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THE DEBATE ABOUT NUCLEAR WEAPON TESTS

By Jozef Goldblat and David Cox

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PREFACE

This publication is the product of a study jointly conducted by the Stockholm International Peace Research Institute (SIPRI) and the Canadian Institute for International Peace and Security (CIIPS). It deals with one of the most hotly discussed items on the agenda of international arms control negotiations: nuclear weapon tests. The aim of the study is to give an analytical review of the complex technical and political issues involved in a possible cessation or limitation of these tests. It is intended as an informed contribution to the debate among governmental and non-governmental experts, with the view to facilitating the achievement of a meaningful arms control measure.

This monograph is the editors' summary and conclusions based on the complete study as presented in the CIIPS/SIPRI book, *Nuclear Weapon Tests: Prohibition or Limitation?* (Oxford University Press). The monograph, and the book from which it is excerpted, may also be useful to those laymen who are concerned about how to control and ultimately stop the nuclear arms race.

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ACRONYMS

CD	Conference on Disarmament
CTB(T)	comprehensive test ban (treaty)
EMP	electromagnetic pulse
ICF	inertial confinement fusion
KILOTON (kt.)	the approximate equivalent of 1,000 tons of TNT
NPT	Non-Proliferation Treaty
PNE	peaceful nuclear explosion
PNET	Peaceful Nuclear Explosions Treaty
PTBT	Partial Test Ban Treaty
SDI	Strategic Defense Initiative (US)
TTBT	Threshold Test Ban Treaty
VLYTTB(T)	very-low-yield threshold test ban (treaty)

EXECUTIVE SUMMARY

This paper is an overview of a study which brought together more than two dozen specialists in various aspects of nuclear weapon testing. The overview draws heavily on the papers presented in the larger study, but the analysis and conclusions are those of the authors, and do not represent the views of all the contributors.

The paper begins with an analysis of the various reasons generally cited to explain the need for continued nuclear weapon testing. It concludes that force modernization through the design and development of new nuclear warheads is the central purpose of continued testing, although it is noted that tests to check the reliability of stockpiled weapons is a controversial issue. Even proponents of testing for this purpose, however, agree that a very small number of tests would suffice to ensure continued reliability.

An examination of the existing treaties limiting nuclear weapon testing — the 1963 Partial Test Ban Treaty (PTBT), the 1974 Threshold Test Ban Treaty (TTBT) limiting explosive yield to 150 kilotons, and the 1976 Peaceful Nuclear Explosions Treaty (PNET) — suggests that these treaties have not seriously restricted nuclear weapons development. However, the failure to ratify the last two has weakened confidence in the arms control process and has hindered negotiations for a comprehensive ban.

US complaints that the Soviet Union has violated the 150 kiloton limit have focussed attention on the verification of further limits on

nuclear testing. Seismology provides the principal means for verification, but the task is complicated by the claim that a state might seek to cheat by concealing the explosion — for example, in a large underground cavity which could muffle the seismic shock wave. Although there is a range of scientific opinion concerning the lowest reliable level of detection, it is generally agreed that a comprehensive or very low yield test ban will require an international system of seismic stations, combined with on-site inspections and non-seismic detection systems. The development of such a network could precede actual agreement on further test bans.

Given that the current policy of the United States appears to preclude early negotiations on a comprehensive test ban, the study addresses the question of what kind of restrictions might be more meaningful than those already agreed upon in the test limitation treaties referred to above. It is argued that, from an arms control point of view, an effective yield limitation would have to set the threshold low enough to preclude the development of new weapon designs. A threshold of one kiloton would meet this requirement, with an additional one or two tests up to five kilotons permitted to provide for reliability testing of stockpiled weapons. A ceiling of one kiloton would preclude controversy over the military significance and verifiability of sub-kiloton tests, thereby reducing the incentive to cheat and the rate of 'false' alarms that might take place under a total ban.

A very low yield threshold test ban of this kind would preclude or significantly limit the freedom to develop new weapon designs. Building on the verification procedures already accepted under the earlier treaties, the network of seismic verification stations described above, combined with on-site inspections and other verification procedures, would provide reasonable assurance of compliance. A very low threshold test ban would not replace but pave the way for the ultimate goal of a complete and universal prohibition on nuclear weapon tests.

INTRODUCTION

The atomic era began with a test conducted by the United States on 16 July 1945 at Alamogordo, New Mexico. The test confirmed the conclusions reached by a team of scientists that an explosion several orders of magnitude greater than that brought about by conventional explosives was possible. Such an explosion can be produced by an assembly of fissile material exceeding a critical mass. The critical mass is the smallest mass needed for a self-sustaining chain reaction, in which the number of neutrons released from fissile nuclei and absorbed by other fissile nuclei equals the number of neutrons lost by absorption in non-fissile material or by escape from the system. At Alamogordo, for the first time in history, an amount of energy equal to that released by 20,000 tons of the conventional explosive TNT was released by fissioning the nuclei of plutonium in an instantaneous chain reaction. The first US bomb that released energy by splitting the nuclei of uranium was exploded over Hiroshima three weeks later. It had an explosive yield of about 13 kt. In 1949, the Soviet Union ended the US monopoly in the field by exploding its own atomic device. Subsequently, Britain (in 1952), France (1960) and China (1964) joined the "club" of atomic weapon states.

Even more powerful explosive devices, so-called thermonuclear (or hydrogen) weapons, were developed and successfully tested in the 1950s. These rely on the fusion of light nuclei, such as those of hydrogen isotopes, brought to the extremely high temperatures which are produced by the fission of plutonium or uranium. Even more energy can be released in a fission-fusion-fission process, in

which the neutrons generated by fusion are allowed to split the uranium nuclei in a uranium "blanket" surrounding the weapon. Atomic fission weapons and thermonuclear weapons, including the fission-fusion-fission devices, have all come to be called "nuclear weapons."

All explosions which result from the release of a large amount of energy in a confined volume create a rapid increase in the temperature and pressure and consequently convert the surrounding materials into hot, compressed gases which expand, causing a shock wave in the atmosphere, in the ground or in water. Nuclear explosions produce other important effects as well. These are thermal radiation and nuclear radiation, the latter involving harmful rays released both immediately after the explosion and over a longer period of time.

By November 1987, well over 1,600 nuclear test explosions of different sizes and varieties had been carried out in different environments by the five nuclear weapon powers mentioned above — the great majority of them by the USA and the USSR. (In addition, one was conducted by India, which, however, maintains that it has no nuclear weapons.) A number of concerns arise in connection with this continuous testing activity, regarding the necessity for explosive tests; the difficulties encountered in the negotiations for a test ban and the value of the treaties they have produced; the problems of verification; the consequences of a possible cessation of tests; and prospects for further test limitations. The following sections address these questions.

I. How necessary was it for the nuclear weapon powers to test a nuclear explosive before building a weapon stockpile?

The first nuclear test explosion was considered indispensable for verification of the feasibility of achieving a large explosion by fission. The material used was plutonium. However, the uranium fission device exploded over Hiroshima, which contained a simpler mechanism, was not tested before being used; such was the scientists' confidence in the correctness of its design. It can, nevertheless, be argued that the use of the bomb was in itself a test. Indeed, the United States possessed no more than two atomic bombs when it decided to employ them in war. Even more essential was the testing of a thermonuclear device, for it is held impossible otherwise to gain confidence in the construction of a fusion bomb. Only after successful tests did the United States start manufacturing nuclear weapons for its stockpile. States which later joined the nuclear "club" acted similarly.

II. Why were further test explosions needed after nuclear weapons had been developed manufactured and stockpiled?

NEW WEAPON DESIGNS

Further testing was required primarily to validate refinements in the design of weapons. It was also necessary to achieve the greatest possible efficiency and economy in the use of fissionable and fusionable materials and, at the same time, make the weapon as-

sembly compatible with the means of delivery, as dictated by current military needs. Thus, while the Hiroshima bomb was designed so as to be compatible with the bomb-bays of the B-29 aircraft, the subsequent proliferation of delivery vehicles called for a variety of weapons of reduced dimensions.

Warheads in the present nuclear arsenals bear little resemblance to the bombs that ushered in the nuclear age. In particular, the development of modern strategic bombers and of strategic missiles equipped with multiple, independently targetable re-entry vehicles (MIRVs) placed a premium on small sizes of nuclear warheads and on optimal yield-to-weight ratios, because one bomber or missile had to accommodate several bombs or re-entry vehicles in addition to guidance systems. Thus new warhead designs became necessary to achieve the desired objectives.

A new weapon design currently requires a testing programme amounting, for the USA, to some 6 explosions or more — depending on the degree of complexity — to 4-5 for the UK, and (according to press reports) to as many as 20 for France, and culminating in a proof test to certify the model for stockpile and deployment. Designs not fully tested through explosions are not deemed reliable. The use of simulation with supercomputers can substitute certain development test explosions, but many weapon designers are sceptical as to the possibility of drastically reducing the number of explosive tests. In any event, at least one explosion of a new or significantly re-designed warhead at or near full yield is generally considered to be indispensable.

It should be added that testing is necessary not only to modernize the first two generations of nuclear weapons — the fission and fusion explosive devices — but also to develop so-called "third-generation" weapons. These constitute a refinement of the techniques involved in fission/fusion processes for the purpose of achieving special weapon effects for given military missions. For example, the enhanced-radiation weapon has been developed to achieve radiation levels sufficient to incapacitate enemy military forces while minimizing

thermal and blast effects as well as radioactive fall-out damaging to civilians and friendly forces. The electromagnetic pulse (EMP), generated by a nuclear detonation, and means of maximizing its effects to damage or disturb electronic devices and disrupt the enemy's command and control capabilities, have also been considered. Another third-generation weapon, the X-ray laser driven by nuclear explosives, is being experimentally tested as one of the possible components of the US Strategic Defense Initiative (SDI) programme. It seeks to maximize X-ray emissions and concentrate the rays in a single beam which can be aimed at a ballistic missile and destroy it in an early phase of its flight. It could also be used to attack space-based elements of a ballistic missile defence system. A great number of nuclear test explosions may be needed for the development of a nuclear-powered X-ray laser.

It is evident that a stop to nuclear testing would also put a stop to the development of essentially new nuclear weapons.

Reliability of the stockpiled weapons

The majority view of nuclear weapon designers, at least in the United States, appears to be that explosive testing is necessary to ensure that weapons which have been deployed or stockpiled continue to be effective. In support of this view, it has been claimed that one-third of US weapon designs introduced into the stockpile after 1958 required such testing for the resolution of reliability problems, and that three-fourths of these problems could not have been discovered and subsequently corrected if nuclear explosive testing had been discontinued. It is likely, however, that the problems that arose were due to design defects rather than to the deterioration of properly constructed weapons. During the period of the test moratorium from 1958 to 1961, some proportion of the newly designed weapons were manufactured and stockpiled without prior testing. It might be added that in certain important cases the defects that were later ascertained related to the yield magnitude rather than to the failure to achieve a nuclear explosion.

It is sometimes asserted, too, that the strict design requirements imposed by the relatively limited payloads of US missiles, and the severe safety and security requirements imposed by US authorities, have necessitated the optimization of weapon designs and thereby increased the possibility of subtle design flaws or susceptibility to unforeseen errors which might emerge only after deployment. US designers assert that Soviet weapons, which are less complex and which are destined for missiles with larger payloads, are considerably less vulnerable to design errors than their US counterparts. They therefore claim that cessation of tests or a moratorium would, for this reason, favour the Soviet Union.

On the basis of experience, one might respond that those weapons which have not been tested at full yield at least once should not be admitted to the stockpile. As regards stockpiled weapons which have been tested, some qualified experts contend that their reliability can be ensured indefinitely without recourse to explosive testing. As far as is known, none of the nuclear weapon states performs much explosive testing for the sole purpose of reliability. Strict adherence to stockpile surveillance programmes, including non-nuclear radiographic, chemical or mechanical testing, may be sufficient. Indeed, meticulous examination of the assembly by visual and electronic means and, if necessary, correction or replacement of faulty components by using materials manufactured in full conformity with the original, proven design specifications, could deal with the ageing problems most frequently encountered in stockpiled weapons. In any case, an explosive test, which destroys the seemingly defective weapon, may not provide confirmation of the diagnosis. Proponents of this standpoint also tend to view with scepticism the suggestion that more "robust" Soviet designs are less prone to deterioration and point out that physical degradation, such as corrosion, is not related to the size of the weapon and is likely to affect Soviet and US weapons alike. If, however, less sophisticated nuclear warheads appear to be more reliable, they could certainly be designed by US weapon laboratories.

At most, over an extended period of time, a programme to ensure

continued reliability might include a replacement, without testing, of certain weapons in the stockpile with newly built weapons of identical design.

EFFECTS AND PHYSICS TESTS

Another of the purposes of nuclear testing is to check the effects of an explosion on military equipment. Since warheads of proven design and yield are used for such tests, a secondary purpose, that of confirming the reliability of a given stockpiled weapon design, is simultaneously served. However, considering the impressive number and variety of nuclear explosions carried out so far, it is doubtful whether effects tests alone would constitute a sufficient reason for continued testing. Even less justified, at least from the point of view of arms control, seem to be field explosions to study the complexity of the physics of a nuclear detonation. Such experiments as inertial confinement fusion (ICF) research on the application of thermonuclear energy can be conducted in contained laboratory setting at extremely low yields. They may have some potential utility for the military, but are not easy to detect and cannot be covered by a test ban treaty anyway.

SECURITY AND SAFETY TESTS

Improved or additional protection of nuclear weapons may require testing, but the testing does not need to be explosive. Should, however, protective devices change the nuclear assembly or its components significantly enough to modify the design of the weapon, explosive testing may prove necessary to check its performance. Whether such far-reaching changes are essential to satisfy security needs is debatable. Many nuclear weapons are deemed already to be adequately protected by the so-called permissive action links permitting the use of weapons only by authorized personnel, as well as by use-denial mechanisms disabling the weapons when their use is attempted by unauthorized persons. Possible improvements of the protective systems would be marginal and could probably be made without affecting weapon design, in so far as they relate chiefly

to the mechanical and electrical components of the weapon.

Safety devices on nuclear weapons are intended to prevent inadvertent or accidental explosions. But in this respect, too, considerable advances have been made. Past accidents with nuclear weapons did not result in explosions of nuclear materials. Detonations of the non-nuclear explosive component have, however, taken place, causing the dispersal of radioactive materials. To minimize the risks of such occurrences, weapon designers have in most weapons replaced the conventional explosive serving to initiate the fission or fission-fusion reaction with a so-called insensitive high explosive (IHE) which is less prone to accidental detonation. This replacement has provided an additional reason for explosive testing, because one could not assume with certainty that the IHE would produce exactly the same effect as a conventional explosive. It is arguable whether safety tests will be needed also in the future. In peacetime, safety concerns could be effectively addressed by prohibiting such activities as the routine flights of aircraft carrying nuclear weapons, which present the greatest danger of mishap.

NEED TO RETAIN THE TECHNOLOGY BASE

It is asserted, mainly by the US military, that tests are needed to retain a core of experienced weapon designers, whose accumulated knowledge is indispensable for maintaining confidence in the nuclear stockpile. Without the incentives provided by continued testing, they contend, leading designers would be tempted to move away from nuclear weapon laboratories to other careers — a trend which might prove irreversible for the United States because of its freer job market, but presumably not for the Soviet Union with its different social system. Others suggest that explosive testing does not need to be part of the nuclear laboratory programmes and that, in any event, it would always be possible to offer compensatory research, in which those scientists currently engaged in test explosions could be fully occupied. A staff of knowledgeable individuals who are capable of producing new weapons could thus be retained, should that be judged necessary.

It is clear that modernization of nuclear weapons is the central purpose of testing. There is a controversy as to whether checking the reliability of stockpiled weapons requires explosive testing, but even the proponents of such testing admit that a very small number of explosions would suffice. As regards other reasons, no combination of them would make up a compelling case for the continuation of nuclear detonations.

III. Why did negotiations for a nuclear test ban begin, and why did they fail?

The idea of stopping all nuclear test explosions grew out of the international concern about nuclear fall-out, especially after the major radiation accident which followed the 1 March 1954 US Bravo test in the Pacific. Thereafter, concerted anti-nuclear movements among scientists and the general public gathered momentum. In addition, in the late 1950s, a number of influential government officials in the USA and the USSR came to regard the test ban as a first step towards more comprehensive discussions on arms control between East and West. On the US side, an additional incentive may have been the belief that unlimited testing by both superpowers could, over time, decrease the strategic lead of the United States over the Soviet Union, primarily in the field of nuclear warhead sophistication. On the Soviet side, the search for the cessation of tests may have been motivated by an apprehension that further testing could widen the technological gap between the two powers to the benefit of the United States. Equally essential was the shared interest of the two powers in stopping or at least dampening the spread of nuclear weapons among nations; in the early days the prime targets of these policies were China, France and West Germany. There were thus both short-term and long-term considerations in negotiating a test ban. From the start, however, the negotiators encountered serious difficulties.

In 1958-62, during the first extended period of negotiation for a comprehensive test ban, verification was a particularly contentious issue. Despite continuous advances in the techniques of checking

compliance, it had not proved possible to obtain assurance that all nuclear explosions would be detected with the use of remote instrumentation. Once this was recognized by the negotiating parties, it was judged necessary to provide for on-site inspections on the territory of a state suspected of violation. The number and modalities of such inspections, however, soon became subjects of acrimonious and inconclusive disputes.

Underlying the verification issue was the overriding mutual suspicion between the Soviet Union on the one hand and the United States and the United Kingdom on the other. In this period of the cold war, growing mistrust was undermining the very concept of a comprehensive test ban. From the defence community of the United States came the objection that a test ban would debilitate US nuclear strategy by preventing the development of new weapons, while the Soviet Union could exploit possible loopholes in verification arrangements to clandestinely proceed with weapon modernization. Soviet obstructiveness on the question of "intrusive" inspections, and the escalation of Soviet military preparedness following the shooting down in 1960 of the US U-2 reconnaissance aircraft over Soviet territory, strengthened the sceptics in their claim that the ban was being sought by Moscow for the sole purpose of arresting Western weapon modernization and consolidating its own position. In spite of repeatedly affirmed intentions to achieve a test ban, neither the United States nor the Soviet Union seemed at that time to be genuinely interested in such a ban. Both sides were conveniently hiding behind the problem of verification: one insisting on measures which were obviously unacceptable, and the other refusing to accept measures which were obviously indispensable.

Nevertheless, the test issue remained on the agenda of international arms control discussions. In 1980, the UK, the USA and the USSR, then engaged in trilateral talks, seemed to be closer to a test ban treaty than ever before. The negotiators were agreed on the following important points. The treaty, initially to be valid for three years, would prohibit any nuclear weapon test explosion in any environment; a moratorium on nuclear explosions for peaceful

purposes would be established until acceptable arrangements for conducting them were worked out; the treaty would enter into force upon ratification by 20 signatory governments, including those of the three nuclear weapon powers initiating it; and a conference would be held at an "appropriate" time to review its operation. A large measure of consensus was reached even on the question of verification, including the possibility of on-site inspection. In 1982, however, at the initiative of the United States, these talks were suspended *sine die.*

In later years, especially since the initiation of the SDI programme, parts of which may require nuclear tests, the United States came to consider a complete ban on nuclear explosions only as a "long-term" objective and only as a component of a large arms control package. Consequently, the USA has opposed a test ban as a separate measure, regardless of its verifiability, challenged the Soviet contention that a halt to nuclear testing is a necessary step towards diminishing the nuclear threat, and refused to emulate the Soviet Union when it proclaimed in 1985 a unilateral moratorium on nuclear explosions and abstained from all testing for over a year and a half. The negotiations for a comprehensive nuclear test ban have ended in limbo. The long-running controversy over the mandate of a working committee to deal with the subject of tests at the Geneva-based Conference on Disarmament (CD) served simply as a distraction from the fundamental difference between the main partners as to whether cessation of nuclear explosions was at all a desirable measure.

IV. What is the value of the test limitation treaties which have been signed?

Thirty years of deliberations and negotiations on a total prohibition of nuclear test explosions have resulted in only partial agreements. The parties thereto may conduct nuclear explosions solely underground, and the yields of the explosions must not exceed the agreed limit.

THE 1963 PARTIAL TEST BAN TREATY

The multilateral treaty banning nuclear weapon tests in the atmosphere, in outer space and under water, called the Partial (or Limited) Test Ban Treaty (PTBT or LTBT), was signed on 5 August 1963. Its conclusion at that particular time was prompted chiefly by the need to improve US-Soviet relations, which had been severely strained by the 1962 Cuban missile crisis, and to bring about a general relaxation of international tension. The fact that both superpowers had by then already carried out extensive series of tests in the atmosphere and were prepared for testing to be continued underground, reduced the cost of their mutual "sacrifice." The Treaty entered into force on 10 October 1963; by 1 January 1987 it had as many as 116 adherents.

It is important to remember that the PTBT was generally considered to be a transitional arrangement: the parties stated their determination to conclude a treaty resulting in the "permanent banning of all nuclear test explosions." Underground explosions, whatever their purpose, have not been covered by the Treaty, but they are not allowed if they cause radioactive debris to be present outside the territorial limits of the state under whose jurisdiction or control they are conducted. The pledge concerning the discontinuance of all explosions has not been fulfilled. The US Government's statement of 1982 that it would "set aside" efforts to negotiate a comprehensive ban on nuclear testing was justifiably regarded by many states as impeding full implementation of the PTBT.

Adherence to the PTBT, though wide, is not universal. Two nuclear weapon powers, France and China, have not joined it. France argued that the Treaty had only limited practical importance, and reaffirmed its intent to proceed with its own nuclear buildup; China criticized the Treaty as not encompassing general disarmament or a ban on underground tests. Both nations eventually gave up atmospheric testing through unilateral statements of renunciation: France in 1975, after a suit had been brought against it by Australia and New Zealand in the International Court of Justice; and China

some 10 years later, after a series of protests made by both neighbouring and distant countries against radioactive contamination resulting from Chinese nuclear explosions in the atmosphere. Such a militarily important non-nuclear weapon country as Pakistan, which refuses formally to forgo the acquisition of nuclear weapons, is also missing from the list of parties. But even if Pakistan or another "nuclear threshold country" decided to cross the threshold to become a nuclear weapon state, it would most probably not do so by detonating a nuclear device in an environment prohibited by such a widely adhered-to treaty as the PTBT and expose itself to international opprobrium. The PTBT appears to have become a norm of behaviour to be observed by parties and non-parties alike.

The PTBT has complicated the development of very high-yield weapons and has made impossible full-scale operational testing of weapons in the environments in which they are meant to be used — notably in the atmosphere. It has also rendered it difficult to measure the effects of the EMP on military and civilian equipment. However, these restrictions have not prevented the USA, the UK and the USSR from satisfying other military requirements. Moreover, by testing underground, they deny important intelligence information to other states about the characteristics of their weapons that could otherwise be gathered from debris produced by atmospheric tests. The rate of testing by the Soviet Union and the United States increased after the PTBT went into force.

The PTBT has helped curb the radioactive pollution of the atmosphere and reduced the health hazards associated with nuclear fall-out. It has thus made an important contribution to the environmental protection regime. In national policies it marked the first major success of the proponents of arms control, who thus managed to overcome the resistance of the proponents of an uncontrolled arms race. In the international arena it became an obstacle to the wider spread of nuclear weapons and paved the way for the 1968 Non-Proliferation Treaty (NPT).

The 1974 Threshold Test Ban Treaty

Talks on a comprehensive test ban resumed after entry into force of the PTBT, but the focus on technical matters precluded systematic discussion of the provisions of a new agreement. The UN General Assembly adopted resolutions deploring or condemning nuclear tests and calling for their complete cessation, but the difficulties encountered gave rise to proposals for a partial approach to a ban on underground nuclear weapon testing. Appeals were made by non-nuclear weapon states for transitional measures of restraint that would suspend testing, or limit or reduce the size and number of tests, pending the entry into force of a comprehensive ban. For a long time, these proposals and appeals were ignored by the main testing powers, the USA and the USSR, until, in the summer of 1974, both countries changed their positions. On 3 July of that year they signed a bilateral treaty on the limitation of underground nuclear weapon tests, which came to be called the Threshold Test Ban Treaty (TTBT).

The scope of the obligations under the TTBT is very limited. The United States and the Soviet Union undertook to "prohibit, to prevent and not to carry out" any underground nuclear weapon test having a yield which exceeds 150 kt beginning on 31 March 1976. The official justification for setting a distant date for the entry into force of the yield limitation was that considerable time would be needed to make all verification arrangements. A more important reason, however, was that some warheads then under development were planned to have a yield exceeding the agreed limit. Testing, therefore, had to take place before the restrictions became effective. Tests with yields exceeding the threshold were in fact hastily conducted by both the USA and the USSR after the signature of the TTBT and before it was to enter into effect. Although the parties committed themselves to restrict the number of tests to a minimum, neither US nor Soviet testing activities slackened.

Ratification of the TTBT has not taken place because of opposition in the USA to making it formally and legally binding. The

parties stated that they would observe the agreed upon limitation during the pre-ratification period. Despite its continuing unratified status, the TTBT has to some extent constrained the development of new high-yield warheads. The yield limitation has also made it difficult for the parties to carry out certain stockpile-sampling, because the existing large thermonuclear weapons cannot be tested at their full yield. (Most strategic nuclear warheads in the super-powers' arsenals have yields in excess of 150 kt.) Moreover, cessation of explosions in the megaton range has had a positive environmental effect: it has further reduced the risks of radioactive venting and of ground disturbance. All this does not alter the fact that the TTBT has hardly contributed to the cessation of the nuclear arms race. The 150-kt yield threshold is too high to be really meaningful: the parties do not experience onerous restraints in continuing their nuclear weapon programmes. Nor does the agreed threshold reflect present verification capabilities: the detection and identification of nuclear explosions of far lower size are possible.

The TTBT was seen by many as a substitute for, rather than a step towards, a comprehensive treaty. It was criticized in both the Conference on Disarmament and the United Nations as inadequate. Unlike the PTBT and other nuclear arms control agreements, it was not welcomed by the UN General Assembly; nor has any international appeal been made for its ratification.

The 1976 Peaceful Nuclear Explosions

The provisions of the TTBT did not extend to underground nuclear explosions for peaceful purposes. Since such explosions cannot be distinguished, at least from a distance, from explosions serving military ends, the possibility remained that the threshold limitation on weapon tests might be circumvented. The United States and the Soviet Union decided, therefore, to work out a separate agreement, which would contain additional obligations closing this loophole. A treaty on underground nuclear explosions for peaceful purposes, called the Peaceful Nuclear Explosions Treaty (PNET), was signed on 28 May 1976. It regulates the explosions carried out

by the USA and the USSR outside their nuclear weapon test sites, as from 31 March 1976, the date valid also for the TTBT.

For many years, peaceful nuclear explosions (PNEs) had been seen as potentially valuable activities for a variety of purposes. In the United States, the so-called Plowshare Programme set out to explore possible uses of PNEs for digging canals or for other industrial ends, such as gas stimulation or oil recovery from otherwise uneconomic deposits. However, progress was slow, given the necessity of systematic tests using both conventional and nuclear explosives, because the need to minimize the risks required careful experimentation. By the mid-1970s, industrial interest in the use of underground nuclear explosions for non-military purposes had waned in the USA, while public concern over possible environmental hazards had increased. These hazards include — in addition to the release of radioactive material — shock wave effects which may occur close to the points of detonation. The programme was terminated in 1977, shortly after the signing of PNET. It can be concluded that PNEs no longer constitute a motivation for the United States to continue explosive testing, unless circumstances were to change in a manner currently unforeseeable.

By comparison, the Soviet Union has pursued an active PNE programme. Its primary interests seem to have focussed on the creation of underground storage facilities, as well as on seismic and geological mapping of Soviet territory. The grandiose Soviet plan for river diversion in Asia, using nuclear explosives, has been stopped, but since Soviet leaders have publicly referred to the economic costs to the USSR resulting from the country's 1985-87 moratorium on nuclear explosions, and since PNEs have been resumed after the expiration of the moratorium, it is reasonable to assume that such activities continue to be considered important in the Soviet Union. It has nevertheless been authoritatively and repeatedly stated that the Soviet Union would be prepared for forgo PNEs if a prohibition on all nuclear explosions were achieved. (The United Kingdom said that it would be prepared to renounce permanently the right to conduct nuclear explosions for peaceful purposes as part of an agreement on

a comprehensive test ban.) Projects to use PNEs in countries other than the United States and the Soviet Union have never come to fruition owing to the large economic, environmental and engineering uncertainties involved.

To ensure that explosions declared to be for peaceful purposes should not provide weapon-related benefits not obtainable from limited weapon testing, the parties to the PNET established the same yield threshold for peaceful applications as had been imposed on weapon tests under the TBT, namely 150 kt. The yield restriction applies to individual explosions as distinct from group explosions. The possibility of carrying out individual explosions with a yield greater than 150 kt has been left open for future consideration "at an appropriate time to be agreed." A group explosion may exceed the 150-kt limit and reach an aggregate yield as high as 1500 kt (1.5 Mt), if it is carried out in such a way that individual explosions in the group can be identified and their individual yields determined to be no more than 150 kt. Certain peaceful applications of nuclear energy may indeed require many nuclear blasts of varying size. The PNET explicitly provides that they must be consistent with the PTBT, which prohibits any explosion that causes radioactive debris to be present outside the territorial limits of the state conducting the explosion, but it is unlikely that observance of such a limitation could be guaranteed. Development testing of nuclear explosives for peaceful uses would have to be carried out only within the boundaries of the nuclear weapon test sites and would be treated as the testing of a nuclear weapon. It is, moreover, implied in an agreed statement attached to the Treaty that proof would have to be given that the explosion outside a weapon test site was being conducted with a view to serving some practical peaceful ends.

The duration of the PNET was to be the same as that of the TTBT, and the exchange of instruments of ratification of the two treaties was to take place simultaneously. Although the PNET has not been ratified, it is covered by the US-Soviet undertaking to observe the 150-kt yield limitation during the pre-ratification period.

The PNET was an indispensable complement to the TTBT: the latter treaty would be deprived of meaning if peaceful explosions were allowed without restrictions. However, the PNET has not increased the very limited arms control value of the TTBT. By unduly emphasizing the importance of civil applications of nuclear explosives, it may even have had a negative impact on the policy of preventing nuclear weapon proliferation in providing respectability to the arguments of those states that seek to develop a nuclear weapon capability under the guise of an interest in peaceful explosions. Nor has the PNET solved the intractable problem of accommodating peaceful nuclear explosions under a test ban. It is true that some constraints have been provided for in the Treaty to limit the possibility of gaining weapon-related information from the peaceful application of nuclear explosions. This, however, would not prevent testing the performance of a stockpiled warhead or, perhaps more important, some limited testing of a new weapon design. Furthermore, it is clear that with a comprehensive ban on nuclear weapon tests it would be impossible to allow development testing of nuclear explosives for peaceful uses without completely defeating the purpose of the ban. Any nuclear explosive device ostensibly developed for peaceful purposes is inherently capable also of being used as a weapon. Hence, no nuclear explosion could be tolerated under a truly comprehensive ban.

In sum, none of the three nuclear test limitation treaties so far concluded has seriously affected weapon programmes by hindering improvements in nuclear weaponry. Nor have these treaties significantly reinforced the nuclear non-proliferation regime by rendering the development of nuclear weapon capability more difficult for non-nuclear weapon states. Especially flawed are the TTBT and the PNET. Nevertheless, the fact that these treaties have remained unratified for more than a decade has weakened confidence in the arms-control negotiating process. Full operation of these agreements might have facilitated progress towards a comprehensive ban.

V. How important is verification in achieving a test ban?

The purpose of verification in arms control is to deter secret violations. This presupposes the ability to detect with a reasonably high degree of certainty any evasion that could pose a security risk, and to do so early enough to enable the injured party to mount an adequate response and redress the situation. An equally important role of verification is to demonstrate that activities prohibited by agreements are not taking place and that the parties are fulfilling their obligations. Thus, verification should help generate a climate of international co-operation which is indispensable for progress in arms control. Suspicions of breaches which have not been disproved become a source of discord among the signatories and undermine the validity of the contracted obligations. They also weaken confidence in arms control in general and thereby negatively affect the relations among states. All these considerations apply to a test ban.

VI. How are the existing test limitation treaties verified?

In nuclear test limitation treaties it is necessary for the parties to ensure that test explosions do not take place in the prohibited environments and do not exceed an agreed yield level.

THE PTBT

In the case of the PTBT, the nuclear weapon parties were confident that their own means of verification were sufficient to provide an assurance of detection of clandestine explosions in the atmosphere, in outer space or under water. Consequently, no international mechanism was set up to check whether the commitments were being complied with. Indeed, the prohibition on testing in those three environments seems to be largely self-enforceable. Any signatory nuclear weapon nation that decided that it needed to conduct such tests would probably use the escape clause of the treaty and withdraw from it, rather than embark on risky secret testing. Similarly, with regard to the parties' commitment not to encourage

other states to carry out nuclear tests in the proscribed environments, one could argue that such an undertaking hardly requires verification. It could not be in the interest of the nuclear weapon powers to help others in obtaining military benefits from tests in these environments.

On the other hand, the absence of an international supervisory body to evaluate events according to some objective criteria makes it very difficult to definitively establish whether, in violation of the PTBT, radioactive substances from an underground nuclear explosion have crossed the national borders of the testing country. In 1984-87 the United States and the Soviet Union formally accused each other of violating the PTBT by allowing radioactive debris from underground tests to vent, but in both instances the charges were denied.

THE TTBT

In the TTBT, the "national technical means" used to verify compliance consist primarily of seismic monitoring. Because seismic signals produced by a given underground explosion vary, yield determination requires knowledge of the environment in which the test has been carried out as well as of previous explosions conducted at the same site. Therefore, to facilitate verification, the USA and the USSR agreed to exchange information necessary to establish a correlation between yields of explosions and the recorded seismic signals. Each party undertakes not to interfere with the means of verification of the other party. This clause can be interpreted as a commitment not to use techniques which might reduce the recorded seismic magnitudes. As a complement to technical verification, the parties undertook to consult with each other and furnish information in response to inquiries. This provision is meant to deal with disputes over explosions that seem to violate the yield restriction.

Soon after the signing of the TTBT, press reports began to appear in the USA to the effect that the Soviet Union had conducted nuclear tests with a yield in excess of the permitted 150-kt threshold. The

accusations were later included in an official US list of complaints of Soviet non-compliance with arms control treaties. The USSR countered with similar allegations about US tests. It may well be that some breaches have indeed occurred because, for technical reasons, it is difficult to predict the exact yield of nuclear explosions. This was recognized by the parties themselves when they reached an understanding that one or two "slight, unintended" breaches per year would not be considered a violation, but would be the subject of consultations at the request of either party. The exchange of data to be carried out simultaneously with the exchange of the instruments of ratification of the TTBT, and complemented with calibration tests to improve each side's assessments of the yields of explosions has been held up pending ratification of the Treaty. Recent US expert reports suggest that it is precisely the lack of adequate information about the geological features of the Soviet nuclear test sites that has contributed to ambiguous evidence of non-compliance by the Soviet Union.

THE PNET

Also under the PNET the parties are to use "national technical means" of verification and have undertaken to supply each other with relevant information. The amount of information would vary according to yields: the higher the yield, the more extensive the data required. Since in the case of a group explosion it is difficult to determine with distant seismic measuring instruments alone the yield of individual explosions if they occur within a few seconds of each other, observers of the verifying party, properly equipped, are to be given access to the site of the explosion. They would be permitted to check that the local circumstances, including facilities and installations associated with the project, were consistent with the stated peaceful purposes; to examine the validity of the geological and geophysical information provided in accordance with the Treaty; to observe the emplacement of each explosive; to observe the area of the entrance to each emplacement hole until all personnel have been withdrawn from the site; and, finally, to observe the explosions. Mandatory on-site observation is envisaged for a group

explosion having an aggregate yield above 150 kt. By mutual agreement, explosions with a planned aggregate yield of between 100 and 150 kt could also be subject to on-site observation when, owing to the special character of the project, the reliability of teleseismic measurement cannot be ensured. Moreover, for any group explosion with a planned yield exceeding 500 kt, the observers would, in addition, have the right to install and operate a local seismic network to help ascertain that no undeclared explosions were taking place along with the announced ones.

So far, no on-site observation of peaceful explosions has been carried out; nor apparently have there been explosions in the category for which the Treaty requires such observation. Besides, it would be difficult to initiate an observation procedure on the basis of an unratified treaty. In any event, peaceful nuclear explosions with yield limitations similar to those set in the TTBT are not likely to produce militarily significant information which is not obtainable through weapon tests permitted under the TTBT. Therefore, the nuclear weapon powers have no incentive to seek such information through allegedly peaceful applications. Although important as a precedent for future arms control measures, the on-site controls — reduced as they are to observing an explosion at a time and place chosen by the host country — are not applicable to a multilateral comprehensive nuclear weapon test ban.

VII. What are the present capabilities for detecting underground nuclear explosions?

The most dependable way known to detect and identify suspicious underground events is through seismological means.

Geological factors complicate the process of detection, because seismic signals produced by explosions are modified by the geological structures through which they pass. Another difficulty faced by seismologists is the phenomenon of seismic "noise" — the vibrations in the earth resulting from wind and water wave motion, as well as from industrial activity — from which the discrete events of nuclear

explosions and earthquakes must be picked out before they can be distinguished from each other. For these and other reasons, there is no simple correlation between the strength and pattern of the seismic waves as recorded and the energy of a seismic event. There is also a problem of possible evasion, that is, of deliberately engineered measures intended to significantly degrade the effectiveness of a test ban monitoring system. The evasion scenarios include conducting multiple explosions, explosion "masking" and "decoupling."

In the multiple-explosion scenario, deception could be practiced by firing a sequence of explosions with increasing yields in order to produce earthquake-like signals. However, if suspicions were aroused, sufficiently detailed seismological examination would show that the signals had not been generated by an earthquake. In another scenario, firing a nuclear explosion shortly after the start of a large earthquake could mask the explosion signal in the tail of the earthquake signal. Such a hide-in-the-earthquake technique could not be undertaken easily: the explosion would have to be conducted only when an earthquake occurred with a magnitude exceeding a given limit and within a given range of the place of testing.

The technique of "decoupling" seems to be the most likely method of eluding verification. It would consist of conducting an explosion in a large underground cavity (preferably in a salt deposit) so that the explosive energy would be "decoupled" from, that is, less well transferred to, its geological surroundings. Seismic signals could also be muffled if explosions were conducted in unconsolidated rock. There is, nevertheless, considerable scepticism as to the probability that the decoupling or muffling techniques would be seriously contemplated by states.

To decouple a nuclear explosion, a stable cavity precisely measured and of suitable shape would be required. Experts doubting the feasibility of effective decoupling argue that these conditions would be very hard to obtain. Moreover, they point out that the extrapolations made to determine the effectiveness of this technique have been based on inadequate or unreliable data, in considerable

measure provided by chemical explosions with a yield many times less than that of an average nuclear test. In the event of a sizeable nuclear explosion being decoupled, the reduced seismic signal may still be identifiable as a clandestine nuclear test. Should the cavity collapse it could leak radiation or cause a surface depression open to detection by radiation and photographic monitoring. In most cases it would also be difficult to pass off the lengthy and elaborate activities connected with decoupling as a conventional mining operation. In other words, attempting to engineer a clandestine test within a cavity while guarding against the risk of detection would be an extremely demanding, expensive and risky procedure. Muffling nuclear explosions in loose rock would be even more difficult to achieve, because geological formations suitable for such a technique are not widespread and their locations are presumably known.

At one end of the spectrum, a group of authoritative scientists claim that reliable detection of nuclear explosions can now be obtained down to very low explosive yields. Moreover, owing to the high-frequency seismic waves to which they give rise, the explosions can be clearly distinguished from earthquakes even at distances of several thousand kilometers. (Explosions put out more energy in high frequency vibrations than do earthquakes of comparable magnitudes.) In addition to the geological data of relevance to test ban verification which have been obtained in recent years, it is now known that high-frequency seismic waves propagate readily across large parts of the Soviet Union, facilitating remote identification of nuclear explosions with yields of only a fraction of a kiloton, at distances exceeding 4000 km, and reducing thereby considerably the chances of evasion. Although the risk of decoupling — a matter of particular concern to the US Administration — cannot be completely dismissed, it is widely acknowledged that a "decoupled" nuclear explosion of 10-kt yield or above, conducted on Soviet territory, could be identified as a nuclear detonation by a network of seismic stations outside the Soviet Union. With some two dozen seismic stations installed on the territory of nuclear weapon states and equipped with high-frequency seismometers, it would be possible to detect decoupled underground explosions down to or near 1 kt in

either the USA or the USSR. The validity of this assessment is now fairly widely accepted.

At the other end of the spectrum, some seismologists take a highly conservative stand, emphasizing the problem of seismic noise. They express the view that, in order to discriminate efficiently between events, verification seismometers would need to be placed at very quiet sites, on land and on the seabed, and that such sites might not be available for technical or political reasons. They further contend that traditional seismological identification techniques are still not fully reliable and that the possibility of evading a test ban should be taken seriously. They suggest that cavity decoupling would provide an effective disguise for a nuclear weapon test. For all these reasons, they believe that the best verification system available today could not persuasively ensure detection of nuclear explosions at the low levels referred to above. Some even mention a figure as high as a few tens of kilotons as the lowest verifiable explosive yield, but they are in the minority.

In between these two extremes, certain seismologists conclude that the present level of seismic knowledge and the presumed effectiveness of cavity decoupling to evade detection allow for near-certain detection of explosions with a yield in the 5-10 kt range.

VIII. How could monitoring capabilities be improved to render evasion difficult or impossible?

INTERNATIONAL SYSTEM

It is generally accepted that a global seismic system, if properly constructed, would be necessary to verify compliance with a comprehensive ban on underground testing. To establish an optimal level of such verification, Canadian and Swedish seismologists have suggested a three-tier network of seismic stations positioned in key locations. The components of the envisaged system are as follows:

(a) a global network of 50 or more "primary" stations which, to

the degree possible, provide uniform global coverage of seismic events;

(b) networks of "secondary" stations drawn from national earthquake monitoring networks to provide data on lower-magnitude seismic events occurring on the territories of the participating states; and

(c) special networks of "in-country" stations and other arrangements that provide the additional capabilities required to monitor the territories of nuclear weapon states.

To overcome the problems of discriminating between nuclear explosions and earthquakes, instrumentation at seismic stations would have to be standardized at the highest possible level of sophistication and sited in the lowest possible seismic noise environment. The seismic event data to be channelled through the system would have to be reliable and full, their transmission rapid, and their diffusion unrestricted, in order to facilitate their uniform interpretation throughout the world. Multilaterally administered facilities for international data communication and interpretation would be a necessary part of this co-operative seismological effort. An especially sensitive problem would probably be that of the third tier of stations on the territories of nuclear weapon states, for the main purpose of such stations would be to discourage clandestine nuclear explosions. On the whole, however, the scheme as described seems unobjectionable. Its introduction even before the conclusion of a test ban — as recommended by some — would be a highly desirable measure, as it could help interested nations to acquire expertise necessary to eliminate unfounded suspicions of breaches.

IN-COUNTRY STATIONS

In-country seismic monitoring is particularly useful. Stations closer to the source of a seismic event register a fuller range of signals from it and make their interpretation easier. Additionally, seismic noise poses less of a problem. Multiple nuclear detonations meant to simulate an earthquake, or a nuclear explosion detonated in the coda of an earthquake, would be highly unlikely to escape discovery,

especially if the in-country seismic stations were linked to a network of stations outside the countries being monitored. Such an arrangement would also permit the detection and identification of decoupled nuclear explosions, as well as the detection of chemical explosions conducted for civil engineering purposes above a certain yield.

NON-SEISMIC MEANS OF VERIFICATION

Supplementary verification capabilities can be provided by monitoring the effects of tests, other than seismic. The most important method of non-seismological remote sensing is satellite photography. Unusual activity — for example, of the kind associated with mining engineering — would be relatively difficult to conceal from military or civilian satellites. It would be possible to concentrate surveillance on existing cavities, sites prepared prior to a test ban, and mining areas which could be converted to test areas. Special satellite- and ground-based stations could be used to monitor for airborne radioactive materials. Given the record of underground tests of which a significant number have released radiation to the surface, the possibility of venting would constitute a dilemma to the potential evader calculating the risk of detection.

ON-SITE INSPECTION

However reliable a test ban verification system might be, the possibility will always remain of unexplained occurrences which the detecting state may wish to investigate: hence the presumed need for on-site inspection. Such inspection would have to consist of interlinked aerial, geophysical and radiological surveys of the area of the suspected nuclear explosion in order to measure ambient radioactivity and temperature anomalies; to discover fresh craters, traces of vehicles, metal artifacts, and so on, connected with a test and preparations for it; and, having identified the location of a suspected underground cavity, to establish whether or not a nuclear explosion has occurred.

On-site inspection does not appear to be particularly useful as a

means of checking compliance with a test ban. Visually detectable evidence of breaches would best be detected by satellite photo-reconnaissance. The geographical area for conducting on-site inspection might well be very large, while determination of the precise location of the event in question is critical, and the only way to prove that a nuclear explosion had taken place would be to drill and find radioactive samples. For reasons of the expense, time and effort involved, it would be impractical to have more than a very few such inspections in a year. In any event, in most cases, the evidence of a test ban violation collected by on-site inspectors would probably be not better than circumstantial.

For obvious reasons, a violator would not be likely to permit inspection of areas in which clandestine tests had been held, whatever the consequences of his refusal. But a "threat" of on-site inspection could have a deterrent value: a government contemplating clandestine nuclear testing would certainly have to hesitate before undertaking a politically costly evasion. In this context, the conditions under which on-site inspections would be allowed to take place — that is, whether they would be voluntary or mandatory — are relevant. Co-operation between the parties would be essential for an effective inspection procedure. Withdrawal of co-operation, whatever the justification, including the rejection of inspection in response to a request to investigate a suspicious event, may not necessarily amount to an admission of guilt, but would certainly exacerbate the suspicion.

"ADVANTAGES" OF CHEATING

It is not likely that any party would sign a test-ban or a test-limitation treaty with the set purpose of evading its terms. The would-be evader would have to go to extreme lengths to do so successfully, considering that an explosive test is an undertaking of major engineering proportions. If, after a period of time, a party were to find a motivation to resume testing or to shed the limitations, it could always withdraw from the treaty. This is allowed under arms control agreements. However, should there exist an overwhelming

interest in cheating and a real possibility of undetectable clandestine nuclear testing in spite of a fully deployed verification system, it would be important to know whether a cheater stood to gain a military advantage.

Under the conditions of a comprehensive test ban, cheating would presumably allow a party to continue its nuclear development at the expense of rivals complying with the ban, or at least to rectify a previously unsuspected serious fault in its weapon stockpile without abrogating its treaty obligations. Under a test limitation treaty the temptation to cheat would be less strong, and the advantage from cheating would depend on the size of the agreed threshold. Thus, for the sake of illustration, if 5 kt were taken as a basis for the minimum fully verifiable yield limit (a threshold many seem to accept today), a programme for the development of certain theatre nuclear weapons would be possible, though it could be restricted by a numerical quota of permitted tests. In addition, some components of existing strategic nuclear weapons could possibly be tested at reduced levels. A lower, 1-kt threshold would, according to the prevailing opinion, prevent military significant tests in the sense of denying the development of new weapon designs, even though at sub-kiloton levels some research into as yet undeveloped nuclear weapons would be possible. Clandestine testing of devices with a yield somewhat higher than 1 kt would hardly be expedient; it would carry a great political risk for little military gain.

As regards the development of newly designed strategic weapons, there could be no cheating, because full-yield detonations, generally considered to be necessary to certify such weapons, would be impossible to conceal both under a comprehensive test ban and under a ban on all but low-yield explosions.

IX. What are the present attitudes of states towards nuclear testing?

In the field of nuclear testing, as in other fields of nuclear

armament, the positions of the United States and the Soviet Union — the states military most powerful and, at the same time, the main partners in disarmament talks — are decisive.

The United States

As regards the USA, its official attitude to a test ban has undergone a dramatic change since 1980. At variance with US policies proclaimed during the preceding quarter of a century, President Reagan's Administration views a test ban only in the context of radical arms reductions, maintenance of a credible nuclear deterrent, expanded confidence-building measures and improved verification capabilities. It does not see the ban as a separate measure to be carried into effect in conformity with the obligations accepted under several international agreements. For not only in the PTBT, but also in the NPT, the parties expressed determination to continue negotiations for ending all test explosions of nuclear weapons for all time. Equally, under the TTBT, the parties have undertaken to work towards achieving this goal.

The current attitude of the United States is based on the notion that its security, as well as that of its allies, is best served by nuclear tests. Consequently, technical considerations related to the verifiability of compliance with test bans are of only marginal concern, protestations to the contrary notwithstanding. The continued argument of the inadequacy of verification methods is now viewed by many as a convenient excuse to avoid a complete nuclear test ban. In other words, a test ban would not be acceptable to the present US Administration even with a foolproof guarantee of compliance, as some of its spokesmen have confirmed.

The Soviet Union

The USSR, on the other hand, maintains that halting all testing would diminish the nuclear threat. Reductions in nuclear arsenals alone, without prohibition of tests, would not help in reaching this objective, because continued testing may serve to modernize

remaining weapons and to develop more sophisticated ones, including directed-energy devices for defence against ballistic missiles (the focus of Soviet concern because of the US Strategic Defense Initiative). Repeated Soviet proposals for a comprehensive test ban, supported by the lengthy 1985-87 unilateral moratorium on nuclear testing, as well as the expressed willingness to accept far-reaching measures of verification, including mandatory on-site inspection, suggest the seriousness of Soviet purpose.

According to some analysts, the present disagreements between the USA and the USSR on the question of nuclear testing represent the difference between the doctrine of mutual assured destruction, which stresses the deterrent role of nuclear weapons, and counter-force doctrines, which stress the military utility of nuclear weapons, both strategic and tactical.

The United Kingdom, France and China

The UK is pursuing a policy more ambiguous than that of the United States, emphasizing the problem of verifiability of a test ban rather than the military necessity of tests. In practice, however, the official position of the UK does not diverge from the position of the USA, not least because of the former's dependence on US testing facilities and nuclear weapon systems.

France has been consistently hostile to a test ban. This hostility may reflect the more limited technical level of its nuclear programme. Testing is seen by the French authorities as essential for upholding the credibility of their nuclear deterrent, including the need to develop weapon systems with a potential to circumvent SDI-type defences. Any commitment France might enter into regarding tests would be linked with those it would be prepared to undertake regarding the limitation of its nuclear forces. But France would embark on this process only when the USA and the USSR had reduced their nuclear arsenals so as to narrow markedly the gap between those arsenals and the nuclear means possessed by France.

China, too, has for years been opposed to the cessation of tests. Only when the USA and the USSR had taken the lead in ending the testing, improvement and manufacture of nuclear weapons and had reduced their nuclear armaments by 50 per cent would China undertake the commitment to cease the development and manufacture of its nuclear weapons. Some change in China's policy may have been heralded by its recently stated preparedness to participate in discussions of a test ban within the framework of the Conference on Disarmament.

If a complete test ban were to be concluded between the superpowers, it would seem likely that the remaining nuclear weapon states might in time feel compelled by international pressure to stop all testing. In any event, the positions of France and China should not be an impediment to a US-Soviet test ban treaty. For many years to come, no amount of testing by these "secondary" nuclear weapon powers could have an adverse impact on the security fo the superpowers.

NON-NUCLEAR WEAPON COUNTRIES

The most outspoken advocates of a test ban are the non-nuclear weapon states, the overwhelming majority of which have joined the NPT and thereby renounced the possession of nuclear explosive devices. At the initiative of these states, successive NPT review conferences have called for the conclusion of a CTB. Participants at the 1985 conference — with the exception of the USA and the UK — deeply regretted that a comprehensive nuclear test ban treaty had not been concluded, and called on the nuclear weapon powers to resume negotiations for the conclusion of such a treaty "as a matter of the highest priority."

However, several non-nuclear weapon countries conducting militarily significant nuclear activities — Argentina, Brazil, India, Israel, Pakistan and South Africa — are not party to the NPT and may be expected to resist a test ban which would restrict the development of their nuclear weapon capability or perhaps foreclose

altogether their nuclear weapon option. Some of these nuclear threshold countries have taken positions formally favourable to a nuclear test ban under the so-called Six-Nation Peace Initiative (Argentina, Greece, India, Mexico, Sweden and Tanzania). In a document adopted in 1986 in Mexico, the leaders of these countries stated that they were prepared to assist in the seismic monitoring of a moratorium on nuclear weapon tests or of a test ban. However, of the participants in this initiative only Sweden and India had previously been active in the work of the group of seismic experts, established by the Conference on Disarmament and open to all states. Argentina and India claim for themselves the right to conduct nuclear explosions for peaceful purposes, even though it is impossible to develop nuclear explosives which would be capable only of peaceful applications. Neither country has joined the NPT or submitted its nuclear activities to the full-scope safeguards of the International Atomic Energy Agency.

The reluctance of the threshold states to give up their nuclear weapon option has its roots in regional political and military rivalries rather than in the big-power rivalry. None the less, in de-emphasizing the military role of nuclear weapons, a cessation of tests by the present nuclear weapon states could affect the views of the threshold states, though it may not be a sufficient *quid pro quo* for their definitive renunciation of nuclear weapons.

X. What would be the impact of a comprehensive test ban on the nuclear arms race?

Under a test ban, the present offensive capabilities of the nuclear weapon states would not decline since one need not perform tests to manufacture additional weapons using old designs and since delivery systems would not be affected. But further nuclear weapon development would be rendered largely impossible. Designing and deploying new nuclear weapons without testing would involve too many uncertainties to be resorted to.

In so far as concern about "technological surprise" drives the arms

race, the cessation of tests may remove at least one of the causes of this apprehension by making it unlikely that something completely new, unpredictable and exotic would suddenly emerge in the nuclear field. Thereby, the race for qualitative improvement of nuclear weapons — an important channel of the potentially destabilizing superpower arms competition — would be considerably narrowed. This would make it easier for the nuclear weapon powers to critically assess the excessive levels of the nuclear forces which they already possess.

According to competent sources, a high degree of confidence in the reliability of stockpiled weapons could be maintained under the conditions of a test ban. If, however, it were accepted that the weapons were subject to irremediable deterioration, one would also have to admit that any such deterioration would, to a greater or lesser extent, affect the arsenals of all the nuclear powers party to the ban. The consequent reduced level of confidence in stockpiles would not need to become a matter of concern if US and Soviet nuclear weaponry served only the stated purpose of deterrence of nuclear war. With so many nuclear weapons available, deterrence does not depend on every single weapon functioning exactly as envisaged; there would hardly be a necessity to compensate for a degree of uncertainty. It might be added that confidence that a warhead would detonate is only one factor in the reliability of a weapon, the performance of the missile carrying the warhead being equally if not more important. However, it is conceivable, assuming rational behaviour, that any power would be less likely to launch a first disarming nuclear strike with weapons considered to be of somewhat doubtful reliability: its own weapons might fail, while those of its opponent might not. Nuclear war would be made less likely.

Whereas there is fairly broad consensus on the braking effect of a test ban on the vertical proliferation of nuclear weapons — in particular, on the qualitative improvement of the nuclear arsenals — opinions are widely divergent as regards the impact of a ban on horizontal proliferation, that is, on decisions of the present non-nuclear weapons states whether or not to develop such weapons.

Historically, the widespread opposition to testing has been sustained by a belief that a ban on tests would reduce the chance that additional countries would enter the nuclear arms race, the assumption being that the ban would be universally adhered to. In fact, however, testing would not be indispensable for newcomers to the nuclear club. First-generation fission devices could be produced without testing, and the producer might be confident that the device would actually explode. But the weapon would be highly unsophisticated, of uncertain yield and perhaps also difficult to deliver. It is unlikely that any country would be willing to create a large arsenal of such untested devices. This circumstance would slow down horizontal proliferation. Thermonuclear weapons involve a quantum jump in physical processes over first-generation atomic devices; their development without tests would therefore be out of the question, and their horizontal proliferation would be precluded.

An argument has been put forward in the United States that a cessation of tests by the USA and the USSR, followed by a consequent decline of confidence in their nuclear stockpiles and, thereby, in the reliability of their security guarantees, would compel those dependent upon the superpowers' "nuclear umbrella" to develop their own, independent nuclear deterrent forces. But the argument appears spurious. There is no sign of pro-nuclear sentiments among the non-nuclear weapon members of the major military alliances. Moreover, a test ban treaty of unlimited duration would no doubt tend to create an international climate in which even non-parties would feel inhibited from engaging in testing, out of fear of being stigmatized as outlaw states. Misgivings that horizontal nuclear weapon proliferation would take place in the aftermath of a test ban are unjustified. On the contrary, a test ban would reinforce the NPT by demonstrating the major powers' awareness of their legal obligation under this Treaty to bring the nuclear arms race to a halt.

XI. What other effects would result from a test ban?

The consequences of a test ban, other than those directly relevant

to arms control, are difficult to foresee. Much would depend on the details of the agreement reached and on the spirit in which it was entered into. The view of proponents is that, by relieving psychological stress associated with nuclear weapons, a test ban might create conditions facilitating changes in NATO-Warsaw Pact relations and a return to the era of political detente between the military blocs.

There is strong support for a test ban in many parts of the world. By providing a political signal and a tangible proof that both sides were seriously looking for an alternative to constant tensions accompanied by an unrestricted arms race, it would be a major international event with considerable confidence-building effects.

CONCLUSIONS

At the time of writing — in the summer of 1987 — the prospects for achieving a suspension of tests through a multilateral, simultaneous moratorium, or their complete cessation through a single, comprehensive treaty, seem slim. The opposition, coming as it does now from several powerful military and political groups, mainly in the United States, may be difficult to overcome. There seems, however, to be less hostility towards further partial restrictions on testing. In this connection, the question arises as to what kind of restrictions would be more meaningful than those already observed in the PTBT, TTBT and PNET.

The limitations could be both on the rate of testing and on the explosive yield of tests. An effective yield limitation would have to set the threshold low enough to preclude the development of new weapon designs, and a threshold not higher than 1 kt would seem to be suitable for this purpose. Tests with lower yields would not be prohibited. One could even admit a few tests per year with a somewhat higher yield ceiling, if the agreed annual quota and yield were small enough to preclude support for a nuclear weapon development programme. From this point of view, one or two tests with a yield of up to 5 kt, per nuclear country and per year, would not be excessive, but might enable the scaling up of results from such explosions to estimate the effectiveness of certain important components of stockpiled weapons. This would be especially applicable to the fission "triggers" setting off the fusion reaction in thermonuclear weapons, the reliability of which appears to be of continuing concern. It is clear that over a period of several years, even a minimal

quota of tests restricted to a 5-kt yield might be taken advantage of to develop a new design of a small nuclear weapon. But this could probably be achieved only at the expense of the reliability tests and would seem, therefore, to be an acceptable risk.

The freedom to conduct a very limited number of tests with a yield higher than 1 kt but not exceeding 5 kt would not permit significant qualitative improvement of nuclear weapons, but would be of some military usefulness, as described above. It would thus go a long way towards meeting one of the main objections to a comprehensive ban, namely, that the nuclear stockpile would deteriorate and become unreliable, or that the repairs of weapons could not be trusted, without the benefit of testing. Furthermore, the freedom to conduct an unlimited number of tests with a yield of up to 1 kt would preclude a controversy over the military value of sub-kiloton yield explosions and their verifiability. It might also satisfy the need to learn more about the physics and about some effects of nuclear weapons, and thereby dispose of the apprehension voiced by the weapon laboratories that their technical teams would disperse. The risk of a party suddenly breaking out of a very-low-threshold test ban (VLTTB) would be less than in the case of a comprehensive ban.

The verification procedures for a VLTTB could build upon those already accepted under the TTBT and the PNET. In addition to an extensive exchange of data and a few calibration shots to aid in yield estimation, there would be a need for suitably located in-country seismic monitoring stations to reduce the possibility of evasion. All tests would be notified in advance and conducted only at an agreed designated site. In addition, those tests subject to an annual quota would be monitored by outside observers. On-site inspections could be envisaged for suspicious events. Moreover, obligatory international observation of chemical explosions for mining or other engineering purposes, exceeding a specified size, would be provided for at sites where thick low-coupling geological formations are known to exist, or where large underground cavities may exist having a capability to accommodate a decoupled nuclear explosion. Because of the permissiveness to test, there would be fewer "false

alarms" than under a total ban, and the incentive to cheat would not be high.

A test ban is more verifiable than most other arms control measures. But the decision whether or not to go ahead with a treaty would not be made only on verification grounds. It would be essentially a political decision based on governmental calculations of national security and international stability. Arms control benefits would be weighed against the perceived risks of a freeze on the modernization of nuclear weapons.

A VLTTB as sketched out above would of course apply only to the present nuclear weapon powers. It could not be a universal commitment, because most non-nuclear weapon countries have already renounced the very possession of nuclear weapons and consequently also the testing of nuclear explosives. These countries could, however, contribute to the verification procedures. In fact, the greatest possible participation in a world-wide system of seismic monitoring would be indispensable for the viability of a VLTTB.

Arms control cannot remove the motives for possessing arms. But it may stop to slow down the arms race both quantitatively and qualitatively, minimize unwarranted military disparity between states, help save resources needed for peaceful purposes, diminish the dangers to the environment and improve the international political climate.

Arms control measures concerning nuclear testing could help fulfil most of these functions on condition that: they precluded or significantly limited the freedom to develop new weapon designs; reinforced the non-proliferation regime; contained no loopholes facilitating circumvention of the contracted obligations through ostensibly peaceful explosions; provided for reasonable assurance of compliance; and opened the way towards, or complemented, more far-reaching measures, including cuts in nuclear weapon arsenals. A comprehensive test ban would meet these requirements. Failing such a ban, a VLTTB would be a meaningful alternative. However, any

partial arrangement should be seen as transitional and contain an explicit unequivocal commitment to achieving a complete prohibition of tests by all states.

ANNEXES

ANNEXE I. EXISTING LEGAL LIMITATIONS ON NUCLEAR EXPLOSIONS

PREPARED BY RAGNHILD FERM

I. MAJOR TREATIES

Treaty banning nuclear weapon tests in the atmosphere, in outer space and under water (PTBT)

Signed at Moscow on 5 August 1963; entered into force on 10 October 1963.

Parties: Afghanistan, Argentina, Australia, Austria, Bahamas, Bangladesh, Belgium, Benin, Bhutan, Bolivia, Botswana, Brazil, Bulgaria, Burma, Byelorussia, Canada, Cape Verde, Central African Republic, Chad, Chile, Columbia, Costa Rica, Côte d'Ivoire, Cyprus, Czechoslovakia, Denmark, Dominican Republic, Ecuador, Egypt, El Salvador, Fiji, Finland, Gabon, Gambia, German Democratic Republic, FR Germany, Ghana, Greece, Guatemala, Guinea-Bissau, Honduras Hungary, Iceland, India, Indonesia, Iran, Iraq, Ireland, Israel, Italy, Japan, Jordan, Kenya, Republic of Korea, Kuwait, Lao People's Democratic Republic, Lebanon, Liberia, Libya, Luxembourg, Madagascar, Malawi, Malaysia, Malta, Mauritania, Mauritius, Mexico, Mongolia, Morocco, Nepal, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Norway, Panama, Papua New Guinea, Peru, Philippines, Poland, Romania, Rwanda, Samoa, San Marino, Senegal, Seychelles, Sierre Leone, Singapore, South Africa, Spain, Sri Lanka, Sudan, Swaziland, Sweden, Switzerland, Syria, Taiwan, Tanzania, Thailand, Togo, Tonga, Trinidad and Tobago, Tunisia, Turkey, Uganda, UK. Ukraine, Uruguay, USA, USSR, Venezuela, Democratic Yemen, Yugoslavia, Zaire, Zambia

The Governments of the United States of America, the United Kingdom of Great Britain and Northern Ireland, and the Union of Soviet Socialist Republics, hereinafter referred to as the 'Original Parties',

Proclaiming as their principal aim the speediest possible achievement of an agreement on general and complete disarmament under strict international control in accordance with the objectives of the United Nations which would put an end to the armaments race and eliminate the incentive to the production and testing of all kinds of weapons, including nuclear weapons,

Seeking to achieve the discontinuance of all test explosions of nuclear weapons for all time, determined to continue negotiations to this end, and desiring to put an end to the contamination of man's environment by radioactive substances,

Have agreed as follows:

Article I

1. Each of the Parties to this Treaty undertakes to prohibit, to prevent, and not to carry out any nuclear weapon test explosion, or any other nuclear explosion, at any place under its jurisdiction or control:

(a) in the atmosphere; beyond its limits, including outer space; or under water, including territorial waters or high seas; or

(b) in any other environment if such explosion causes radioactive debris to be present outside the territorial limits of the State under whose jurisdiction or control such explosion is conducted. It is understood in this connection that the provisions of this subparagraph are without prejudice to the conclusion of a treaty resulting in the permanent banning of all nuclear test explosions, including all such explosions underground, the conclusion of which, as the Parties have stated in the Preamble to this Treaty, they seek to achieve.

2. Each of the Parties of this Treaty undertakes furthermore to refrain from causing, encouraging, or in any way participating in, the carrying out of any nuclear weapon test explosion, or any other nuclear explosion, anywhere which would take place in any of the environments described, or have the effect referred to, in paragraph 1 of this Article.

Article II

1. Any Party may propose amendments to this Treaty. The text of any proposed amendment shall be submitted to the Depositary Governments which shall circulate it to all Parties to this Treaty. Thereafter, if requested to do so by one-third or more of the Parties, the Depositary Governments shall convene a conference, to which they shall invite all the Parties, to consider such amendment.

2. Any amendment to this Treaty must be approved by a majority of the votes of all the Parties to this Treaty, including the votes of all the Original Parties. The amendment shall enter into force for all Parties upon the deposit of instruments of ratification by a majority of all the Parties, including the instruments of ratification of all the Original Parties.

Article III

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 paragraph 3 of this Article may accede to it at any time.

2. This Treaty shall be subject to ratification by signatory States. Instruments of ratification and instruments of accession shall be deposited with the Governments of the Original Parties — the United States of America, the United Kingdom of Great Britain and Northern Ireland, and the Union of Soviet Socialist Republics-which are hereby designated the Depositary Governments.

3. The Treaty shall enter into force after its ratification by all the Original Parties and the deposit of their instruments of ratification.

4. For States whose instruments of ratification or accession are deposited subsequent to 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.

5. The Depositary Governments shall promptly inform all signatory and acceding States of the date of each signature, the date of deposit of each instrument of ratification of and accession to this Treaty, the date of its entry into force, and the date of receipt of any requests for conferences or other notices.

6. This Treaty shall be registered by the Depositary Governments pursuant to Article 102 of the Charter of the United Nations.

Article IV

This Treaty shall be of unlimited duration.

Each Party shall in exercising its national sovereignty have the right to withdraw from the Treaty if it decides that extraordinary events, related to the subject matter of this Treaty, have jeopardized the supreme interests of its country. It shall give notice of such withdrawal to all other Parties to the Treaty three months in advance.

Article V

1. This Treaty, of which the English and Russian texts are equally authentic, shall be deposited in the archives of the Depositary Governments. Duly certified copies of this Treaty shall be transmitted by the Depositary Governments to the Governments of the signatory and acceding States.

Source: *Treaty Series*, Vol. 480 (United Nations, New York).

Treaty between the USA and the USSR on the limitation of underground nuclear weapon tests (Threshold Test Ban Treaty, TTBT)

Signed at Moscow on 3 July 1974; not in force by 1 July 1988.

The United States of America and the Union of Soviet Socialist Republics, hereinafter referred to as the Parties.

Declaring their intention to achieve at the earliest possible date the cessation of the nuclear arms race and to take effective measures towards reductions in strategic arms, nuclear disarmament, and general and complete disarmament under strict and effective international control,

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

Noting that the adoption of measures for the further limitation of underground nuclear weapon tests would contribute to the achievement of these objectives and would meet the interests of strengthening peace and the further relaxation of international tension.

Reaffirming their adherence to the objectives and principles of the Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water and of the Treaty on the Non-Proliferation of Nuclear Weapons.

Have agreed as follows:

Article I

1. Each Party undertakes to prohibit, to prevent, and not to carry out any underground nuclear weapon test having a yield exceeding 150 kilotons at any place under its jurisdiction or control, beginning 31 March 1976.

2. Each Party shall limit the number of its underground nuclear weapon tests to a minimum.

3. The Parties shall continue their negotiations with a view towards achieving a solution to the problem of the cessation of all underground nuclear weapon tests.

Article II

1. For the purpose of providing assurance of compliance with the provisions of this Treaty, each Party shall use national technical means of verification at its disposal in a manner consistent with the generally recognized principles of international law.

2. Each Party undertakes not to interfere with the national technical means of verification of the other Party operating in accordance with paragraph 1 of this article.

3. To promote the objectives and implementation of the provisions of this Treaty the Parties shall, as necessary, consult with each other, make inquiries and furnish information in response to such inquiries.

Article III

The provisions of this Treaty do not extend to underground nuclear explosions carried out by the Parties for peaceful purposes. Underground nuclear explosions for peaceful purposes shall be governed by an agreement which is to be negotiated and concluded by the Parties at the earliest possible time.

Article IV

This Treaty shall be subject to ratification in accordance with the constitutional procedures of each Party. This Treaty shall enter into force on the day of the exchange of instruments of ratification.

Article V

1. This Treaty shall remain in force for a period of five years. Unless replaced earlier by an agreement in implementation of the objectives specified in paragraph 3 of article I of this Treaty, it shall be extended for successive five-year periods unless either Party notifies the other of its termination no later than six months prior to the expiration of the Treaty. Before the expiration of this period the Parties may, as necessary, hold consultations to consider the situation relevant to the substance of this Treaty and to introduce possible amendments to the text of the Treaty.

2. Each 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 this Treaty have jeopardized its supreme interests. It shall give notice of its decision to the other Party six months prior to withdrawal from this Treaty. Such notice shall include a statement of the extraordinary events the notifying Party regards as having jeopardized its supreme interests.

3. This treaty shall be registered pursuant to Article 102 of the Charter of the United Nations.

Protocol to the Threshold Test Ban Treaty

The United States of America and the Union of Soviet Socialist Republics, hereinafter referred to as the Parties,

Having agreed to limit underground nuclear weapon tests,

Have agreed as follows:

1. For the purpose of ensuring verification of compliance with the obligations of the Parties under the Treaty by national technical means, the Parties shall, on the basis of reciprocity, exchange the following data:

(a) The geographic co-ordinates of the boundaries of each test site and of the boundaries of the geophysically distinct testing areas therein.

(b) Information on the geology of the testing areas of the sites (the rock characteristics of geological formations and the basic physical properties of the rock, i.e., density, seismic velocity, water saturation, porosity and depth of water table).

(c) The geographic co-ordinates of underground nuclear weapon tests, after they have been conducted.

(d) Yield, date, time, depth and co-ordinates for two nuclear weapon tests for calibration purposes from each geophysically distinct testing area where underground nuclear weapon tests have been and are to be conducted. In this connexion the yield of such explosions for calibration purposes should be as near as possible to the limit defined in article 1 of the Treaty and not less than one tenth of that limit. In the case of testing areas where data are not available on two tests for calibration purposes, the data pertaining to one such test shall be exchanged, if available, and the data pertaining to the second test shall be exchanged as soon as possible after a second test having a yield in the above-mentioned range. The provisions of this Protocol shall not require the Parties to conduct tests solely for calibration purposes.

2. The Parties agree that the exchange of data pursuant to subparagraphs (a), (b) and (d) of paragraph 1 shall be carried out simultaneously with the exchange of instruments of ratification of the Treaty, as provided in article IV of the Treaty, having in mind that the Parties shall, on the basis of reciprocity, afford each other the opportunity to familiarize themselves with these data before the exchange of instruments of ratification.

3. Should a Party specify a new test site or testing area after the entry into force of the Treaty, the data called for by subparagraphs (a) and (b) of paragraph 1 shall be transmitted to the other Party in advance of use of that site or area. The data called for by subparagraph (d) of paragraph 1 shall also be transmitted in advance of use of that site or area if they are available; if they are not available, they shall be transmitted as soon as possible after they have been obtained by the transmitting Party.

4. The Parties agree that the test sites of each Party shall be located at places under its jurisdiction or control and that all nuclear weapon tests shall be conducted solely within the testing areas specified in accordance with paragraph 1.

5. For the purposes of the Treaty, all underground nuclear explosions at the specified test sites shall be considered nuclear weapon tests and shall be subject to all the provisions of the Treaty relating to nuclear weapon tests. The provisions of article III of the Treaty apply to all underground nuclear explosions conducted outside of the specified test sites, and only to such explosions.

This Protocol shall be considered an integral part of the Treaty.

Source: UN document A/9698, Annex I and II, 9 August 1974

Treaty between the USA and the USSR on underground nuclear explosions for peaceful purposes (PNET)

Signed at Moscow and Washington, DC, on 28 May 1976; not in force by 1 July 1988.

The United States of America and the Union of Soviet Socialist Republics, hereinafter referred to as the Parties,

Proceeding from a desire to implement Article III of the Treaty between the United States of America and the Union of Soviet Socialist Republics on the Limitation of Underground Nuclear Weapon Tests, which calls for the earliest possible conclusion of an agreement on underground nuclear explosions for peaceful purposes,

Reaffirming their adherence to the objectives and principles of the Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water, the Treaty on the Non-Proliferation of Nuclear Weapons, and the Treaty on the Limitation of Underground Nuclear Weapon Tests, and their determination to observe strictly the provisions of these international agreements,

Desiring to assure that underground nuclear explosions for peaceful purposes shall not be used for purposes related to nuclear weapons,

Desiring that utilization of nuclear energy be directed only toward peaceful purposes,

Desiring to develop appropriately cooperation in the field of underground nuclear explosions for peaceful purposes,

Have agreed as follows:

Article I

1. The Parties enter into this Treaty to satisfy the obligations in Article III of the Treaty on the Limitation of Underground Nuclear Weapon Tests, and assume additional obligations in accordance with the provisions of this Treaty.

2. This Treaty shall govern all underground nuclear explosions for peaceful purposes conducted by the Parties after 31 March 1976.

Article II

For the purposes of this Treaty:

(a) 'explosion' means any individual or group underground nuclear explosion for peaceful purposes;

(b) 'explosive' means any device, mechanism or system for producing an individual explosion;

(c) 'group explosion' means two or more individual explosions for which the time interval between successive individual explosions does not exceed five seconds and for which the emplacement points of all explosives can be interconnected by straight line segments, each of which joins two emplacement points and each of which does not exceed 40 kilometres.

Article III

1. Each Party, subject to the obligations assumed under this Treaty and other international agreements, reserves the right to:

(a) carry out explosions at any place under its jurisdiction or control outside the geographical boundaries of test sites specified under the provisions of the Treaty on the Limitation of Underground Nuclear Weapon Tests; and

(b) carry out, participate or assist in carrying out explosions in the territory of another State at the request of such other State.

2. Each Party undertakes to prohibit, to prevent and not to carry out at any place under its jurisdiction or control, and further undertakes not to carry out, participate or assist in carrying out anywhere:

(a) any individual explosion having a yield exceeding 150 kilotons;

(b) any group explosion:

(1) having an aggregate yield exceeding 150 kilotons except in ways that will permit identification of each individual explosion and determination of the yield of each individual explosion in the group in accordance with the provision of Article IV of and the Protocol to this Treaty;

(2) having an aggregate yield exceeding one and one-half megatons;

(c) any explosion which does not carry out a peaceful application;

(d) any explosion except in compliance with the provisions of the Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water, the Treaty on Non-Proliferation of Nuclear Weapons, and other international agreements entered into by that Party.

3. The question of carrying out any individual explosion having a yield exceeding the yield specified in paragraph 2(a) of this article will be considered by Parties at an appropriate time to be agreed.

Article IV

1. For the purpose of providing assurance of compliance with the provisions of this Treaty, each party shall:

(a) use national technical means of verification at its disposal in a manner consistent with generally recognized principles of international law; and

(b) provide to the other Party information and access to sites of explosions and furnish assistance in accordance with the provisions set forth in the Protocol to this Treaty.

2. Each Party undertakes not to interfere with the national technical means of verification of the other Party operating in accordance with paragraph 1(a) of this article, or with the implementation of the provisions of paragraph 1(b) of this article.

Article V

1. To promote the objectives and implementation of the provisions of this Treaty, the Parties shall establish promptly a Joint Consultative Commission within the framework of which they will:

(a) consult with each other, make inquiries and furnish information in response to such inquiries, to assure confidence in compliance with the obligations assumed;

(b) consider questions concerning compliance with the obligations assumed and related situations which may be considered ambiguous;

(c) consider questions involving unintended interference with the means for assuring compliance with the provisions of this Treaty;

(d) consider changes in technology or other new circumstances which have a bearing on the provisions of this Treaty; and

(e) consider possible amendments to provisions governing underground nuclear explosions for peaceful purposes.

2. The Parties through consultation shall establish, and may amend as appropriate, Regulations for the Joint Consultative Commission governing procedures, composition and other relevant matters.

Article VI

1. The Parties will develop co-operation on the basis of mutual benefit, equality and reciprocity in various areas related to carrying out underground nuclear explosions for peaceful purposes.

2. The Joint Consultative Commission will facilitate this co-operation by considering specific areas and forms of co-operation which shall be determined by agreement between the Parties in accordance with their constitutional procedures.

3. The Parties will appropriately inform the International Atomic Energy Agency of results of their co-operation in the field of underground nuclear explosions for peaceful purposes.

Article VII

1. Each Party shall continue to promote the development of the international agreement or agreements and procedures provided for in Article V of the Treaty on the Non-Proliferation of Nuclear Weapons, and shall provide appropriate assistance to the International Atomic Energy Agency in this regard.

2. Each Party undertakes not to carry out, participate or assist in the carrying out of any explosion in the territory of another State unless that State agrees to the implementation in its territory of the international observation and procedures contemplated by Article V of the Treaty on the Non-Proliferation of Nuclear Weapons and the provisions of Article IV of and the Protocol to this Treaty, including the provision by that State of the assistance necessary for such implementation and of the privileges and immunities specified in the Protocol.

Article VIII

1. This Treaty shall remain in force for a period of five years, and it shall be extended for successive five-year periods unless either Party notifies the other of its termination no later than six months prior to its expiration.

Before the expiration of this period the Parties may, as necessary, hold consultations to consider the situation relevant to the substance of this Treaty. However, under no circumstances shall either Party be entitled to terminate this Treaty while the Treaty on the Limitation of Underground Nuclear Weapon Tests remains in force.

2. Termination of the Treaty on the Limitation of Underground Nuclear Weapon Tests shall entitle either Party to withdraw from this Treaty at any time.

3. Each Party may propose amendments to this Treaty. Amendments shall enter into force on the day of the exchange of instruments of ratification of such amendments.

Article IX

1. This Treaty including the Protocol which forms an integral part hereof, shall be subject to ratification in accordance with the constitutional procedures of each Party. This Treaty shall enter into force on the day of the exchange of instruments of ratification which exchange shall take place simultaneously with the exchange of instruments of ratification of the Treaty on the Limitation of Underground Nuclear Weapon Tests.

2. This Treaty shall be registered pursuant to Article 102 of the Charter of the United Nations.

Protocol to the Treaty on Underground Nuclear Explosions for Peaceful Purposes

The United States of America and the Union of Soviet Socialist Republics, hereinafter referred to as the Parties,

Having agreed to the provisions in the Treaty on Underground Nuclear Explosions for Peaceful Purposes, hereinafter referred to as the Treaty,

Have agreed as follows:

Article I

1. No individual explosion shall take place at a distance, in metres, from the ground surface which is less than 30 times the 3.4 root of its planned yield in kilotons.

2. Any group explosion with a planned aggregate yield exceeding 500 kilotons shall not include more than five individual explosions, each of which has a planned yield not exceeding 50 kilotons.

Article II

1. For each explosion, the Party carrying out the explosion shall provide the other Party:

(a) not later than 90 days before the beginning of emplacement of the explosives when the planned aggregate yield of the explosion does not exceed 100 kilotons, or not later than 180 days before the beginning of emplacement of the explosives when the planned aggregate yield of the explosion exceeds 100 kilotons, with the following information to the extent and degree of precision available when it is conveyed:

(1) the purpose of the planned explosion;

(2) the location of the explosion expressed in geographical co-ordinates with a precision of four or less kilometres, planned date and aggregate yield of the explosion;

(3) the type or types of rock in which the explosion will be carried out, including the degree of liquid saturation of the rock at the point of emplacement of each explosive; and

(4) a description of specific technological features of the project, of which the explosion is a part, that could influence the determination of its yield and confirmation of purpose; and

(b) not later than 60 days before the beginning of emplacement of the explosives the information specified in subparagraph 1(a) of this article to the full extent and with the precision included in that subparagraph.

2. For each explosion with a planned aggregate yield exceeding 50 kilotons, the Party carrying out the explosion shall provide the other Party, not later than 60 days before the beginning of emplacement of the explosives with the following information:

(a) the number of explosives, the planned yield of each explosive, the location of each explosive to be used in a group explosion relative to all other explosives in the group with a precision of 100 or less metres, the depth of emplacement of each explosive with a precision of one metre and the time intervals between individual explosions in any group explosion with a precision of one-tenth second; and

(b) a description of specific features of geological structure or other local conditions that could influence the determination of the yield.

3. For each explosion with a planned aggregate yield exceeding 75 kilotons, the Party carrying out the explosion shall provide the other Party, not later than 60 days before the beginning of emplacement of the explosives, with a description of the geological and geophysical characteristics of the site of each explosion which could influence determination of the yield, which shall include: the depth of the water table; a stratigraphic column above each emplacement point; the position of each emplacement point relative to nearby geological and other features which influenced the design of the project of which the explosion is a part; and the physical parameters of the rock, including density, seismic velocity, porosity, degree and liquid saturation, and rock strength, within the sphere centred on each emplacement point and having a radius, in metres, equal to 30 times the cube root of the planned yield in kilotons of the explosive emplaced at that point.

4. For each explosion with a planned aggregate yield exceeding 100 kilotons, the party carrying out the explosion shall provide the other Party, not later than 60 days before the beginning of emplacement of the explosives with:

(a) information on locations and purposes of facilities and installations which are associated with the conduct of the explosion;

(b) information regarding the planned date of the beginning of emplacement of each explosive; and

(c) a topographic plan in local coordinates of the areas specified in paragraph 7 of Article IV, at a scale of 1:24,000 or 1:25,000 with a contour interval of 10 metres or less.

5. For application of an explosion to alleviate the consequences of an emergency situation involving an unforeseen combination of circumstances which calls for immediate action for which it would not be practicable to observe the timing requirements of paragraphs 1, 2 and 3 of this article, the following conditions shall be met:

(a) the Party deciding to carry out an explosion for such purposes shall inform the other Party of that decision immediately after it has been made and describe such circumstances;

(b) the planned aggregate yield of an explosion of such purpose shall not exceed 100 kilotons; and

(c) the Party carrying out an explosion for such purpose shall provide to the other Party the information specified in paragraph 1 of this article, and the information specified in paragraphs 2 and 3 of this article if applicable, after the decision to conduct the explosion is taken, but not later than 30 days before the beginning of emplacement of the explosives.

6. For each explosion, the Party carrying out the explosion shall inform the other Party, not later than two days before the explosion, of the planned time of detonation of each explosive with a precision of one second.

7. Prior to the explosion, the Party carrying out the explosion shall provide the other Party with timely notification of changes in the information provided in accordance with this article.

8. The explosion shall not be carried out earlier than 90 days after notification of any change in the information provided in accordance with this article which requires more extensive verification procedures than those required on the basis of the original information, unless an earlier time for carrying out the explosion is agreed between the Parties.

9. Not later than 90 days after each explosion the Party carrying out the explosion shall provide the other Party with the following information:

(a) the actual time of the explosion with a precision of one-tenth second and its aggregate yield;

(b) when the planned aggregate yield of a group explosion exceeds 50 kilotons, the actual time of the first individual explosion with a precision of one-tenth second, the time interval between individual explosions with a precision of one millisecond and the yield of each individual explosion; and

(c) confirmation of other information provided in accordance with paragraphs 1, 2, 3 and 4 of this article and explanation of any changes or corrections based on the results of the explosion.

10. At any time, but not later than one year after the explosion, the other Party may request the Party carrying out the explosion to clarify any item of the information provided in accordance with this article. Such clarification shall be provided as soon as practicable, but not later than 30 days after the request is made.

Article III

1. For the purposes of this Protocol:

(a) 'designated personnel' means those nationals of the other Party identified to the Party carrying out an explosion as the persons who will exercise the rights and functions provided for in the Treaty and this Protocol; and

(b) 'emplacement hole' means the entire interior of any drill-hole, shaft, adit or tunnel in which an explosive and associated cables and other equipment are to be installed.

2. For any explosion with a planned aggregate yield exceeding 100 kilotons but not exceeding 150 kilotons if the Parties, in consultation based on information provided in accordance with Article II and other information that may be introduced by either Party, deem it appropriate for the confirmation of the yield of the explosion, and for any explosion with a planned aggregate yield exceeding 150 kilotons, the Party carrying out the explosion shall allow designated personnel within the areas and at the locations described in Article V to exercise the following rights and functions;

(a) confirmation that the local circumstances, including facilities and installations associated with the project, are consistent with the stated peaceful purposes;

(b) confirmation of the validity of the geological and geophysical information provided in accordance with Article II through the following procedures:

(1) examination by designated personnel of research and measurement data of the Party carrying out the explosion and of rock core or rock fragments removed from each emplacement hole, and of any logs and drill core from existing exploratory holes which shall be provided to designated personnel upon their arrival at the site of the explosion;

(2) examination by designated personnel of rock core or rock fragments as they become available in accordance with the procedures specified in subparagraph 2(b)(3) of this article; and

(3) observation by designated personnel of implementation by the Party carrying out the explosion of one of the following four procedures, unless this right is waived by the other Party:

(i) construction of that portion of each emplacement hole starting from a point nearest the entrance of the emplacement hole which is at a distance, in metres, from the nearest emplacement point equal to 30 times the cube root of the planned yield in kilotons of the explosive to be emplaced at that point and continuing to the completion of the emplacement hole; or

(ii) construction of that portion of each emplacement hole starting from a point nearest the entrance of the emplacement hole which is at a distance, in metres, from the nearest emplacement point equal to six times the cube root of the planned yield in kilotons of the explosive to be emplaced at that point and continuing to the completion of the emplacement hole as well as the removal of rock core or rock fragments from the wall of an existing exploratory hole, which is substantially parallel with and at no point more than 100 metres from the emplacement hole, at locations specified by designated personnel which lie within a distance, in metres, from the same horizon as each emplacement point of 30 times the cube root of the planned yield in kilotons of the explosive to be emplaced at that point; or

(iii) removal of rock core or rock fragments from the wall of each emplacement hole at locations specified by designated personnel which lie within a distance, in metres, from each emplacement point of 30 times the cube root of the planned yield in kilotons of the explosive to be emplaced at each such point; or

(iv) construction of one or more new exploratory holes so that for each emplacement hole there will be a new exploratory hole to the same depth as that of the emplacement of the explosive, substantially parallel with and at no point more than 100 metres from each emplacement hole, from which rock cores would be removed at locations specified by designated personnel which lie within a distance, in metres, from the same horizon as each emplacement point of 30 times the cube root of the planned yield in kilotons of the explosive to be emplaced at each such point;

(c) observation of the emplacement of each explosive, confirmation of the depth of its emplacement and observation of the stemming of each emplacment hole;

(d) unobstructed visual observation of

the area of the entrance to each emplacement hole at any time from the time of emplacement of each explosive until all personnel have been withdrawn from the site for the detonation of the explosion; and

(e) observation of each explosion.

3. Designated personnel, using equipment provided in accordance with paragraph 1 of Article IV, shall have the right, for any explosion with a planned aggregate yield exceeding 150 kilotons, to determine the yield of each individual explosion in a group explosion in accordance with the provisions of Article VI.

4. Designated personnel, when using their equipment in accordance with paragraph 1 of Article IV, shall have the right, for any explosion with a planned aggregate yield exceeding 500 kilotons, to emplace, install and operate under the observation and with the assistance of personnel of the Party carrying out the explosion, if such assistance is requested by designated personnel, a local seismic network in accordance with the provisions of paragraph 7 of Article IV. Radio links may be used for the transmission of data and control signals between the seismic stations and the control centre. Frequencies, maximum power output of radio transmitters, directivity of antennas and times of operation of the local seismic network radio transmitters before the explosion shall be agreed between the Parties in accordance with Article X and time of operation after the explosion shall conform to the time specified in paragraph 7 of Article IV.

5. Designated personnel shall have the right to:

(a) acquire photographs under the following conditions:

(1) the Party carrying out the explosion shall identify to the other Party those personnel of the Party carrying out the explosion who shall take photographs as requested by designated personnel;

(2) photographs shall be taken by personnel of the Party carrying out the explosion in the presence of designated personnel and at the time requested by designated personnel for taking such photographs. Designated personnel shall determine whether these photographs are in conformity with their requests and, if not, additional photographs shall be taken immediately;

(3) photographs shall be taken with cameras provided by the other Party having built-in, rapid developing capability and a copy of each photograph shall be provided at the completion of the development process to both Parties;

(4) cameras provided by designated personnel shall be kept in agreed secure storage when not in use; and

(5) the request for photographs can be made, at any time, of the following:

(i) exterior views of facilities and installations associated with the conduct of the explosion as described in subparagraph 4(a) of Article II;

(ii) geological samples used for confirmation of geological and geophysical information, as provided for in subparagraph 2(b) of this article and the equipment utilized in the acquisition of such samples;

(iii) emplacement and installation of equipment and associated cables used by designated personnel for yield determination;

(iv) emplacement and installation of the local seismic network used by designated personnel;

(v) emplacement of the explosives and the stemming of the emplacement hole; and

(vi) containers, facilities and installations for storage and operation of equipment used by designated personnel;

(b) photographs of visual displays and records produced by the equipment used by designated personnel and photographs within the control centres taken by cameras which are component parts of such equipment; and

(c) receive at the request of designated personnel and with the agreement of the Party carrying out the explosion supplementary photographs taken by the Party carrying out the explosion.

Article IV

1. Designated personnel in exercising their rights and functions may choose to use the following equipment of either Party, of which choice the Party carrying out the explosion shall be informed not later than 150 days before the beginning of emplacement of the explosives:

(a) electrical equipment for yield determination and equipment for a local seismic network as described in paragraphs 3, 4 and 7 of this article; and

(b) geologist's field tools and kits and equipment for recording of field notes.

2. Designated personnel shall have the right in exercising their rights and functions to utilize the following additional equipment which shall be provided by the Party carrying out the explosion, under procedures to be established in accordance with Article X to ensure that the equipment meets the specifications of the other Party: portable short-range communication equipment, field glasses, optical equipment for surveying and other items which may be specified by the other Party. A description of such equipment and operating instructions shall be provided to the other Party not later than 90 days before the beginning of emplacement of the explosives in connexion with which such equipment is to be used.

3. A complete set of electrical equipment for yield determination shall consist of:

(a) sensing elements and associated cables for transmission of electrical power, control signals and data;

(b) equipment of the control centre, electrical power supplies and cables for transmission of electrical power, control signals and data; and

(c) measuring and calibration instruments, maintenance equipment and spare parts necessary for ensuring the functioning of sensing elements, cables and equipment of the control centre.

4. A complete set of equipment for the local seismic network shall consist of:

(a) seismic stations each of which contains a seismic instrument, electrical power supply and associated cables and radio equipment for receiving and transmission of control signals and data or equipment for recording control signals and data;

(b) equipment of the control centre and electrical power supplies; and

(c) measuring and calibration instruments, maintenance equipment and spare parts necessary for ensuring the functioning of the complete network.

5. In case designated personnel, in accordance with paragraph 1 of this article, choose to use equipment of the Party carrying out the explosion for yield determination or for a local seismic network, a description of such equipment and installation and operating instructions shall be provided to the other Party not later than 90 days before the beginning of emplacement of the explosives in connexion with which such equipment is to be used. Personnel of the Party carrying out the explosion shall emplace, install and operate the equipment in the presence of designated personnel. After the explosion, designated personnel shall receive duplicate copies of the recorded data. Equipment for yield determination shall be emplaced in accordance with Article VI. Equipment for a local seismic network shall be emplaced in accordance with paragraph 7 of this article.

6. In case designated personnel, in accordance with paragraph 1 of this article, choose to use their own equipment for yield determination and their own equipment for a local seismic network, the following procedures shall apply:

(a) the Party carrying out the explosion shall be provided by the other Party with the equipment and information specified in subparagraphs (a)(1) and (a)(2) of this paragraph not later than 150 days prior to the beginning of emplacement of the explosives in connexion with which such equipment is to be used in order to permit the Party carrying out the explosion to familiarize itself with such equipment, if such equipment and information has not been previously provided, which equipment shall be returned to the other Party not later than 90 days before the beginning of emplacement of the explosives. The equipment and information to be provided are:

(1) one complete set of electrical equipment for yield determination as described in paragraph 3 of this article, electrical and mechanical design information, specifications and installation and operating instructions concerning this equipment; and

(2) one complete set of equipment for the local seismic network described in paragraph 4 of this article, including one seismic station, electrical and mechanical design information, specifications and installation and operating instructions concerning this equipment;

(b) not later than 35 days prior to the beginning of emplacement of the explosives in connexion with which the following equipment is to be used, two complete sets of electrical equipment for yield determination as described in paragraph 3 of this article and specific installation instructions for the emplacement of the sensing elements based on

information provided in accordance with subparagraph 2(a) of Article VI and two complete sets of equipment for the local seismic network as described in paragraph 4 of this article, which sets of equipment shall have the same components and technical characteristics as the corresponding equipment specified in subparagraph 6(a) of this article, shall be delivered in sealed containers to the port of entry;

(c) the Party carrying out the explosion shall choose one of each of the two sets of equipment described above which shall be used by designated personnel in connexion with the explosion;

(d) the set or sets of equipment not chosen for use in connexion with the explosion shall be at the disposal of the Party carrying out the explosion for a period that may be as long as 30 days after the explosion at which time such equipment shall be returned to the other Party;

(e) the set or sets of equipment chosen for use shall be transported by the Party carrying out the explosion in the sealed containers in which this equipment arrived, after seals of the Party carrying out the explosion have been affixed to them, to the site of the explosion, so that this equipment is delivered to designated personnel for emplacement, installation and operation not later than 20 days before the beginning of emplacement of the explosives. This equipment shall remain in the custody of designated personnel in accordance with paragraph 7 of Article V or in agreed secure storage. Personnel of the Party carrying out the explosion shall have the right to observe the use of this equipment by designated personnel during the time the equipment is at the site of the explosion. Before the beginning of emplacement of the explosives, designated personnel shall demonstrate to personnel of the Party carrying out the explosion that this equipment is in working order;

(f) each set of equipment shall include two sets of components for recording data and associated calibration equipment. Both of these sets of components in the equipment chosen for use shall simultaneously record data. After the explosion, and after duplicate copies of all data have been obtained by designated personnel and the Party carrying out the explosion, one of each of the two sets of components for recording data and associated calibration equipment shall be selected, by an agreed process of chance, to be retained by designated personnel. Designated personnel shall pack and seal such components for recording data and associated calibration equipment which shall accompany them from the site of explosion to the port of exit; and

(g) all remaining equipment may be retained by the Party carrying out the explosion for a period that may be as long as 30 days, after which time this equipment shall be returned to the other Party.

7. For any explosion with a planned aggregate yield exceeding 500 kilotons, a local seismic network, the number of stations of which shall be determined by designated personnel but shall not exceed the number of explosives in the group plus five, shall be emplaced, installed and operated at agreed sites of emplacement within an area circumscribed by circles of 15 kilometres in radius centered on points of the surface of the earth above the points of emplacement of the explosives during a period beginning not later than 20 days before the beginning of emplacement of the explosives and continuing after the explosion not later than three days unless otherwise agreed between the Parties.

8. The Party carrying out the explosion shall have the right to examine in the presence of designated personnel, all equipment, instruments and tools of designated personnel specified in subparagraph 1(b) of this article.

9. The Joint Consultative Commission will consider proposals that either Party may put forward for the joint development of standardized equipment for verification purposes.

Article V

1. Except as limited by the provisions of paragraph 5 of this article, designated personnel in the exercise of their rights and functions shall access along agreed routes:

(a) for an explosion with a planned aggregate yield exceeding 100 kilotons in accordance with paragraph 2 of Article III:

(1) to the locations of facilities and installations associated with the conduct of the explosion provided in accordance with subparagraph 4(a) of Article II; and

(2) to the locations described in paragraph 2 of Article III; and

(b) for any explosion with a planned aggregate yield exceeding 150 kilotons, in

addition to the access described in subparagraph 1(a) of this article:

(1) to other locations within the area circumscribed by circles of 10 kilometres in radius centered on points on the surface of the earth above the points of emplacement of the explosives in order to confirm that the local circumstances are consistent with the stated peaceful purposes;

(2) to the locations of the components of the electrical equipment for yield determination to be used for recording data when, by agreement between the Parties, such equipment is located outside the area described in subparagraph 1(b)(1) of this article; and

(3) to the sites of emplacement of the equipment of the local seismic network provided for in paragraph 7 of Article IV.

2. The Party carrying out the explosion shall notify the other Party of the procedure it has chosen from among those specified in subparagraph 2(b)(3) of Article III not later than 30 days before beginning the implementation of such procedure. Designated personnel shall have the right to be present at the site of the explosion to exercise their rights and functions in the areas and at the locations described in paragraph 1 of this article for a period of time beginning two days before the beginning of the implementation of the procedure and continuing for a period of three days after the completion of this procedure.

3. Except as specified in paragraph 4 of this article, designated personnel shall have the right to be present in the areas and at the locations described in paragraph 1 of this article:

(a) for an explosion with a planned aggregate yield exceeding 100 kilotons but not exceeding 150 kilotons, in accordance with paragraph 2 of Article III, at any time beginning five days before the beginning of emplacement of the explosives and continuing after the explosion and after safe access to evacuated areas has been established according to standards determined by the Party carrying out the explosion for a period of two days; and

(b) for any explosion with a planned aggregate yield exceeding 150 kilotons, at any time beginning 20 days before the beginning of emplacement of the explosives and continuing after the explosion and after safe access to evacuated areas has been established according to standards determined by the Party carrying out the explosion for a period of:

(1) five days in the case of an explosion with a planned aggregate yield exceeding 150 kilotons but not exceeding 500 kilotons; or

(2) eight days in the case of an explosion with a planned aggregate yield exceeding 500 kilotons.

4. Designated personnel shall not have the right to be present in those areas from which all personnel have been evacuated in connexion with carrying out an explosion, but shall have the right to re-enter those areas at the same time as personnel of the Party carrying out the explosion.

5. Designated personnel shall not have or seek access by physical, visual, or technical means to the interior of the canister containing an explosive, to documentary or other information descriptive of the design of an explosive nor to equipment for control and firing of explosives. The Party carrying out the explosion shall not locate documentary or other information descriptive of the design of an explosive in such ways as to impede the designated personnel in the exercise of their rights and functions.

6. The number of designated personnel present at the site of an explosion shall not exceed:

(a) for the exercise of their rights and functions in connexion with the confirmation of the geographical and geophysical information in accordance with the provisions of subparagraph 2(b) and applicable provisions of paragraph 5 of Article III — the number of emplacement holes plus three;

(b) for the exercise of their rights and functions in connexion with confirming that the local circumstances are consistent with the information provided and with the stated peaceful purposes in accordance with the provisions in subparagraphs 2(a), 2(c), 2(d) and 2(e) and applicable provisions of paragraph 5 of Article III — the number of explosives plus two;

(c) for the exercise of their rights and functions in connexion with confirming that the local circumstances are consistent with the information provided and with the stated peaceful purposes in accordance with the provisions in subparagraphs 2(a), 2(c), 2(d) and 2(e) and applicable provisions of paragraph 5 of Article III and in connexion with

the use of electrical equipment for determination of the yield in accordance with paragraph 3 of Article III — the number of explosives plus seven; and

(d) for the exercise of their rights and functions in connexion with confirming that the local circumstances are consistent with the information provided and with the stated peaceful purposes in accordance with the provisions in subparagraphs 2(a), 2(c), 2(d) and 2(e) and applicable provisions of paragraph 5 of Article III and in connexion with the use of electrical equipment for determination of the yield in accordance with paragraph 3 of Article III and with the use of the local seismic network in accordance with paragraph 4 of Article III — the number of explosives plus 10.

7. The Party carrying out the explosion shall have the right to assign its personnel to accompany designated personnel while the latter exercise their rights and functions.

8. The Party carrying out an explosion shall assure for designated personnel telecommunications with their authorities, transportation and other services appropriate to their presence and to the exercise of their rights and functions at the site of the explosion.

9. The expenses incurred for the transportation of designated personnel and their equipment to and from the site of the explosion, telecommunications provided for in paragraph 8 of this article, their living and working quarters, subsistence and all other personal expenses shall be the responsibility of the Party other than the Party carrying out the explosion.

10. Designated personnel shall consult with the Party carrying out the explosion in order to co-ordinate the planned programme and schedule of activities of designated personnel with the programme of the Party carrying out the explosion for the conduct of the project so as to ensure that designated personnel are able to conduct their activities in an orderly and timely way that is compatible with the implementation of the project. Procedures for such consultations shall be established in accordance with Article X.

Article VI

For any explosion with a planned aggregate yield exceeding 150 kilotons, determination of the yield of each explosive used shall be carried out in accordance with the following provisions:

1. Determination of the yield of each individual explosion in the group shall be based on measurements of the velocity of propagation, as a function of time, of the hydrodynamic shock wave generated by the explosion, taken by means of electrical equipment described in paragraph 3 of Article IV.

2. The Party carrying out the explosion shall provide the other Party with the following information:

(a) not later than 60 days before the beginning of emplacement of the explosives, the length of each canister in which the explosive will be contained in the corresponding emplacement hole, the dimensions of the tube or other device used to emplace the canister and the cross-sectional dimensions of the emplacement hole to a distance, in metres, from the emplacement point of 10 times the cube root of its yield in kilotons;

(b) not later than 60 days before the beginning of emplacement of the explosives, a description of materials, including their densities, to be used to stem each emplacement hole; and

(c) not later than 30 days before the beginning of emplacement of the explosives for each emplacement hole of a group explosion, the local co-ordinates of the point of emplacement of the explosive, the entrance of the emplacement hole, the point of the emplacement hole most distant from the entrance, the location of the emplacement hole at each 200 metres distance from the entrance and the configuration of any known voids larger than one cubic metre located within the distance, in metres, of 10 times the cube root of the planned yield in kilotons measured from the bottom of the canister containing the explosive. The error in these co-ordinates shall not exceed 1 per cent of the distance between the emplacement hole and the nearest other emplacement hole or 1 per cent of the distance between the point of measurement and the entrance of the emplacement hole, whichever is smaller, but in no case shall the error be required to be less than one metre.

3. The Party carrying out the explosion shall emplace for each explosive that portion of the electrical equipment for yield determination described in subparagraph 3(a) of Article IV, supplied in accordance with paragraph 1 of Article IV, in the same emplacement hole as the explosive in accordance with the installation instructions supplied under

the provisions of paragraph 5 or 6 of Article IV. Such emplacement shall be carried out under the observation of designated personnel. Other equipment specified in subparagraph 3(b) of Article IV shall be emplaced and installed.

(a) by designated personnel under the observation and with the assistance of personnel of the Party carrying out the explosion, if such assistance is requested by designated personnel; or

(b) in accordance with paragraph 5 of Article IV.

4. That portion of the electrical equipment for yield determination described in subparagraph 3(a) of Article IV that is to be emplaced in each emplacement hole shall be located so that the end of the electrical equipment which is farthest from the entrance to the emplacement hole is at a distance, in metres, from the bottom of the canister containing the explosive equal to 3.5 times the cube root of the planned yield in kilotons of the explosive when the planned yield is less than 20 kilotons and three times the cube root of the planned yield in kilotons of the explosive when the planned yield is 20 kilotons or more. Canisters longer than 10 metres containing the explosive shall only be utilized if there is prior agreement between the Parties establishing provisions for their use. The Party carrying out the explosions shall provide the other Party with data on the distribution of density inside any other canister in the emplacement hole with a transverse cross-sectional area exceeding 10 square centimetres located within a distance, in metres, of 10 times the cube root of the planned yield in kilotons of the explosion from the bottom of the canister containing the explosive. The Party carrying out the explosion shall provide the other Party with access to confirm such data on density distribution within any such canister.

5. The Party carrying out an explosion shall fill each emplacement hole, including all pipes and tubes contained therein which have at any transverse section an aggregate cross-sectional area exceeding 10 square centimetres in the region containing the electrical equipment for yield determination and to a distance, in metres, of six times the cube root of the planned yield in kilotons of the explosive from the explosive emplacement point, with material having a density not less than seven-tenths of the average density of the surrounding rock, and from that point to a distance of not less than 60 metres from the explosive emplacement point with material having a density greater than one gram per cubic centimetre.

6. Designated personnel shall have the right to:

(a) confirm information provided in accordance with subparagraph 2(a) of this article;

(b) confirm information provided in accordance with subparagraph 2(b) of this article and be provided, upon request, with a sample of each batch of stemming material as that material is put into the emplacement hole; and

(c) confirm the information provided in accordance with subparagraph 2(c) of this article by having access to the data acquired and by observing, upon their request, the making of measurements.

7. For those explosives which are emplaced in separate emplacement holes, the emplacement shall be such that the distance D, in metres, between any explosive and any portion of the electrical equipment for determination of the yield of any other explosive in the group shall be not less than 10 times the cube root of the planned yield in kilotons of the larger explosive of such a pair of explosives. Individual explosions shall be separated by time intervals, in milliseconds, not greater than one-sixth the amount by which the distance D, in metres, exceeds 10 times the cube root of the planned yield in kilotons of the larger explosive of such a pair of explosives.

8. For those explosives in a group which are emplaced in a common emplacement hole, the distance, in metres, between each explosive and any other explosive in that emplacement hole shall be not less than 10 times the cube root of the planned yield in kilotons of the larger explosive of such a pair of explosives, and the explosives shall be detonated in sequential order, beginning with the explosive farthest from the entrance to the emplacement hole, with the individual detonations separated by time intervals, in milliseconds, of not less than one times the cube root of the planned yield in kilotons of the largest explosive in this emplacement hole.

Article VII

1. Designated personnel with their personal baggage and their equipment as provided in Article IV shall be permitted to enter the territory of the Party carrying out the

explosion at an entry port to be agreed upon by the Parties, to remain in the territory of the Party carrying out the explosion for the purpose of fulfilling their rights and functions provided for in the Treaty and this Protocol, and to depart from an exit port to be agreed upon by the Parties.

2. At all times while designated personnel are in the territory of the Party carrying out the explosion, their persons, property, personal baggage, archives and documents as well as their temporary official and living quarters shall be accorded the same privileges and immunities as provided in Articles 22, 23, 24, 29 30, 31, 34 and 36 of the Vienna Convention on Diplomatic Relations of 1961 to the persons, property, personal baggage, archives and documents of diplomatic agents as well as to the premises of diplomatic missions and private residences of diplomatic agents.

3. Without prejudice to their privileges and immunities it shall be the duty of designated personnel to respect the laws and regulations of the State in whose territory the explosion is to be carried out insofar as they do not impede in any way whatsoever the proper exercising of their rights and functions provided for by the Treaty and this Protocol.

Article VIII

The Party carrying out an explosion shall have sole and exclusive control over and full responsibility for the conduct of the explosion.

Article IX

1. Nothing in the Treaty and this Protocol shall affect proprietary rights in information made available under the Treaty and this Protocol and in information which may be disclosed in preparation for and carrying out of explosions; however, claims to such proprietary rights shall not impede implementation of the provisions of the Treaty and this Protocol.

2. Public release of the information provided in accordance with Article II or publication of material using such information, as well as public release of the results of observation and measurements obtained by designated personnel, may take place only by agreement with the Party carrying out an explosion; however, the other Party shall have the right to issue statements after the explosion that do not divulge information in which the Party carrying out the explosion has rights which are referred to in paragraph 1 of this article.

Article X

The joint Consultative Commission shall establish procedures through which the Parties will, as appropriate, consult with each other for the purpose of ensuring efficient implementation of this Protocol.

Agreed Statement

The Parties to the Treaty Between the United States of America and the Union of Soviet Socialist Republics on Underground Nuclear Explosions for Peaceful Purposes, hereinafter referred to as the Treaty, agree that under subparagraph 2(c) of Article III of the Treaty:

(a) Development testing of nuclear explosives does not constitute a 'peaceful application' and any such development tests shall be carried out only within the boundaries of nuclear weapon test sites specified in accordance with the Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Limitation of Underground Nuclear Weapon Tests;

(b) Associating test facilities, instrumentation or procedures related only to testing of nuclear weapons or their effects with any explosion carried out in accordance with the Treaty does not constitute a 'peaceful application'.

Source: Disarmament Conference documents CCD/496 23 June 1976, and CCD/496/Corr. 1, 5 August 1976.

II. OTHER TREATIES

Antarctic Treaty

Signed at Washington, D.C. on 1 December 1959, entered into force on 23 June 1961.

Excerpts:

. . .

Article I

1. Antarctica shall be used for peaceful purposes only. There shall be prohibited, *inter*

alia, any measures of a military nature, such as the establishment of military bases and fortifications, the carrying out of military maneuvers, as well as the testing of any type of weapons.

2. The present Treaty shall not prevent the use of military personnel or equipment for scientific research or for any other peaceful purpose.

. . .

Article V

1. Any nuclear explosions in Antarctica and the disposal there of radioactive waste material shall be prohibited.

2. In the event of the conclusion of international agreements concerning the use of nuclear energy, including nuclear explosions and the disposal of radioactive waste material, to which all of the Contracting Parties whose representatives are entitled to participate in the meetings provided for under Article IX are parties, the rules established under such agreements shall apply in Antarctica.

. . .

Source: *Treaty Series.* Vol. 402 (United Nations, New York).

Treaty on principles governing the activities of states in the exploration and use of outer space, including the moon and other celestial bodies (Outer Space Treaty)

Signed at London, Moscow and Washington, D.C. on 27 January 1967, entered into force on 10 October 1967.

Excerpt:

. . .

Article IV

States Parties to the Treaty undertake not to place in orbit around the earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction, install such weapons on celestial bodies, or station such weapons in outer space in any other manner.

The moon and other celestial bodies shall be used by all States Parties to the Treaty exclusively for peaceful purposes. The establishment of military bases, installations and fortifications, the testing of any type of weapons and the conduct of military manoeuvres on celestial bodies shall be forbidden. The use of military personnel for scientific research or for any other peaceful purposes shall not be prohibited. The use of any equipment or facility necessary for peaceful exploration of the moon and other celestial bodies shall also not be prohibited.

. . .

Source: *Treaty Series,* Vol. 610 (United Nations, New York).

Treaty for the prohibition of nuclear weapons in Latin America (Treaty of Tlatelolco)

Signed at Mexico, Distrito Federal, on 14 February 1967, entered into force on 22 April 1968.

Excerpts:

. . .

Article 1. *Obligations*

1. The Contracting Parties hereby undertake to use exclusively for peaceful purposes the nuclear material and facilities which are under their jurisdiction, and to prohibit and prevent in their respective territories:

(a) The testing, use, manufacture, production or acquisition by any means whatsoever of any nuclear weapons, by the Parties themselves, directly or indirectly, on behalf of anyone else or in any other way, and

(b) The receipt, storage, installation, deployment and any form of possession of any nuclear weapons, directly or indirectly, by the Parties themselves, by anyone on their behalf or in any other way.

2. The Contracting Parties also undertake to refrain from engaging in, encouraging or authorizing, directly or indirectly, or in any way participating in the testing, use, manufacture, production, possession or control of any nuclear weapon.

. . .

Article 18. *Explosions for peaceful purposes*

1. The Contracting Parties may carry out explosions of nuclear devices for peaceful purposes — including explosions which involve devices similar to those used in nuclear weapons — or collaborate with third parties for the same purpose, provided that they do so in accordance with the provisions of this article and the other articles of the Treaty, particularly articles 1 and 5.

2. Contracting Parties intending to carry out, or to co-operate in carrying out, such an explosion shall notify the Agency and the International Atomic Energy Agency, as far in advance as the circumstances require, of the date of the explosion and shall at the same time provide the following information:

(a) The nature of the nuclear device and the source from which it was obtained;

(b) The place and purpose of the planned explosion;

(c) The procedures which will be followed in order to comply with paragraph 3 of this article;

(d) The expected force of the device, and

(e) The fullest possible information on any possible radioactive fall-out that may result from the explosion or explosions, and measures which will be taken to avoid danger to the population, flora, fauna and territories of any other Party or Parties.

3. The General Secretary and the technical personnel designated by the Council and the International Atomic Energy Agency may observe all the preparations, including the explosion of the device, and shall have unrestricted access to any area in the vicinity of the site of the explosion in order to ascertain whether the device and the procedures followed during the explosion are in conformity with the information supplied under paragraph 2 of this article and the other provisions of this Treaty.

4. The Contracting Parties may accept the collaboration of third parties for the purpose set forth in paragraph 1 of the present article, in accordance with paragraphs 2 and 3 thereof.

. . .

Source: *Treaty Series,* Vol. 634 (United Nations, New York).

Treaty on the prohibition of the emplacement of nuclear weapons and other weapons of mass destruction on the seabed and the ocean floor and in the subsoil thereof (Seabed Treaty)

Signed at London, Moscow and Washington, D.C., on 11 February 1971; entered into force on 18 May 1972.

Excerpt:

. . .

Article I

1. The States Parties to this Treaty undertake not to emplant or emplace on the seabed and the ocean floor and in the subsoil thereof beyond the outer limit of a seabed zone, as defined in article II, any nuclear weapons or any other types of weapons of mass destruction as well as structures, launching installations or any other facilities specifically designed for storing, testing or using such weapons.

2. The undertakings of paragraph 1 of this article shall also apply to the seabed zone referred to in the same paragraph, except that within such seabed zone, they shall not apply either to the coastal State or to the seabed beneath its territorial waters.

3. The States Parties to this Treaty undertake not to assist, encourage or induce any State to carry out activities referred to in paragraph 1 of this article and not to participate in any other way in such actions.

. . .

Source: *Treaties and Other International Acts,* Series 7337 (U.S. Department of State, Washington, D.C., 1972).

Agreement governing the activities of states on the moon and other celestial bodies (Moon Treaty)

Opened for signature at New York on 18 December 1979; entered into force on 11 July 1984.

Excerpt:

. . .

Article 3

1. The moon shall be used by all States Parties exclusively for peaceful purposes.

2. Any threat or use of force or any other hostile act or threat of hostile act on the moon is prohibited. It is likewise prohibited to use the moon in order to commit any such act or to engage in any such threat in relation to the earth, the moon, spacecraft, the personnel of spacecraft or man-made space objects.

3. States Parties shall not place in orbit around or other trajectory to or around the moon objects carrying nuclear weapons or any other kinds of weapons of mass destruction or place or use such weapons on or in the moon.

4. The establishment of military bases, installations and fortifications, the testing of any type of weapons and the conduct of military manoeuvres on the moon shall be forbidden. The use of military personnel for scientific research or for any other peaceful purposes shall not be prohibited. The use of any equipment or facility necessary for peaceful exploration and use of the moon shall also not prohibited.

. . .

Source: UN document, General Assembly Resolution 34/68, Annex.

South Pacific nuclear free zone treaty (Treaty of Rarotonga)

Signed at Rarotonga, Cook Islands, on 6 August 1985; entered into force on 11 December 1986.

Excerpt:

. . .

Article 6

Prevention of testing of nuclear explosive devices

Each Party undertakes:

(a) to prevent in its territory the testing of any nuclear explosive device;

(b) not to take any action to assist or encourage the testing of any nuclear explosive device by any State.

. . .

Source: Conference on Disarmament document CD/633, 16 August 1985.

ANNEXE 2. MAJOR PROPOSALS FOR A COMPREHENSIVE TEST BAN TREATY

I. UK-USA-USSR: Tripartite Report to the Committee on Disarmament, 30 July 1980

1. This report on the status of the negotiations between the Union of Soviet Socialist Republics, the United Kingdom of Great Britain and Northern Ireland and the United States of America on a treaty prohibiting nuclear weapon test explosions in all environments and its protocol covering nuclear explosions for peaceful purposes has been jointly prepared by the three parties to the negotiations.

2. The three negotiating parties are well aware of the deep and long-standing commitment to the objective of this treaty that has

been demonstrated by the Committee on Disarmament and its predecessor bodies. They recognize the strong and legitimate interest of the Committee on Disarmament in their activities, and they have reported to the Committee on Disarmament previously, most recently on 31 July 1979. They welcome the opportunity to do so again, just as they welcome the continued support and encouragement that their negotiations derive from the interest of the Committee on Disarmament.

3. Since the last report to the Committee on Disarmament, the three delegations have completed two rounds of negotiations. The negotiations reconvened on 16 July 1980.

4. The negotiating parties are seeking a treaty that for decades has been given one of the highest priorities in the field of arms limitation, and the Soviet Union, the United Kingdom and the United States continue to attach great importance to it. The desire to achieve an early agreement, which is so widely shared by the international community, has been repeatedly expressed at the highest level of all three governments.

5. Global interest in the cessation of nuclear weapon tests by all States has been recorded by a succession of resolutions of the United Nations General Assembly and by the Final Document of the Special Session on Disarmament of the United Nations General Assembly. It has been stated in the preambles to a number of international arms limitation treaties now in force, and its significance will again be underlined in the forthcoming second Review Conference of the Treaty on the Non-Proliferation of Nuclear Weapons.

6. The objectives which the negotiating parties seek to achieve as a result of this treaty are important to all mankind. Specifically, they seek to attain a treaty which will make a major contribution to the shared objectives of constraining the nuclear arms race, curbing the spread of nuclear weapons, and strengthening international peace and security.

7. Given the importance of these objectives, it is understandable that the international community has repeatedly called for the earliest possible conclusion of the treaty. At the same time, it is important to note that this treaty is, in many respects, a difficult one to negotiate. Many of the issues are novel, sensitive and intricate. The treaty directly affects vital national security concerns and the process of negotiation requires considerable and painstaking work.

8. In spite of these challenges, however, the Soviet Union, the United Kingdom and the United States have made considerable progress in negotiating the treaty.

9. The negotiating parties have agreed that the treaty will require each party to prohibit, prevent and not to carry out any nuclear weapon test explosion at any place under its jurisdiction or control in any environment; and to refrain from causing, encouraging or in any way participating in the carrying out of any nuclear weapon test explosion anywhere.

10. The negotiating parties have agreed that the treaty will be accompanied by a protocol on nuclear explosions for peaceful purposes, which will be an integral part of the treaty. The protocol will take into account the provisions of Article V of the Treaty on the Non-Proliferation of Nuclear Weapons. In the protocol, the parties will establish a moratorium on nuclear explosions for peaceful purposes and accordingly will refrain from causing, encouraging, permitting or in any way participating in, the carrying out of such explosions until arrangements for conducting them are worked out which would be consistent with the treaty being negotiated, the Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water and the Treaty on the Non-Proliferation of Nuclear Weapons. Without delay after entry into force of the treaty, the parties will keep under consideration the subject of arrangements for conducting nuclear explosions for peaceful purposes, including the aspect of precluding military benefits. Such arrangements, which could take the form of a special agreement or agreements, would be made effective by appropriate amendment to the protocol.

11. To ensure that the treaty does not detract from previous arms limitation agreements, there will be a provision stating that the treaty does not affect obligations compatible with it that have been assumed by parties under other international agreements. Such other agreements include the Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water and the Treaty on the Non-Proliferation of Nuclear Weapons. The three negotiating parties have agreed that the treaty will provide procedures for amendment, and that any amendments will require the approval of a majority of all parties, which majority shall include all parties that are permanent members of the

Security Council of the United Nations. They have also agreed that, as in other arms limitation agreements, there will be provision for withdrawal from the treaty on the grounds of supreme national interests. They have also agreed that the treaty should enter into force upon ratification by twenty signatory governments, including those of the Soviet Union, the United Kingdom and the United States.

12. The parties are considering formulations relating to the duration of the treaty. They envisage that a conference will be held at an appropriate time to review the operation of the treaty. Decisions at the conference will require a majority of the parties to the treaty, which majority shall include all parties that are permanent members of the Security Council of the United Nations.

13. The negotiating parties, recognizing the importance of verification, have agreed that a variety of verification measures should be provided to enhance confidence that all parties to the treaty are in strict compliance with it. Such measures in the treaty itself, and the additional measures under negotiation to facilitate verification of compliance with the treaty, must first be agreed in principle, and then drafted in detail, which is of course a laborious process. It must be done with care because the implementation of these measures will have important impact not only on ensuring compliance with the treaty, but also on political relations among its parties.

14. It has been agreed that the parties will use national technical means of verification at their disposal in a manner consistent with generally recognized principles of international law to verify compliance with the treaty, and that each party will undertake not to interfere with such means of verification.

15. It has long been recognized that co-operative seismic monitoring measures can make an important contribution to verifying compliance with the treaty. The Committee on Disarmament and its predecessors have played a leading role in developing such measures. On the basis of the work done in the past few years under those auspices, the negotiating parties have agreed to provisions establishing an International Exchange of Seismic Data. Each treaty party will have the right to participate in this exchange, to contribute data from designated seismic stations on its territory, and to receive all the seismic data made available through the International Exchange. Seismic data will be transmitted through the Global Telecommunications System of the World Meteorological Organization or through other agreed communications channels. International seismic data centres will be established in agreed locations, taking into account the desirability of appropriate geographical distribution.

16. A Committee of Experts will be established to consider questions related to the International Seismic Data Exchange and all treaty parties will be entitled to appoint representatives to participate in the work of the Committee. The Committee of Experts will be responsible for developing detailed arrangements for establishing and operating the International Exchange, drawing on the recommendations of the *Ad Hoc* Group of Scientific Experts, which was established under the auspices of the Conference of the Committee on Disarmament and has continued its work under the Committee on Disarmament. Arrangements for establishing and operating the International Exchange will include the development of standards for the technical and operational characteristics of participating seismic stations and international seismic data centres, for the form in which data are transmitted to the centres, and for the form and manner in which the centres make seismic data available to the participants and respond to their requests for additional seismic data regarding specified seismic events.

17. In addition to its role in setting up the International Exchange, the Committee of Experts will have ongoing responsibility for facilitating the implementation of the International Exchange, for reviewing its operation and considering improvements to it, and for considering technological developments that have a bearing on its operation. The Committee will serve as a forum in which treaty parties may exchange technical information and co-operate in promoting the effectiveness of the International Exchange. The Committee of Experts will hold its first meeting not later than 90 days after the entry into force of the treaty and will meet thereafter as it determines.

18. The negotiating parties have agreed to other co-operative measures as well. There will be provision in the treaty for direct consultations, and for the exchange of inquiries and responses among treaty parties in order to resolve questions that may arise concerning treaty compliance. If a party has questions regarding an event on the territory of any other party, it may request an on-site inspection for the purpose of ascertaining whether or not the event was a nuclear explosion. The requesting party shall state the

reasons for its request, including appropriate evidence. The party which receives the request, understanding the importance of ensuring confidence among parties that treaty obligations are being fulfilled, shall state whether or not it is prepared to agree to an inspection. If the party which receives the request is not prepared to agree to an inspection on its territory, it shall provide the reasons for its decision. Tripartitite agreement on these general conditions with regard to on-site inspections represents an important achievement by the negotiating parties in resolving issues regarding verification of compliance with the treaty.

19. The three negotiating parties believe that the verification measures being negotiated — particularly the provisions regarding the International Exchange of Seismic Data, the Committee of Experts, and on-site inspections — break significant new ground in international arms limitation efforts and will give all treaty parties the opportunity to participate in a substantial and constructive way in the process of verifying compliance with the treaty.

20. The treaty will also contain a provision permitting any two or more treaty parties, because of special concerns or circumstances, to agree by mutual consent upon additional measures to facilitate verification of compliance with the treaty. The three negotiating parties have agreed that it is necessary to develop such additional measures for themselves in connexion with the treaty under negotiation.

21. The additional measures to facilitate verification of compliance with the treaty, while paralleling those of the treaty itself, will specify in greater detail the procedures under which on-site inspection would be conducted, and will incorporate a list of the rights and functions of the personnel carrying out the inspection. They will also contain a description of the role to be played by the host party during an inspection.

22. In addition, the three parties are negotiating an exchange of supplemental seismic data. This would involve the installation and use by the three parties of high-quality national seismic stations of agreed characteristics.

23. Despite significant accomplishments, there are important areas where substantial work is still to be done.

24. The three negotiating parties have demonstrated their strong political commitment to completion of this treaty by achieving solutions to problems that for many years made a treaty difficult to attain. Most notable in this regard are the agreements concerning the prohibition of any nuclear weapon test explosion in any environment, the moratorium on nuclear explosions for peaceful purposes, the general conditions with regard to on-site inspections, and a number of important seismic verification issues.

25. The negotiating parties are mindful of the great value for all mankind that the prohibition of nuclear weapon test explosions in all environments will have, and they are conscious of the important responsibility placed upon them to find solutions to the remaining problems. The three negotiating parties have come far in their pursuit of a sound treaty and continue to believe that their trilateral negotiations offer the best way forward. They are determined to exert their best efforts and necessary will and persistence to bring the negotiations to an early and successful conclusion.

Source: Committee on Disarmament document CD/130, 30 July 1980.

II. SWEDEN: Draft treaty banning any nuclear weapon test explosion in any environment, 14 July 1983

The States Parties to this Treaty,

Declaring their intention to achieve at the earliest possible date the cessation of the nuclear arms race and to undertake effective measures towards nuclear disarmament,

Urging the co-operation of all States in the attainment of this objective,

Have agreed as follows:

Article I

1. Each Party to this Treaty undertakes not to carry out any nuclear weapon test explosion in any environment at any place under its jurisdiction or control.

2. Each Party to this Treaty undertakes, furthermore, to refrain from causing, encouraging, assisting, permitting or in any other

way participating in the carrying out of any nuclear weapon test explosion anywhere.

3. Each Party to this Treaty undertakes to take any measures it considers necessary in accordance with its constitutional process to prohibit and prevent any activity in violation of the provisions of the Treaty anywhere under its jurisdiction or control.

Article II

1. Each Party to this Treaty undertakes not to carry out any nuclear explosion for peaceful purposes and accordingly to refrain from causing, encouraging, assisting, permitting or in any other way participating in the carrying out of any such explosion until international arrangements for conducting them are worked out which would be consistent with this Treaty and the obligations of each Party under other relevant international treaties.

2. The Parties undertake to keep under consideration the question of arrangements for conducting nuclear explosions for peaceful purposes on a non-discriminatory basis, including the aspect of precluding military benefits. Such arrangements may take the form of a special agreement or agreements constituting an integral part of this Treaty.

Article III

This Treaty does not affect obligations which have been assumed by Parties under other international agreements, including the Treaty banning nuclear weapon tests in the atmosphere, in outer space and under water.

Article IV

1. Each Party to this Treaty will 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 and undertakes not to interfere with such means of verification.

2. Each Party to this Treaty undertakes to co-operate in good faith in an effective international exchange of seismological data in order to facilitate the monitoring of this Treaty.

Each Party to this Treaty undertakes to co-operate in good faith in order to achieve an effective international exchange of data on atmospheric radioactivity and other measures for facilitating the monitoring of this Treaty.

The arrangements for these international co-operative measures, which are laid down in Protocol I annexed to this Treaty, shall be operative at the time of the entry into force of this Treaty.

3. The Parties to this Treaty undertake to consult one another and to co-operate in good faith for the clarification of all events pertaining to the subject matter of this Treaty. In accordance with this provision, each Party to the Treaty is entitled:

(a) to request and receive information from any other Party;

(b) to request an on-site inspection in the territory of any other Party for the purpose of ascertaining whether or not a specified event was a nuclear explosion. The requesting Party shall state the reasons for its request, including available evidence. Recognizing the importance of ensuring confidence among Parties that treaty obligations are being fulfilled, the Party which receives the request shall state whether or not it is prepared to agree to an inspection. If the Party which receives the request does not agree to an inspection in its territory, it shall state the reason for its refusal. Procedures for such inspections and the manner of their conduct, including the rights and functions of the inspecting personnel, are laid down in Protocol II annexed to this Treaty.

4. In order to avoid unfounded accusations or misinterpretations of large non-nuclear explosions the Party conducting such an explosion may invite an inspection at the site of the explosion. The rules and procedures for such inspections are laid down in Protocol II.

5. For the purpose set forth in this article a Consultative Committee shall be established to oversee the implementation of the Treaty and of the international verification arrangements. A Technical Expert Group and a permanent Secretariat shall be established to assist the Consultative Committee. The functions and rules of procedure of the Consultative Committee, the Technical Expert Group and the Secretariat are set out in Protocol III annexed to this Treaty.

Article V

The Protocols annexed to this Treaty constitute an integral part of the Treaty.

Article VI

Any Party may propose amendments to

this Treaty. Such proposals shall be submitted to the Depositary, who shall, in consultation with States Parties, take appropriate action. Amendments shall enter into force for each Party accepting them upon their acceptance by a majority of the Parties to the Treaty and thereafter for each remaining Party on the date of acceptance by it.

Article VII

Five years after the entry into force of this Treaty, a conference of Parties to the Treaty shall be held in Geneva, Switzerland, in order to review the operation of this Treaty with a view to assuring that the purposes of the preamble and the provisions of the Treaty are being realized. 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 VIII

1. This Treaty shall be open to all States for signature. Any State which does not sign the Treaty before its entry into force in accordance with paragraph 3 of this article may accede to it at any time.

2. This Treaty shall be subject to ratification by signatory States. Instruments of ratification and instruments of accession shall be deposited with the Secretary-General of the United Nations, who shall be the Depositary of this Treaty.

3. This Treaty shall enter into force upon the deposit with the Depositary of instruments of ratification by twenty Governments, including the Governments of the United States of America, the United Kingdom of Great Britain and Northern Ireland and the Union of Soviet Socialist Republics.

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 of accession.

5. 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, as well as of the receipt of other notices. He shall also inform the Security Council of the United Nations of any notice of withdrawal.

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

Article IX

This Treaty shall be of unlimited duration. Each Party shall in exercising its national sovereignty have the right to withdraw from the Treaty, if it decides that extraordinary events, related to the subject matter of this Treaty, have jeopardized the supreme interests of its country. It shall give notice of such withdrawal to the Depositary three months in advance. Such notice shall include a statement of the extraordinary events it regards as having jeopardized its supreme interests.

Article X

If this Treaty has not been adhered to by all Permanent Members of the United Nations Security Council five years after its entry into force, each Party shall by giving notice to the Depositary have the right to withdraw from the Treaty with immediate effect.

Article XI

1. 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 certified copies thereof to the Governments of the signatory and acceding States.

Protocol I

International co-operative measures to facilitate the verification of a Treaty banning any nuclear weapon test explosion in any environment.

1. Each Party to this Treaty undertakes to co-operate in good faith in an effective international exchange of seismological and other data. The purpose of these international measures is to assist the Parties in the verification of the Treaty by providing additional technical information for their national assessment. These international co-operative measures include designated seismological stations in participating countries and in other territories, efficient systems for the exchange of seismological data, and especially established International Data Centres.

2. Each Party to this Treaty shall have the right to participate in the international

exchange of seismological data by contributing data from designated seismological stations and by receiving all the seismological data made available through the international exchange. To ensure that seismological stations having the necessary geographical coverage will be incorporated in the exchange, the States given in table 1 have agreed to provide data from the stations specified in the same table.

Each Party participating in the international data exchange shall provide geographical co-ordinates, geological site description and a description of the instrumentation of each designated station. Any changes in these data shall be immediately reported. Data on designated stations are collected, compiled and regularly reported by the Secretariat of the Consultative Committee.

3. Each Party participating in the international data exchange shall for this purpose designate an appropriate National Body through which it will communicate.

This body shall handle the exchange of seismological data and contacts with International Data Centres, the Consultative Committee and its Secretariat on matters related to the operation of the data exchange.

4. The seismological stations designated for participation in the international exchange shall have the basic equipment as specified in the Operational Manual for Seismological Stations. These stations shall be operated, calibrated and maintained as specified in the same manual. Information on the operation and the calibration of the stations shall regularly be sent to the Secretariat of the Consultative Committee.

5. Seismological data from each designated station shall routinely and regularly be reported through the appropriate National Body. The seismological data to be reported, the reporting format and time schedule are specified in the Operational Manual for Data Exchange. The seismological stations shall, through the appropriate National Body, cooperate with the International Data Centres to clarify any technical question in connection with reported data.

In addition to routinely submitted data each Party participating in the international data exchange shall provide any additional seismological data from its designated stations requested through International Data Centres by any Party to the Treaty. The procedures for making such requests and the format and time schedule for responding are laid down in the Operational Manual for Data Exchange.

6. Seismological data shall be transmitted through the Global Telecommunication System of the World Meteorological Organization, WMO/GTS, or through other agreed communication channels. The detailed procedures for exchanging data are laid down in the Operational Manual on Data Exchange.

7. International Data Centres shall be established at the following location:

. . .

Each Centre shall be under the jurisdiction of the State in whose territory it is located, and the cost of establishing and operating it shall be borne by that State. Easy and free access for representatives from all Parties to the Treaty and for Officers of the Secretariat of the Consultative Committee shall be guaranteed to all facilities of all International Data Centres.

Each International Data Centre shall receive all seismological data contributed to the international exchange by its participants, process these seismological data without interpreting the nature of seismological events, make the processed seismological data available to all participants and maintain all seismological data contributed by participants as well as the results of the processing at the Centres. The procedures to be used at International Data Centres to receive and compile reported data, to conduct necessary computation, to interact with other International Data Centres in the analysis and to transmit the results of the computations to participating States are laid down in the Operational Manual for International Data Centres.

International Data Centres shall also coordinate requests for additional seismological data from one Party to another and redistribute data obtained as a result of such requests.

8. In addition to the exchange of seismological data specified in paragraphs 2-7 of this Protocol, a similar exchange of data on atmospheric radioactivity shall be established. This exchange shall include equipment for collecting atmospheric radioactivity operated by each contributing State, an exchange of collected data and International Data Centres where data are processed, compiled and redistributed as described in paragraph 7 of this Protocol. The additional

rules and procedures needed to establish and operate this exchange, are laid down in an Operational Manual for the Exchange of Atmospheric Radioactivity.

9. International Co-operative Measures described in this Protocol and in the Operational Manuals annexed to it, shall be established and be operative at the time of entry into force of this Treaty.

10. The Consultative Committee and its Secretariat have the task of overseeing the over-all operation of the international data exchange as is set forth in Protocol III.

The Committee, its Technical Expert Group and Secretariat have the responsibility to maintain the efficiency of the exchange by improving and amending the equipment and the operational procedures. The Parties to the Treaty undertake to implement such changes of the data exchange which may be agreed upon.

11. With a view to improving the verification of this Treaty, negotiations on additional international measures such as the exchange of data on atmospheric radioactivity, hydro-acoustic signals in the oceans and infrasound and microbarographic signals in the atmosphere, shall be undertaken by the Parties to the Treaty. Such additional measures shall as closely as possible be integrated in the co-operative measures specified in this Protocol and an agreement on such additional measures shall be annexed to this Protocol.

Table I

(Text to be elaborated.)

PROTOCOL II

Procedures for International On-Site Inspection

1. The Parties to this Treaty undertake to consult one another and co-operate in good faith for the clarification of all events pertaining to the subject-matter of this Treaty. If any Party sees the need to further clarify any event observed in the territory of another Party to the Treaty it shall seek such clarification through bilateral consultations. These consultations may include the exchange of additional technical information and other measures, such as on-site inspections, which the two Parties concerned may agree upon.

If the event cannot be satisfactorily clarified through such bilateral consultations, the Party seeking further clarification can request an international on-site inspection. Requests for such international on-site inspection shall be made through the Consultative Committee. The requesting Party shall state the reasons for its request, including appropriate technical and other evidence.

The requesting Party shall further specify the area to be inspected. This area must be continuous and not exceed 1000 km^2 or a length of 50 km in any direction.

2. If a Party receiving a request agrees to an international on-site inspection of the requested area, or part thereof, the practical arrangements for the inspection shall be worked out by the Secretariat of the Consultative Committee in co-operation with the Party to be inspected. Such arrangements shall be worked out within one month after a Party has agreed to an inspection. The inspection shall be conducted by experts chosen by the Chairman of the Consultative Committee among experts made available for this purpose by the Parties to the Treaty. The experts shall be selected taking into account available expertise and the desire to obtain equitable geographical and political representation. The International Inspection Team shall be headed by an officer from the Secretariat and contain . . . additional experts. The International Inspection Team shall further comprise necessary technicians, interpreters and secretaries provided by the Secretariat.

The total number of such support personnel shall not exceed. . . .

At all times while the inspecting personnel are in the territory of the Party to be inspected, their persons, property, personal baggage, archives and documents as well as their temporary official and living quarters shall be accorded the same privileges and immunities as provided in Articles 22, 23, 24, 29, 30, 31, 34 and 36 of the Vienna Convention on Diplomatic Relations to the persons, property, personal baggage, archives and documents of diplomatic agents as well as to the premises of diplomatic missions and private residences of diplomatic agents.

Without prejudice to their privileges and immunities it shall be the duty of the inspecting personnel to respect the laws and regulations of the State in whose territory the inspection is to be carried out, in so far as they do not impede in any way whatsoever the proper exercising of the rights and functions provided for by the Treaty and this Protocol.

3. The purpose of an international on-site inspection is purely fact-finding and the International Inspection Team shall not make any assessment as to the nature of the inspected event. The Inspection Team shall present a factual report of the observations made during the inspection. This report shall as far as possible present the consensus view of the participating experts. In case consensus cannot be achieved, the report shall reflect the views of all the participating experts.

The report shall be made available to all Parties to the Treaty through the Consultative Committee.

4. (This paragraph should contain a specification of the techniques to be used and the procedures to be followed when conducting on-site inspections. As these issues have not been properly discussed, there is at present no basis for preparing an appropriate text. To facilitate further discussions some more or less intrusive techniques are presented that might be considered in connection with on-site inspections. More technical data must be collected and compiled on the various inspection techniques and their potential usefulness. Rules and procedures have to be worked out for the conduct of these inspections, for the selection and the acceptance or refusal of more intrusive techniques and for the transportation of people and material.

The following inspection techniques might be useful to consider:

- — visual inspection from the air and on the ground including rules and procedures for taking photographs;
- — measurement of radioactive radiation in the atmosphere above the area, at ground level and in waters;
- — temporary seismological measurements in the area to record possible aftershocks and also events at larger distances to improve the possibilities to interpret the recordings of the event that led to the inspection;
- — seismological reflection measurements, in limited areas, to provide data for detection of possible subsurface activities;
- — measurement of temperature anomalies;
- — drilling and measurements in boreholes to obtain subsurface data at selected points.)

5. If the Party which receives the request does not agree to the inspection of the requested area or part of it, it shall provide the reasons for its decision.

6. As stated in Article IV, paragraph 4, of this Treaty, a Party conducting a large non-nuclear explosion may invite an inspection at the site of the explosion. An Inspection team, established as in paragraph 2 of this Protocol and headed by an officer of the Secretariat of the Consultative Committee, containing . . . experts, shall be established. The privileges and immunities of members of this Inspection Team shall be the same as specified in paragraph 2 of this Protocol. The Inspection Team shall be present before the explosion takes place and stay until the explosion has been conducted. Only visual observations shall be made. The Inspection Team shall provide a factual report of the observations during the inspection. This report shall be distributed to all Parties to the Treaty.

Protocol III

The Consultative Committee, its functions and rules of procedures

1. A Consultative Committee shall be established to oversee the over-all functioning of the Treaty and its verification arrangements. The Consultative Committee shall also serve as a forum to discuss and resolve disputes concerning the Treaty and its verification arrangements which might occur between Parties to the Treaty. The Consultative Committee and its subsidiary bodies, the Technical Expert Group and the Secretariat shall be established when the Treaty enters into force.

In performing its duties the Consultative Committee shall:

- — oversee the implementation of the Treaty;
- — prepare review conferences in accordance with Article VII of this Treaty;
- — review the verification arrangements of the Treaty on the basis of material provided by the Technical Expert Group and the Secretariat;
- — decide on changes in the equipment and technical procedures used to verify compliance with the Treaty;
- — be a forum in which any Party can make inquiries and receive information as a result of such inquiries;
- — be a forum in which any Party can request an international on-site inspection and the factual results of such inspections are presented;
- — guide and oversee the work of the Technical Expert Group and the Secretariat;

— decide on the annual budget of the Secretariat and elect the Director and the Deputy Director of the Secretariat.

2. Each Party to the Treaty shall have the right to be a member of the Consultative Committee.

3. The Depositary of the Treaty or his representative shall act as Chairman of the Consultative Committee.

4. The Committee shall meet annually and, in addition, upon the request of any Party when an extraordinary meeting is considered necessary to oversee the implementation of the Treaty or to settle disputes between Parties to the Treaty concerning its compliance.

The Consultative Committee shall work on the basis of consensus on the following matters;

— review and analysis of the over-all operation of the Treaty and its verification arrangements;
— decisions on changes in the equipment and technical procedures used to verify compliance with the Treaty.

The Consultative Committee shall take decisions by a majority of the members present and voting on the following issues:

— decisions on the annual budget of the Secretariat;
— election of the Director and the Deputy Director of the Secretariat.

5. The Consultative Committee shall establish a Technical Expert Group open to governmental experts from all Parties to the Treaty. The Technical Expert Group shall evaluate the technical performance of the international verification measures, including the techniques and procedures for on-site inspections, propose changes in the equipment and technical procedures used to verify compliance with the Treaty and undertake any technical studies that the Consultative Committee may request. The Technical Expert Group shall further be a forum for technical discussions of events for which a Party seeks clarification through international measures.

The Technical Expert Group shall meet at least once a year. The Group shall establish its own rules of procedure and elect its own Chairman. The Group shall try to achieve consensus. In case consensus cannot be achieved, reports from the Group shall reflect the views of all the participating experts.

The Technical Expert Group shall report to the Consultative Committee on an annual basis or when requested.

6. To support the work of the Consultative Committee and the Technical Expert Group a permanent Secretariat shall be established.

The Secretariat shall:

— support the work of the Consultative Committee and the Technical Expert Group by organizing their meetings and by preparing requested background material and studies;
— supervise that the participating seismological stations are operated and data are reported as specified in paragraphs 4 and 5 of Protocol I of this Treaty;
— act as a contact with the WMO on matters of Data Exchange through its Global Telecommunications System and supervise and review, in co-operation with WMO, the data exchange specified in paragraph 6 of Protocol I of this Treaty;
— supervise the operation of the International Data Centres to ascertain that these Centres are established and operated as specified in paragraph 7 of Protocol I of this Treaty;
— supervise the exchange of data on atmospheric radioactivity to ascertain that the exchange is established and conducted as specified in paragraph 8 of Protocol I of this Treaty;
— compile and present operational statistics and reports on experiences of the International Data Exchange to the Technical Expert Group;
— organize and conduct international on-site inspections as specified in Protocol II of this Treaty, and report the result of such inspections to the Consultative Committee;
— maintain lists, in co-operation with the Parties to the Treaty, of international experts available to conduct on-site inspections and the equipment necessary for such inspections.

7. The Secretariat shall consist of a Director and a Deputy Director, elected for a period of four years by the Consultative Committee, as specified in paragraph 2 of this Protocol, and an appropriate number of officers and support personnel. The annual budget of the Secretariat shall be approved by the Consultative Committee, as specified in paragraph 2 of this Protocol. The cost shall be

borne by the Parties to the Treaty in accordance with the United Nations assessment scale prorated to take into account differences between the United Nations membership and the number of Parties to this Treaty. The Secretariat shall be located at. . . .

Source: Committee on Disarmament document CD/381*, 14 June 1983.

III. GROUP OF SOCIALIST COUNTRIES: Basic provisions of a treaty on the complete and general prohibition of nuclear weapon tests, 8 June 1987

A. General provisions

1. The complete and general prohibition of nuclear weapon tests is in itself an important measure facilitating progress toward the limitation, reduction and complete elimination of nuclear arms.

2. The prohibition of nuclear weapon tests by the Soviet Union and the United States of America, the States which possess the greatest nuclear potentials, is an important step toward general and complete prohibition of such tests. They must be joined by the other nuclear Powers if the main objective of the Treaty is to be attained and its universal nature genuinely ensured.

3. The States Parties to the Treaty are guided by a desire to complement and develop the regime established by the Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and under Water of 5 August 1963, which would be consistent with the determination expressed in that Treaty to achieve the discontinuance of all test explosions of nuclear weapons for all time, and to that end to prohibit such explosions in the only remaining environment, i.e. underground.

4. When all nuclear weapons have been completely eliminated the Treaty will serve as a safeguard against the reappearance of this kind of weapon in the future and an important element in the comprehensive system of international security.

B. Scope of the prohibition

1. Each State Party to this Treaty shall undertake to prohibit, to prevent, and not to carry out any nuclear weapon test explosions at any place under its jurisdiction or control, in all environments — in the atmosphere, in outer space, under water or underground.

2. No Party shall cause, encourage or in any way participate in the conduct of any nuclear weapon test explosions anywhere.

3. Provision should be made for the formulation of a provision preventing the ban on nuclear weapon test explosions from being circumvented by means of peaceful nuclear explosions.

C. Termination of activities at nuclear weapon test ranges

I. Declarations

Thirty days after the entry into force of the Treaty, the States Parties shall declare the locations of the test ranges for nuclear weapon test explosions in their territory or under their control, including the geographical coordinates of nuclear weapon test sites.

II. Termination of activities at nuclear weapon test ranges

On the day of the entry into force of the Treaty, each State Party to the Treaty shall terminate all activities related to nuclear weapon test explosions at its test ranges.

D. Ensuring compliance with the Treaty

I. General provisions on verification

Effective comprehensive verification of strict and unfailing fulfillment by the Parties of their obligations under the Treaty shall be carried out using national technical means of verification, international verification measures and on-site inspection.

II. National technical means of verification

1. For the purpose of verifying the implementation of this Treaty, each State Party to this Treaty shall use the national technical means of verification which it has at its disposal in a manner consistent with the generally recognized norms of international law, and undertakes not to interfere with such means of verification of other States Parties to this Treaty.

2. States Parties to this Treaty which possess national technical means of verification shall place the information which they obtained through those means, and which is important for the purposes of this Treaty, at the disposal of the appropriate organ established under the Treaty, and may, where

necessary, place it at the disposal of other Parties.

III. International verification measures

International system of seismic verification

1. For the purpose of better assuring compliance with obligations under this Treaty, the States Parties shall establish an international system of seismic verification.

2. To this end, a network of seismic stations with standard specifications shall be established on the territory under the jurisdiction or control of the States Parties to the Treaty, to ensure the continuous international exchange of level II seismic data in accordance with agreed guidelines which will form an integral part of the Treaty.

3. These stations shall operate with the participation of observers from among the members of an international inspectorate.

The number, location, main performance characteristics and general principles of operation of such stations shall be subject to agreement.

International exchange of data on atmospheric radioactivity

1. For the purpose of better assuring compliance with obligations under the Treaty, each State Party to this Treaty undertakes to co-operate in good faith in an international exchange of data on atmospheric radioactivity.

2. To this end, the States Parties to this Treaty shall establish, on the territory under their jurisdiction or control, aerosol monitoring stations to ensure the international exchange of data on atmospheric radioactivity in accordance with agreed guidelines which will form an integral part of this Treaty.

IV. Ensuring the non-functioning of nuclear weapon test ranges

Verification that no nuclear explosions are conducted at test ranges shall be carried out by national personnel with the participation of international inspectors in accordance with agreed procedures.

V. On-site inspection

1. For the purpose of clarifying and resolving questions which give rise to doubt as to compliance with the Treaty and which cannot be eliminated by means of the other verification measures provided for in the Treaty, each State Party shall have the right to request an on-site inspection in the territory of another State Party, citing appropriate grounds for the request.

2. The State so requested will be obligated to grant access to the locations specified in the request for the purpose of an inspection at the site of the event whose status is unclear, in order to clarify whether it was related to a nuclear explosion carried out in circumvention of the provisions of this Treaty.

3. Criteria and procedures for requesting such inspections, and rules for conducting them, shall be elaborated including a list of the rights and functions of the inspecting personnel.

VI. Treaty organs

1. For the purpose of effective implementation of this Treaty, there shall be established appropriate organs, including an international inspectorate, whose functions will be specified in the annex to this Treaty.

2. A method of decision-making in the Treaty organs is to be agreed upon which will ensure that decisions are taken on a mutually acceptable basis and within a short time where necessary.

E. Concluding provisions of the Treaty

1. The Treaty shall be of unlimited duration. It shall enter into force upon ratification by . . . States, including the USSR and the United States of America.

Five years after the entry into force of the Treaty, a conference of the States Parties to the Treaty shall be convened to review the operation of the Treaty and to consider whether it should remain in effect if other nuclear Powers have not acceded thereto over the five-year period.

2. Provision should be made for a procedure for the signing and ratification of the Treaty, for the depositary, for accession by States to, and withdrawal from, the Treaty, for amendment and for review conferences.

Source: Conference on Disarmament document CD/756*, 17 June 1987.

ANNEXE 3. NUCLEAR EXPLOSIONS, 16 JULY 1945 — 1 JULY 1987

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Basic to an informed debate about nuclear weapon testing is an accurate and a comprehensive list of all known or presumed nuclear explosions. Facts about how many nuclear explosions have been conducted, and by whom, where and when they have taken place, are an essential starting point for further research and debate about testing and test ban issues. The lists provided in this appendix are as accurate and as comprehensive as it is possible to make them at this time. Because a large amount of secrecy has surrounded and still surrounds nuclear testing, these lists are inevitably incomplete.

I. SOURCES

Basic factual information about nuclear testing comes from several sources. Each of the governments that have conducted nuclear tests (the USA, the USSR, the UK, France, China and India) has provided information, in varying degrees, about its programme. In addition those governments have occasionally reported on the testing programmes and activities of other countries. Official government data, while the most authoritative, are normally incomplete and must be supplemented by other sources.

The US Government has provided the most information about its own test programme and the programmes of other countries. The basic document is the Department of Energy's *Announced United States Nuclear Tests, July 1945 through December 1986.*[1] All US tests conducted prior to the Partial Test Ban Treaty (PTBT) of 1963 are included, though at the time many of those tests were not announced. As for the tests conducted since 1963, "[s]ome tests conducted underground since the signing of the Treaty and designed to be contained completely have not been announced. Information concerning these events is classified." The information which has been

provided includes the date (in Greenwich Mean Time), location, type, purpose and yield or yield range of the event.[2]

The United States Geological Survey (USGS), a part of the Department of the Interior, publishes a monthly listing called *Preliminary Determination of Epicenters*, which reports global seismic activity as recorded by stations all over the world. While the USGS does not identify certain seismic events as nuclear tests, activities listed in such places as Southern Nevada, Eastern Kazakhstan, Novaya Zemlya, Tuamoto Archipelago and Sinkiang Province are likely candidates. The analyst must be knowledgeable about the exact geographic co-ordinates of each nation's test site(s). Another indicator that certain seismic activity may be a test is the origin time. Explosions, unlike earthquakes, normally occur on the minute or the hour and usually during the daytime.

The USSR had, by 1987, not announced its tests. It has published some information about its peaceful nuclear explosion (PNE) programme and during a turbulent period following the 1958-61 moratorium announced a few high-yield atmospheric tests.

The UK has conducted only a few dozen tests since it started its nuclear testing programme in 1952. This could mean either that Britain has a very small number of warhead types in its stockpile or that it obtains a good deal of information from the USA, or both. The first 21 British tests were conducted in the atmosphere between October 1952 and September 1958.[3] The tests from 1962 to 1987 were conducted jointly with the United States at the Nevada Test Site and were announced by the US Government.

Keeping track of French tests is not too difficult. The French Government reported quite a lot of information about many of the tests of the 1960s and early 1970s. More recent French tests were announced by New Zealand seismologists who record the explosions at Tuamotu Archipelago from a station at Rarotonga in the Cook Islands.[4] France stopped testing in the atmosphere in 1975.

China announced almost all of its tests in 1964-77.[5] China's test on 16 October 1980 was the last conducted in the atmosphere, Premier Zhao Ziyang announced on 21 March 1986 that China would no longer conduct tests in the atmosphere.

An important source of official information is that supplied by certain non-nuclear-weapon state governments which record the testing activity of the nuclear powers. The most prominent source in this category is the Swedish National Defence Research Institute (known by its Swedish acronym as FOA). Its work on seismic discrimination, which is financed by the Swedish Foreign Office, is meant to establish an acceptable verification system for a comprehensive test ban. FOA operates the Hagfors Observatory and publishes the data; it uses data from its own seismic network and those from other observatories, comparing them and updating the lists. Several other institutions, such as those in New Zealand, Norway and the Australian Seismological Centre which opened in 1986, are co-operating in efforts to establish a world-wide seismic monitoring system. Most of the seismic data exchanged by such institutions are incomprehensible to the non-specialist, although several institutions translate these data into understandable lists of nuclear explosions or seismic events.

Newspaper accounts, books and journal articles also constitute a source of information.

II. Interpretation

With as much information accumulated about the tests as possible, certain patterns emerge which begin to indicate the more significant aspects of testing. Simple statistical summaries reveal basic and interesting facts. How many tests have been conducted by each country? How many were conducted above and below ground? How many were conducted before and after the PTBT? How many were done underwater, at very high altitudes, and so on?

Other patterns emerge by examining US and Soviet testing activity just prior to the entry into force of the PTBT and the Threshold Test Ban Treaty (TTBT). From November 1958 to September 1961, neither the USA nor the USSR tested nuclear weapons. The USSR resumed testing on 1 September 1961 and conducted approximately 50 tests by the end of the year, while the United States conducted only 10. In 1962 the USA conducted 98 tests (including 2 with the UK) and the Soviet Union 44. These more than 200 explosions in a 16-month period (one every two and one-half days)

represent an intense period of testing. One cause of this fervent pace was not doubt to test the backlog of designs developed during the moratorium.

The TTBT was signed on 3 July 1974, prohibiting tests having a yield exceeding 150 kt. As stipulated in Article I, the ban would not take effect until 31 March 1976.[6] The interesting period of time is therefore the 21 months between July 1974 and March 1976; during that time the USA conducted 34 tests and the Soviet Union 29, of which 5 may have been PNEs.

In the US case, numerous officials have stated that the warhead designs for the Minuteman III (335 kt), the MX (300 kt), the Trident II (450 kt) and the B83 strategic bomb (1.2 Mt) were tested at their full yield prior to 31 March 1976. By comparing the known yields of those warheads with yield estimates of certain tests during the period, it is possible to speculate on which tests were for which warheads. It seems to be the case that no new warhead introduced into the stockpile, with the exception of the above four, has a yield greater than 150 kt, thus implying that new warheads may not be certified for the stockpile unless they have been tested at full yield.

In the Soviet case, according to one analyst, several high-yield tests (c.2-3.5 Mt) conducted during this period were for the single-re-entry vehicle ICBM modifications (SS-17 mod. 2, SS-18 mod. 1 and SS-19 mod. 2), and a series of 500-kt tests were probably for later modifications of these MIRVed missiles (SS-17 mod. 3, SS-18 mod. 4 and SS-19 mod. 3).[7]

Notes and References

[1] DOE Nevada Operations Office, NVO-209 (Rev. 7), Jan 1987. Announced tests are notified by the Nevada Operations Office, Las Vegas, Nevada. If a test is to be announced it is done approximately 48 hours before the scheduled time. Occasionally a test is announced after it has taken place.

[2] More detail must be obtained from other sources. It is useful to know the exact time of the explosion as well as the co-ordinates of where it took place. The purpose of the test is given in vague terms, such as "weapon related" or for "weapon effects." The exact purpose of the test is not divulged, nor in recent years is the exact yield.

[3] For valuable information about the dozen tests conducted in Australia, see *A History of British Atomic Tests in Australia*, prepared by Dr. J.L. Symonds, Department of Resources and Energy (Australian Government Publishing Service: Canberra, 1985).

[4] Department of Scientific and Industrial Research, Geophysics Division, Wellington, New Zealand.

[5] Twenty of the first 23.

[6] Submission for ratification was held in abeyance until the companion Peaceful

Nuclear Explosions Treaty was negotiated. That Treaty was negotiated between October 1974 and April 1976, and was signed on 28 May 1976. Both treaties were submitted to the Senate on 29 July 1976, where they still awaited ratification by July 1988.

[7] Sykes, L.R. and Davis, D.M., "The yields of Soviet strategic weapons", *Scientific American*, Jan. 1987 p. 34. The warheads for the first group of Soviet MIRVed ICBMs deployed between 1974 and 1976 were tested earlier.

[*CIIPS Editor's note: The data presented below is based on revised information gathered after the original study was published by Oxford University Press. The tables differ slightly from those presented in the CIIPS/SIPRI book.*]

Table 1. Estimated number of nuclear explosions 16 July 1945-5 August 1976 (the signing of the Partial Test Ban Treaty)

a = atmospheric
u = underground

	USA		USSR		UK		France		
	a	u	a	u	a	u	a	u	Total
1945	3	0							3
1946	2[a]	0							2
1947	0	0							0
1948	3	0							3
1949	0	0	1	0					1
1950	0	0	0	0					0
1951	15	1	2	0					18
1952	10	0	0	0	1	0			11
1953	11	0	4	0	2	0			17
1954	6	0	7	0	0	0			13
1955	18[a]	1	5[a]	0	0	0			24
1956	18	0	9	0	6	0			33
1957	27	5	15[a]	0	7	0			54
1958	62[b]	15	29	0	5	0			111
1949-58 exact years unknown			18						18
1959	0	0	0	0	0	0			0
1960	0	0	0	0	0	0	3	0	3
1961	0	10	50[a]	1	0	0	1	1	63
1962	39[a]	57	43	1	0	2[d]	0	1	143
1 Jan - 5 Aug. 1963	4	25	0	0	0	0	0	2	31
Total	218	114	183[c]	2	21	2	4	4	548

[a] At least one of these tests was carried out under water.

[b] Two of these tests were carried out under water.

[c] The total figure for Soviet atmospheric tests includes the 18 additional tests conducted in the period 1949-58, for which exact years are not available.

[d] Conducted jointly with the USA at the Nevada Test Site.

Table 2. Estimated number of nuclear explosions 6 August 1963-30 March 1976.

a = atmospheric
u = underground

Year	USA[a]		USSR		UK[a]		France		China		India		Total
	a	u	a	u	a	u	a	u	a	u	a	u	
6 Aug. - 31 Dec. 1963	0	15	0	0	0	0	0	1					16
1964	0	40	0	6	0	1	0	3	1	0			51
1965	0	37	0	9	0	1	0	4	1	0			52
1966	0	43	0	15	0	0	5	1	3	0			67
1967	0	34	0	17	0	0	3	0	2	0			56
1968	0	45[b]	0	13	0	0	5	0	1	0			64
1969	0	38	0	16	0	0	0	0	1	1			56
1970	0	35	0	17	0	0	8	0	1	0			61
1971	0	17	0	19	0	0	5	0	1	0			42
1972	0	18	0	22	0	0	3	0	2	0			45
1973	0	16[c]	0	14	0	0	5	0	1	0			36
1974	0	14	0	19	0	1	7	0	1	0	0	1	43
1975	0	20	0	15	0	0	0	2	0	1	0	0	38
1 Jan. - 30 Mar. 1976	0	10	0	1	0	0	0	0	1	0	0	0	12
Total	0	382	0	183	0	3	41	11	16	2	0	1	639

a See note *a*, table 4.
b Five devices used simultaneously in the same test are counted here as one explosion.
c Three devices used simultaneously in the same test are counted here as one explosion.

Table 3. Estimated number of nuclear explosions 31 March 1976 (date of the envisaged application of the 150-kt explosive yield limitation under the TTBT and the PNET) - 1 July 1987.

a = atmospheric
u = underground

	USA[a]		USSR		UK[a]		France		China		India		
Year	a	u	a	u	a	u	a	u	a	u	a	u	Total
31 Mar. - 31 Dec.													
1976	0	8	0	16	0	1	0	4	2	1	0	0	32
1977	0	19	0	18	0	0	0	6	1	0	0	0	44
1978	0	17	0	28	0	2	0	7	2	1	0	0	57
1979	0	15	0	29	0	1	0	9	0	0	0	0	54
1980	0	14	0	21	0	3	0	11	1	0	0	0	50
1981	0	16	0	22	0	1	0	10	0	0	0	0	49
1982	0	18	0	31	0	1	0	5	0	0	0	0	55
1983	0	17	0	27	0	1	0	7	0	1	0	0	53
1984	0	17	0	28	0	2	0	8	0	2	0	0	57
1985	0	17	0	9	0	1	0	8	0	0	0	0	35
1986	0	14	0	0	0	1	0	8	0	0	0	0	23
1 Jan. - 1 July 1987	0	9	0	9	0	0	0	4	0	1	0	0	23
Total	0	181	0	238	0	14	0	87	6	6	0	0	532

[a] See note *a*, table 4.

Table 4. Estimated aggregate number of nuclear explosions 16 July 1945—1 July 1987.

USA[a]	USSR	UK[a]	France	China	India	Total
895	606	40	147	30	1	1719

[a] All British tests from 1962 have been conducted jointly with the United States at the Nevada Test Site. Therefore, the number of US tests is actually higher than indicated here.

Sources used for the tables:

Swedish National Defence Research Institute (FOA), various estimates; Norris, R.S., Cochran, T.B. And Arkin, W.M., 'Known US nuclear tests July 1945 to 16 October 1986', *Nuclear Weapons Databook*, Working Paper no. 86-2 (Rev. 1) (Natural Resources Defense Council: Washington, DC, Oct. 1986); Sands, J.I., Norris, R.S. and Cochran, T.B., 'Known Soviet nuclear explosions, 1949-1985', *Nuclear Weapons Databook*, Working Paper no. 86-3 (Rev. 2 June 1986) (Natural Resources Defense Council: Washington, DC, Feb. 1986); Department of Scientific and Industrial Research (DSIR), Geophysics Division, New Zealand, various estimates; and US Geological Survey.

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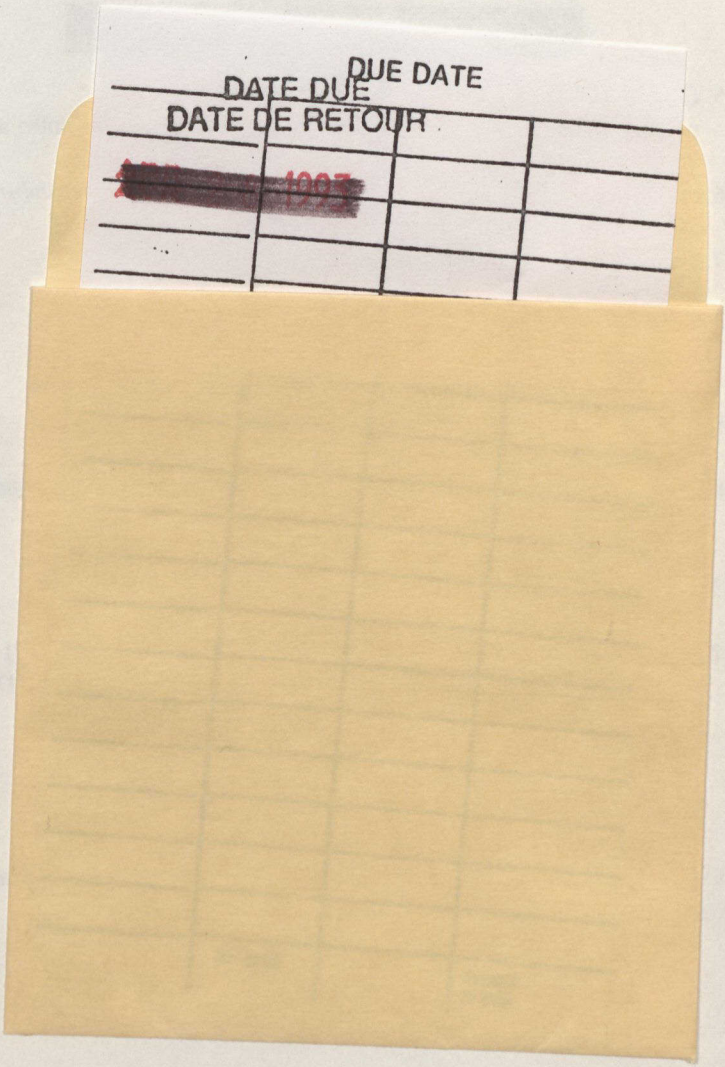
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The Debate about Nuclear Weapon Tests

This monograph deals with one of the most hotly discussed items on the agenda of international arms control negotiations: nuclear weapon tests. The aim of the study is to give an analytical view of the complex technical and political issues involved in a possible cessation or limitation of these tests. It is intended as an informed contribution to the debate among governmental and non-governmental experts, with a view to facilitating the achievement of a meaningful arms control measure.

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