense. It ensures that civilian activities which also release nuclear energy by other means are permitted, but the formulation 'parts, devices or assemblies belonging to a nuclear explosive device' captures HNEs and HDEs in the ban. Specifying 'the release of nuclear energy' bans HNEs as well as full nuclear weapon tests, since an HNE is the detonation of a slightly modified nuclear weapon, while permitting HDEs. If it were replaced by 'the release of energy', HDEs would also be banned.

V. Conclusion

This analysis makes it clear that PNEs should be banned under the CTB, and that such a ban could be achieved without difficulty. On the other hand, it would be impossible to ban computer simulations effectively. In more ambiguous areas, HDEs and ICF would be very difficult to ban for both technical and political reasons, but HNEs may be simpler on both counts. It might not be easy to achieve a ban on HNEs but, because of the great importance of an HNE ban for non-proliferation, the attempt is worthwhile. If the CD members that would prefer to reserve the right to conduct HNEs can be persuaded not to block consensus on this issue, and key states that are not members of the CD can be convinced to sign a treaty that proscribes HNEs, they could be banned either through the definition suggested in this analysis, or by ensuring that the treaty's negotiating record clearly establishes a binding commitment not to conduct HNEs. The decision to include an explicit definition in the treaty text or an additional protocol must be made on the basis of judgements about the urgency of concluding the treaty.

3. The proscription on preparing to test: Consequences for verification

Eric Arnett

I. Introduction

The Swedish draft prohibits, *inter alia*, 'preparing . . . any nuclear explosion', but its verification protocol only provides explicitly for the detection and identification of the explosions themselves, not preparations. Some argue that the word 'preparing' should simply be omitted from the relevant passage, as it is in the Australian draft. The commentary accompanying the Australian draft asserts that preparation is practically banned by other language ('not to carry out any weapon test explosion or any other nuclear explosion . . . refrain from causing . . . or in any way participating . . . in the carrying out of any nuclear weapon test explosion or any other explosion') and the legal obligation not to defeat the object and purposes of a treaty while technically observing its provisions.

Both schools of thought see the prohibition of preparations as a crucial tool for stopping a test before it is carried out, since the actual explosion might do more damage to the regime of which the treaty is a part than the discovered preparatory activities. Such a symbolic blow is arguably of greater significance in the post-cold war world, in which the treaty's primary goal is its political contribution to curbing horizontal proliferation rather than the previous foci on capping vertical proliferation and protecting the environment. It would be better to nip the problem in the bud. Some in this second group argue that the treaty must explicitly provide for verification measures that would ensure that preparations to test could be detected confidently and quickly enough for diplomatic steps to be taken to prevent an actual test. Some of their proposals have provoked strong opposition to accepting a ban on preparations, whether explicit or implicit, as part of the CTB regime.

This chapter explores the feasibility of detecting preparations to test, the role of on-site inspection in verifying and demonstrating that a state is or is not preparing to test, and the appropriate treatment of these concerns in the CTB treaty and regime. It reviews historical

examples in which preparations to test were detected in order to evaluate the utility of special pre-test verification provisions. It concludes that under the CTB, any state found to be preparing a nuclear weapon test will be pressured not to conduct it, whether or not preparation is banned by the treaty and, indeed, whether or not the state is party to the treaty. Unfortunately, a state that has decided to conduct a test under those circumstances is unlikely to be stopped simply because its preparations have been detected and denounced. Nevertheless, national and international means should be adequate to deter or detect advanced preparations as well as any special verification provisions that might be included in a treaty banning preparations. If an obligation to allow inspections of sites where ambiguous activities similar to preparations were included in the treaty, it would prevent most if not all of the nuclear weapon states and those on the threshold from joining. Such a provision is therefore unlikely to be included in the CTB treaty.

II. Detecting preparations to test

Although the Swedish draft does not provide for special measures to detect preparations, it does allow states parties to use NTM[1] 'to assist in interpretation of any event that may be of relevance to the Treaty' and to 'request an on-site inspection . . . for the purpose of ascertaining compliance with this Treaty'.

Methods

Before considering the specific preparations necessary for a nuclear weapon test, it should be recalled that a nuclear weapon test requires a nuclear device, the manufacture of which has been forsworn by the states that have joined the NPT as non-nuclear weapon states. The NPT provides for routine inspections of nuclear facilities in non-nuclear weapon states parties, and the IAEA has recently sought to broaden its inspection mandate. Further, Iran (a non-nuclear weapon

[1] NTM include all methods of collecting intelligence that do not involve trespass on the target countries' territory. Although, practically speaking, states also collect intelligence information through other intelligence means including defectors and espionage, these cannot be legally countenanced and protected by treaty, as NTM usually are. See chapter 4 of this report and Krass, A. S., SIPRI, *Verification: How Much is Enough?* (Taylor & Francis: London, 1985).

state party to the NPT) has established a precedent by inviting the IAEA to inspect at any time, any place to reassure observers who suspect that it may be seeking a nuclear weapon capability.[2] These provisions act as a first line of defence against states parties to the CTB that might attempt to violate the treaty.[3] States that are not party to the NPT, in particular India, Israel and Pakistan, can only offer this assurance if they agree to accept full-scope safeguards and additional disarmament measures to assess the disposition of any fissile material they have already produced, as Brazil has done. Such a step could be taken unilaterally or in the context of a negotiated ban on the production of fissile material.

Preparatory activities that might be detected by the means described below include creating and maintaining an organization for the purpose of manufacturing and testing nuclear explosives, drawing up and discussing plans for a nuclear explosion, manufacturing and assembling an explosive device or its components (which might be used for an HDE or HNE), preparing a test site (perhaps by digging a shaft or tunnel, or installing appropriate equipment), and delivering the explosive device to the test site and installing it.[4] Some of these activities are ambiguous, especially for states that have already conducted tests and will continue to possess and manufacture nuclear weapons. All can be detected by different means, but not always reliably.

Satellite observation

Satellite imagery is the most popularly familiar form of NTM.[5] It is evident from the historical record that US satellites are capable of observing the emplacement of a nuclear device in a prepared shaft and detecting craters that may have been left by high-explosive tests,

[2] Simpson, J., 'Nuclear arms control and an extended non-proliferation regime', *SIPRI Yearbook 1994* (Oxford University Press: Oxford, 1994).

[3] In fact, the NPT is effectively a CTB for the states that have joined as non-nuclear weapon states. Bunn, G. and Timerbaev, R., 'Avoiding the "definition" pitfall to a Comprehensive Test Ban', *Arms Control Today*, May 1993, p. 15.

[4] The region near a nuclear weapon test or a peaceful nuclear explosion is often evacuated, but this indicator is highly ambiguous given other motivations for evacuation. In two historical cases, India evacuated the Pokhran area before its 1974 PNE and the Soviet Union evacuated the 8000 residents of Yunokummunarsk before detonating a 0.3-kt PNE in order to release mine gas. van der Vink, G., *et al.*, *Nuclear Testing and Nonproliferation: The Role of Seismology in Deterring the Development of Nuclear Weapons* (The IRIS Consortium: Arlington, Va., 1994), p. II-8.

[5] In the context of the CTB, seismology has traditionally dominated the discussion, as discussed in chapter 4.

including HDEs.[6] With the exception of Russia, no other state is likely to have a similar capability in the near future. Less advanced satellites, including those providing imagery to private customers, can detect the excavation of a shaft or tunnel, but do not give a clear indication that the excavation is related to a nuclear weapon test or that a test is imminent. Observation of both excavation and emplacement depends heavily on first ascertaining the location of the test site, a task that may be more complex if a state party is attempting to hide its violation of a treaty commitment.[7] Satellites monitoring terrestrial emissions in the infra-red range can detect variations in the heat emitted by nuclear facilities (primarily through effluent), and thereby give an indication of whether fissile materials might be extracted and used in the manufacture of nuclear explosives.

Electronic eavesdropping is also conducted from satellites. Russia and the USA operate SIGINT satellites for this purpose.[8] By monitoring discussions conducted in any medium that relies on broadcast or satellite relay (rather than cable or optical fibre), these satellites can detect the planning and implementation of preparations to test. As with satellite imagery, a large amount of data can be collected, and sorting through them can be difficult if it is not clear in advance what one is searching for and where one might find it.

Other signals intelligence

While orbiting SIGINT capabilities are held in the hands of a few, their terrestrial (ground-based and airborne) counterparts are more widespread and proliferating.[9] They are also more diverse, offering

[6] Fainberg suggests that explosions with characteristic signatures (symmetric streamers of burning uranium) might be evidence of hydrodynamic experiments. He acknowledges that the probability of observing the explosion is not high. Fainberg, T., *Strengthening IAEA Safeguards: Lessons from Iraq* (Center for International Security and Arms Control, Stanford University: Stanford, Calif., 1993), p. 38.

[7] Skorve, J. and Skogan, J. K., *The NUPI Satellite Study of the Northern Underground Nuclear Test Area on Novaya Zemlya* (Norwegian Institute of International Affairs (NUPI): Oslo, 1992), p. 20.

[8] Arnett, E., *Antisatellite Weapons* (American Association for the Advancement of Science: Washington, DC, 1989), p. 2.

[9] For example, in 1974, the director of Australia's Joint Intelligence Organization reported that SIGINT made 'a substantial contribution to our total information . . . [on] French nuclear testing activities and pre-knowledge of detonations'. Joint Intelligence Organization, *Fourth Annual Report, 1974* (JIO: Canberra, 1974), part 2, p. 4, cited in Findlay, T., ' Conclusion: verifying a test ban', ed. T. Findlay, *Verifying a Test Ban* (Australian National University: Canberra, 1989), p. 111.

the opportunity in some cases to monitor cable transmissions as well as shorter-range radio. Larger states, those without enemies nearby, and those with telecommunications systems less vulnerable to SIGINT (for example, dedicated fibre-optics telephone) are less likely to reveal their national secrets through terrestrial SIGINT.

Human intelligence

Although it plays a large and perhaps increasing role in treaty verification, HUMINT is so sensitive that it is rarely included in formal discussions of compliance monitoring. Although HUMINT includes entirely legal activities like informal discussions with a state's officials and monitoring of 'open source' publications, it also encompasses espionage. Although they know that spying goes on and that it makes a major contribution to verifying compliance or detecting noncompliance with treaties, negotiators are understandably loath to codify the role of HUMINT in treaty language.[10]

HUMINT also includes what has recently been called 'societal verification', that is, citizens, journalists and legislators acting as compliance monitors in their own countries to ensure that their governments do not violate treaty commitments. The effectiveness of this form of HUMINT can be high in liberal democracies that safeguard public access to information, but cannot be counted on in more closed societies where information is not as widely available and dissidents are liable to prosecution, if not persecution. This asymmetry makes explicit reliance on societal verification difficult for negotiators.[11]

HUMINT can and has furnished data on the entire range of activities relating to nuclear weapon testing, but it can be irregular in furnishing data and the data are sometimes unreliable. The CTB treaty is unlikely to provide for enhancing HUMINT, for example, by providing for intrusive routine inspections of the files of the organizations responsible for nuclear weapons in the nuclear weapon states. Such

[10] HUMINT was understood to be separate from NTM in superpower cold-war arms control talks because of the commitment not to interfere with NTM. While both sides understood that spying went on and contributed to monitoring nuclear modernization, neither wanted to agree that they would not interfere with the other's espionage networks.

[11] During the cold war, for example, some US officials argued that the Soviet Union could more easily judge US compliance with superpower treaties because of the nature of the US political process, whereas a higher standard of treaty-imposed transparency might be required to assure the USA that the USSR was in compliance. For a discussion of this problem in the case of sea-launched cruise missiles and START, see Arnett, E. H., *Sea-Launched Cruise Missiles and US Security* (Praeger: New York, 1991).

measures are only legally possible in the case of a defeated state, as with Iraq, and even then may be difficult to implement. Inclusion of such provisions in the CTB treaty would create a major obstacle to key states signing and ratifying.

Of the three methods of monitoring discussed, only human intelligence is available to most countries. Satellite imagery is still collected by relatively few states, although much of it is available on the open market. SIGINT equipment is available for sale, but very few countries have access to a range of technologies so broad that they can be confident of intercepting and deciphering the crucial messages that will alert them to an adversary's preparations to test.

Historical examples

There are at least six cases in which a nuclear weapon state or a state not party to the NPT has prepared to conduct a nuclear weapon test and is publicly known to have been observed by an actor other than the organization responsible for those preparations.[12] In all of these cases, the intention to test was not hidden—either the test was part of a known modernization programme or the displayed willingness to test was a political signal—but these incidents give some useful insight into ways in which intelligence of use to monitoring compliance with the CTB is collected.

Soviet Union, 1961

On 30 August 1961, Moscow's announcement that it had decided to break its testing moratorium on 1 September was sent via teletype to a TASS regional office in the Caucasus. This message was intercepted by a US SIGINT station in Cyprus at 1.15 p.m. (Washington time), reported to US negotiators in Geneva at 6 p.m. and appeared in TASS at 7 p.m.[13]

[12] In addition, in 1989, the Soviet Union and the USA notified one another of the dates on which they would conduct tests to be observed by the other as part of the Joint Verification Experiment.

[13] Seaborg, G. T., *Kennedy, Khrushchev, and the Test Ban* (University of California Press: Berkeley, Calif., 1981), p. 77.

South Africa, 1977

On 6 August 1977, the Soviet Union informed France, FR Germany, the UK and the USA that one of its satellites had detected a nuclear weapon test site in the Kalahari Desert. A US satellite may have been detailed to confirm this observation.[14] South Africa probably had not yet separated fissile materials and feared a Cuban- and Soviet-supported attack from the front-line states, so the preparation of the test site was most likely meant to be detected in hopes of coercing Western support. Upon dismantling their programme and acceding to the NPT 15 years later, South African officials confirmed that their strategy was to use the threat of a nuclear weapon test in this way.

The Soviet Union, 1976–85

In the heated debate over the Reagan Administration's charge that the Soviet Union had violated the unratified 1976 Threshold Test Ban Treaty by conducting tests with yields of over 150 kt,[15] official commentary revealed that the USA used not only seismic data but also other intelligence sources to monitor the activities of the Soviet nuclear weapon design and testing bureaucracy.[16]

[14] Marder, M., and D. Oberdorfer, 'How West, Soviets moved to head off S. Africa A-test', *Washington Post*, 28 Aug. 1977; Jasani, B., 'Military satellites', SIPRI, *World Armaments and Disarmament: SIPRI Yearbook 1978* (Taylor & Francis: London, 1978), pp. 73–79; and Spector, L. S. and Smith, J. R., *Nuclear Ambitions: The Spread of Nuclear Weapons 1989–1990* (Westview Press: Boulder, Colo., 1990), p. 272.

[15] The seismic evidence and attendant uncertainties were evaluated in Sykes, L. R. and Davis, D. M., 'The yields of Soviet strategic weapons', *Scientific American*, Jan. 1987, pp. 21–29.; and Sykes, L. R., 'Present capabilities for the detection and identification of seismic events', eds J. Goldblat and D. Cox, SIPRI, *Nuclear Weapon Tests: Prohibition or Limitation?* (Oxford University Press: Oxford, 1988), pp. 151–53. The TTBT was ratified by the USA in Sep. 1990.

[16] R. Barker in 'Nuclear testing: technical requirements and new limits,' eds. E. H. Arnett, E. J. Kirk, and W. T. Wander, *Science and Security: Technology and Arms Control for the 1990s* (American Association for the Advancement of Science: Washington, DC, 1989), pp. 270–72. Barker, once a nuclear weapon designer, was an assistant secretary in the Reagan Administration's Arms Control and Disarmament Agency (ACDA). See also Leitenberg, M., 'Non-seismic detection of underground nuclear tests', SIPRI, *World Armaments and Disarmament: SIPRI Yearbook 1972* (Almqvist & Wiksell: Stockholm, 1972), pp. 439–42.

India, 1981, 1983 and 1984

In April 1981[17] and again in June 1983, US sources reported that they had detected Indian preparations to conduct a nuclear weapon test in response to revelations about Pakistan's nuclear programme (and perhaps China's first test of an intercontinental ballistic missile). In the 1983 case, test shafts had been excavated at Pokhran, the site of the 1974 explosion.[18] In both cases, the preparations were primarily symbolic or political (Prime Minister Indira Gandhi had been threatening a second test since 1980[19]) and were detected by reading Indian newspapers. In 1987, the Indian press reported that in 1984 the Gandhi Administration had again readied the test site at Pokhran, but had been persuaded not to test after the preparations were detected by a US satellite.[20]

Brazil, 1986

In August 1986, the Brazilian press reported that shafts had been excavated on a military reservation near Cachimbo.[21] The Brazilian Government denied that the shafts were intended for nuclear weapon testing at the time, and Brazil had not separated fissile material. Expert opinion was divided as to whether the shafts were suitable for nuclear weapon tests or anything else, one theory being that a faction of the military was attempting to fool the Argentinian Government into believing that the Brazilian nuclear weapon programme was further advanced than it was.[22] The shafts were later filled as a confidence-building measure when tensions with Argentina eased.

[17] Miller, J., 'Cranston says India and Pakistan are preparing for nuclear testing', *New York Times*, 28 Apr. 1981.

[18] Benjamin, M. R., 'US is delaying nuclear exports to India', *Washington Post*, 23 June 1983; and Balsubramanium, V., 'India preparing for 2nd n-test, says US paper', *Hindustan Times*, 24 June 1983.

[19] 'Gandhi says national interest may require nuclear blasts', *Washington Post*, 14 Mar. 1980.

[20] 'India's claim on N-bomb not true', *Times of India*, 27 Jun. 1987; cited in Anthony, I., *The Arms Trade and Medium Powers: Case Studies of India and Pakistan 1947–1990* (Harvester Wheatsheaf: Hertfordshire, 1992), p. 170.

[21] 'Further reportage of alleged nuclear test site', *Fôlha de São Paulo*, 8 Aug. 1986, translated in Foreign Broadcast Information Service–Latin America, *FBIS-LAT*, 12 Aug. 1986, p. D-1; and House, R., 'Brazil steps back from race to build nuclear weapons', *Washington Post*, 28 Aug. 1986.

[22] Spector and Smith (note 14), pp. 245–46.

China, 1993

On 16 September 1993, the USA said it had evidence that China was preparing to test in the near future. High-resolution satellite imagery was said to show that a nuclear explosive device had been installed in a test shaft.[23] Private analysts had been predicting a test for months, based on signs of excavation in lower resolution but publicly available imagery of the Lop Nor test range and the arrival of the autumn testing season.[24] On 5 October 1993, China exploded the device. A similar cycle of events transpired before China's most recent test, 10 June 1994.

III. Goals of inspections

In the context of preparations to test, inspections would be less important for detection than for deterrence and demonstration.[25] Routine inspections are unlikely to detect preparations, and challenge inspections can only be invoked once apparent or alleged preparations have been detected by some other means (as described above). The very existence of the possibility that preparations might be detected and later demonstrated (proved) acts as a deterrent to a potential cheater. Demonstration is therefore the benchmark against which provisions for challenge inspection must be measured.[26]

The general problem of demonstration

Unlike detection and deterrence, the concept of demonstration inherently involves an audience. The goal of demonstration is to persuade a third party that one party has detected or has good reason to suspect

[23] Smith, R. J., 'China planning a nuclear test, US aides say: nations pressure Beijing to observe moratorium', *Washington Post*, 17 Sep. 1993, p. 1.

[24] Gupta, V., 'Future Chinese nuclear tests on the horizon', *Trust and Verify*, no. 30 (July/Aug. 1992), p. 3; and Gupta, V. and McNab, P., 'Sleuthing from home', *Bulletin of the Atomic Scientists*, Dec. 1993, pp. 44–47.

[25] This terminology follows Seiders, B. A. B., 'Verification of chemical weapons arms control', ed. E. H. Arnett, *New Technologies for Security and Arms Control: Threats and Promise* (American Association for the Advancement of Science: Washington, DC, 1989).

[26] Inspections can also be used to resolve uncertainties about ambiguous data, but such inspections should be a simple matter to arrange in cases where the apparent violator is in compliance. Of course, inspection provisions must also be adequate to secure the signature and ratification of states. On ratification as a verification design requirement, see Arnett (note 11), pp. 114–15.

non-compliance on the part of a second. It must therefore take into account not only the detection capabilities of the first party and the activities of the second party, but also the predisposition of the third party to find guilt or innocence.[27] There are two basic cases: one in which the audience is friendly, and one in which the audience is sceptical or even hostile.

Audiences are likely to be friendly within the executive bodies of individual governments and between allied or friendly governments, although differences in ideology and policy position among organizations or governments may arise. As long as they do not, the finding of the monitoring organization is likely to be accepted by the audience. If it is not, evidence gathered by national means can often be shared persuasively. In this case, inspections serve primarily to resolve uncertainty and deter non-compliance. Demonstration is in this instance not as important.

If the audience is hostile, as it might be if power is shared between different political parties within a state[28] or if the monitoring organization must gain the confidence of hostile or neutral governments or international opinion generally, demonstration is not only more important but also more difficult. Not only would a hostile audience require more evidence to accept a finding of non-compliance or authorize an inspection, it may not be possible to share evidence gathered through national means in order to make the more difficult case. Ironically, the smoking pistol that might be retrieved through inspection may be needed in order to gain the consensus that an inspection is necessary. The negotiators of the CWC faced this seeming paradox most directly, and the efficacy of their solution—requests for inspection may not be refused unless a three-quarters majority of the 41-member Executive Council agree to block it—remains to be seen.

In an important precedent, the USA provided information gathered through NTM to the IAEA Board of Governors in order to strengthen the case for special inspections under the NPT in North Korea, and made public its information that China was about to test in 1993 and

[27] In the context of bilateral strategic arms control, the audience was the US Congress and public opinion.

[28] Since this eventuality is less common in most countries than in the USA, the US experience with verification may not always be applicable in other contexts. Specifically, it may not be necessary for other states to provide as extensively for the government to demonstrate findings of compliance or non-compliance to the legislature, so verification measures designed for that purpose (rather than confidence-building or deterring non-compliance) would be less important.

1994. More generally, the burden of proof has largely been on the accused state. In recent cases, there has been a widespread assumption that the accused were guilty until proved innocent; disagreement was on the issue of selecting an appropriate response, and primarily political in nature.

Demonstration and preparations to test under the CTB

Two audiences are involved in the case of the CTB. First, the implementing authority (the IAEA Board of Governors in the Swedish draft or the Director-General and Executive Council if another organization is created, as discussed in chapter 5) will assess whether the evidence assembled without an inspection is such that an inspection will go forward or be blocked. Second, the UN Security Council and the international community will assess whether the body of evidence assembled after the inspection (or perhaps the fact that the accused state party will not allow an inspection) is such that coercive measures must be taken to bring the state into compliance.[29] The burden of proof will not only be on the quality of the evidence but also on the international status of the alleged violator. In addition, the quality of evidence will itself be related to the status of the state, especially with respect to the NPT.

Nuclear weapon states

In the cases of the five openly declared nuclear weapon states, their status as the permanent members of the UN Security Council with attendant veto power ensures that they can avert any concerted action of that body. Similarly, the USA has traditionally prevented the Security Council from taking strong action against Israel, the sixth nuclear weapon state (albeit not recognized as such by the NPT, to which it is not party). This need not rule out any international reaction to these states preparing for nuclear weapon tests under a CTB, but such a reaction would have to take another form.

In many cases, only Russia and the USA will have the wherewithal to detect preparations to test. As a result, other states can legitimately ask whether they will be able to verify the compliance of these two

[29] In the context of proving that a state is preparing to test, this could mean either preventing the test from taking place or rolling back the preparations themselves.

states or other states parties in close security partnerships with one or both of them. The most important such state is Israel.

The USA. The USA has a nuclear weapon test range, an organization responsible for nuclear weapon design, a stockpile of fissile material and an arsenal of nuclear weapons. The USA intends to maintain at least thousands of weapons of six or more types for the foreseeable future and plans to re-manufacture the weapons as they age. As part of its effort to maintain the arsenal, the USA will conduct HDEs and probably HNEs to assure itself that the weapons are reliable and safe. All these factors will create some ambiguity about US intentions regarding testing, if not modernization.

President Clinton has decided that, after the Hatfield Amendment makes US nuclear weapon testing illegal from 30 September 1996, the USA will not only refrain from testing, but neither will it prepare a breakout testing programme. During the cold war, the USA spent an estimated $1 billion on 'Safeguard C', under which a test programme was developed and maintained on the off-chance that the USA might no longer be bound by the Partial Test Ban Treaty's prohibition on testing anywhere but underground.[30] Clinton Administration officials see a similar programme as unnecessarily wasteful, but have committed the USA to maintain its nuclear weapon design and testing expertise.[31]

The USA is the nuclear weapon state most amenable to societal verification. If a future president decides secretly to violate the CTB, he or she will require the collusion of the nuclear weapon bureaucracy (some of whom can be expected to oppose his or her decision), the committees of the US Congress responsible for funding such activities (members of which will assuredly oppose the decision) and perhaps the newspaper editors responsible for deciding whether leaked reports will be published. The utility of planning such a test secretly in the knowledge that it will be detected anyway and made public once it is conducted is difficult to imagine.

Israel. Israel, which is expected to accede to the CTB, has an organization responsible for nuclear weapon design, a stockpile of

[30] Weiner, T., 'Costly relic, nuclear unit sits ready for atmospheric tests', *New York Times*, 9 June 1993, pp. 1, 18.

[31] In the US Department of Energy's FY 1994 budget, $211 million was requested for maintaining the option to test through 1996 and $157 million for 'stockpile stewardship'. Another $55 million will be spent on capital investments.

fissile material[32] and an arsenal of nuclear weapons, and may have conducted a nuclear weapon test with the co-operation of South Africa.[33] In contrast with the USA, there is no official public information on Israeli nuclear forces or plans, or any other aspect of nuclear policy.[34] Any effort to collect or disseminate such information is a criminal offence in Israel. If information has been shared with Israel's security partners, they have not made it public either, suggesting they might not do so in the context of monitoring compliance with a multilateral treaty.

Despite these difficulties, it should be remembered that several factors simplify verification in Israel. It is a small country, so the decision to build a nuclear weapon test site would more likely be noticed than in a country as large as Russia or the USA. Israel is visited by millions of people each year and is home to a large minority, the Palestinians, who would have an interest in discovering and publicizing efforts to prepare a nuclear weapon test site. The areas where they might conceivably test are shrinking as a result of urbanization and the peace process. Further, despite Israeli media and public participation in the government policy of nuclear opacity, popular debate is sufficiently open and diverse for a major undertaking like the preparation of a test site to have a high probability of being revealed in open sources. In this regard, recall that the secrecy surrounding Israeli nuclear forces and doctrine has not prevented the world from detecting the Dimona facility and developing a reasonable, if incomplete, picture of Israeli nuclear activities. At the same time, Israel is unlikely to join any regime which would disrupt its highly refined policy of nuclear ambiguity.

Finally, it is hard to imagine why Israel might hypothetically want to test a nuclear weapon but keep the preparations for the test secret.

[32] Israel will have produced enough plutonium for 55–95 nuclear weapons by 1995, according to a recent SIPRI study. Some observers believe that Israel has also imported highly enriched uranium from South Africa, which produced between 200 and 525 kg before halting its nuclear weapon programme. Albright, D., Berkhout, F. and Walker, W., SIPRI, *World Inventory of Plutonium and Highly Enriched Uranium 1992* (Oxford University Press: Oxford, 1993).

[33] Miller, M., 'Israel', ed. E. Arnett, SIPRI, *Nuclear Weapons after the Comprehensive Test Ban: Implications for Modernization and Proliferation* (Oxford University Press: Oxford, forthcoming).

[34] Israel's oft-repeated declaration that it 'will not be the first to introduce nuclear weapons into the region' cannot be considered policy so much as a reflection of widely known information. France, the UK, the USA and the USSR long ago introduced nuclear weapons into the Middle East aboard their warships.

Such a scenario necessarily entails an Israeli decision to abandon in a dramatic fashion its policy of nuclear ambiguity, a development which is divergent from current trends in the region. In any case, if Israel decided to test as a political signal in response to, say, a hostile neighbour's overt acquisition of a nuclear weapon capability, Tel Aviv's abrogation of the CTB would likely be overt and unstoppable. The premise of those who would have the treaty ban and verify the proscription on preparations to test—that detection of the preparations could be used to marshal international pressure and stop the test—would be inoperable.

France and the UK. France and the UK resemble the USA politically, in the sense that their nuclear postures create an irreducible ambiguity, which is all the stronger given both states' reluctance to conclude the CTB. Neither state has ruled out requirements for new types of nuclear weapon, as the USA has, but the promulgation of a new requirement and design, development and non-nuclear testing would certainly alert observers to the possibility of a test.[35] Their political systems are less open and adversarial than that of the USA, but still make it difficult to imagine that a covert programme to prepare for nuclear weapon testing could be kept secret. Test preparation for both is further complicated by the small areas of both countries and their reliance on distant test sites.

China and Russia. Prospects for reliable societal verification are not as bright in China and Russia as they are in the other nuclear weapon states, and both countries are much vaster than France, Israel or the UK. That said, both have established test sites and bureaucracies which will be monitored closely by the USA and other states with advanced NTM and intelligence capabilities. There is also good reason to expect that the USA will be quick to take action if there is any indication that either country is preparing to test, as it did in the case of China in 1993 and 1994.

[35] In the case of the UK, the closing of its test range in Australia in the 1960s and US compliance with the CTB would make it necessary for a hypothetical British Government intent on breaching the CTB to approach another state to enlist its co-operation. Such an approach would be risky, offering an additional deterrent and an opportunity for other states to detect preparations at an early stage. France, having lost its test site in Algeria, may face a similar situation after the CTB comes into effect if the Government is reluctant to continue funding for the test site on Mururoa indefinitely. Labbé, M.-H., 'France', ed. Arnett (note 33).

Both the CTB implementing authority and international opinion are likely to respond to intelligence shared by the USA if it indicates that either China or Russia is preparing to test. If, hypothetically, such a charge were levelled and inspections sought, either state might well refuse to submit, even if obliged to by the treaty. As in the case of Israel discussed above, the hypothetical developments that might lead China or Russia to prepare for a test after signing the CTB would probably be of such a nature that it would go on to conduct the test regardless of international opinion, much as China did in 1993 and 1994 and can be expected to do again before the treaty enters into force. Thus, any additional information provided by special treaty provisions designed to detect preparations to test in a timely manner would be of little practical use.

Non-nuclear weapon states parties to the NPT

As has been noted, states parties to the NPT as non-nuclear weapon states are already subject to intrusive inspections intended to detect any attempt on their part to divert fissile material into a weapon programme. The extent of their openness to inspection has been increased since 1991 by the IAEA's new willingness to invoke its asserted right to special inspections, demonstrated in the case of North Korea, and Iran's precedent of inviting additional 'any time, anywhere' inspections to demonstrate its compliance. The Swedish draft explicitly provides for and encourages invited inspections.

Two considerations make it extremely unlikely that a non-nuclear weapon state party to the NPT would succeed in preparing a nuclear weapon test covertly. First, such preparations would involve either violation of or withdrawal from the NPT (otherwise fissile material for the explosive device would not be available), a sure sign of something amiss and bound to draw as much attention as North Korea's decision to withdraw did in 1993. Second, there are no non-nuclear weapon states parties to the NPT that can confidently expect that Russia and the USA, the two states with the most extensive NTM, would not detect and publicize their preparations to test (as they arguably might in the case of Israel).

States not party to the NPT

Of the non-nuclear weapon states not party to the NPT, only India and Pakistan continue to be of proliferation concern[36] but have not exploited their nuclear options.[37] Both support the CTB and neither appears to be interested in testing, although India has tested once and used the threat of testing again for political ends in the 1980s, as discussed above. The USA has been consistent in revealing information about both states' nuclear programmes and applying pressure to limit the activities of both. In both cases, such pressure has hardened the resolve of the target countries, illustrating the difficulty of using information to change outcomes, even when it is available. As in other cases described above, circumstances that might lead India or Pakistan to prepare a nuclear weapon test covertly are likely to create such an imperative that the discovery of those preparations and consequent pressure from other governments are unlikely to prevent the test from taking place. Again, the premise of the case for pre-test verification provisions is not applicable. Further, intrusive pre-test verification provisions which forced them to reveal too much about the nuclear weapon capabilities to which they reserve both a right and a studied ambiguity are likely to keep them from allowing the CD to come to consensus.[38]

IV. Conclusion

Even if preparing to test is explicitly banned by the treaty, which is unlikely, additional verification measures are undesirable. Since this is the case, there is little motivation to supplement the obligation to prevent testing from taking place and the implicit commitment not to

[36] Algeria, Argentina and Brazil are no longer generally seen as states of proliferation concern, and Algeria and Argentina have said that they will join the NPT by 1995. If Ukraine does not ratify the NPT, other aspects of its nuclear posture will overwhelm its position on the CTB and the possibility of covert preparations to test.

[37] India's efforts to develop delivery systems indigenously are assessed in Arnett, E. H., 'Military technology: the case of India', *SIPRI Yearbook 1994* (Oxford University Press: Oxford, 1994). Both aircraft and missile programmes are found to be less advanced than they are commonly said to be.

[38] Indeed, Pakistan's concern that the CWC verification provisions, which would be much less intrusive on the nuclear programme than a hypothetical pre-test provision in the CTB would be, may prevent it from ratifying the CWC. Stern, J., 'All's well that ends well? Verification and the CWC', eds J. B. Poole and R. Guthrie, VERTIC, *Verification 1993: Peacekeeping, Arms Control and the Environment* (Brassey's: London, 1993), p. 38.

undermine the object and purposes of the treaty with an explicit ban on preparation. The remaining question, then, is whether the CTB should be interpreted as having an implicit ban on preparations that can lead to challenge inspections upon request, or whether such inspections should be excluded through the negotiating history, leaving states parties to detect preparations through national, multinational and private means and attempt to prevent any incipient test that might be detected without an inspection. The above analysis indicates that the latter is preferable, because a state determined to test will be difficult to stop regardless of the treaty's provisions, and the prospect of inspections in support of a ban on preparations will at best drive key potential states parties away. At worst, they prevent the treaty from being completed.

It is important to keep the treaty's provisions in harmony with its goals. While a single test by a state party would be a blow to the regime, it would not necessarily lead to modernization or proliferation. Although such a test would without doubt be designed to furnish scientists with information useful for designing nuclear weapons, it would not lead to the unravelling of the CTB any more than North Korea's challenge to the NPT has undermined that treaty. A determined response would demonstrate that the international community's commitment to the treaty is sufficient to maintain each state party's interest in the regime's success. Further, the first illegal test undertaken by a state party would alert others that additional tests might be in the offing, increasing the monitoring effort and political pressure focused on the offending state.

There is no case in which additional treaty provisions for verification of pre-test activities improve the security of a potential state party by improving its confidence in compliance. Since such provisions would consume valuable resources, political capital and negotiating time, the treaty is better off without them.

4. The complementary roles of national, private and multinational means of verification

Eric Arnett

I. Introduction

While there is a widespread appreciation that the primary emphasis of the CTB has changed from technically inhibiting the qualitative aspect of vertical nuclear proliferation to politically reinforcing the trend away from horizontal nuclear proliferation, much of the verification debate remains implicitly concerned with preventing Russia from mounting a sustained covert nuclear weapon testing programme. While no one claims that this is likely (although it cannot be ruled out), the concept underlying the design of the CTB verification provisions has changed little since the Reagan–Brezhnev era. If the hold of this anachronistic mindset is not relaxed, it threatens to make implementation of the treaty needlessly expensive and complex. A more timely conception would recognize that, while there is some small chance of Russia becoming an expansionist state and engaging in a nuclear weapon buildup, the basis for arms control in the 1990s and the foreseeable future does not require excessive verification means to be operated by the CTB implementing authority to contain the risk of this eventuality.

The states with testing experience are either open societies or closely observed by national and private (open or non-governmental) means of verification. The states without testing experience or access to it cannot hope fully or reliably to exploit the techniques necessary to keep tests covert, because their designs will be for nuclear explosive devices with yields greater than 10 kt and they have no experience with the technologies relevant to evading detection. Further, the more likely scenario for any state resuming nuclear weapon testing for the foreseeable future is not a risky attempt to test covertly, but an open flouting for political reasons of the norms embodied in the CTB. Even the most elaborate verification system is inconsequential in this scenario.

Monitoring compliance with a CTB treaty has been one of the most thoroughly discussed problems in the arms control and verification literature.[1] It is clear that the CTB can be effectively verified, but less clear how best to do it in the specific context of the treaty being negotiated in Geneva. How much effort and resources should be put into the official network of sensors for monitoring compliance before it falls victim to the law of diminishing returns and makes the treaty unnecessarily expensive? How will national, private and multinational monitors interact? When will challenge inspections be necessary, and what can they be expected to find?

This chapter answers these questions by reviewing the monitoring techniques available to the states parties and the authority to be responsible for implementing the CTB treaty and their relative strengths and weaknesses from the perspective of the goals of the treaty and the needs of each state. On the basis of this net assessment, it recommends the appropriate treatment in the treaty itself, bearing in mind that an agreed draft should be completed quickly and that by mandate the treaty must be effectively and internationally verifiable. The perspective is that of the potential signatory considering whether the treaty's verification provisions are sufficient to make joining worthwhile, rather than simply a description of the verification system to be created by the treaty.

II. Available means of verification

National intelligence means are the bedrock on which any treaty verification regime is built.[2] These include NTM and other means states use to collect intelligence which are not necessarily legal and not recognized or protected by treaty (as NTM often are). To an increasing extent, the public has been furnished with information bearing on

[1] The most complete recent treatment is Findlay, T. (ed.), *Verifying a Test Ban* (Australian National University: Canberra, 1989), especially Findlay, T., 'Conclusion: verifying a test ban'. See also Arnett, E. H., *Verifying Limits on Nuclear Testing* (American Association for the Advancement of Science: Washington, DC, 1989); and Goldblat, J. and Cox, D. (eds), SIPRI, *Nuclear Weapon Tests: Prohibition or Limitation?* (Oxford University Press: Oxford, 1988).

[2] It might be objected that the CWC does not rely on national means as heavily as its regime of routine inspections. In fact, national means are more likely to detect possibly non-compliant activities that can be investigated through challenge inspections. Intentional instances of non-compliance may be deterred by routine inspections, but are unlikely to be attempted at declared sites.

treaty compliance from private sources. This is particularly true with regard to nuclear weapon testing. Still, the CD's negotiating mandate specifies that the treaty should be verified not just 'effectively', but also 'internationally',[3] that is, other states parties should not have to rely too heavily on Russia and the USA, the two states with the greatest across-the-board capabilities for NTM (although some states have better capabilities in specific niches). The Swedish draft would establish MTM dedicated to monitoring compliance with the CTB treaty to supplement national and private means, as well as other multinational capabilities, and some MTM will no doubt be included in the final CTB document. In the Australian draft, however, a more modest role is seen for the implementing authority; it would simply co-ordinate existing or new capabilities and analyse the data provided.

This broad range of capabilities will strengthen the treaty in a number of ways. First, of course, they will detect attempts to test covertly and distinguish them from other phenomena that might resemble tests, for example, industrial explosions associated with mining.[4] Second, the very existence of a vast array of verification means acts as a deterrent to any state party considering the option of covert testing. Third, the combination of sensitive national means and publicly accessible national, multinational and private means ensures that data will be available to demonstrate that a state party is either non-compliant or strongly suspected. Proof that can be examined independently strengthens the cause of those who would respond strongly to suspected or confirmed non-compliance, whether by enforcing the obligation for a state party to submit to challenge inspections or to marshal support for a stronger response in national and international forums. Of course, it might also demonstrate an accused state party's innocence. Finally, a robust verification capability increases the confidence of governments, legislatures and publics, improving the chances that more states will sign and ratify the treaty.

An effective verification regime should reliably detect and identify tests as low as 1 kt, the yield of current tactical nuclear weapons and the primaries of fission–fusion weapons, conducted by any of the six

[3] Conference on Disarmament document CD/1212, 10 Aug. 1993.

[4] This chapter does not consider methods by which preparations to test could be detected, the subject of chapter 3. Nevertheless, the reader should bear in mind that evidence of preparing to test, especially attempts on the part of a non-nuclear weapon state to manufacture a nuclear explosive device, can be detected and would give early warning that a test might be in the offing. Brazil has gone so far as to propose that states subject to IAEA full-scope safeguards need not be monitored as closely as those that are not.

countries with extensive testing experience or access thereto: China, France, Israel,[5] Russia, the UK and the USA.[6] Other states are unlikely to test at yields so low, except as the culmination of a testing programme begun at higher yields.

National means

National means comprise all the sources of information directly available to any government, including NTM and human intelligence, without the co-operation of the target states.

Seismic monitoring

In the countries most difficult to monitor—those larger countries with experience in nuclear weapon testing, China, Russia and the USA—seismic monitoring through NTM will be remote or teleseismic in nature.[7] Teleseismic techniques and geological data exchanged since 1990 under the PNET and TTBT are now such that explosions of roughly 1-kt yield can be detected reliably anywhere in Russia, as long as those explosions are not muffled or decoupled. A similar standard can be set globally with a network of 50–100 teleseismic stations, depending on their locations. There is a scientific consensus that even decoupled tests can be detected reliably to roughly 5 kt through teleseismic measurements.[8] Explosions smaller than 1 kt have

[5] Israel is reported to have had access to French and US nuclear weapon design and test information in the 1950s, 1960s and 1980s as summarized in Spector, L. S. and Smith, J. R. *Nuclear Ambitions: The Spread of Nuclear Weapons 1989–1990* (Westview Press: Boulder, Colo., 1990), pp. 156–57.

[6] While there has been public speculation about the need for a bureaucratic 'requirement' for nuclear weapons with yields below 1 kt in France, the UK and the USA, the decision to establish such a requirement in any of these countries would be made public long before a test was conducted. The Clinton Administration and the US Congress have ruled out any new requirements for US nuclear weapons for the foreseeable future.

[7] The term 'teleseismic' refers to low-frequency waves that travel farther than 1500 km. Higher-frequency waves that do not travel as far are referred to as 'regional'. Private or multilateral seismic installations located on the territories of states parties but not controlled by them are discussed in the sections below.

[8] US Congress, Office of Technology Assessment, *Seismic Verification of Nuclear Testing Treaties* (US Government Printing Office: Washington, DC, 1988); and van der Vink, G. E., and Park, J., 'Nuclear test ban monitoring: new resources, new requirements', *Science*, vol. 263 (4 Feb. 1994), p. 634. Decoupling is impracticable at yields greater than about 10 kt. Richards, P. G., 'Testing the test-ban treaty', *Nature*, vol. 364 (15 July 1993), p. 188. Decoupling could be made more difficult if the locations of all cavities created by peaceful nuclear explosions were disclosed by the Russian Government in support of the treaty. Findlay, 'Conclusion' (note 1), p. 112.

also been detected teleseismically, so a cheater could not be confident that a lower-yield test would not be detected.

In smaller countries or near the borders of the larger countries (within 1500 km), explosions can also be detected by monitoring signals at high frequencies. High-frequency arrays are able to detect even decoupled explosions of 1-kt yield at regional distances. Reliable seismic detection at any lower level will quickly be overwhelmed by false alarms, that is, events that will have to be investigated by other means.[9]

The US Air Force Technical Applications Center (AFTAC) operates an Atomic Explosion Detection System (AEDS) with some 92 sites in 35 countries, including at least 15 special-purpose regional arrays.[10] The British Atomic Energy Authority and Ministry of Defence operate a network for the same purpose in some Commonwealth countries. France operates 16 stations in co-operating countries, and Italy stations in Algeria, Egypt, Morocco and Tunisia.[11] No other states are known to operate independent seismic systems dedicated to monitoring test activities or in foreign countries, but it seems likely that the Soviet Union operated a similar network. Russia is unlikely to have maintained it fully intact, given changes in its domestic affairs and security partnerships. In addition to the AFTAC AEDS, the USA also operates the Worldwide Standardized Seismograph Network, 120 stations in 50 countries built during the 1960s and administered by the US Geological Survey (USGS).[12]

Other states operate their own stations or exert some measure of control over the foreign seismic stations deployed on or in their soil, including administrative or financial control, and receive data from

[9] In general, the number of events that create the potential for false alarms—primarily industrial explosions—increases by a factor of 10 for every factor of 10 by which the detection threshold is decreased. van der Vink and Park (note 8), pp. 635.

[10] These sites, located at diplomatic missions and military installations, are not necessarily all in countries friendly to the USA. Some fluctuation in the number of stations and co-operating countries can be expected since the extent of the AEDS was made public. Arkin, W. and Norris, S., 'Nuclear notebook', *Bulletin of the Atomic Scientists*, July/Aug. 1987, p. 63. The capability of the AEDS network and its data are kept secret. van der Vink *et al.*, *Nuclear Testing and Nonproliferation: The Role of Seismology in Deterring the Development of Nuclear Weapons* (The IRIS Consortium: Arlington, Va., 1994), p. III-8.

[11] van der Vink *et al.* (note 10), p. III-6.

[12] Ingate, S., 'Capabilities of the present global seismic network', ed. Findlay (note 1), p. 27. Eleven of the USGS stations are in China, operated jointly as the China Digital Seismic Network. They are supported by the US Defense Department's Advanced Research Projects Agency (ARPA) and contribute data to IRIS. ARPA supports most AFTAC and USGS stations.

them. Most of these data are used for commercial or scientific purposes and the sites are not necessarily operated by government agencies, but these stations are properly considered to be among the NTM of the host state, and are perhaps best thought of as international technical means. The stations in Finland and Norway operated in co-operation with the USA have been especially important for monitoring the former Soviet test site on Novaya Zemlya, because they are state-of-the-art arrays on the same geological plate as the test site.[13] Other states operating array stations include Australia, Brazil, Canada, Germany, India, Sweden, the UK and the USA.[14] An older station at Raratonga operated by New Zealand was able to detect and identify French nuclear weapon tests of inferred yields below 1 kt at the Mururoa site, despite much local seismic activity.[15]

Atmospheric monitoring

Radionuclides enter the atmosphere not only when tests are conducted above ground or underwater, but also from underground tests. Although not all underground tests vent to the atmosphere, venting or seeping is difficult to prevent with certainty, especially for organizations with less experience in nuclear weapon testing.[16] In addition to

[13] By 1992, these arrays gave the US Defense Department confidence that events at Novaya Zemlya could be monitored continuously to magnitude 2.7 for 99 per cent of the time, good enough to detect a fully decoupled 1-kt explosion. Alewine, R. W., 'Prepared statement' in US Senate, Committee on Foreign Relations, *Nuclear Testing Moratorium Act, S. 2064 and Other Nuclear Testing Matters* (US Government Printing Office: Washington, DC, 1992), pp. 5, 68. The experience of the CD's Group of Scientific Experts suggests that the detection threshold is even lower, between 2.0 and 2.5 on the Richter scale. Korhonen, H., 'Testing the components of the global seismological system for nuclear test ban monitoring', eds J. B. Poole and R. Guthrie, VERTIC, *Verification 1993: Peacekeeping, Arms Control and the Environment* (Brassey's: London, 1993), p. 106.

[14] Schmalberger, T., *In Pursuit of a Nuclear Test Ban Treaty: A Guide to the Debate in the Conference on Disarmament* (United Nations: New York, 1992), p. 71. Most of these are financed by and operated in co-operation with the UK or the USA. Ingate (note 12).

[15] Smith, W., 'New Zealand's role in nuclear detection', ed. Findlay (note 1), pp. 94–95. High-frequency regional arrays are roughly three times as capable as the older three-component stations. Korhonen (note 13), p. 106. The Raratonga station has since been upgraded with funds from the reparations France paid for the Greenpeace *Rainbow Warrior* bombing.

[16] The last and best known major venting at the US Nevada Test Site was associated with the 1970 Baneberry test, in which an estimated 248 PBq (6.7 megacuries) of radioactive material—more than 13 per cent of the amount released in the Chernobyl accident—was released and some carried into Canada, where it was detected and reported. Some 30 other US tests released radionuclides in amounts of the same order of magnitude between 1958 and 1970. Venting occurred in roughly one-third of the tests at the Soviet Semipalatinsk Test Site, now in Kazakhstan, and venting occurred as recently as 1989. US Congress, Office of Technology Assessment, *The Containment of Underground Nuclear Explosions* (US Govern-

its seismic stations, the US AFTAC AEDS also operates fixed atmospheric radiation monitors. As with seismic stations, other states operate atmospheric monitoring stations that are properly considered among their NTM, but do not dedicate them to monitoring nuclear explosions. Radiation can also be detected in samples collected by aircraft travelling in international airspace or designated corridors and by ships at sea.

Satellite surveillance

In addition to detecting preparations to test (see chapter 3), satellites can detect the test itself and its effects on the environment. Various Russian and US satellite sensors primarily intended to detect and locate nuclear explosions above the ground in the context of a nuclear war would also detect atmospheric nuclear weapon tests.[17] Underground nuclear explosions can cause subsidence craters or changes in surface characteristics, particularly if the surface is vegetated. These, in turn, can be observed by satellites or aircraft.[18] Satellite imagery can also help to locate a covert test and distinguish between possible tests and probable false alarms by, for example, checking to see if an event is within 10 km of a road or other evidence of human activity.[19]

Hydro-acoustic monitoring

Nuclear explosions detonated at sea (including on or beneath islands like the French site at Mururoa or the former US site at the Bikini Atoll) release energy into the water much as those on land release it into the ground. Although water is not solid, it is an incompressible fluid with excellent acoustic properties, so this energy can be detected

ment Printing Office: Washington, DC, 1989), p. 48; Kianitsa, V., 'Test anxiety', *Bulletin of the Atomic Scientists*, Oct. 1993, pp. 37–39; Birely, J. H., 'Prepared statement' in US Senate, Committee on Foreign Relations (note 13), p. 18.

[17] Arnett, E., *Antisatellite Weapons* (American Association for the Advancement of Science: Washington, DC, 1990), pp. 1–3.

[18] Skorve, J., and Skogan, J. K., *The NUPI Satellite Study of the Northern Underground Nuclear Test Area on Novaya Zemlya* (Norwegian Institute of International Affairs (NUPI): Oslo, 1992); Leitenberg, M., 'Non-seismic detection of underground nuclear tests', SIPRI, *World Armaments and Disarmament: SIPRI Yearbook 1972* (Almqvist & Wiksell: Stockholm, 1972), pp. 439-42.

[19] Fetter estimates that more than 90 per cent of seismic false alarms in Russia could be eliminated in this way. Fetter, S., *Toward a Comprehensive Test Ban* (Ballinger Publishing Company: Cambridge, Mass., 1988), p. 134.

at long distances, often as great as one-fourth of the Earth's circumference.

The US AFTAC operates a network of seabed acoustic sensors. The locations of these sensors are not known, nor is the sensitivity of the network.[20] It has been reported that US submarines operate in the territorial waters of hostile countries, in part to install intelligence-gathering equipment, and it would be reasonable to assume that hydro-acoustic sensors are among this equipment.[21] Most navies operate sonars that can detect energy at frequencies of interest for monitoring nuclear explosions. These sonars, meant primarily for detecting and tracking submarines, are carried by helicopters, ships and submarines, dropped in floating buoys from aircraft, and laid in networks on the sea floor. State-of-the-art sonars are extremely sensitive in order to counter the advances that have made submarines quieter, and advanced models are available to most states.[22]

Signals intelligence

At its simplest, SIGINT can detect a test or cue other means of verification by intercepting a message referring to it. At a more complex level, the detonation of a nuclear weapon test is the culmination of intense activity on the part of an organization that is likely to be large and in communication with other organizations. If an increase in communication coincided with a suspicious seismic event, it would strengthen the case that the event might be a nuclear weapon test, even if the messages were encrypted. If the event also occurred on the hour, for example, that would be a strong sign. Although organizations are not compelled to (and generally do not) test on the hour, coordination of activities makes setting a time necessary. Although a covert cheater might be expected to go to some lengths to avoid detection, common experience with planning in large organizations would lead one to expect that the possibility and consequences of such prosaic oversights cannot be discounted.

[20] Blackaby, F. and Ferm, R., 'A comprehensive test ban and nuclear explosions in 1985', SIPRI, *World Armaments and Disarmament*: *SIPRI Yearbook 1986* (Oxford University Press: Oxford, 1986), p. 123.

[21] Arnett, E., *Attack Submarines: Modernization, Proliferation, and Arms Control* (American Association for the Advancement of Science: Washington, DC, 1991); van der Vink *et al*. (note 10), p. II-9.

[22] Some 40 states operate submarines. See Arnett (note 21), p. 2.

Human intelligence

HUMINT encompasses a broad range of activities, from reading newspapers or government reports and interviewing officials to acts of espionage. While the aspects of HUMINT that are not sanctioned by international law are not protected or encouraged by any arms control treaty, they play an important role in any intelligence assessment, including those concerning compliance with treaty commitments.[23] HUMINT is unlikely to detect a test in the precise way NTM can and is unlikely to be shared publicly, at least in detail. Nevertheless, a state party to any treaty considering the option of cheating must weigh the possibility that illegal activities will be divulged by leaks to the press, defectors or similar means. In the case of Iraq, HUMINT regarding a defeated country was acquired not only from defectors, but also directly from the confiscated files of personnel working on a nuclear explosive device.

Information provided by HUMINT can detect the intention to test, preparations to test or details of the test itself. In some cases, specific information that can narrow the search for a covert test site may be available, even if information from technical means is insufficient by itself.

All states have the same basic ability to collect HUMINT. In practice, however, some states are more open than others. A hypothetical decision by officials in France, the UK or the USA to violate the CTB, for example, would probably first be detected in legislative hearings or newspaper reports long before the test ever occurred. A less open state may still be vulnerable to espionage, depending on *inter alia* the popularity of the government, the importance of loyalty in its national culture and the nature of its relationships with other nearby or culturally similar states.

[23] Although NTM are discussed more thoroughly in the arms control literature and are therefore implicitly seen as more important than HUMINT, US Director of Central Intelligence James Woolsey recently attempted to clarify the relative strengths of each: 'Gathering intelligence on closed societies involved in proliferation is a form of combined puzzle solving, using imagery, SIGINT and HUMINT. You never know which one will tip another one off. Spies tip off satellites, and satellites tip off spies.' Canan, J. W., 'Mr. Woolsey's neighborhood', *Air Force Magazine*, Apr. 1994, p. 45.

Other methods

In addition to the well established means discussed above, there has been some speculation that disturbances in the ionosphere caused by underground nuclear weapon tests could be detected by satellites or terrestrial radars. This technology is not yet proven and may be difficult to test in the absence of further nuclear explosions. The USA has suggested that several other technologies being developed at its national laboratories might be useful for monitoring compliance with the CTB, including: infrasound for underground and atmospheric tests and ground-based optical and electromagnetic pulse detection systems for detecting nuclear explosions in the upper atmosphere or outer space.

Private means

Before considering ways in which national means can be supplemented by multinational means tailored to the CTB, it is important to recognize the role of private data-gathering methods in any assessment of treaty compliance. Private technical means of verification have the advantage of being available to the public, including the governments of states not endowed with advanced NTM or sufficient access to HUMINT. A disadvantage is that some private means can be disrupted if they lose the favour of the hosting or sponsoring government.[24]

Seismic monitoring

Seismic stations are operated by a number of universities and other private organizations, primarily for earthquake monitoring. Although they are often sponsored by governments, they retain their independence and their data are available to the public. Many of these are involved in the network administered by IRIS, a consortium of about 80 research institutes.[25]

[24] A corollary issue is the possibility that government sponsorship can bias the gathering or release of data. While this is an issue of theoretical or political interest, it does not have a significant effect in the context of the CTB.

[25] IRIS will eventually operate 128 stations globally. Of these, 15 are already operating in the CIS (1 in Armenia, 2 in Kazakhstan, 1 in Kyrgyzstan, 9 in Russia, 1 in Tajikistan and 1 in Turkmenistan), and 4 more are planned for Russia. Sweet, W., 'IRIS and other open seismic networks could be crucial to test-ban regime', *Physics Today*, Dec. 1993, p. 36; and van der Vink and Park (note 8), pp. 634–35.

Nevertheless, even when complete the IRIS network alone is expected to provide only coverage to magnitude 5 or higher.[26] When augmented by data from the 2000 stations around the world contributing data to the USGS's open list of events, the threshold of reliable detection drops to magnitude 4 for most locations.[27] In all, there are more than 10 000 seismic stations in operation globally, including roughly 2000 in or around Russia and 200 in North America.[28] In October 1993, the US Congress appropriated $21 million to the National Science Foundation for additional IRIS stations and improvements to existing stations in regions of proliferation concern.[29]

Atmospheric monitoring

Atmospheric monitoring is a straightforward enterprise and can be undertaken with little fanfare almost anywhere. Although the freedom of private individuals to travel and collect samples is not guaranteed in all likely states parties to the CTB treaty, there is a sufficiently high probability of a detectable quantity of fission products venting from any underground explosion and being transported across an international border that any country considering covert testing is likely to be deterred or caught, especially if they have little experience with underground nuclear explosions.

Satellite surveillance

Many of the phenomena associated with underground nuclear weapon tests that can be observed by advanced high resolution Russian and US imaging satellites can also be observed at lower resolution by privately operated satellites such as the French SPOT satellite or by satellites operated by Russia and the USA from which they are willing to sell imagery.[30] Skorve and Skogan have demonstrated that publicly available satellite imagery can be used with seismic data to

[26] On the Richter scale, magnitude 4 corresponds roughly with a tamped (fully coupled) explosion of about 1 kt. A very demanding standard set by the US Defense Department during George Bush's presidency would mandate a network that would make the USA confident that an explosion greater than 1 kt detonated by any state of concern could be detected and located to within 10 km, even if it were fully decoupled (magnitude 2.5). Richards (note 8), p. 189. Sweet (note 25), p. 36.

[27] Sweet (note 25), p. 36.

[28] Arnett (note 1), p. 3.

[29] Sweet (note 25), p. 36.

[30] Skorve and Skogan (note 18); Gupta, V., 'Future Chinese nuclear tests on the horizon', *Trust and Verify*, no. 30 (July/Aug. 1992), p. 3.

locate tests to within 30–50 m in many cases, and no worse than 4 km in the case of the Novaya Zemlya site.[31]

Remaining requirements for multinational means

The CD's negotiating mandate specifies that the CTB must be effectively and internationally verifiable. In practical terms, this should mean simply that any state party can be confident that no other state party will be able to violate the treaty without its knowledge and having means to demonstrate non-compliance in order to redress its grievance. However, the obligation to negotiate international verification has been interpreted by some as necessitating an elaborate and costly network of multinational technical means. For example, the Swedish draft envisions robust seismic, atmospheric monitoring and hydro-acoustic networks, financed and operated by the IAEA. Even if the capital costs of these facilities can be kept low by working with existing stations, staffing costs for as many as several hundred stations would quickly become controversial. Other observers suggest a UN imaging satellite to monitor compliance with the CTB and other treaties. This analysis demonstrates that the treaty is better off without provisions for elaborate MTM (although some MTM are a good idea), and should instead recognize that national, multinational and private means are both effective and sufficiently international.

An implicit assumption of the proponents of elaborate MTM is that the Russo-US oligopoly on the most advanced NTM will prevent some states parties from getting access to information that might incriminate security partners of Russia and the USA. This supposition neglects the internal political dynamics of both countries. In particular, the extent to which sensitive US intelligence bearing on the alleged Israeli–South African nuclear weapon test of September 1979 has been made public seriously undercuts the case of those who speculate that Washington might be complicit in any state's covert nuclear weapon testing programme. The Office of Science and Technology Policy under the Carter Administration concluded that there had not been a nuclear weapon test, and the Defense Intelligence Agency and the Naval Research Laboratory dissented. From the perspective of the CTB negotiations, the most important point in the

[31] Their area of radius 4 km corresponds to a search area of about 50 km^2. Skorve and Skogan (note 18), p. 40.

affair is that US data were made public to such an extent that—if the same thing were to happen under the treaty—the CTB implementing authority would be likely (depending on decision procedures) to insist on a challenge inspection and there would be a basis upon which to discuss possible non-compliance. The political question of whether any state's security partners would support enforcement of a non-compliance policy if allegations were adequately demonstrated to be true is beyond the scope of any discussion of verification methods.[32]

A related concern is whether the possibility of the USA selectively releasing intelligence to control the agenda—as in the case of sharing satellite imagery of the North Korean nuclear complex at Yongbyon at a closed meeting of the IAEA Board of Governors—should lead the CTB implementing authority and the international community more generally to discount or disregard such intelligence.[33] Although Beijing and Pyongyang might wish it otherwise, even the unofficial disclosure (e.g., again, the closed presentation to the IAEA Board and later leaks to the press) of such information has affected, will affect and should affect assessments of treaty compliance. That anyone's leaks can focus the attention of the international community—witness the effect of the report in a small Lebanese newspaper that touched off the Iran–Contra scandal in the USA—should offer some consolation until NTM are more widely available.[34]

Seismic monitoring

The verification protocol to the Swedish draft specifies 53 seismic stations in 33 countries[35] to be linked into a network in support of the

[32] In general, it is useful to consider the value of additional information in the making of a decision such as one to enforce non-compliance policy. If such a decision must be taken by the UN Security Council, it may be difficult to persuade any of the permanent five members to support strong action against even a clearly non-compliant security partner. This holds true whether the hypothetical violator is, say, Israel or North Korea, and the security partner is China or the USA. Put simply, additional investment in verification technology, no matter how great, cannot undo the structure of power in the international system. See the discussion of demonstration and inspection in chapter 3.

[33] This is essentially the argument made by China and North Korea, although it is secondary to their central argument that North Korea has been singled out for an unprecedented special inspection and inconsistent treatment from the point of view of egalitarian non-proliferation norms.

[34] The assertion made by some, that the states possessing advanced NTM are obligated to transfer the relevant technology as a quid pro quo for joining the treaty, is both normatively and prescriptively untenable.

[35] An ambiguous passage (article 16) in the Protocol to the Swedish draft appears to obligate every state party to host at least one seismic station on its territory and obligate the

treaty.[36] The CD's Group of Scientific Experts (GSE) has since increased the size of the Alpha network to 58 stations in 34 countries (see table 4.1; Algeria, Colombia and Mexico have also been recommended). This 'Alpha' network, in constant real-time connection with the treaty's International Data Centre, would trigger the collection of data in a 'Beta' network of 100 other national and private stations reporting continuously to national data centres in a tiered approach.[37] Other stations would participate informally in a 'Gamma' tier as needed. Components of the Alpha network will be tested for the third time in GSETT-3, the next verification experiment, beginning in January 1995. While there is general agreement on the GSE's tiered approach to seismic monitoring, it is not clear that the GSE Alpha network will comprise the CTB Alpha network.

Given the open nature of national, multinational and private stations, the need for the implementing authority to take over the financing and operation of so many stations is difficult to demonstrate.[38] The Australian draft suggests that the implementing authority should simply 'co-ordinate' operations, whereas the USA says that stations should remain nationally owned and operated.[39] Further, since most recent and future stations are or will be digital, all their data will

implementation authority to provide at least one. If the treaty's supporters are successful in attracting as many signatories as the CWC or the NPT and this interpretation is correct, the Alpha network is likely to expand to as many as 200 stations, many of them completely unneeded.

[36] The Swedish draft would have these stations operated by the IAEA with funding raised according to the standard UN method (that is, proportional to gross national product, so that the USA would pay some 30 per cent of the costs). At present, only 19 are operational and 38 in 17 countries are committed to GSETT-3 (Group of Scientific Expert's Technical Test no. 3), the next verification experiment. Many of these stations are fully or partly funded by the USA. In the inspection protocol, the Swedish draft also provides for installation of seismic equipment at declared sites where explosions in excess of 100 t TNT equivalent are common.

[37] van der Vink and Park, (note 8), pp. 634–35. The International Data Centre was developed by the US ARPA and is already being tested with the operational stations. Richards, P. G., 'Testing the test-ban treaty', p. 189.

[38] From a broader perspective, the inclusion of many stations now providing scientific information to other users threatens to disrupt research efforts not directly related to the treaty. The Swedish draft provides for the implementing authority to change equipment and procedures at Alpha stations.

[39] The Australian draft also provides for the implementing authority to negotiate the level of compensation and support to be provided to each station with the host government. Although some states apparently see the establishment of Alpha stations on their territories as a sort of arms control pork barrel, the technology transferred and jobs created are so inconsequential that this consideration should not affect the design of the treaty. Since the list of Alpha stations is not an integral part of the treaty, it can be modified in response to increasing or decreasing concerns in any region.

be available to the CTB implementing authority just as quickly if they are Beta stations as if they are Alpha stations.[40]

While it is desirable for the Alpha network to be completed, completion should not be seen as a prerequisite for entry into force or effective verification. On the other hand, it would be preferable to have as many stations as possible in operation before entry into force in order to maximize operational experience and show states' support for the negotiations and the treaty's goals. To the extent that this is accomplished, the preparatory commission and implementing authority will not have to worry about the modalities of subsidizing the core of the network.

Atmospheric monitoring

The Swedish draft provides for the implementing authority to establish and operate a network of stations to monitor radionuclides in the atmosphere, but does not specify how many stations are necessary or where they should be located.[41] In addition to national and private capabilities, the IAEA already operates an international warning system for distributing emergency information about atmospheric radiation. The World Meteorological Organization (WMO) Global Environmental Monitoring Network, established in 1990, would link sites in 74 countries.[42] It is therefore difficult to justify a major investment in specialized stations for atmospheric monitoring, as long as existing stations and those in the WMO network provide data to the International Data Centre for analysis.

Satellite surveillance

The Swedish draft provides only for compiling and reporting satellite data provided by states parties and other sources, but others have recommended that a UN satellite be procured and launched to monitor compliance with the CTB and other treaties. Given other data available for monitoring compliance, a UN satellite is not required for

[40] Interestingly, since low-frequency teleseismic waves travel at a rate on the order of km/s, wave propagation is the limiting factor in data diffusion, not the bureaucratic status of stations in the global network. van der Vink and Park (note 8), p. 635.

[41] As with seismic stations, an ambiguous passage seems to mandate stations to be established and operated by the implementing authority in every state party.

[42] Sixteen are already participating. They form the basis of the atmospheric monitoring network in the Australian draft.

Table 4.1. The Alpha network as presented in the Australian draft treaty

State	Location/Station	Type
Stations committed to GSETT-3 as of 30 March 1994		
Brazil	Brasilia	Regional array
Finland	FINESA	Regional array
Japan	Matsushiro	Regional array
Norway	ARCESS	Regional array
	NORSAR, NORESS	Regional array
Pakistan	Islamabad	Regional array
South Africa	Boshof	Regional array
Spain	Sonesca	Regional array
United States of America	Texas	Regional array
	Wyoming	Regional array
Australia	Alice Springs	Teleseismic array
	Tennant Creek/Warramunga	Teleseismic array
India	Gauribidanur	Teleseismic array
Norway	Spitzbergen	Teleseismic array
Sweden	Hagfors	Teleseismic array
Australia	Coolgardie	3-component station
	Mawson, Antarctica	3-component station
	Stephen's Creek	3-component station
United States of America	Alaska	3-component station
	Arkansas	3-component station
	California	3-component station
	New York	3-component station
	Scott Base, Antarctica	3-component station
Stations not committed to GSETT-3, despite GSE recommendation		
China	Hubei	Regional array
Egypt	Luxor	Regional array
Germany	GERESS	Regional array
Russia	Norilsk	Regional array
Turkmenistan	Alibeck	Regional array
Canada	Northwest Territories	Teleseismic array
South Korea	Korean Research Array	Teleseismic array
Thailand	Thailand	Teleseismic array
Turkey	Turkey	Teleseismic array
Argentina	Paso Flores	3-component station
Bolivia	La Paz	3-component station
Botswana	Lombatsi	3-component station
Canada	Alberta	3-component station
	Manitoba	3-component station
	Northwest Territories	3-component station
	Quebec	3-component station
	Yukon	3-component station
Central African Republic	Bangui	3-component station
China	Hailar	3-component station
	Urumchi	3-component station

State	Location/Station	Type
Côte d'Ivoire	Dimbroko	3-component station
Denmark	Greenland	3-component station
Indonesia	Sumatra	3-component station
Kazakhstan	Aktubinsk	3-component station
Kenya	Nairobi	3-component station
Papua New Guinea	New Guinea	3-component station
Paraguay	Villa Florida	3-component station
Russia	Eastern Siberia	3-component station
	Khabaz	3-component station
	Peleduy	3-component station
	Zaleaova	3-component station

Source: CD document CD/NTB/WP.49, table 1, pp. 23–25.

effective international verification of the CTB, especially if it is no more capable than those already providing imagery on the open market.

Hydro-acoustic monitoring

The Swedish draft provides for the implementing authority to establish and operate a network of hydro-acoustic stations, but does not specify how many stations are necessary or where they should be located.[43] The USA has offered two of its older undersea arrays for incorporation into the CTB verification network. The idea of deploying a new network capable of monitoring every possible testing site in the world's seas with static monitoring stations is much less attractive than taking advantage of the inherent flexibility of seaborne or air-deliverable sonars that can be quickly moved to areas of possible test activity identified by other means.

On-site inspections

The CTB treaty must provide for two general types of inspection, which can be categorized as *routine* inspections and *challenge* inspections. Routine inspections allow the states parties to monitor permit-

[43] In contrast with the ambiguous passages on seismic and atmospheric monitoring stations, the relevant passage makes clear that the implementing authority has some discretion over where it will operate hydro-acoustic stations.

ted activities regularly through the implementing authority in order to assure themselves that violations are not being masked by legitimate activities.[44] Challenge inspections are intended to provide the states parties with an opportunity through the implementing authority to collect additional information regarding suspicious events.[45] The possibility of a challenge inspection provides an additional deterrent to any organization considering the option of covert nuclear weapon testing.

Routine inspections

The Swedish draft provides for routine inspections of all explosions in excess of 500 t (0.5 kt) TNT equivalent and sites where explosions in excess of 100 t TNT equivalent are detonated frequently. The International Data Centre would catalogue all explosions in excess of 100 t TNT equivalent (of the order of tens of thousands every year). These provisions, if accepted by the other members of the CD, would simplify the problem of distinguishing between covert nuclear weapon tests and industrial explosions. Such provisions were not included in the Australian draft. Both routine inspections and notifications were seen as too costly for their marginal deterrent and confidence-building effect, given that there are less formal but workable alternatives. If routine inspections are not provided for in the treaty, it is possible that challenge inspections will become more frequent, an eventuality that the commentary associated with the Australian draft would prefer to avoid.

A second type of routine inspection would be required if hydronuclear experiments were banned by the treaty and if compliance with that ban were meant to be monitored effectively (as suggested in chapter 2). Unless hydrodynamic experiments were banned as well,

[44] Similar inspections are provided for in the CWC, to minimize the probability that chemical warfare agents might be produced at industrial facilities producing other materials. The CWC and other treaties (e.g., the START treaties) also provide for inspections to verify data declarations and monitor dismantling and destruction. These are not necessary for a CTB. Confidence-building inspections of current and former test sites have also been mooted.

[45] Challenge inspections are provided for in the CWC and other treaties. In addition, the Swedish draft encourages states parties to invite the implementing authority to inspect ambiguous events that occur on their territories, even if they have not been directed to accept challenge inspections. In general, it seems reasonable to assume that once the CTB enters into force any state publicly accused of conducting a nuclear weapon test would be expected to allow relevant information to be gathered, regardless of how the treaty is worded. Whether or not a non-compliant state party would submit to inspection is another matter.

an unlikely prospect, facilities in several countries at which HDEs or similar experiments are or could be conducted would have to be inspected regularly to assure other states parties that none were HNEs. Such an inspection regime would be expensive and intrusive and would only deter non-compliance at the sites inspected, not at other, potentially covert sites. For many observers, avoiding such an inspection regime (or a series of challenge inspections that had the same effect) would be the main reason not to include an explicit or implicit ban on HNEs in the CTB treaty or its negotiating history. Threshold states not party to the NPT and seeking to protect the carefully cultivated ambiguity surrounding their nuclear programmes (not to mention munitions industries) are likely to be at least as uncomfortable with such inspections as the declared nuclear states.

Challenge inspections

The Australian and Swedish drafts limit the area to be searched in any challenge inspection to no greater than 1000 km^2,[46] all of which must be within 25 km of a central point. Seismic methods can locate an event to within 10 km^2.[47] Airborne and ground-based sampling in a region so identified could collect evidence consistent with a nuclear weapon test, including air and soil samples and measurements of earth and ground-water displacements, but such evidence would not always resolve lingering uncertainties or be compelling to a sceptical or hostile audience. This is not to say that there would never be compelling evidence, only that inspections will not necessarily make or break the case for either the state party accused of non-compliance or the accuser. Samples collected at a test site operated before the CTB is concluded would be ambiguous.[48] As a result, challenge inspections in the context of the CTB are sometimes seen as primarily political in nature.[49]

China, Israel and the USA, among others, have expressed concern about abuse of challenge inspections to harass the nuclear weapon states, collect intelligence or interfere in a state party's internal affairs.

[46] A circle of area 1000 km^2 has a radius of 18 km.

[47] Fetter (note 19), pp. 134.

[48] These sites in Algeria, Australia, China, India, Kazakhstan, Russia, the USA and the Pacific Ocean could be declared and closed.

[49] Fetter goes so far as to claim that a cheater's unwillingness to accept an inspection is likely to offer more compelling evidence of non-compliance than anything collected during an inspection. Fetter (note 19), pp. 132–36.

Indeed, personnel with appropriate experience to work as inspectors are in high demand and scarce supply, and it is likely that the skilled-labour pool drawn upon will include current or past intelligence operatives, some of whom will return to intelligence work with improved credentials.[50] Similar concerns informed the CD's negotiations on the CWC, which forms the basis of the relevant passages in the Australian draft, and will no doubt affect the structure and decision protocols of the implementing authority. In the Australian draft as in the CWC, a challenge inspection must be based on a reasonable suspicion, as judged by the Director-General of the implementing authority,[51] and can be blocked if three-quarters (31 of the 41 members in the case of the CWC) of the Executive Council consider the inspection request frivolous, abusive or beyond the scope of the treaty. Further, if the inspection reveals evidence that the request was abusive, the requesting party may be penalized. Some CD members and observers see even this as creating too strong an obligation to submit to inspections and would prefer a process of consultations that might result in an invited inspection to resolve lingering doubts.

III. Conclusion: providing for verification in the treaty

If every additional increment of verification capability supports the treaty's technical goals of detecting, deterring and demonstrating non-compliance, the issue is less clear when it comes to the treaty's political goal of securing signatures and ratification. Including what are arguably unnecessary multinational capabilities does help governments assure themselves, their publics and legislators that the treaty can be verified effectively, but may also put them in the position of having to foot their share of the bill for what might be seen as an unduly expensive treaty. Presenting this trade-off will be a particularly thankless job if refining the verification provisions delays the conclusion of the treaty beyond the immediate negotiating goals

[50] The most prominent example of this phenomenon must be US Major-General Roland Lajoie, who directed the US On-Site Inspection Agency, the part of the US Defense Department created to implement the 1987 INF Treaty and now responsible for all US inspection obligations, and is now associate deputy director of operations in the US Central Intelligence Agency Directorate of Operations. Canan (note 23), p. 46.

[51] In principle, the Director-General could act as a first filter of inspection requests. Most observers see his or her role as primarily administrative. In practice, the balance will be determined by the politics of the implementing authority and the individual chosen for the position. See chapter 5.

offered by the 1995 NPT Review and Extension Conference and the Hatfield Amendment's 1996 US testing cut-off.[52] From this perspective, additional investments in MTM beyond a modest role in the international seismic network to complement national, multinational and private capabilities and an international data centre with some collection and analysis capabilities are difficult to justify.

More importantly, the inspection regime must not be so intrusive that key states, in particular the three threshold states not party to the NPT, are reluctant to sign and ratify it for fear of endangering their postures of nuclear ambiguity. India and Pakistan are unlikely to allow the CD to come to consensus on such a treaty, even if the states openly possessing nuclear weapons do so. Israel, which is not a member of the CD, is unlikely to sign or ratify such a treaty. Without Israel in the regime, it is unlikely that the states already critical of its exceptional position in the region would sign, including several other states of proliferation concern. For this reason, provisions for on-site inspections must be drawn conservatively, and it would seem desirable to make clear in the negotiating record that preparations and suspected HNEs will not be considered sufficient cause for intrusive challenge inspections.

[52] The issue of timely completion can be finessed if the verification provisions are left in a binding protocol that need not be finished at the time of signing, but there are drawbacks to this approach. If there is a remaining possibility that the protocol will mandate creation of unnecessarily expensive multilateral means, the treaty's ratification and entry into force are likely to be delayed until concerns are resolved, even if states are willing to sign. Further, the experiment in fleshing out the finer details of a treaty between signature and entry into force conducted by the CD and the PrepCom in the case of the Chemical Weapons Convention demonstrates that the task is not simple and may embarrass negotiators and signatories by delaying entry into force. Stock, T., 'The Chemical Weapons Convention: institutionalization and preparation for entry into force', *SIPRI Yearbook 1994* (Oxford University Press: Oxford, 1994).

5. Organizing for effective implementation

Patricia M. Lewis

1. Introduction

Effective implementation of the CTB treaty will be critically dependent on a number of organizational aspects of the treaty. The most important of these aspects is the organization of the verification regime and responses to suspected non-compliance. Years of study have gone into the technologies for verifying compliance with a CTB. If the verification provisions are not embedded in an effective structure of organizations and procedures, those years could go to waste. The CTB has the potential to become the most successfully implemented treaty in history, but great care must be taken to structure the implementation provisions so as to maximize this potential.

In order for implementation of the treaty to be considered effective, it must meet certain criteria. Many of these criteria will be affected as much by the organization responsible for implementing the treaty, referred to in this report as the 'implementing authority', as by the treaty text and its associated protocols and negotiating history. This chapter first considers the criteria by which implementation should be judged, then elucidates and examines proposals for an appropriate implementing authority.

II. Criteria for effective implementation

Clearly, if the CTB treaty is to be implemented effectively, it will have to be verifiable. A number of delegations and observers to the CD have specified that verification must not only be effective, but also international, suggesting that means for monitoring compliance must be multinational (as discussed in chapter 4) and that procedures for deciding when to inspect and how to solve problems and settle disputes must be multilateral and non-discriminatory. Effective verification may also require timely decision making to ensure that inspection teams can quickly reach sites related to suspected non-compliance. While all of these are desirable, CTB negotiators are increasingly sensitive to the cost of implementation.

A multilateral, non-discriminatory structure

Considering the amount of time and effort that have gone into trying to achieve a CTB treaty over the past four decades, it is legitimate to wonder whether there is anything new to contribute to the discussions over organization. The current re-examination of the organizational aspects of a CTB treaty is the result of the end of the cold war. No longer can the old assumptions be taken for granted about what may or may not be acceptable to Russia, the USA or any other state. One of Moscow's former nuclear weapon test sites is now located in another country, and there has been a sea-change in attitudes towards transparency and on-site inspections over the past few years. The old concept of relying entirely on national means no longer holds, and multilateral aspects of implementation have come to the fore. It is not acceptable today, as it may have been in the 1960s and 1970s, for three nuclear weapon states to negotiate a treaty on nuclear testing and expect the rest of the world to come on board. Many more nations have expertise and experience in global seismic monitoring, radionuclide monitoring and satellite or aerial image analysis. As they improve their national verification means, many more states are being given a say in the way the treaty is to be structured and implemented by the decision to negotiate it at the CD.

What this means in practical terms is that states parties will have access to data from a multilateral monitoring network in addition to whatever data are available from national, multinational and private means. It is also likely that they will be given assistance in interpreting those data by the staff of an International Data Centre. Acquisition and interpretation are only the beginning of the story, however. States parties will expect procedures for initiating inspections, resolving disputes and handling non-compliance to be equally accessible to all and not unduly favour either the more powerful states or those with a particular nuclear capability.

Timely decision making and inspection

For verification to be effective as a deterrent at a high level of confidence, procedures for data collection need to be fast, efficient and thorough. This is quite a new field for international co-operation and heavy reliance will be placed upon the experience of the IAEA and recent work of the Organisation for the Prohibition of Chemical

Weapons. In order to maximize the deterrent capability of available detection methods, a rapid response to an ambiguous event or suspicious activity is essential. This is particularly true in the case of on-site inspections. Seismic after-shocks, potentially of considerable significance for discriminating between explosions and earthquakes, must be measured soon after an event, preferably within about two weeks, ideally within hours.

It may be less difficult to conduct inspections quickly if they are seen as routine and less politically charged. If a request for inspection comes from one of the states parties to the treaty, it could be construed as being political in nature and possibly even for espionage purposes. For that reason it would not be reasonable to make challenge inspections mandatory, unless there is a mechanism for blocking or punishing abusive inspections. Another approach would be to give the implementing authority the capability and right to determine when an inspection is appropriate without any request, data or suggestion from the states parties, in addition to responding to requests from states parties.

Start-up and operational costs

Although most negotiators would agree that multilateral verification, non-discriminatory decision making, and prompt, non-confrontational inspections are desirable, there is a limit to what they are willing to pay for what might come to be seen as too much of a good thing. Not only would the cost of excess be fiscal, although that is a major concern, but overly ambitious plans might also delay completion of the treaty, creation of the implementing authority, signature, ratification and entry into force. Anything that can be done to speed up the negotiating process without damaging the long-term effectiveness of the implementing authority would be an advantage. Finally, some potential states parties might be concerned that aspects of the organization and procedure might take a toll on their security if they are seen as too intrusive or discriminatory in a way that can be manipulated by their enemies.

III. Proposals for the CTB implementing authority

The two types of framework that have been proposed for the CTB implementing authority can be categorized roughly as *centralized* and *decentralized*. The 1983 Swedish draft proposed a decentralized framework, with a multilateral discussion forum but little responsibility delegated to the organizations created to support the treaty regime.[1] In contrast, the 1991 Swedish draft, the 1991 draft PTBT Amendment Protocol[2] and the 1994 Australian draft structured the monitoring activities related to verifying compliance in a centralized framework with a new organization. In the draft PTBT Amendment Protocol, the implementing authority would act autonomously, initiating inspections as well as responding to requests from states parties, whereas the Australian draft provides only for inspections upon request. The 1993 Swedish draft also includes a centralized framework, and envisages the IAEA playing the central role. The Australian draft borrows many elements of the OPCW, making use of IAEA capabilities where appropriate. These proposals are considered below in roughly increasing order of centralization and organization autonomy.

The decentralized framework

The 1983 Swedish draft proposed that each state party 'use national technical means at its disposal' and undertake 'to co-operate in good faith in an effective international exchange of seismological [and other] data'. Although this option has fallen from favour, it is worth discussion for two reasons. First, there are still those who believe that the decentralized approach is viable and even preferable to centralized approaches. Indeed, it would have been agreed by the parties to the

[1] Throughout this report, the 1993 Swedish draft is referred to as 'the Swedish draft'. The discussion in this chapter also refers to the 1983 Swedish draft and the 1991 Swedish draft, as well as the 1991 draft PTBT Amendment Protocol and the Australian draft, which was submitted in 1994. The 1983 Swedish draft was submitted as CD document CD/381, 14 June 1983. See also Goldblat, J., 'Multilateral arms control efforts', SIPRI, *World Armaments and Disarmament: SIPRI Yearbook 1984* (Taylor & Francis: London, 1984), pp. 594–601. The 1983 draft was an expanded version of a 1977 Swedish draft presented to the Committee of the CD as document CCD/526.

[2] CD documents CD/1089, 31 July 1991 and CD/1054, 4 Feb. 1991, p. 14. Both drafts are discussed in Goldblat, J., 'Nuclear explosions and the talks on test limitations', *SIPRI Yearbook 1992: World Armaments and Disarmament* (Oxford University Press: Oxford, 1992), pp. 111–16.

1977–80 Tripartite Negotiations—the UK, the USA and the Soviet Union—and therefore the basis of the CTB today if those negotiations had borne fruit. Second, it is important to understand why the decentralized approach is no longer found to be compelling by others.

The decentralized framework was proposed under international conditions different from those which exist today. It relied upon the states parties undertaking to exchange information with each other through national bodies. The primary concern that informed the design of the framework was cost and a preference not to create an ungainly bureaucracy. The structure would have been centred around a Consultative Committee, on which all states parties to the treaty would have the right to be represented, and a Technical Committee drawn, in part, from the existing CD Group of Scientific Experts. The Consultative Committee, where common standards for collection and storage of relevant data would be discussed and agreed, would also act as a channel for inspection requests by the states parties and be supported by a permanent Secretariat as well as a Technical Committee. The Technical Committee would suggest procedures for data collection and storage, including the development of new parts of the verification network. The Secretariat would be responsible for administration, including inspections, the status of seismic stations, data storage at International Data Centres and liaison with the national body of each state party.

The relatively free exchange of geological data essential to the decentralized model is already well established, in part because seismic signals do not respect national boundaries and have considerable significance outside defence interests. There is no comparable exchange of satellite imagery, which is less freely available. Nor are satellite data likely to become more freely available without a specific treaty obligation.[3] This would not have been a problem if the CTB were to have only three states parties, but it goes to the heart of the matter of multilateral and non-discriminatory implementation. Images from commercial satellites bought by states parties could be shown to other states to support a compliance decision supported by the purchasing state. Otherwise data from satellites might not be shared among all the states parties. A three-tier system might result: states

[3] The 1993 Swedish draft would oblige states parties to supply any data relevant to an ambiguous event, but such a strong requirement seems unlikely to be included in the CTB or any other treaty.

with access to European Space Agency, French, Japanese, Russian or US data; states with access to Chinese or Indian data; and states without access to any data at all.

Even if a decentralized data-collection system worked well in a politically benign climate of international relations, procedures would be complicated in a more adversarial context. Accusations of data falsification would be difficult to disprove. Inspections, always an onerous task, would be difficult to organize. Within the decentralized framework inspections would less likely be timely, undermining their effectiveness and credibility. In the decentralized framework of the 1983 Swedish draft, the decision to carry out a challenge inspection could be made in one of two ways: a request would come from one state party to another bilaterally and be accepted or refused, or the request would come from a state party to the Consultative and Technical Committees. After consultation, they would carry out the inspection on behalf of the requesting party. If the state party under investigation agreed to the request,[4] the Consultative Committee and the Technical Committee would discuss with the GSE how to go about the inspection. They would analyse seismic records and agree upon the basis for the inspection. Even assuming that the committees could meet with very little notice, the discussion procedure might be lengthy and valuable time could be lost. The 1983 Swedish draft allowed up to one month after the party under investigation agreed to accept the inspection, which it would be free to refuse.

The centralized framework

Under a centralized framework, the CTB treaty would create an authority with greater responsibility for implementation than the committees envisaged in the decentralized approach. The 1993 Swedish draft envisaged what might be seen as a minimally centralized authority, responsible for little more than collecting and disseminating data and conducting inspections, although the ability of the IAEA as implementing authority to analyse data might be exploited. In explicit contrast, the Australian draft follows the 1991 Swedish draft in providing for the implementing authority to analyse

[4] In 1983, the pre-Gorbachev Soviet Union still would not allow inspections without a right of refusal. This right has been reconsidered in the post-Gorbachev era, although some CD members and observers still have qualms about mandatory inspections.

data as well as collect and disseminate them and conduct inspections, allowing all states parties to compensate for any lack of relevant expertise. The 1991 draft PTBT Amendment Protocol goes the furthest by allowing the authority to initiate an inspection based on its own data and analysis.

The IAEA in the centralized framework

The IAEA statute states the two objectives of the Agency as: 'to seek to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world' and to 'ensure, so far as it is able, that assistance provided by it or at its request or under its supervision or control is not used in such a way as to further any military purpose'.[5] In addition, the Agency is to act 'in conformity with the policies of the United Nations furthering the establishment of safeguarded worldwide disarmament and in conformity with any international agreements entered into pursuant to such policies'. From this point of view, monitoring compliance with the CTB treaty is in line with the Agency's statutory objectives, but it is not necessarily the best option.

The IAEA Board of Governors has 35 member states.[6] Thirteen members are designated as states most advanced in the technology of atomic energy, including the production of source materials. The Board is composed of states some of which may not be party to the CTB, and most states parties to the treaty will not sit on the Board, which is created by a separate procedure. The same situation obtains in the case of the NPT, for which the IAEA Board has been the authority responsible for safeguards and inspections. NPT safeguards are almost the same as the IAEA safeguards on nuclear exports which had been in place for a decade prior to the NPT's completion, but the IAEA has little or no experience with some of the tasks to be undertaken by the CTB implementing authority.

The IAEA as implementing authority. In response to the 1993 Swedish draft proposal that the IAEA be given responsibility for

[5] Statute of the International Atomic Energy Agency (as amended up to 28 December 1989), IAEA, Vienna, June 1990, Articles II and II, para. B1.

[6] IAEA Board Members 1993–94: Argentina, Australia, Brazil, Canada, Chile, China, Colombia, Cuba, Egypt, Ethiopia, Finland, France, Germany, Hungary, India, Indonesia, Ireland, Italy, Japan, Lebanon, Libya, Malaysia, Nigeria, Paraguay, the Philippines, Poland, Russia, Saudi Arabia, Sweden, Switzerland, Syria, Tunisia, Ukraine, the UK and the USA.

implementing the CTB, the CD invited the IAEA to present information relevant to the proposal. In February 1994 Mohammed El Baradei of the IAEA presented a working paper to the CD.[7] In the presentation, he laid out the IAEA's view of the technical requirements of the verification regime and the relevant capabilities, legal standing and in-house expertise of the Agency. In addition he addressed the financial and administrative implications of the proposal. Since then, there have been a number of other presentations from the IAEA to the delegations at the CD, along with a large number of other expert presentations.

Under the provisions of the 1993 Swedish draft, the IAEA would be required to co-ordinate the international monitoring regime, including the analysis and exchange of seismic and other data. If questions were to arise, the IAEA would request additional data from the states parties. If there were still no resolution to the discrepancy, the IAEA would carry out a challenge inspection. The 1993 Swedish draft also envisages the IAEA monitoring all non-nuclear explosions greater than 500 t TNT equivalent through inspections and routinely inspecting sites where explosions greater than 100 t are common. All of these explosions would be announced and logged at the IAEA's International Data Centre. No other routine inspections are provided for in the Swedish draft,[8] and Baradei's presentation did not address the issue of prompt response to requests for challenge inspections.

The technical expertise of the IAEA has some overlap with the needs of a CTB verification regime. In the area of monitoring airborne radioactivity, for example, the IAEA has experience as well as expertise. The IAEA uses the World Meteorological Organization for its Emergency Notification System, a 24-hour global information service. It has some limited expertise in seismic measurements for determining the safe positioning of nuclear facilities in the Mediterranean region, studies of local earthquake monitoring and recruitment of seismologists. The IAEA has extensive experience in photo- and video-image analysis which may have some application to verification of a CTB treaty, but little experience with satellite imagery. Baradei cited

[7] *Working Paper with Information and Comments on the Relevance of the IAEA's Mandate and Capabilities to the Task of Verification of Compliance with a Comprehensive Test Ban Treaty* (IAEA: Vienna, Feb. 1994).

[8] Recall that inspections might be required if HNEs were explicitly banned by the CTB. The 1993 Swedish draft contains wording which could preclude HNEs, but by not providing for routine inspections of sites where HNEs could be conducted, leaves the issue to challenge inspections. See chapter 4.

the IAEA's strengths in laboratory analysis relevant to assessing samples retrieved during challenge inspections, although its capability would need to be expanded for the CTB. He noted that the IAEA sees itself a pioneer in developing and conducting inspections. His paper points out the range of on-site inspections carried out by the Agency, from a single inspector for routine inspections to a 30-strong team for UNSCOM–IAEA inspections in Iraq following the 1991 Persian Gulf War.

Aside from some demonstrated competencies, the financial and administrative implications, especially the ability to put the elements of the regime in place upon completion of the treaty, are the most attractive aspects of accepting the IAEA as the implementing authority. The IAEA already exists; it has a building and a working infrastructure. There would be no negotiations over premises like those that have bedevilled the start-up of the OPCW, but by dint of the fact that the IAEA does not have vast amounts of office space to spare, the part of the organization devoted to the CTB would necessarily remain small and overworked. On the other hand, the 1993 Swedish draft provisions for many inspections and massive data notification (an estimated 100 pages per day of seismic activity alone) might require a larger area, which might then lead to the very lease negotiations and other starting pains that were to be averted. The incremental costs for the IAEA are likely to be less than the start-up costs of a new organization, and therefore more resources could be put into the regime itself.

On the other hand, critics point out that the IAEA has little experience with seismic data interpretation and none on the scale required for monitoring the CTB. They also point out that one of the key problems the IAEA has faced in the past few years has been the adjustment from a cold-war framework to new international political structures. From that point of view it would be healthier to set up a separate organization.

The IAEA as a subcontractor. An alternative proposed in the commentary accompanying the Australian draft would establish 'a small separate CTBT Organization, collocated in Vienna with the IAEA, which would be able to contract out certain technical and administrative and conference support tasks to the IAEA'.[9] The intent was to

[9] See chapter 1, note 8.

capture the advantages offered by the IAEA while avoiding the disadvantages. Other possibilities include collocating the implementation activities with the OPCW in the Hague or the WMO in Geneva. All such proposals should be explored from mid-1994 to see which option presents the least difficulties and best prospects for effective verification. Although Sweden still stands by its recommendation, the option of entrusting the IAEA with the CTB has lost much of what support it had over the first months of 1994. Australia's approach of treating the IAEA as a subcontractor had increasing support in July 1994.

The Australian approach to centralization

The Australian draft not only addresses the concerns that many have over the IAEA but also takes into account the lessons of the OPCW. It provides for the implementing authority to analyse seismic, radionuclide and other data, rather than simply facilitate the exchange of data among states parties. In contrast with the 1993 Swedish draft, it envisages the implementing authority co-ordinating the activities of monitoring stations, but not financing or running them, on a case-by-case basis, primarily to save money. It also assumes that the CTB is unlikely to require routine inspections, so there is no need for a large cadre of permanent inspectors to be recruited and employed by the organization. While this may well be true, there are some inspections that might be necessary (monitoring large industrial explosions or closing declared test sites, for example), unless other means of resolving ambiguities can be worked out, as suggested in the draft's accompanying commentary (see chapter 4).

Experience from the IAEA, UNSCOM and other verification activities strongly suggests that inspectors should work or train together frequently as a team; otherwise it is difficult to create the necessary unit cohesion when carrying out an inspection. Inspection missions, delicate and politically sensitive even at the best of times, have certain irreducible difficulties. These can be aggravated when inspectors do not know their team-mates well. Although the CTB's inspection effort will be small in comparison with NPT safeguards or CWC inspections and the implementing authority will most likely simply maintain a roster of expert inspectors made available by the states parties, it is crucial that inspectors be trained together, with routine or practice inspections being held as often as possible.

Under the Australian modification of the CWC procedure for handling ambiguous events, any state can request an inspection. During the following 12 hours, the Director-General must ascertain that the request is not obviously frivolous or abusive and the Executive Council, made up of an as yet unspecified number of states parties, will convene. If the Director-General or three-fourths of the members of the Council judge that the request is patently frivolous or abusive, it will be blocked. Otherwise, it will be carried out by the Technical Secretariat, with the inspection team to arrive as soon after the expiration of the 12 hours as is feasible.[10] The confidence of states parties that they will not be subject to inappropriate inspections would thus depend as much on the judgement of the individual chosen as Director General and the composition of the Council as on treaty provisions and procedures. States with few allies might find it difficult to arrange a three-quarters blocking majority unless the inspection requested seemed to set an equally unpopular precedent.

For these reasons, the power of the Director-General and the composition of the Executive Council have been controversial. Most negotiators see the office of Director-General as exclusively administrative, with very little latitude for making judgements about requests for inspection. A strong personality in the office might strengthen that role under favourable political circumstances, however. While some negotiators see it as desirable, if not inevitable, that the five openly declared nuclear weapon states sit permanently on the Council, there are problems with such a provision. Since some members of the CD object to what they see as the discriminatory nature of the NPT and UN Security Council, neither of these can be used as the basis for creating permanent seats on the CTB Executive Council. On the other hand, simply specifying that states possessing nuclear weapons would be permanent members of the Council would touch on the delicate issue of Israel's status as a nuclear weapon state and contested candidate for CD membership. Some negotiators feel so strongly that the very idea of an Executive Council entails irresolvable biases and complexities that they would rather do away with it altogether and refer all questions to the Conference of States Parties.

[10] The 1991 Swedish draft had allowed 7 days for the initiation of challenge inspections upon a state party's request, plus 24 hours for transportation from a point of entry to the area to be inspected.

The OPCW as an example

If a new organization is to be created as the CTB implementing authority, it is likely to look very much like the OPCW in important respects. While many of the tasks are different and there have been complications in setting up the OPCW, it was created by the same delegations that are negotiating the CTB and they will be addressing similar problems, especially regarding challenge inspections. In fact, the Australian draft explicitly marries the strongest elements of the CWC and the 1991 and 1993 Swedish drafts. This discussion highlights some difficulties encountered in creating the OPCW that should be borne in mind as the CTB negotiations come to a conclusion.

Immediately following the CWC signing ceremony, the Preparatory Commission (PrepCom)—a mechanism devised to allow details to be resolved following the conclusion of negotiations—set to work. Two Working Groups were established: one to deal with organizational and fiscal issues and another to deal with technical issues. A number of Expert Groups stemming from the Working Groups are to recommend particular courses of action. During the first session of the PrepCom, the Provisional Technical Secretariat was established, which, by the end of 1993, had 78 staff members from 34 member states.

Criticism of the PrepCom's procedure has been rife. In the first place, as with any UN-family organization, the process of making appointments was protracted by the need to achieve a representative geographical and political spread without compromising competence. This will be true for any CTB implementing authority, too. Simple matters like finding appropriate office space and securing proper leases bogged down the process of setting up the OPCW.[11] Similar problems might be avoided if the designers of the CTB regime can learn from the experience of the OPCW.

In any event, the CTB implementing authority will not follow the OPCW so closely that parallels can be drawn in all areas. The CWC is far more complex than the CTB will be. The verification tasks of the OPCW include challenge inspections of suspect sites and routine inspections of declared sites including:

[11] Stock, T., 'The Chemical Weapons Convention: institutionalization and preparation for entry into force', *SIPRI Yearbook 1994* (Oxford University Press: Oxford, 1994).

43 CW production facilities
33 storage facilities
3 destruction facilities
40 old and abandoned CW sites
75 Schedule 1 facilities
300+ Schedule 2 facilities
400 Schedule 3 facilities
5000+ other chemical production facilities.[12]

Because of the complexity of the CWC and the daunting task set for the verification regime, the treaty cannot come into force before 13 January 1995 and not before 65 states have ratified it.

Setting up the CTB verification regime will be simpler than setting up the OPCW in other ways. The GSE has already done much of the spadework, building on more than three decades' study. Further, there are not the same sensitivities over seismic signals and other aspects of CTB verification as there are over commercially valuable chemical sites.[13] Seismic signals are detected and analysed routinely all over the world and the global seismic network and International Data Centre are already in operation on a provisional level (see chapter 4).

An autonomous authority?

The main difference between the centralized and decentralized frameworks as they have been proposed is the capability and independence of the implementing authority. The draft PTBT Amendment Protocol proposed taking the process a step further and making the implementing authority autonomous; that is, it would not only collect and analyse data itself and carry out routine and requested inspections but it would also be able to initiate inspections of ambiguous events. This would give the authority both flexibility and independence.

The decision to carry out an inspection could be made more quickly and be based solely on technical information. The same decision under the decentralized approach of the 1983 Swedish draft could involve delays as long as one month to allow for consultation. The

[12] Mathews, R. J. and Taubman, A. S., 'Preparing for implementation of the Chemical Weapons Convention: progress during 1993', eds J. Poole and R. Guthrie, VERTIC, *Verification 1994—Arms Control, Peacekeeping and the Environment* (Brassey's: London, 1994), p. 117.

[13] Inspections of sites where HNEs could be conducted would be as or more sensitive an issue than inspections of chemical facilities, as discussed in chapters 2 and 4.

Australian draft's approach to the centralized framework provides only 12 hours to block an inspection once it is requested by a state party. Although the draft PTBT Amendment Protocol did not envisage such complete independence, an autonomous authority could cut out this 12-hour delay, but would be accountable to the states parties after the fact through reports to the Conference of States Parties and to the United Nations.[14] Since the inspection would not necessarily involve a request from a state party, tantamount to an accusation, the inspection procedure might not be as politically charged.

Some states may be reluctant to turn over the decision to inspect to a bureaucracy that was accountable only after the fact, as recognized by the provision for appeals. Key states of proliferation concern may see a UN-family bureaucracy as more rather than less politically charged and vulnerable to manipulation in unfair ways than one responsive to requests from all states parties and subject to procedures for blocking inspections, as evidenced by Iraq's relationship with the UN Special Commission on Iraq and North Korea's relationship with the IAEA.[15] The nuclear weapon and threshold states may be uncomfortable letting an autonomous authority make its own judgements about the treaty's intention in areas like HNEs and preparations. The draft PTBT Amendment Protocol avoided this concern by specifying that ambiguous evidence of an event had to be consistent with a nuclear weapon test of yield greater than 1 kt. Finally, the autonomous approach would require the implementing authority to have continuous access to a broad range of data, suggesting that it might be more expensive to implement and slower to start up than the Australian draft's co-ordination approach to centralization.

[14] The draft PTBT Amendment Protocol allowed for a 24-hour delay upon the arrival of the inspection team in the country. It also provided for the inspected state to appeal the decision of the authority to the Conference of States Parties, which could block the inspection with a two-thirds majority. Such an appeal would also delay an inspection.

[15] Some North Korean officials hold the position that their country is in a state of war (albeit suspended) with a group of countries led by the UN and the USA. Pae S. H., 'North Korea', ed. E. Arnett, SIPRI, *Nuclear Weapons after the Comprehensive Test Ban: Implications for Modernization and Proliferation* (Oxford University Press: Oxford, forthcoming).

IV. Settlement of disputes

The Australian draft's treatment of the methods for settling disputes is lifted nearly verbatim from the CWC, which says that in the event of 'a dispute . . . relating to the interpretations or application of [the] Treaty, the parties concerned shall consult together with a view to . . . expeditious settlement . . . by negotiation or by other peaceful means . . . including referral to the International Court of Justice.'[16] The 1993 Swedish draft is similar but lists more explicitly the methods for settlement: negotiation, inquiry, mediation, conciliation, arbitration or any other peaceful means. The Swedish draft also specifies that disputes may be referred to the ICJ.

Ultimately, any state party may lodge a complaint with the UN Security Council about another state party acting in breach of its treaty obligations, as reflected in the 1993 Swedish draft. In the interest of creating a progression of responses short of referring disagreements to the ICJ or the UN Security Council, the protocol to the Australian draft takes a different line, following the 1991 Swedish text and the CWC. The first response envisaged in the Australian draft is the Conference of States Parties taking 'the necessary measures to ensure compliance with the Treaty and to redress and remedy any situation which contravenes [its] provisions', upon referral from the Executive Council. The draft treaty suggests punitive measures might include 'rights and privileges under the Treaty [being] restricted or suspended . . . [or] collective measures . . . in conformity with international law', including sanctions. The UN Security Council would remain as a court of last resort if these measures failed to rectify the situation, leaving states parties with strong partners among the five permanent members in a somewhat better position to resist possible punitive actions than those without.

V. Conclusion

There are three main issues to be considered when deciding how to organize for effective implementation of the CTB: (*a*) non-

[16] See also Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction, Article XIV, para. 2. The text of the Convention is reproduced in SIPRI, *SIPRI Yearbook 1993: World Armaments and Disarmament* (Oxford University Press: Oxford, 1993), pp. 735–57.

discriminatory and multilateral participation in the monitoring and verification process; (*b*) speed of response in decision making and the level at which decisions are made; and (*c*) cost and cost-effectiveness.

Equitable and multilateral participation in the implementation of the treaty will rely heavily on access to information. In order to provide true access to all the data and enable states parties to make compliance decisions, both independently and collectively, it is necessary that the data be presented in a digestible form. Such a process will demand a high input from the organization charged with monitoring treaty compliance. Any analysis performed by the organization must be seen as impartial and competent so that states parties are able to make judgements founded on trust.

It is clear that there is a consensus in favour of a multilateral, non-discriminatory structure for the CTB implementing authority and this has brought about a requirement for a centralized organization which is able to disseminate the information in a form for all states parties to use. However, there are pressures within technologically advanced states, which are able to rely on their own national means, to push for only a modest multinational capability for collecting and analysing data. If such a two-tiered system were to be realized, the treaty would suffer in the long run. A centralized structure with easy access would allow the less technologically advanced non-nuclear weapon states to play a greater role and they would therefore be more committed to the long-term success of the CTB.

A fundamental question, then, is how to marry this criterion of a non-discriminatory, multilateral verification process with speed of decision making and cost and cost-effectiveness.

To summarize the discussion in this chapter, the 1983 Swedish draft's decentralized framework would sacrifice equitable and timely decision making on the altar of minimizing costs and avoiding intrusiveness, whereas the 1993 Swedish draft arguably errs on the other side by giving the implementing authority too much responsibility for the monitoring stations at a high cost without necessarily solving the problems of timely and non-discriminatory decision making.

The very concept of the fully autonomous authority is such that it would be optimized for timely and non-discriminatory decision making, but it might also be very costly; depending on the bureaucratic structure, however, it could be considered cost effective.

In the end, however, a compromise between cost, speed of response and multilateral decision making will be made. While it will involve some slight delays and reflect the structure of power in the international system to some extent, the Australian draft seems to offer a good compromise at a reasonable cost.

Appendix A. The Swedish Draft Comprehensive Nuclear Test-Ban Treaty

The States Parties to this Treaty, hereinafter referred to as the 'States Parties',

Convinced that recent fundamental international political changes provide opportunities to take further effective measures against the proliferation of nuclear arms,

Welcoming the conclusion of the START I and START II agreements, envisaging drastic reductions in present strategic nuclear arsenals,

Underlining the importance of the prompt implementation of these and other international disarmament and arms regulation agreements,

Stressing the need for further reductions of tactical and strategical nuclear weapons and their delivery systems,

Declaring their intention to undertake further measures towards nuclear disarmament and against the proliferation of nuclear weapons,

Recalling the determination expressed by the Parties in the Preamble to the 1963 Treaty Banning Nuclear Weapons Tests in the Atmosphere, in Outer Space and Under Water to seek to achieve the discontinuance of all test explosions of nuclear weapons for all time, and to continue negotiations to this end,

Recalling that the Parties in the above mentioned Treaty undertake to prohibit, to prevent and not to carry out any nuclear weapon test explosion, or any other nuclear explosion in the atmosphere, in outer space and under water,

Convinced that a ban on all nuclear weapon test explosions, and any other nuclear explosions, is an important instrument in preventing the further proliferation of nuclear weapons,

Have agreed as follows:

Article I

Basic Obligations

l. Each State Party undertakes to prohibit, to prevent, and not to carry out, in any environment, any nuclear weapon test explosion, or any other nuclear explosion at any place under its jurisdiction or control.

2. Each State Party undertakes, furthermore, to refrain from causing, encouraging, assisting, preparing, permitting or in any way participating in the carrying out anywhere of any nuclear explosion referred to in paragraph 1 of this Article.

Article II

Implementation

l. The States Parties, in order to achieve the objectives of the Treaty and to ensure the implementation of the provisions of the Treaty, entrust the International Atomic Energy Agency, hereinafter referred to as the 'Agency', with verification of compliance with the Treaty, as defined in Article IIIB.

2. The States Parties undertake to cooperate in good faith with the Agency in the exercise of its functions in accordance with this Treaty.

3. In order to fulfil its obligations under the Treaty, each State Party shall designate or set up a National Authority and shall so inform the Agency upon entry into force of the Treaty for such a State Party. The National Authority shall serve as the national focal point for liaison with the Agency and with other States Parties.

4. Each State Party undertakes to take any measures it considers necessary to prohibit and prevent any activity in vio

lation of the provisions of the Treaty anywhere under its jurisdiction or control.

5. Each State Party shall inform the Depositary of the legislative and administrative measures taken to implement the Treaty.

Article III

Obligations of States Parties and the Agency

A. States Parties

l. Each State Party undertakes to establish in cooperation with the Agency an effective international and universal monitoring regime. The regime includes the establishment of international monitoring systems based on seismological data, hydroacoustic data and data on radionuclides in the atmosphere and the use of additional relevant techniques.

The arrangements for these international monitoring measures are laid down in the Protocol, annexed to this Treaty.

Each State Party undertakes to establish the necessary facilities to participate in these cooperative measures and through its National Authority to establish the necessary communication channels with the Agency. These arrangements shall be operative on the entry into force of this Treaty.

2. Large non-nuclear explosions carried out by a State Party shall be conducted in accordance with provisions laid down in the Protocol, annexed to this Treaty.

B. The Agency

In the exercise of its functions in accordance with this Treaty, the Agency shall

– coordinate the international monitoring regime including the exchange of seismological data, data on radionuclides in the atmosphere and other data relevant to the monitoring of compliance with the Treaty;

– endeavour, at the request of a State Party, through cooperation with the National Authorities of the States Parties and through other means, to clarify inconsistencies that may occur with regard to events relevant to compliance with the Treaty;

– verify, when inconsistencies are not clarified, compliance with the Treaty through on-site inspection in accordance with Article IV.

Article IV

Verification

l. Each State Party shall, in order to assist in the interpretation of an event that may be of relevance to the Treaty at any place under its jurisdiction or control, provide such additional information that the Agency might request.

2. Each State Party may use national technical means of verification at its disposal in a manner consistent with generally recognized principles of international law to verify compliance with the Treaty.

3. If the nature of an event can not be clarified through the measures specified in paragraphs l and 2 of this Article, each State Party is entitled to request an on-site inspection on the territory of any other State Party for the purpose of ascertaining compliance with this Treaty. The requesting State Party shall state the reasons for its request including the evidence available. Such requests shall be addressed to the Director-General of the Agency, who shall bring the matter to the attention of the Board of Governors of the Agency.

4. If the Board of Governors decides to conduct an on-site inspection, the relevant State Party is under obligation to comply with the Board's decision. Such inspections shall be conducted by the Agency, and the report shall be transmitted by the Director-General of the Agency to the Board of Governors and all States Parties. The Board of Governors shall decide on and report

any findings of non-compliance essential to the achievement of the objectives of the Treaty or of the spirit of the Treaty, to the Security Council of the United Nations and all States Parties. Decisions on questions mentioned in this paragraph shall be made by the Board of Governors by two-thirds majority of those present and voting. Procedures for such inspections, including the rights and functions of the inspecting personnel, are laid down in the Protocol, annexed to this Treaty.

5. A State Party, on whose territory an event has occurred, may invite the Agency to conduct an on-site inspection.

Article V

Complaints

Any State Party which finds that any other State Party is acting in breach of obligations deriving from the provisions of the Treaty, may lodge a complaint with the Security Council of the United Nations. Such a complaint shall include all possible evidence confirming its validity.

Article VI

Privileges and Immunities

1. In order to enable them to carry out the functions entrusted to them under this Treaty, the States Parties to this Treaty shall grant privileges and immunities to the Director-General and personnel of the Agency in accordance with the Vienna Convention on Diplomatic Relations of 18 April 1961.

2. Provisions regarding privileges and immunities in connection with on-site inspections are contained in the Protocol, annexed to this Treaty.

Article VII

Status of Protocol

The Protocol to this Treaty constitutes an integral part of the Treaty.

Article VIII

Settlement of Disputes

If any dispute arises between two or more State Parties or between two or more States Parties and the Agency concerning the interpretation or application of the present Treaty, the Parties concerned shall consult among themselves with a view to having the dispute resolved by negotiation, inquiry, mediation, conciliation, arbitration, or other peaceful means of their own choice. Any dispute may, with the consent of all parties to the dispute, be referred to the International Court of Justice for settlement.

Article IX

Amendments

At any time after the entry into force of this Treaty, any State Party may propose amendments to the Treaty or to the annexed Protocol. Any proposal for an amendment shall be communicated to the Depositary, who shall circulate it to all States Parties and seek their views on whether a conference should be convened to consider the proposal. If a majority, that shall not be less than thirty of the States Parties, including the nuclear-weapon States, so agree, the Depositary shall promptly convene a conference to which all States Parties shall be invited. The Conference may adopt amendments proposed, if a majority of the States Parties present and voting, including the nuclear-weapon States, so agree. Amendments shall enter into force for each Party accepting them upon their adoption by the Conference and thereafter for each remaining Party on the date of acceptance of the amendments by such a Party.

Article X

Review of the Treaty

Five years after the entry into force of this Treaty, or earlier if it is requested by

a majority of the States Parties to the Treaty by submitting a proposal to this effect to the Depositary, a conference of States Parties to the Treaty shall be held at . . . , to review the operation of the Treaty, with a view to assuring that the purposes of the preamble and the provisions of the Treaty are being realized. Such review shall take into account any new scientific and technological developments relevant to the Treaty. At intervals of five years thereafter, a majority of the Parties to the Treaty may obtain, by submitting a proposal to this effect to the Depositary, the convening of further conferences with the same objective of reviewing the operation of the Treaty.

Article XI

Entry into force

l. This Treaty shall be open to all States for signature. Any State which does not sign this Treaty before its entry into force in accordance with this Article may accede to it at any time.

2. This Treaty shall be subject to ratification by Signatory States.

3. This Treaty shall enter into force upon the deposit of instruments of ratification by forty States, including the nuclear-weapon States. For the purposes of this Treaty, a nuclear-weapon State is one which has manufactured and exploded a nuclear weapon or other nuclear explosive device prior to l January 1967.

4. For those States whose instruments of ratification or accession are deposited after the entry into force of this Treaty, it shall enter into force on the date of the deposit of their instruments of ratification or accession.

Article XII

Reservations

The Articles of this Treaty, including the Articles of the annexed Protocol which constitutes an integral part of the Treaty, shall not be subject to reservations.

Article XIII

Depositary

l. The Secretary-General of the United Nations shall be the Depositary of this Treaty and shall receive the instruments of ratification and instruments of accession.

2. The Depositary shall promptly inform all signatory and acceding States of the date of each signature, the date of deposit of each instrument of ratification or of accession and the date of the entry into force of this Treaty and of any amendments thereto, any notice of withdrawal, and the receipt of other notices. He shall also inform the Security Council of the United Nations of any notice of withdrawal.

3. This Treaty shall be registered by the Depositary in accordance with Article 102 of the Charter of the United Nations.

Article XIV

Duration and Withdrawal

1. This Treaty is of a permanent nature and shall remain in force indefinitely, provided that in the event of a violation by any party of a provision of this Treaty essential to the achievement of the objectives of the Treaty or of the spirit of the Treaty, every other Party shall have the right to withdraw from the Treaty.

2. Withdrawal shall be effected by giving notice twelve months in advance to the Depositary who shall circulate such notice to all other Parties.

Article XV

Official Languages

This Treaty, of which the Arabic, Chinese, English, French, Russian and Spanish texts are equally authentic, shall be deposited with the Secretary-General of the United Nations, who shall send duly certified copies thereof to the Gov-

ernments of the signatory and acceding States.

In witness whereof, the undersigned, duly authorized thereto, have signed this Treaty.

Source: Conference on Disarmament document CD/1232, CD/NTB/WP.33, 6 Dec. 1993.

Appendix B. Comprehensive Test Ban Treaty: Australian Resource Paper on Draft Treaty Elements

Preamble

The States Parties to this Treaty, hereinafter referred to as the States Parties ,

(pp 1) *Convinced* that recent fundamental international political changes provide opportunities to take further effective measures against the proliferation of nuclear arms,

(pp 2) *Welcoming* the conclusion of the START I and START II agreements, envisaging drastic reductions in present strategic nuclear arsenals,

(pp 3) *Underlining* the importance of the prompt implementation of these and other international disarmament and arms regulation agreements,

(pp 4) *Stressing* the need for further reductions of tactical and strategical nuclear weapons and their delivery systems,

(pp 5) *Declaring* their intention to undertake further measures towards nuclear disarmament and against the proliferation of nuclear weapons,

(pp 6) *Recalling* the determination expressed by the Parties in the Preamble to the 1963 Treaty Banning Nuclear Weapons Tests in the Atmosphere, in Outer Space and Under Water to seek to achieve the discontinuance of all test explosions of nuclear weapons for all time, and to continue negotiations to this end, **and also recalling the reiteration of this goal in the Preamble to the 1968 Treaty on the Non-Proliferation of Nuclear Weapons,**

(pp 7) *Recalling* that the Parties **in the 1963 Treaty Banning Nuclear Weapons Tests in the Atmosphere, in Outer Space and Under Water** undertake to prohibit, to prevent and not to carry out any nuclear weapons test explosion, or any other nuclear explosion in the atmosphere, in outer space and under water,

(pp 8) *Convinced* that a ban on all nuclear weapon test explosions, and any other nuclear explosions, is an important instrument in preventing the further proliferation of nuclear weapons,

Have agreed as follows:

Article I

Basic Obligations

1.˚**Each State Party undertakes not to carry out any nuclear weapon test explosion or any other nuclear explosion, and to prohibit and prevent such explosions at any place under its jurisdiction or control**.

2.˚Each State Party undertakes, furthermore, to refrain from causing, encouraging, assisting, permitting or in any way participating in the carrying out anywhere of any nuclear **weapon test explosion or any other nuclear explosion.**

Legend

abc – 1993 Swedish CTBT text (CD/1232 of 6 Dec. 1993)

abc – Adapted from the Chemical Weapons Convention

abc – From earlier [1991] Swedish draft CTBT (CD/1089), other arms control treaties, or new language

Article II

The Organization

1. **The States Parties hereby establish a body hereinafter referred to as the Organization to achieve the objectives of the Treaty and to ensure the implementation of its provisions, including those for international verification of compliance with it, and to provide a forum for consultation and cooperation among the States Parties.**

2. **All States Parties shall be members of the Organization.**

3. **The seat of the Headquarters of the Organization shall be in . . .**

4. **The organs of the Organization shall be the Conference of the States Parties, the Executive Council and the Technical Secretariat.**

5. **The Conference of the State Parties is composed of all States Parties. It is the principal organ and oversees the implementation of, and the compliance with, the Treaty. It shall oversee the activities of the Executive Council and the Technical Secretariat.**

6. **The Executive Council, which is the executive organ of the Conference of the States Parties, shall in particular**

(a) **promote the effective implementation of, and compliance with, the Treaty;**

(b) **supervise the operation of the Technical Secretariat.**

The Executive Council shall comprise x number of State Parties serving for a period of two years. The members of the Executive Council shall be elected by the Conference of the States Parties, with due regard given to an equitable political and geographical representation.

7. **The Technical Secretariat shall assist States Parties, the Conference of the States Parties, and the Executive Council on issues of verification. It shall be headed by a Director-General. The Secretariat shall, *inter alia*,**

(a) **coordinate international cooperative arrangements to receive, analyse and make reports on seismological data, data on radionuclides in the atmosphere and other data relevant to the monitoring of compliance with the Treaty;**

(b) **conduct on-site monitoring and inspection in accordance with the procedures set out in the Protocol annexed to this Treaty;**

(c) **cooperate with the National Authorities of the States Parties to resolve uncertainties that a State Party may have about an event relevant to compliance with the Treaty.**

8. **The duties, functions and organization of the Conference of the States Parties, the Executive Council and the Technical Secretariat are further outlined in the Protocol annexed to this Treaty.**

Article III

National Implementation Measures

1. **Each State Party undertakes to take any measures it considers necessary,** *including enacting penal legislation,* **to prohibit and prevent any activity in violation of the provisions of the Treaty anywhere under its jurisdiction or control** *and any such activity undertaken anywhere by natural persons possessing its nationality, in conformity with international law*.

2. **Each State Party shall inform the Organization established pursuant to Article II of this Treaty of the legislative and administrative measures taken to implement the Treaty.**

3. **In order to fulfil its obligations under the Treaty, each State Party shall designate or set up a National Authority and shall so inform the Organization upon entry into force of the treaty for such a State Party. The**

National Authority shall serve as the national focal point for liaison with the Organization and with other States Parties.

4.˚**Each State Party undertakes to cooperate with the Organization in the exercise of its functions in accordance with this Treaty.**

5.˚Each State Party shall cooperate with other States Parties and afford the appropriate form of legal assistance to facilitate the implementation of the obligations under paragraph 1.

6.˚Each State Party shall treat as confidential and afford special handling to information and data that it receives in confidence from the Organization in connection with the implementation of this Treaty. It shall treat such information and data exclusively in connection with its rights and obligations under this Treaty.

Article IV

Verification

1.˚**Each State Party undertakes to cooperate with other States Parties and with the Technical Secretariat to facilitate the verification of compliance with this Treaty, *inter alia* by providing for verification purposes information available to it relating to compliance with the Treaty, including**:

(a)˚seismological data;

(b)˚measurements of radionuclides in the atmosphere;

(c)˚**information from** additional relevant techniques, as specified in the Protocol annexed to this Treaty **or that may be added to this Treaty in accordance with the Protocol to this Treaty**

2.˚The arrangements for these **verification** measures are laid down in the Protocol, annexed to this Treaty. Each State Party undertakes to establish the necessary facilities to participate in these **verification** measures and through its National Authority to establish the necessary communication channels with the Technical Secretariat. These arrangements shall be operative on the entry into force of this Treaty.

3.˚Each State Party shall, in order to assist in the interpretation of an event that may be of relevance to the Treaty, provide such additional information that the Organization might request.

4.˚**Each State Party undertakes to cooperate with other States Parties and with the Technical Secretariat in the examination of the verification potential of additional technologies, with a view to agreeing specific measures to enhance, on a cost-effective basis, the monitoring of compliance with the Treaty, such measures when concluded to be set out in additional Sections to the Protocol annexed to the Treaty**.

5.˚**Each State Party may conduct bilateral consultations with any other State Party on matters relevant to the Treaty, and request information from any State Party, through the Technical Secretariat, on any events relevant to this Treaty occurring on the territory of that State or under its jurisdiction or control**.

Procedures for Inspections

6.˚*Each State party has the right to request an on-site inspection in the territory or in any other place under the jurisdiction or control of any other State Party,* **or in an area beyond the jurisdiction of any state,** *for the sole purpose of clarifying and resolving any questions concerning possible non-compliance with the provisions of this Treaty, and to have this inspection conducted anywhere without delay by an inspection team designated by the Director-General and in accordance with the procedures set down in the Protocol, annexed to this Treaty.*

7.˚*Each State Party is under the obligation to keep the inspection request within the scope of this Treaty and to*

provide in the inspection request all appropriate information on the basis of which a concern has arisen regarding possible non-compliance with this Treaty. Each State Party shall refrain from unfounded inspection requests, care being taken to avoid abuse. The inspection shall be carried out for the sole purpose of determining facts relating to the possible non-compliance.

8.˚*Each State Party shall permit the Technical Secretariat to conduct the on-site inspection pursuant to paragraph 6.*

9.˚*Pursuant to a request for inspection of a facility or location, and in accordance with the procedures provided for in the Protocol annexed to this Treaty, the inspected State Party shall have*:

(a) *The right and the obligation to make every reasonable effort to demonstrate its compliance with this Treaty and, to this end, to enable the inspection team to fulfil its mandate*;

(b) *The obligation to provide access within the requested site for the sole purpose of establishing facts relevant to the concern regarding possible non-compliance; and*

(c) *The right to take measures to protect sensitive installations, and to prevent disclosure of confidential information and data, not related to this Treaty.*

10.˚*With regard to an observer, the following shall apply*:

(a) *The requesting State Party may, subject to the agreement of the inspected State Party, send a representative who may be a national either of the requesting State Party or of a third State Party, to observe the conduct of the inspection.*

(b) *The inspected State Party shall then grant access to the observer in accordance with the Protocol, annexed to this Treaty.*

(c) *The inspected State Party shall, as a rule, accept the proposed observer, but if the inspected State Party exercises a refusal, that fact shall be recorded in the final report.*

11.˚*The requesting State Party shall present an inspection request for an on-site inspection to the Executive Council and at the same time to the Director-General for immediate processing.*

12.˚*The Director-General shall immediately ascertain that the inspection request meets the requirements specified in Section I Part E of the Protocol annexed to this Treaty, and, if necessary, assist the requesting State Party in filing the inspection request accordingly. When the inspection request fulfils the requirements, preparations for the inspection shall begin.*

13.˚*The Director-General shall notify the inspected State Party not less than 12 hours before the planned arrival of the inspection team at the point of entry.*

14.˚*The Executive Council shall take cognizance of the Director-General s actions and shall keep the case under its consideration throughout the inspection procedure. However, its deliberations shall not delay the inspection process.*

15.˚*The Executive Council may, not later than 12 hours after having received the inspection request, decide by a three-quarter majority of all its members against carrying out the inspection, if it considers the inspection request to be frivolous, abusive, or clearly beyond the scope of this Treaty, as described in paragraph 6. Neither the requesting nor the inspected State Party shall participate in such a decision. If the Executive Council decides against the inspection, preparations shall be stopped, no further action on the inspection request shall be taken, and the States Parties concerned shall be informed accordingly.*

16.˚*The Director-General shall issue an inspection mandate for the conduct of the inspection. The inspection mandate shall put the inspection request into operational terms, and shall conform with the inspection request.*

17.˚*The inspection shall be conducted in accordance with the procedures laid down in the Protocol, annexed to this Treaty. The inspection team shall be*

guided by the principle of conducting the inspection in the least intrusive manner possible, consistent with the effective and timely accomplishment of its mission.

18. *The inspected State Party shall assist the inspection team throughout the inspection and facilitate its task.*

19. *The final report shall contain the factual findings as well as an assessment by the inspection team of the degree and nature of access and cooperation granted for the satisfactory implementation of the inspection. The Director-General shall promptly transmit the final report of the inspection team to the requesting State Party, to the inspected State Party, to the Executive Council and to all other States Parties. The Director-General shall further transmit promptly to the Executive Council the assessments of the requesting and of the inspected States Parties, as well as the views of other States Parties which may be conveyed to the Director-General for that purpose, and then provide them to all States Parties.*

20. T*he Executive Council shall, in accordance with its powers and functions, review the final report of the inspection team as soon as it is presented, and address any concerns as to:*

(a) *Whether any non-compliance has occurred;*

(b) *Whether the request had been within the scope of the Treaty; and*

(c) *Whether the right to request inspection had been abused.*

21. *If the Executive Council reaches the conclusion, in keeping with its powers and functions, that further action may be necessary with regard to paragraph 20, it shall take the appropriate measures to redress the situation and to ensure compliance with this Treaty, including specific recommendations to the Conference of the States Parties. In the case of abuse, the Executive Council shall examine whether the requesting State Party should bear any of the financial implications of the inspection.*

22. *The requesting State Party and the inspected State Party shall have the right to participate in the review process. The Executive Council shall inform the States Parties and the next session of the Conference of the States Parties of the outcome of the process.*

23. *If the Executive Council has made specific recommendations to the Conference of the States Parties, the Conference of the States Parties shall consider action in accordance with Article V.*

Article V

Measures to Redress a Situation and to Ensure Compliance, including Sanctions

1. **The Conference of the States Parties shall take the necessary measures to ensure compliance with the Treaty and to redress and remedy any situation which contravenes the provisions of the Treaty.** *In considering action pursuant to this paragraph, the Conference shall take into account all information and recommendations on the issues submitted by the Executive Council.*

2. **In cases where a State Party fails to fulfil a request to take measures to redress a situation which gives rise to problems with regard to its compliance with the Treaty, the Conference of the States Parties may decide that the State Party s rights and privileges under the Treaty be** *restricted or* **suspended until it undertakes the necessary action to conform with its obligations under the Treaty.**

3. *In cases where serious damage to the object and purpose of the Treaty may result from activities prohibited under this Treaty, the Conference of the States Parties may recommend collective measures to States Parties in conformity with international law.*

4. *The* **Executive Council** *shall in cases of particular gravity and urgency,*

bring the issue, including relevant information and conclusions, to the attention of the United Nations General Assembly and the United Nations Security Council.

Article VI

Settlement of Disputes

1.˚*Disputes that may arise concerning the application or the interpretation of this Treaty shall be settled in accordance with the relevant provision of this Treaty and in conformity with the provisions of the Charter of the United Nations.*

2.˚*When a dispute arises between two or more States Parties, or between one or more States Parties and the Organization, relating to the interpretations or application of this Treaty, the parties concerned shall consult together with a view to the expeditious settlement of the dispute by negotiation or by other peaceful means of the parties choice, including recourse to appropriate organs of this Treaty and, by mutual consent, referral to the International Court of Justice in conformity with the Statute of the Court. The States Parties involved shall keep the Executive Council informed of actions being taken.*

3.˚*The Executive Council may contribute to the settlement of a dispute by whatever means it deems appropriate, including offering its good offices, calling upon the States Parties to a dispute to start the settlement process of their choice and recommending a time-limit for any agreed procedure.*

4.˚*The Conference of the States Parties shall consider questions related to disputes raised by States Parties or brought to its attention by the Executive Council.*

5.˚*The Conference of the States Parties and the Executive Council are separately empowered, subject to authorization from the General Assembly of the United Nations, to request the International Court of Justice to give an advisory opinion on any legal question arising within the scope of the activities of the Organization. An agreement between the Organization and the United Nations shall be concluded for this purpose.*

6.˚*This Article is without prejudice to the provisions in Article IV and Article˚V.*

Article VII

Privileges and Immunities

1.˚*The Organization shall enjoy on the territory and in any other place under the jurisdiction or control of a State Party such legal capacity and such privileges and immunities as are necessary for the exercise of its functions.*

2.˚*Delegates of States Parties, together with their alternates and advisers, representatives appointed to the Executive Council together with their alternates and advisers, the Director-General and the staff of the Organization shall enjoy such privileges and immunities as are necessary in the independent exercise of their functions in connection with the Organization.*

3.˚*The legal capacity, privileges, and immunities referred to in this Article shall be defined in agreements between the Organization and the States Parties as well as in an agreement between the Organization and the State in which the headquarters of the Organization is seated. These agreements shall be considered and approved by the Conference of the States Parties.*

4.˚*Notwithstanding paragraphs 1 and 2, the privileges and immunities enjoyed by the Director-General and the staff of the Technical Secretariat during the conduct of verification activities shall be those set forth in the Protocol annexed to this Treaty.*

Article VIII

Status of Protocol

The Protocol to this Treaty constitutes an integral part of the Treaty.

Article IX

Amendments

1.˚At any time after the entry into force of this Treaty, any State Party may propose amendments to the Treaty or to the annexed Protocol. Any proposal for an amendment shall be communicated to the *Director-General*, who shall circulate it to all States Parties and seek their views on whether a conference should be convened to consider the proposal. If *one third or more of the States Parties notify the Director-General not later than 30 days after its circulation that they support further consideration of the proposal*, the Director-General shall promptly convene a conference to which all States Parties shall be invited.

2.˚*Amendments shall enter into force for all States Parties 30 days after deposit of the instruments of ratification or acceptance by all the States Parties referred to under subparagraph (b) below*:

(a) When adopted by the Amendment Conference by a positive vote of a majority of all States Parties; and

(b) Ratified or accepted by all those States Parties casting a positive vote at the Amendment Conference.

3.˚In order to ensure the viability and the effectiveness of this Treaty, provisions in the Protocol shall be subject to changes in accordance with paragraph 4, if proposed changes are related only to matters of an administrative or technical nature. Those provisions subject to such changes comprise˚.˚.˚.

4.˚Proposed changes referred to in paragraph 3 shall be made in accordance with the following procedure:˚.˚.˚.

Article X

Review of the Treaty

Ten years after the entry into force of this Treaty, or earlier if it is requested by a majority of the States Parties to the Treaty by submitting a proposal to this effect to the **Director-General**, a conference of States Parties to the Treaty shall be held to review the operation of the Treaty, with a view to assuring that the purposes of the preamble and the provisions of the Treaty are being realized. Such review shall take into account any new scientific and technological developments relevant to the Treaty. At intervals of **ten** years thereafter, a majority of the Parties to the Treaty may obtain, by submitting a proposal to this effect to the **Director-General**, the convening of further conferences with the same objective of reviewing the operation of the Treaty.

Article XI

Entry into force

1.˚This Treaty shall be open to all States for signature. Any State which does not sign this Treaty before its entry into force in accordance with this Article may accede to it at any time thereafter.

2.˚This Treaty shall be subject to ratification by Signatory States *according to their respective constitutional processes*.

3.˚This Treaty shall enter into force **180 days after** the deposit of instruments of ratification by˚.˚.˚.

4.˚For those States whose instruments of ratification or accession are deposited after the entry into force of this Treaty, it shall enter into force on the *30th day following the* date of the deposit of their instruments of ratification or accession.

Article XII

Depositary

1.˚The Secretary-General of the United Nations shall be the Depositary of this Treaty and shall receive the instruments of ratification and instruments of accession.

2.˚The Depositary shall promptly inform all signatory and acceding States of the date of each signature, the date of deposit of each instrument of ratification or of accession and the date of the entry into force of this Treaty and of any amendments thereto, any notice of withdrawal, and the receipt of other notices. He or she shall also inform the Security Council of the United Nations of any notice of withdrawal.

3.˚This Treaty shall be registered by the Depositary in accordance with Article 102 of the Charter of the United Nations.

Article XIII

Duration and Withdrawal

1.˚This Treaty is of a permanent nature and shall remain in force indefinitely. **Each State Party shall, in exercising its national sovereignty, have the right to withdraw from this Treaty if it decides that extraordinary events, related to the subject matter of the Treaty, have jeopardized the supreme interests of its country**.

2.˚Withdrawal shall be effected by giving notice twelve months in advance to the Depositary who shall circulate such notice to all other Parties. *Notice of withdrawal shall include a statement of the reasons for the withdrawal.*

Article XIV

Reservations

The Articles of this Treaty shall not be subject to reservations. The Protocol annexed to this Treaty shall not be subject to reservations incompatible with its object and purpose.

Article XV

Official Languages

This Treaty, of which the Arabic, Chinese, English, French, Russian and Spanish texts are equally authentic, shall be deposited with the Secretary-General of the United Nations, who shall send duly certified copies thereof to the Governments of the signatory and acceding States.

PROTOCOL TO THE DRAFT COMPREHENSIVE TEST BAN TREATY

SECTION I : THE ORGANIZATION

Part 1. General Provisions

1.˚**The Organization shall oversee the overall function of the Treaty and its verification arrangements and shall consist of the organs specified in Article II.**

2. **All States Parties to the Treaty shall be members of the Organization.**

3. *The Organization shall conduct its verification activities provided for under this Treaty in the least intrusive manner possible consistent with the timely and efficient accomplishment of their objectives. It shall request only the information and data necessary to fulfil its responsibilities under this Treaty. It shall take every precaution to protect the confidentiality of information on civil and military activities and facilities coming to its knowledge in the implementation of the Treaty*.

4.˚*In undertaking its verification activities the Organization shall consider measures to make use of advances in science and technology*.

5.˚The Organization shall seek to benefit from existing international expertise and facilities where possible, and to maximise cost efficiencies, by developing a collaboration with the International Atomic Energy Agency and other bodies (including States

Parties as appropriate) whereby functions of the Organization are delegated to the maximum degree consistent with adequate financial and resource management. Such arrangements (excluding those of a minor and normal commercial and contractual nature) are to be set out in agreements, which are to be submitted to the Conference of the States Parties for approval.

6.˚The cost of the Organization shall be borne by the States Parties in accordance with the United Nations scale of assessment *adjusted to take into account differences in membership between the United Nations and this Organization. Financial contributions of States Parties to the Preparatory Commission shall be deducted in an appropriate way from their contributions to the regular budget. The budget of the Organization shall comprise two separate chapters, one relating to administrative and other costs, and one relating to verification costs*.

7.˚*A member of the Organization which is in arrears in the payment of its financial contribution to the Organization shall have no vote in the Organization if the amount of its arrears equals or exceeds the amount of the contribution due from it for the preceding two full years. The Conference of the States Parties may, nevertheless, permit such a member to vote if it is satisfied that the failure to pay is due to conditions beyond the control of the member*.

Part 2. The Conference of the States Parties

Composition, procedures and decision-making

1.˚**Each State Party shall have one representative in the Conference of the States Parties (hereinafter referred to as the Conference), who may be accompanied by alternates and advisers.**

2.˚*The first session of the Conference shall be convened by the Depository not later than 30 days after the entry into force of this Treaty*.

3.˚**The Conference shall meet annually unless it decides otherwise.**

4.˚*Special sessions of the Conference shall be convened:*

(a) When decided by the Conference;

(b) When requested by the Executive Council;

(c) When requested by any member and supported by one third of the members; or

(d) In accordance with Article X to undertake reviews of the operation of this Treaty.

Except in the case of subparagraph (d), the special session shall be convened not later than 30 days after receipt of the request by the Director-General of the Technical Secretariat, unless specified otherwise in the request.

5.˚*The Conference may also be convened in the form of an Amendment Conference in accordance with Article IX, paragraph 1.*

6.˚*Sessions of the Conference shall take place at the seat of the Organization unless the Conference decides otherwise.*

7.˚*The Conference shall adopt its rules of procedure. At the beginning of each regular session, it shall elect its Chair and such other officers as may be required. They shall hold office until a new Chair and other officers are elected at the next regular session.*

8.˚*A majority of the members of the Organization shall constitute a quorum for the Conference.*

9.˚*Each member of the Organization shall have one vote in the Conference*.

10.˚**The Conference shall take decisions on questions of procedure, including decisions to convene special sessions of the Conference, by a simple majority of the members present and voting. Decisions on matters**

of substance should be taken as far as possible by consensus. If consensus is not attainable when an issue comes up for decision, the Chair shall defer any vote for 24 hours and during this period of deferment shall make every effort to facilitate achievement of consensus, and shall report to the Conference prior to the end of the period. If there is no possibility of achieving consensus at the end of 24 hours, the Conference shall take the decision by a two-thirds majority of members present and voting unless otherwise specified in the Treaty. When the issue arises as to whether or not the question is one of substance, that question shall be treated as one of substance unless otherwise decided by the Conference by the majority required for decisions on questions of substance.

Powers and functions

11.˚In accordance with Article II, paragraph 5, the Conference shall be the principal organ of the Organization. It shall consider any questions, matters or issues within the scope of this Treaty, including those relating to the powers and functions of the Executive Council and the Technical Secretariat. It may make recommendations and take decisions on any questions, matters or issues related to this Treaty raised by a State Party or brought to its attention by the Executive Council.

12.˚In accordance with Article II, paragraph 5, the Conference shall oversee the implementation of this Treaty, and act in order to promote its object and purpose. The Conference shall review compliance with this Treaty and shall also oversee the activities of the Executive Council and the Technical Secretariat and any issue guidelines in accordance with this Treaty to either of them in the exercise of their functions.

13.˚*The Conference shall:*

(a) Consider and adopt at its regular sessions the report, programme and budget of the Organization, submitted by the Executive Council, as well as consider other reports;

(b) Decide on the scale of financial contributions to be paid by States Parties in accordance with Part 1, paragraph 6;

(c) Elect the members of the Executive Council;

(d) Appoint the Director-General of the Technical Secretariat (hereinafter referred to as the Director-General);

(e) Approve the rules of procedure of the Executive Council submitted by the latter;

(f) Establish such subsidiary organs as it finds necessary for the exercise of its functions in accordance with this Treaty;

(g)˚Review scientific and technological developments that could affect the operation of this Treaty and, in this context, direct the Director-General to establish a Scientific Advisory Board to enable him or her, in the performance of his or her functions, to render specialized advice in areas of science and technology relevant to this Treaty, to the Conference, the Executive Council or States Parties. The Scientific Advisory Board shall be composed of independent experts appointed in accordance with terms of reference adopted by the Conference;

(h) Consider and approve at its first session any draft agreements, provisions and guidelines developed by the Preparatory Commission;

(i) Take the necessary measures to ensure compliance with this Treaty and to redress and remedy any situation which contravenes the provisions of this Treaty, in accordance with Article V.

Part 3.˚ The Executive Council

Composition, procedure and decision-making

1.˚*In accordance with Article II, paragraph 6, the Executive Council shall consist of x members. Each State Party shall have the right, in accordance with the principle of rotation, to serve on the Executive Council. The members of the Executive Council shall be elected by the Conference for a term of two years. In order to ensure the effective functioning of this Treaty, due regard being specially paid to equitable geographic distribution, as well as to political and security interests, the Executive Council shall be composed as follows:*

(a)˚.˚.˚.
(b)˚.˚.˚.
(c)˚.˚.˚.

2.˚*For the first election of the Executive Council x members shall be elected for a term of one year, due regard being paid to the established numerical proportions as described in paragraph 1.*

3.˚*The Executive Council shall elaborate its rules of procedure and submit them to the Conference for approval.*

4.˚*The Executive Council shall elect its Chair from among its members.*

5.˚*The Executive Council shall meet for regular sessions. Between regular sessions it shall meet as often as may be required for the fulfilment of its powers and functions.*

6.˚*Each member of the Executive Council shall have one vote. Unless otherwise specified in this Treaty, the Executive Council shall take decisions on matters of substance by a two-thirds majority of all its members. The Executive Council shall take decisions on questions of procedure by a simple majority of all its members. When the issue arises as to whether the question is one of substance or not, that question shall be treated as a matter of substance unless otherwise decided by the Executive Council by the majority required for decisions on matters of substance.*

Powers and functions

7.˚**The Executive Council is responsible to the Conference. It shall carry out the powers and functions entrusted to it under the Treaty and this Protocol, as well as such functions delegated to it by the Conference. In so doing, it shall act in conformity with the recommendations, decisions and guidelines of the Conference and assure their continuous and proper implementation.**

8.˚**The Executive Council shall keep the overall operation of the Treaty and its verification arrangements under review to promote the effective implementation of and compliance with the Treaty. It shall supervise the activities of the Technical Secretariat, cooperate with the National Authority of each State Party and facilitate consultations and cooperation among States Parties at their request.**

9.˚**Pursuant to Article IX 3 and 4 of the Treaty, the Executive Council shall decide on proposals for amendments to Sections II, Part(s)˚.˚.˚.˚and paragraph(s)˚.˚.˚.˚and III, Part(s)˚.˚.˚. and paragraphs)˚.˚.˚.˚of the Protocol to this Treaty on matters concerning the equipment and technical procedures to be used to verify compliance with the Treaty following proposals from a State Party or from the Technical Secretariat.**

10.˚*The Executive Council shall:*

(a) Consider and submit to the Conference the draft programme and budget of the Organization;

(b) Consider and submit to the Conference the draft report of the Organization on the implementation of this Treaty, the report on the performance of it own activities and such special reports

as it deems necessary or which the Conference may request;

(c)˚Make arrangements for the sessions of the Conference including the preparation of the draft agenda.

The Executive Council may request the convening of a special session of the Conference.

11.˚*The Executive Council shall:*

(a)˚Conclude agreements or arrangements with States and international organizations on behalf of the Organization, subject to prior approval by the Conference;

(b)˚Approve agreements or arrangements relating to the implementation of the verification activities, negotiated by the Technical Secretariat with States Parties.

12.˚*The Executive Council shall consider any issue or matter within its competence affecting this Treaty and its implementation, including concerns regarding compliance, and cases of non-compliance, and, as appropriate, inform States Parties and bring the issue or matter to the attention of the Conference.*

13.˚*In its consideration of doubts or concerns regarding compliance and cases of non-compliance, including, inter alia, abuse of the rights provided for under this Treaty, the Executive Council shall consult with the States Parties involved and, as appropriate, request the State Party to take measures to redress the situation within a specified time. To the extent that the Executive Council considers further action to be necessary, it shall take, inter alia, one or more of the following measures:*

(a) Inform all States Parties of the issue or matter;

(b) Bring the issue or matter to the attention of the Conference;

(c) Make recommendations to the Conference regarding measures to redress the situation and to ensure compliance.

The Executive Council shall, in cases of particular gravity and urgency, bring the issue or matter, including relevant information and conclusions, directly to the attention of the United Nations General Assembly and the United Nations Security Council. It shall at the same time inform all States Parties of this step.

14.˚**The functions of the Executive Council with regard to on-site inspections are laid down in Article IV and Section III of the Protocol to the Treaty.**

Part 4.˚ The Technical Secretariat

1.˚**A Technical Secretariat shall be established to assist States Parties, the Conference and the Executive Council in the performance of their functions. The Technical Secretariat shall carry out the verification measures provided for in the Treaty. The Technical Secretariat shall, inter alia,**

(a)˚**coordinate international cooperative arrangements to analyse and facilitate an exchange of seismological data, data on radionuclides in the atmosphere and other data relevant to the monitoring of the Treaty**;

(b)˚**conduct on-site monitoring and inspection at the invitation of a State Party or at the request of the Executive Council or otherwise pursuant to the provisions of Article IV**;

(c)˚**cooperate with the National Authorities of the States Parties to resolve uncertainties regarding compliance with the Treaty;**

(d)˚assist States Parties on other issues of verification of the Treaty.

2.˚The **Technical Secretariat** shall establish, and the **Executive Council** shall approve, Operational Manuals to guide the operation of the various com-

ponents of the verification system **including the following**:

(a)˚Operational Manual for **Seismological Monitoring and the** International Exchange of Seismological Data;

(b)˚Operational Manual for **the Surveillance of Radionuclides in the Atmosphere and the** International Exchange of Data on Radionuclides in the Atmosphere;

(c)˚Operational Manual for International On-Site Inspections;

[(d)˚Operational Manual for **Hydroacoustic Monitoring and the** International Exchange of Hydroacoustic Data;]

[(e)˚Operational Manual for Satellite Data Processing;]

[**(f)˚Operational Manual for the International Data Centre**];

(x)˚.˚.˚.

These Manuals shall not constitute parts of the Treaty and can be changed by the **Executive Council**. The **Technical Secretariat** shall inform the States Parties of any changes in the Operational Manuals.

3.˚**The Technical Secretariat shall coordinate the operation of the global seismological, radionuclide and** [hydroacoustic] **networks, and other global verification techniques as may be developed and agreed pursuant to Article IV for inclusion in Section II of this Protocol, and in particular:**

(a)˚operate an International Data Centre to analyse and report on the data gathered by the verification networks;

(b)˚supervise and coordinate stations in the verification networks;

(c)˚ensure that the operation of participating stations and their reporting are in compliance with the relevant Operational Manuals;

(d)˚provide technical assistance in, and if necessary, support for the installation and operation of monitoring stations in regions of the world where there is a lack of such stations;

(e)˚compile and assess results and experiences of the operation of the verification networks.

[4.˚The **Technical Secretariat** shall assist States Parties in utilising satellite data in order to clarify seismic and other events in relation to this Treaty. The Technical Secretariat shall **through** the International Data Centre compile and report on satellite observations, provided by States Parties or obtained from other sources.]

5.˚The **Technical Secretariat** shall receive, compile and report to all States Parties any additional information that a State Party may provide to assist in the interpretation of an event which has occurred on its territory.

6.˚The **Technical Secretariat** shall forward requests for information made by any State Party to any other State Party on any event relevant to this Treaty occurring on the territory of the latter State. The **Technical Secretariat** shall receive, compile and report on any information received in response to such requests.

7.˚The **Technical Secretariat** shall facilitate consultations among States Parties to resolve issues related to the verification of the Treaty.

8.˚**The functions of the Technical Secretariat with regard to on-site inspections are laid down in Article IV and Section III of the Protocol to this Treaty**.

9.˚**The Technical Secretariat shall comprise a Director-General, appointed by the Conference for a period of four years, who shall be its Head and Chief Administrative Officer and such scientific, technical and other personnel as may be required. The Director-General may be reappointed for one further term, but not thereafter. Only citizens of States Parties shall serve as**

members of the Technical Secretariat.

10.˚*The Director-General shall be responsible to the Conference and the Executive Council for the appointment of the staff and the organization and functioning of the Technical Secretariat. The paramount consideration in the employment of the staff and in the determination of the conditions of service shall be the necessity of securing the highest standards of efficiency, competence and integrity. Due regard shall be paid to the importance of recruiting the staff on as wide a geographical basis as possible. Recruitment shall be guided by the principle that the staff shall be kept to a minimum necessary for the proper discharge of the responsibilities of the Technical Secretariat.*

11.˚*The Director-General shall be responsible for the organization and functioning of the Scientific Advisory Board referred to in paragraph 13 (g) of Part 2 of this Section. The Director-General shall, in consultation with States Parties, appoint members of the Scientific Advisory Board, who shall serve in their individual capacity. The members of the Board shall be appointed on the basis of their expertise in the particular scientific fields relevant to the implementation of this Treaty. The Director-General may also, as appropriate, in consultation with members of the Board, establish temporary working groups of scientific experts to provide recommendations on specific issues. In regard to the above, States Parties may submit lists of experts to the Director-General.*

12.˚*In the performance of their duties, the Director-General and the other members of the staff shall not seek or receive instructions from any Government or from any other source external to the Organization. They shall refrain from any action that might reflect on their positions as international officers responsible only to the Conference and the Executive Council.*

13.˚*Each State Party shall respect the exclusively international character of the responsibilities of the Director-General, the inspectors and the other members of the staff and not seek to influence them in the discharge of their responsibilities.*

14.˚*The Technical Secretariat shall:*

(a)˚Prepare and submit to the Executive Council the draft programme and budget of the Organization;

(b)˚Prepare and submit to the Executive Council the draft report of the Organization on the implementation of this Treaty and such other reports as the Conference or the Executive Council may request;

(c) Provide administrative and technical support to the Conference, the Executive Council and subsidiary organs;

(d) Address and receive communications on behalf of the Organization to and from States Parties on matters pertaining to the implementation of this Treaty;

(e) Provide technical assistance and technical evaluation to States Parties in the implementation of the provisions of this Treaty;

(f)˚Negotiate agreements or arrangements relating to the implementation of verification activities with States Parties, subject to approval by the Executive Council.

15.˚**The Technical Secretariat shall inform the Executive Council of any problem that has arisen with regard to the discharge of its functions, including doubts, ambiguities or uncertainties about compliance with this Treaty and the Protocol annexed thereto that have come to its notice in the performance of its verification activities and that it has been unable to resolve or clarify through its consultations with the State Party concerned**.

SECTION II: THE GLOBAL MONITORING SYSTEM

(. ° . ° .)

SECTION III: PROCEDURES FOR ON SITE-INSPECTIONS AND MONITORING

(. ° . ° .)

Source: Conference on Disarmament document CD/NTB/WP.49, 30 Mar. 1994.

Index