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In Pursuit of a Nuclear Test Ban Treaty

A Guide to the Debate in the Conference on Disarmament

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(b) Promoting informed participation by all States in disarmament efforts;

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Preface

The mandate of UNIDIR, as set out in its Statute includes the provision of support and assistance to on-going negotiations. UNIDIR's proximity to the Conference on Disarmament (CD) - the single multilateral disarmament negotiating forum - gives the Institute many advantages in observing the important work of this body.

In 1989, with the cooperation of the Secretariat of the CD, UNIDIR initiated a series of research reports on the multilateral arms control and disarmament negotiations in the CD. The reports were intended to fulfill a need for a ready guide to the proceedings of the CD. They have been planned not as compendia of proposals or as summary records but rather as analytical guides identifying the key issues, tracing their evolution and examining the positions of the various delegations. The present status of the negotiations and their likely development within the context of the CD and external developments are also featured.

These guides are intended to provide diplomats, researchers, and the interested public with the background information necessary to follow future developments in the CD and to participate actively in the negotiations, discussions or research on the issues concerned. The first report published in this series was on the negotiations for a Chemical Weapons Convention, written by Thomas Bernauer. UNIDIR has been greatly encouraged by the positive response in diplomatic and academic circles to this publication and by the wide use being made of it.

This research report is on the CD's work in the field of a Nuclear Test Ban. It is written by Thomas Schmalberger who has been a research assistant at UNIDIR. Thomas Bernauer remained coordinator of the series of guides and Dr. Jozef Goldblat continued to serve as a consultant to the project.

UNIDIR would like to thank Ambassador Miljan Komatina, the Secretary-General of the CD, Ambassador Vicente Berasategui, Deputy Secretary-General of the CD, and the other members of the CD Secretariat for their unfailing cooperation and assistance. We owe a debt of gratitude to the Ford Foundation for their funding of this research project.

Jayantha Dhanapala
Director

Contents

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Thomas Schmalberger

Abbreviations

BCC	Bilateral Consultative Committee
CD	Conference on Disarmament
CCD	Conference of the Committee on Disarmament
CORRTEX	Continous Reflectometry for Radius versus Time Experiments
CTB	Comprehensive Test Ban
EIDC	Experimental International Data Centre
EMP	Electromagnetic Pulse
ENDC	Eighteen Nation Disarmament Committee
GSE	Group of Scientific Experts
GSETT	Group of Scientific Experts' Technical Test
GTS	Global Telecommuncation System
G21	Group of 21
IAEA	International Atomic Energy Agency
IDC	International Data Centre
IHE	Insensitive High Explosives
JCC	Joint Consultative Committee
JVE	Joint Verification Experiment
NATO	North Atlantic Treaty Organization
NDC	National Data Centre
NGO	Non-Governmental Organization
NPT	Non-Proliferation Treaty
NRDC	National Resources Defense Council
NTM	National Technical Means
NST	Nuclear and Space Talks
PNE	Peaceful Nuclear Explosions
PNET	Peaceful Nuclear Explosions Treaty
PTBT	Partial Test Ban Treaty
SDI	Strategic Defense Initiative
TNF	Technical National Facility
TTBT	Threshold Test Ban Treaty
UN	United Nations
UNSSOD	Special Session of the UN General Assembly Devoted to Disarmment
WMO	World Meteorological Organization
WTO	Warsaw Treaty Organization

Introduction

The nuclear era was introduced in 1945 by a nuclear test explosion in the desert of New Mexico. This test was conducted to prove the functioning of a weapon whose entire spectrum of effects was still unknown. A few weeks later, the destructive power of such a weapon became visible in the extinction of the cities of Hiroshima and Nagasaki. Soon thereafter, the competition to develop nuclear weapons resulted in an arms race.

The United States, the Soviet Union, the United Kingdom, France and China developed nuclear weapons as a major component in their national defense strategies. Their arguments for continued nuclear testing focus on the military requirement to develop nuclear weapons of different sizes, with various yields and effects (such as radiation or electromagnetic pulse), as well as to assure the reliability of the existing nuclear weapons stockpiles. National security concerns prevent a comprehensive test ban which would slow down the nuclear arms race, erect an obstacle to nuclear proliferation, and which would represent a major step towards nuclear disarmament. Due to public pressure, however, these States have undertaken efforts to negotiate the cessation of nuclear testing.

In 1958, the then three nuclear weapons powers, UK, U.S., and USSR, began negotiations with the ultimate goal of a comprehensive test ban treaty aiming to prohibit all nuclear explosions in all environments for all time. However, the verification of such a treaty represented a long-term obstacle in the negotiations. Up to the present, there are still a number of differences over technical verification capabilities which have diverted nuclear testing agreements from a comprehensive to a partial scope. During three decades of discussions on a comprehensive test ban treaty, however, it has become apparent that the verification issue can also offer a possibility to hide a lack of political will to conclude a treaty.

After five years of deliberations, the Partial Test Ban Treaty (PTBT) was signed in 1963, prohibiting nuclear explosions in all environments except underground. In 1974 and 1976 the Threshold Test Ban and the Peaceful Nuclear Explosions Treaties (TTBT, PNET) were signed, limiting the yield of nuclear tests. These treaties, however, entered into force only in 1990.

The test ban issue has been the first item on the agenda of the Conference on Disarmament for more than ten years. In fact, the Conference on Disarmament has been the only multilateral negotiating body where test ban discussions have been continuously held. Within this forum, the forty member States have presented numerous positions and proposals on the test ban issue. Although the Conference on Disarmament has not yet served as an arena for the actual negotiation of a test ban treaty, it has done valuable and essential work for this purpose.

The objective of this guide is to focus on the political issues in the test ban debate in the Conference on Disarmament, and to produce a guide providing diplomats, researchers, and the interested public with background information. Such a complex negotiating process requires a selection of proposals, comments and technical details. The criterion for selecting material was based upon the importance for present negotiations. An effort has been made to be as comprehensive as possible with respect to proposals but to minimize the discussion of technical aspects.

The first part of this guide will provide a historical perspective on the arguments used for and against continued nuclear testing, and on the record of negotiating activities on this subject. This provides a general overview of the test ban debate with particular emphasis on the negotiations before 1980. The second and most substantive portion, will examine the test ban debate in the Conference on Disarmament during the past ten years.

The Tripartite Report was chosen as the point of departure for this research because it marked the beginning of a new era in test ban negotiations. The earlier era was characterized by a more unified position vis-a-vis testing on the part of the negotiating nuclear weapon powers. This came to an end in 1980 with the suspension sine die of the trilateral negotiations between the United Kingdom, the United States and the Soviet Union from which the Tripartite Report originated. The present epoch has been characterized by significant policy shifts which have postponed the ultimate goal of a comprehensive test ban treaty. However, since the Conference on Disarmament has been the only forum where a nuclear test ban has been addressed, the multilateral approach to the cessation of nuclear testing has gained new importance.

Since this guide is also intended to facilitate the work of the diplomatic community, the framework used for analysing the discussions on the test ban issue will reflect the categories outlined in the current mandate of the CD's Ad-Hoc Committee on a nuclear test ban, i.e. structure, scope, verification and compliance. The issues of scope and compliance have received less attention, whereas structure and verification have been subject of intense discussions in the CD. The term structure has not yet been clearly defined and therefore is subject to different interpretations reflecting the different approaches to the negotiation of a nuclear test ban treaty. These approaches will be outlined with their practical impact on the efforts to find a mandate for an ad-hoc committee. The issue of verification has focused mainly on seismological means of monitoring. Therefore, the work of the Group of Scientific Experts, established as an Ad-Hoc Committee within the framework of the Conference on Disarmament, will be presented, and proposals on an international seismic monitoring system will be analyzed. Annex III of this guide is intended to serve as a complement to this chapter and to provide some technical aspects of the different verification techniques.

This guide is based mainly on official documents, the working papers and verbatim records of the Conference on Disarmament and of its predecessors as well as verbal communications with experts. For background information, especially on technical aspects and events outside the Conference on Disarmament, additional documents and secondary literature were consulted. References to sources outside the Conference on Disarmament were provided only in particular cases as this guide is primarily intended as a resource for the negotiations in the Conference on Disarmament.

PART ONE

BACKGROUND

CHAPTER I

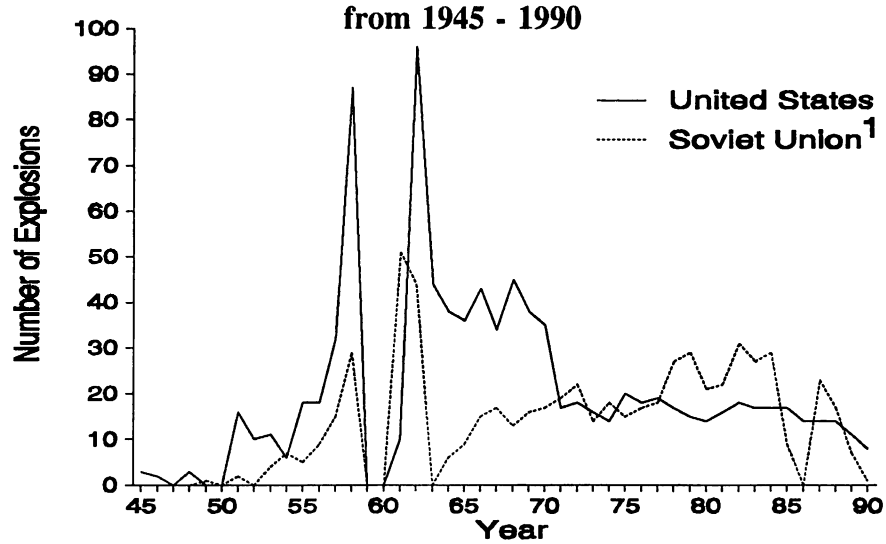
Motivations for Nuclear Testing

1.1 Introduction

Nuclear tests are essential for the development of nuclear explosive devices. Although such devices can be developed and produced in laboratories if the necessary materials and scientific skills are available, nuclear explosive devices which are reliable cannot, at present, be obtained without field tests. Only the latter are usually defined as nuclear tests.[1]

Six States have so far carried out nuclear explosions: the U.S. (1945-), the USSR (1949-), the United Kingdom (1952-), France (1960-), the People's Republic of China (1964-), and India which detonated a nuclear explosive device in 1974, allegedly for peaceful purposes. The first five States are considered nuclear weapons States. Most of the explosions reported were used for military purposes; only a minor percentage were conducted for peaceful purposes.[2] Figure 1.1 and 1.2 show the estimated number of nuclear explosions from 1945 to 1990 by the U.S. and the USSR and the UK, France, China, and India.

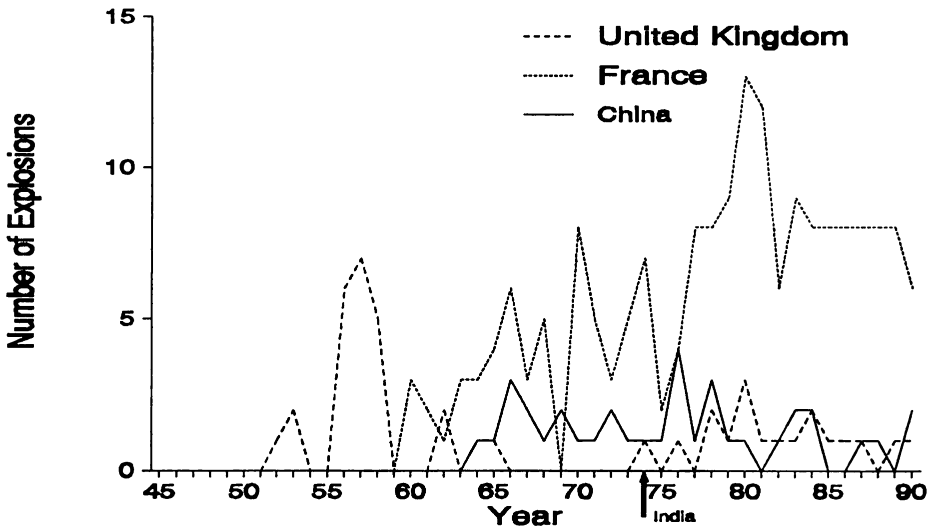
Figure 1.1: Estimated Number of Nuclear Explosions by the U.S. and the USSR from 1945 - 1990



1 According to Westervelt, three types of tests can be distinguished: **Nuclear tests** involving chemical high explosives and small quantities of fissionable material and focusing on the ignition mechanism; **nuclear explosions** which examine the fission energy released, hence aiming at the calibration of the yield; and **nuclear weapons tests** that serve to analyze the overall performance of a nuclear weapons system. "It will become clear that useful nuclear tests need not involve nuclear explosions, and that significant nuclear explosions might be distinguishable from nuclear weapons test explosions, but only if some attribute of the explosive device precluded any weapon application." (Donald A. Westervelt, The Role of Laboratory Tests, in Jozef Goldblat and David Cox, eds., Nuclear Weapon Tests: Prohibition or Limitation ?, New York, Oxford University, p.48)

2 Iris Y.P. Borg, Nuclear Explosions for Peaceful Purposes, in Jozef Goldblat and David Cox, eds., Nuclear Weapon Tests: Prohibition or Limitation ?, p.59

Figure 1.2: Estimated Number of Nuclear Explosions by the UK, France and China from 1945 - 1990



1 The exact years for additional 18 Soviet tests between 1949 and 1958 are unknown. In 1990, the Soviet Union revealed that it has conducted 72 tests more than have been documented. (See Bulletin of the Atomic Scientist, November 1990, p.48)

Source: SIPRI Yearbook 1990 of World Armaments and Disarmament, SIPRI, Oxford, Oxford University Press, 1990, pp.56-57; various U.S. and Swedish sources.

To facilitate the understanding of the nuclear test ban issue, we will first examine the arguments for nuclear test explosions in reference to military reasoning and the peaceful application of nuclear explosions. To illustrate the different views in the discussion we will examine, in a second step, the possible impact of a comprehensive test ban.

1.2 Military Motivations for Nuclear Testing

All five declared nuclear weapons States have the technological know-how to manufacture hydrogen-bombs which are second generation nuclear weapons and some are working on the development of third generation weapons. At least six other States are considered nuclear threshold countries: Argentina, Brazil, India, Israel, Pakistan, South Africa[3]. This means that they are actively seeking to acquire a nuclear weapon capability or have already done so without advertising it and refuse formally to renounce the nuclear weapon option. In the discussion of nuclear testing several military motivations have been pointed out. They relate

[3] See Jozef Goldblat and David Cox, Nuclear Weapon Tests: Prohibition or Limitation?, p.24; Jozef Goldblat, Twenty Years of the Non-Proliferation Treaty, Implementation and Prospects, PRIO, Oslo, Ostfold Trykkeri A/S, 1990, pp.10-16; Department of Political and Security Affairs, United Nations Centre for Disarmament, Report of the Secretary-General, South Africa's Plan and Capability in the Nuclear Field, Study Series No.2, United Nations, New York, 1981; ibid, Study on Israeli Nuclear Armament, Study Series No.6, United Nations, New York, 1982; Leonard S. Spector with Jacqueline R. Smith, Nuclear Ambitions, The Spread of Nuclear Weapons 1989-1990, A Carnegie Endowment Book, Westview Press, Boulder, 1990.

to the reliability of existing stocks, the development of new generations of nuclear weapons, and improvements in terms of delivery systems, safety, and the effects of nuclear weapons.

1.2.1 Reliability of Nuclear Weapons

Although a nuclear weapons system is usually tested before it is introduced into the stockpile, uncertainties may remain. Prolonged storage may in particular affect the nuclear as well as the non-nuclear components of weapon systems through chemical decomposition, corrosion and other changes. Most reliability problems which have occurred relate to the "primary", that is the trigger of a second generation nuclear weapon.[4]

The need of testing to assure the reliability of nuclear weapons stockpiles is disputed. The decomposition of chemical high explosives releases gases which might change the crystal structure of these explosives, hence hampering a proper ignition of the nuclear device. According to some scientists this problem could be sufficiently controlled through laboratory tests. Corrosion is also caused by these gases and might affect the nuclear materials therefore possibly causing alterations in the process of the explosion. These same scientists claim that this could be checked through "meticulous examination of the material and the device"[5].

Other scientists, and those who consider testing indispensable, point out that 75 per cent of all reliability problems of the U.S. stockpile were discovered owing to nuclear tests.[6] They argue moreover that U.S. nuclear weapons are more sophisticated in their technological design than the Soviet stockpile, and hence are more vulnerable to defects.[7] All these arguments, however, have been weakened by disclosure of the fact that from 1945 to 1986 only 0.4 per cent of U.S. nuclear explosions, well under one per year, were designed to check weapon reliability.[8]

The reliability issue was given particular emphasis by the U.S. administration after the failure of the tripartite U.S.-UK-USSR negotiations in 1980 and has since been used as an argument to support continued nuclear testing. No comparable argument has been put forward by the Soviet Union.

A point of view in favour of nuclear testing and supported by the U.S. administration, concerns the maintenance of the scientific expertise to keep a modern and reliable nuclear weapons stockpile. Some proponents of nuclear testing argue that a cessation of tests would lead to a brain drain from the military to the non-military establishments. They hold that the

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4 Frank N. von Hippel, Harold A. Feiveson, and Christopher E. Paine, A Low-Threshold Test Ban, in *International Security*, vol.12, no.2, Fall 1987, pp. 144-147; see also Part Two, Chapter II

5 J. Carson Mark, The Purpose of Nuclear Explosions, in Jozef Goldblat and David Cox, eds., Nuclear Weapon Tests: Prohibition or Limitation ?, p.39

6 Mackubin Thomas Owens, A Nuclear Test Ban and Arms Control, in *Comparative Strategy*, vol.8, 1989, p.206

7 Desmond Ball, The Comprehensive Test Ban Treaty: A Role for Australia, Working Paper No.6, Australian National University, Canberra, Peace Research Centre, p.30

8 Senators Kennedy, E., Mathias, C. and Hart, G., News Conference, Washington, D.C., 8. April 1986; see also Stop Nuclear Weapons, Moscow, Novosti, 30. May 1986

Soviet Union, due to their social and political system, would be privileged in this regard. No corresponding concerns have been expressed by the Soviet Union.

1.2.2 Developing Nuclear Weapons

Three generations mark the development of nuclear weapons:

(a) *First generation* nuclear weapons are based on a fission process (See ANNEX I). Testing such weapons is necessary to assure the proper performance of the ignition mechanism and to calibrate the yield in order to produce a weapon which fulfils defined military requirements. All five nuclear weapons States have produced very high yield devices for countervalue[9] applications. Theoretically a fission device cannot exceed the yield of 1 megaton or one thousand kilotons.[10] However, it is not generally known, if it is practically feasible to achieve such a yield from a fission device at all. For higher yields a fusion mechanism is required. (see b) The yield of 1 megaton releases as much energy as 1 million tons of TNT or 4.18×10^{15} joules. The production of a fission bomb represents the starting point for all advancements in nuclear weapons technology. Latest developments in very low yield explosions have shown, however, that today it might be possible for a State with high technological standards to produce a fairly reliable nuclear device by the mere observation of the neutron release. The observation provides essential information on the explosive behaviour and, to a certain extent, replaces the need for a field test.[11] However, to calibrate the yield, and to advance nuclear weapons in terms of effect and size, testing cannot be avoided.

(b) *Second generation* nuclear weapons are based on a nuclear fusion mechanism. In nuclear fusion, the heavy water isotopes Deuterium and Tritium merge to become Helium and produce an energy release which is several times greater than that of a fission and can be expanded without any limit in yield.[12] The electrostatic shields of the isotopes have to be penetrated in order to merge and to ignite the fusion process. This can be achieved by compressing the thermonuclear portion of the nuclear explosive device, by producing a temperature of the order of 100 million °C.[13] Such temperatures can only be produced by a fission process. A fission device therefore serves as a trigger and is called a "primary". A fusion mechanism is also applied in so-called "boosted fission weapons". The trigger is based

9 *Countervalue* strikes are targeted on economic and civilian areas which are exposed to attacks. The weapons used do not have to be very accurate since high yields are used which outweigh the lack of precision. *Counterforce* strikes, on the other hand, are directed towards military targets which usually are well protected and hence require very accurate weapons systems.

10 Up to the present, no fission device has been tested beyond the yield of 500 kilotons (McGraw-Hill Encyclopedia of Science & Technology, 6th edition, New York, McGraw-Hill Book Company, 1987, vol.2, p.192). See also George M. Temmer, The Nuclear Arms Race: A Scientific Perspective, p.18 (not published); Ola Dahlman and Hans Israelson, Monitoring Underground Nuclear Explosions, National Defense Research Institute, Elsevier Scientific Publishing Company, Amsterdam, 1977, p.39.

11 J. Altman, J.Rotblat, ed., Verification of Arms Reductions, Nuclear, Conventional and Chemical, Springer Verlag, Berlin, Heidelberg, p.82

12 The highest yield ever achieved was the Soviet test in 1962 which amounted to 57 megatons.

13 Frank N. von Hippel, Harold A. Feiveson, and Christopher E. Paine, A Low-Threshold Nuclear Test Ban, p.11,

on a fission process but a few grams of Deuterium and Tritium are installed in the jacket of the nuclear device to cause fusion and to increase the energy released in the last phase of the explosion. The complementary fusion reaction produces a large number of neutrons and gives a final boost to the fission before it runs out due to the expansion of the explosion. The functioning of fusion, as well as boosted fission devices, depends on the accurate performance of the primary in terms of neutron release.[14] The ignition of a thermonuclear device cannot at present be simulated in laboratory tests but can only be realized through field testing. Although present technological capabilities allow the production of thermonuclear weapons with yields as low as 1 kiloton, an initial test of a fusion device will most likely be greater than 10 kilotons[15]. In sum, several tests are necessary to produce a primary which is efficient and reliable enough to ignite a fusion process. Many more tests are needed to optimize weight and size of the primary which is by far the heaviest part in a thermonuclear device and therefore has an impact on the design and range of the delivery system. Still more tests are required to produce weapons with different yields.

(c) *Third generation* nuclear weapons have been developed to yield a more precise use of the total energy release. The "enhanced radiation weapon" which belongs to this category is a small hydrogen bomb designed to produce the highest possible release of radiation and the smallest effect in terms of physical damage caused mainly by the blast and heat wave. In a usual hydrogen-bomb the primary uses most of the neutrons released to trigger the thermonuclear explosion. In an "enhanced radiation weapon" (ERW), the primary releases enough neutrons to ignite the fusion and releases the remaining amount of neutrons in the form of radiation. The prime targets of this radiation are human beings. Since the radiation effect predominates the other effects of nuclear explosions[16] only in the yield range of less than 10 kilotons ERW devices remain small in yield.[17] Moreover, according to some scientists its yield does not exceed 1 kiloton.[18]

The Strategic Defense Initiative (SDI), launched by the U.S. Administration in 1983, marks the latest development in research on nuclear weapons technology. Within the framework of the SDI program, research has been initiated on a x-ray laser system which channels the energy released by a hydrogen-bomb into an x-ray laser-beam,[19] and on to enhanced microwave devices which yield a comparatively larger electromagnetic pulse (EMP) to damage "electrical and electronic equipment used in command, control, and communications (C^3) systems"[20]. It also channels energy onto nuclear powered kinetic energy

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14 ibid, p.142

15 J. Altman, J. Rotblat, ed.,Verification of Arms Reductions, Nuclear, Conventional and Chemical, p.83

16 Immediate effects of nuclear explosions include thermal radiation in the form of a heat wave, blast effects in the form of shock waves, initial nuclear radiation in the form of gamma and neutron radiation and the so-called electromagnetic pulse (EMP). Longer term effects include nuclear fallout which occurs up to 24 hours after an explosion (early fallout) and which may occur days and years later (delayed fallout) as well as the so-called nuclear winter.

17 Herbert Scoville, Jr., The Neutron Bomb, in SIPRI Yearbook 1982 of World Armaments and Disarmament, SIPRI, London, Taylor & Francis, 1982, p.63-64

18 Frank N. von Hippel, Harold A. Feiveson, and Christopher E. Paine, A Low-Threshold Nuclear Test Ban, p.144

19 G. Allen Greb, Science Advice to Presidents, From Test Bans to the Strategic Defense Initiative, IGCC Research Paper no. 3, IGCC, University of California, Institute on Global Conflict and Cooperation,, University of California, San Diego, 1987, p.15

20 Desmond Ball, The Comprehensive Test Ban Treaty: A Role for Australia, p.30

weapons which generate the shock wave of a nuclear explosion in order to direct the vaporized particles of the explosion[21]. The development of such systems would necessitate at least 200 nuclear test explosions to prove their feasibility, and many more to achieve the final goal.[22]

Third generation weapons which aim to optimize particular effects of nuclear fusion therefore require tests of several yields in various environments because the effects may vary. For the development of such weapons, underground tests would not suffice and a resumption of nuclear testing in the atmosphere and in space would have to be resumed. This, however, would violate current legal constraints on nuclear testing (See ANNEX II).[23]

1.2.3 Development Tests

Development tests are conducted for the modernization of warheads and their adaptation to new delivery vehicles. In normal parlance this is the explosive charge - warhead or bomb - which together with a delivery vehicle forms a nuclear weapons system. Aircraft are the most simple and widely available means for the delivery of bombs but missiles are more effective especially over very long ranges or if used against countries operating powerful anti-aircraft defenses. For the development of a nuclear warhead carried by a missile system, testing is indispensable since the warhead becomes an integral part of the entire system.[24] Any further change in the design of a component of the weapon which is likely to affect its assembly or the detonation process necessitates further tests to verify its performance. All five declared possessors of nuclear weapons first produced bombs to be delivered by aircraft before developing warheads for missile systems. Except for the UK all other nuclear weapon powers are producing their own missiles for nuclear warheads.[25]

1.2.4 Safety Tests

Another reason for continuous nuclear testing relates to the need to assure safety. Safety refers to the handling of nuclear devices and to the prevention of an accidental explosion or dispersal of fissionable material.[26] Two safety mechanisms have been applied to ensure the

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[21] Dan L. Fenstermacher, The Effects of Nuclear Test Ban Regimes on Third Generation Weapons Innovations, in *Science & Global Security*, Vol. 1, No.3-4, January 1990, pp.13-18

[22] Carl G. Jacobsen, Attitudes of the Nuclear Weapon Powers, in Jozef Goldblat and David Cox, eds., Nuclear Weapon Tests: Prohibition or Limitation?, p.304

[23] J. Altman, J. Rotblat, eds., Verification of Arms Reductions, Nuclear, Conventional and Chemical, p.84

[24] J. Carson Mark, The Purpose of Nuclear Test Explosions, p.32

[25] The UK purchased U.S. missiles for its stockpile and deployment and is currently discussing the acquisition of a tactical air-to-surface missile system. It is considering the development of such a delivery system in cooperation with France. (See SIPRI Yearbook 1990 of World Armaments and Disarmament, Oxford, Oxford University Press, 1990, p.20 and pp.38-40)

[26] The term security differs from safety in so far as it is concerned with provisions to make it difficult, or impossible, for an unauthorized person to fire a weapon which he might obtain by theft or capture. It seems that no nuclear tests have been carried out to examine security mechanisms and therefore we will not address this issue.

safety of nuclear stockpiles: "one-point safety" and "insensitive high explosives" (IHE). "One-point safety" serves to assure that in a worst case scenario where a nuclear weapon is struck on a single spot - for example by a projectile or simply dropped - the probability of a nuclear explosion with a yield larger than 2 kilograms does not exceed one chance in a million.[27] "Insensitive high explosives" (IHE) which are used as triggers for a fission explosion are intended to prevent accidents caused by an unintended detonation of the conventional explosives. Special attention is paid to this requirement by States whose nuclear arsenals rely on the transportation of airborne and mobile land systems.

The introduction of "one-point safety" and IHE requires a change in the design of the explosive charge because of the different detonation characteristics of the trigger. Some scientists as well as the American administration believe that the application of such measures requires continuous explosive tests to prove the proper performance of the weapon.[28] Other U.S. scientists and Soviet scientists, on the other hand, argue that safety could be maintained without explosive experiments.[29] They assert that virtually all safety improvements focus on the mechanical and electrical design of the triggering systems and can therefore be adequately tested without nuclear explosions.[30]

1.2.5 Testing the Effects of Nuclear Explosions

Whereas the majority of nuclear weapons tests have been carried out for the development and modernization of nuclear weapons systems, only a relatively modest number of tests have been conducted to evaluate the effects of nuclear explosions. Up to 1963, when the PTBT - which bans tests in the atmosphere, in space and under water - went into force, the impact of pressure and heat wave, radiation and electromagnetic pulse (EMP) could be studied under real conditions. Although, the PTBT constrained testing of the effects of nuclear explosions in terms of EMP in space and the cratering behaviour of large surface-burst explosions, most of the information on such effects can be gained through underground tests including low-yield explosions[31], or through laboratory experiments[32]. Tests conducted to study the effects of nuclear explosions, can at the same time, serve as reliability tests because stockpiled weapons are used. Testing effects is also used for R&D purposes and hence can contribute to nuclear weapons development. Presently, the development of third generation nuclear

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27 J. Carson Mark, The Purpose of Nuclear Test Explosions, p.36

28 According to press reports computers to simulate the effects of nuclear blasts discovered defective nuclear artillery shells that could have exploded accidentally. Three devices were affected: The W-79 artillery shell, the W-88 Trident warhead, and the W-69 SRAM A-warhead which together make up about 10 % of the U.S. inventory of nuclear warheads. None of the three warheads use IHE because it is heavier and thus decreases the range of a missile or artillery shell. Although, by presidential order IHE was applied in all new weapons produced since 1985, the W-88 Trident warhead remained an exception. (TIME, June 4, 1990, No.23, p.31; Washington Post, May 23, 1990)

29 Vitaly Goldansky, "Verificational Deterrence" and Nuclear Explosions, in *International Affairs*, No.6, June 1988, p.30

30 Frank N. von Hippel, Harold A. Feiveson, and Christopher E. Paine, A Low-Threshold Nuclear Test Ban, p.149

31 ibid, p.150

32 Vitaly Goldansky, "Verificational Deterrence" and Nuclear Explosions, p.32

weapons draws strongly on data gained through such tests. Many observers argue that testing effects "do not constitute a sufficient reason for continued testing"[33].

1.3 Nuclear Explosions for Peaceful Purposes

Two categories of Peaceful Nuclear Explosions (PNEs) can be distinguished:

(a) The first category concerns the development of devices for nuclear explosions which may serve non-military purposes. Since the range of applications of PNEs may differ widely the nuclear devices used have to be adapted for particular purposes. Such purposes are research and phenomenology experiments which focus on the effects of peaceful nuclear explosions, especially their effects on the environment. Also, research is conducted for the production of heavy elements which could be applied in diagnostic and therapeutic medicine. However, these tests are usually conducted in conjunction with nuclear tests for military purposes.

(b) The second category relates to the application of nuclear explosive devices for large earth-moving operations such as excavation, underground storage, oil and gas stimulation. Nuclear excavation can be used for the construction of canals, dams, water reservoirs or rock cutting for railroads and highways. Underground storage may be utilized for reservoirs for natural gas, gas condensation, and petroleum products, as well as for dangerous waste material. Oil and gas stimulation is intended to enhance the recovery of natural resources, and aims at a less costly and more efficient methods of drilling.[34]

The first Soviet nuclear detonation in 1949 was officially declared to be for the exploration of peaceful applications.[35] The American response was that fission devices could have only limited peaceful applications due to the high radiation released. With the advent of thermonuclear devices, however, the U.S. began to consider the development of nuclear explosives for peaceful purposes because they could be manufactured with almost unlimited yield and with a significantly reduced release of radiation. An early idea was to dig canals to replace the Suez or Panama Canals to avoid another blockade such as the one during the Suez Crisis of 1956.[36] The "Plowshare program"[37] was set up in 1957 to examine the possibilities of using nuclear explosions for engineering purposes. However, due to unsatisfactory results and decreasing industrial interest, as well as growing concern about

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33 Jozef Goldblat and David Cox, The Debate About Nuclear Weapon Tests, Occasional Papers no.5, Ottawa, Canadian Institute for International Peace and Security, 1988, p.11

34 See Vitaly Goldansky, "Verificational Deterrence" and Nuclear Explosions, p.31; see also Iris Y.P. Borg, Nuclear Explosions for Peaceful Purposes, pp.59-71

35 Trevor Findlay, Swords into Plowshares: The "Invention" of Peaceful Nuclear Explosions, Working Paper No.15, Peace Research Centre, Canberra, 1986, p.1

36 ibid, p. 8

37 The "Plowshare Program" referred to the "Biblical exhortation to nations to beat their swords into plowshares". (ibid, p.9)

released radioactivity, the last experiment took place in 1973. The Plowshare Program was officially terminated in 1977 after some 48 PNEs.[38]

More than 100 peaceful nuclear explosions reportedly took place within the framework of the Soviet counterpart to the American program. Whether this indicates more success or less care about environmental effects cannot be determined since information about Soviet nuclear explosions is scarce. However, it is known that early interests focused on phenomenology and research on the development of peaceful nuclear explosives. In addition, tests were conducted for various industrial reasons, such as excavations to test the possibility of diverting rivers, for the detection of deep-lying resources, the creation of cavities and the stimulation of oil. At present, the Soviet Union appears to have stopped its peaceful nuclear explosions program.[39]

Apart from the U.S. and the USSR no other nuclear weapons State has publicly demonstrated real interest in the peaceful application of nuclear explosions. India conducted a nuclear test in 1974, supposedly for peaceful purposes. Also Argentina and Brazil have expressed interest in acquiring a nuclear explosive capability for peaceful purposes. However, PNEs cannot be distinguished from nuclear weapons tests, and could - whatever the declared intention - be used for military purposes. Also the development of PNE devices is similar to weapons development: phenomenology and research tests can be carried out for peaceful purposes as well as for the advancement of nuclear weapons, and even the creation of underground storage space by means of PNEs can be abused for decoupled testing of nuclear weapons[40].

1.4 The Impact of a Comprehensive Test Ban

A comprehensive test ban (CTB), which has been under negotiation since the 1950s, aims to prohibit all nuclear test explosions in all environments for all time. With a view to what has been discussed above, such a prohibition would have the following effects:

(a) Military impacts: A CTB would place constraints on the further improvement of nuclear weapons systems in a number of different ways. Further sophistication in the size, yield, or weight-to-yield ratio would be impossible. Third generation weapons programs which have not yet been completed would most likely have to be abandoned. Additionally, data which so far has been gained through the testing of the effects of nuclear explosions could not contribute any longer to the hardening of military equipment or to the sophistication of second and third generation weapons. Although delivery systems would not be subject to a CTB, a ban could complicate the development of entirely new models of nuclear weapons vehicles. Thus, a CTB would preserve the status quo. Current standards of safety could be

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[38] Y.P. Borg, Nuclear Explosions for Peaceful Purposes, p.62

[39] The Fourth NPT Review Conference noted "that no nuclear weapon state has an active programme for the peaceful application of nuclear explosions". (NPT/CONF IV/DC/1/Add.3(A), p.12)

[40] A decoupled nuclear underground test explosion is conducted in a large cavity where the seismic noise is muffled and consequently difficult to detect.

ensured, yet their qualitative improvement may be rendered difficult. Reliability, one of the main issues in the test ban dispute, might suffer only if the deteriorating components of nuclear weapons could not be properly replaced. As for the nuclear threshold countries which have formally not renounced the nuclear weapon option, a CTB - if they decided to sign it - would prevent them from entering the "nuclear club" as fully-fledged members. They could manufacture fairly reliable first generation fission devices, but without nuclear testing such devices would remain relatively primitive. Any further advancement of the nuclear components or the nuclear weapons systems would be impossible under a CTB.

(b) Peaceful Nuclear Explosions: A CTB would also have to prohibit peaceful nuclear explosions because these cannot be distinguished from nuclear weapons tests and, otherwise, a CTB may lose its value.

(c) Environmental impacts: The nuclear testing issue appeared on the international arms control and disarmament agenda when it was recognized that nuclear fallout - especially Strontium 90 and Cesium 137 which constitute a considerable health hazard - was severely contaminating the atmosphere. After the Partial Test Ban Treaty (PTBT) entered into force in 1963, the deposition of fallout products declined rapidly from the peak year of 1963 (Compare Figure 2.1) to much lower levels. After France and China had ceased atmospheric testing in 1974 and 1980 respectively - neither country joined the PTBT - the deposition levels declined even further.[41] Current legal constraints on nuclear testing have confined nuclear test explosions to underground and have reduced their yields. Although, this has considerably diminished the main environmental hazards, some dangers remain: Firstly, "venting", which refers to the release of radioactive material in the atmosphere, has not been completely prevented. Secondly, "leaking", the migration of radioactive material in ground water may also occur. Thirdly, serious geological effects might be caused by the shock waves which can provoke ground movements, subsidence collapse, crater formation, cliff falls and submarine slides. This may happen within a range of a few kilometres of the point of detonation. From an environmental perspective a comprehensive test ban would enhance the effects of the PTBT.

(d) Political impact: Finally, even though a CTB does not constitute a disarmament measure as such, it would represent an important step towards nuclear disarmament. One of the initial objectives of a CTB was to prevent the further spread of nuclear weapons. This function has been fulfilled by the Non-Proliferation Treaty (NPT), but a CTB would strengthen the non-proliferation regime by raising yet another barrier to the spread of nuclear weapons and by preventing further technological developments. Its political value stems from the fact that it is considered by many countries as a litmus test of the great powers' willingness to stop the nuclear arms race. Psychologically it would remove the most "visible" manifestation of the nuclear arms race.

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41 A.C. McEwan, Environmental Effects of Underground Nuclear Explosions, in Jozef Goldblat and David Cox, Nuclear Weapon Tests: Prohibition or Limitation ?, p.83

CHAPTER II

Test Ban Negotiations: A Historical Overview

2.1 Introduction

The test ban negotiations started more than a decade after the advent of nuclear weapons. By that time, major advancements in nuclear weapons technology had already been achieved, sizeable stockpiles had been accumulated by the then three nuclear weapons powers (U.S., UK and USSR), the dangers of the nuclear arms race had become apparent, and the environmental concerns of the world public had increased. Additionally, "the distinction between those States which possessed such weapons and those which did not seemed greater than any difference in the power position of States than had previously existed"[1]. The three nuclear weapons States started formal negotiations on a CTB in 1958 but only partial agreements could be reached: the multilateral Partial Test Ban Treaty (PTBT) of 1963, which bans nuclear tests in the atmosphere, underwater and in space; the bilateral Threshold Test Ban Treaty (TTBT) of 1974, and the Peaceful Nuclear Explosion Treaty (PNET) of 1976, which limit the yield of underground tests. The main obstacles to a comprehensive test ban treaty (CTBT) were military and strategic considerations and, allegedly, also the problem of verifying compliance. No disarmament item has been discussed continuously for such a long period of time as the CTBT. This chapter provides a historical overview of the course of negotiations, as well as the proposals and events which have influenced the debate.

2.2 A Comprehensive Test Ban Enters the Arms Control Agenda

On 1 March 1954, an American nuclear test of a 15 megaton hydrogen-bomb was conducted on Namu Island in the Bikini-Atoll.[2] Before the detonation, meterological data had been collected and evaluated but the detonation surpassed the estimated yield and caused severe fallout beyond the restricted testing area. Official statements confirmed the radioactive contamination of 28 Americans and 236 residents of the nearby Marshall Island.[3] Severe contamination of a Japanese fishing boat which returned to its home harbour two weeks later caught public attention since the crew was exposed to such high radiation that one of the members subsequently died of radiation sickness. The spreading fear of contaminated tuna culminated in a boycott of fish and intensified public concern which swept over the borders of Japan. Asian countries which had been the only victims of nuclear weapons and their

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[1] Harold Karan Jacobson and Eric Stein, Diplomats, Scientists, and Politicians, The United States and the Nuclear Test Ban Negotiations, The University of Michigan Press, Ann Arbor, 1966, p.4

[2] Robert A. Divine, Blowing on the Wind, The Nuclear Test Ban Debate, 1954-1960, Oxford University Press, New York, 1978, p.3

[3] ibid, p.6

testing were extremely concerned. In an address to the Indian Parliament on 2 April 1954, Prime Minister Nehru called for an "immediate standstill" agreement by the two superpowers until the United Nations had elaborated a comprehensive disarmament agreement.[4] During the same month, other distinguished figures like Albert Schweitzer and Pope Pius XII called for the cessation of nuclear explosions[5].

2.3 Early Efforts

At the UN General Assembly in December 1954, India repeated its proposal for a total cessation of nuclear testing[6] but did not insist on putting it to the vote. However, its proposal to establish a scientific committee to enquire into the effects of radiation[7] was adopted unanimously.[8] The mandate given to the "United Nations Committee on the Effects of Atomic Radiation"[9] asked for a report on the amount of radiation the world population was exposed to. This mandate reflected the U.S. view held at that time that fallout from nuclear tests was harmless and that properly conducted bomb tests would produce no health hazards.[10] The report of the Committee which appeared in August 1958, ambigously stated that radiation can cause somatic and genetic effects, but that no such effects had been found. The Committee has continued to meet and has submitted periodic reports.

In 1955 the Soviet Union submitted a two stage plan for the reduction of arms which included in its first stage the cessation of tests.[11] During 1956 the U.S., the UK, and the USSR intensified their discussions on disarmament issues which included the cessation of nuclear tests. A first breakthrough on the issue seemed to have been achieved when, for the first time, the USSR proposed a test ban as a separate measure independent of any agreement on other disarmament measures.[12] In October 1956, Soviet Prime Minister Bulganin formally proposed the cessation of nuclear testing but dismissed any need for international verification of compliance.[13] The U.S. administration rejected this proposal for two reasons: Firstly, international verification of compliance was regarded as indispensable. Secondly, the U.S. was pursuing the strategy of military superiority, hence a cessation of tests could have enabled the USSR to catch up quantitatively.

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4 Official Records of the Disarmament Commission, Supplement for April, May and June 1954, Document DC/44 and Corr 1.

5 Robert A. Divine, Blowing on the Wind, p.21

6 Official Records of the General Assembly, Ninth Session, Plenary Meetings, 492nd meeting

7 ibid, Tenth Session, Annexes agenda item 59, Document A/2949 and Add.1

8 A/RES/913 (X)

9 The UN Scientific Committee on the Effect of Atomic Radiation consisting of 11 members (Australia, Brazil, Canada, Czechoslovakia, France, India, Japan, Sweden, UK, USA and USSR) was joined by Argentina, Belgium, Egypt, and Mexico, the number of members raising to 15.

10 Robert A. Divine, Blowing on the Wind, p.65

11 Official Records of the Disarmament Commission, Supplement for April to December 1955, Document DC/71, Annex 15, (DC/SC.1/26/Rev.2).

12 Official Records of the Disarmament Commission, Supplement for January to December 1956, Document DC/83, Annex 5 (DC/SC.1/41).

13 Robert A. Dive, Blowing on the Wind, p.86

Concurrently, the UK approached the U.S. for "private discussions on 'test restrictions'"[14] but the proposal was refused for the same two reasons. In January 1957, the U.S. presented to the UN General Assembly a five point plan which focused on the cessation of the production of nuclear weapons, and, if this could be achieved, on the cessation of nuclear testing as well. This reflected the traditional U.S. position, yet it was modified with a proposal calling for advance notice of nuclear tests.[15] During the course of the discussion, the two superpowers continued their testing activities although public pressure was growing and some States demanded the cessation of tests.[16] On 15 May 1957 the UK tested its first thermonuclear device and reported that it had now entered the select circle of full-fledged nuclear powers.[17] In the aftermath, the UK opposed a test ban since it still maintained only a very small stockpile of H-bombs and first wanted to develop it further. A similar position was taken by France which was engaged in the development of its own nuclear weapons arsenal.

The "United Nations Subcommittee of the Disarmament Commission" which included Canada, France, the UK, the USA and the USSR had been the platform for test ban talks from 1955. However, only at its last session, held at the Lancaster House in London from March to September of 1957, some modest progress was achieved. In June 1957 the USSR agreed to establish an international control system which was related to an agreement on the cessation of nuclear tests, including control posts on its own territory. It also proposed the suspension of nuclear tests temporarily for a two or three year period.[18] The U.S. and the UK however proposed a test ban only as part of a package of twelve items embracing conventional and nuclear disarmament.[19] They altered their position somewhat when they later acknowledged the importance of a test ban and subsequently offered a vague compromise by "loosening the ties between the test ban issue and other measures of disarmament"[20].

In 1958 the U.S. administration was faced with increasing domestic concerns about the effects of radiation from continued nuclear testing. The policy of the "peaceful atom", however, reflected the early intentions to use and control nuclear energy for civilian purposes. Within this context, the U.S. "Plowshare Program" was initiated to investigate possible applications for the peaceful use of nuclear explosions and the first underground nuclear test code-named "Rainier" was conducted to prove that tests without fallout were possible. This test demonstrated a possible alternative to a comprehensive test ban, namely a partial test ban. The U.S. administration announced in March 1958 that it had developed nuclear devices

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14 G. Allen Greb, Survey of Past Nuclear Test Ban Negotiations, in Jozef Goldblat and David Cox, Nuclear Weapon Tests: Prohibition or Limitation ?, New York, Oxford University Press, 1988, p.96

15 The same proposal was already made earlier by Canada, Japan and Norway. (Official records of the General Assembly, Eleventh Session, Annexes, agenda item 22, document A/C.1/L.162/Rev.1)

16 E.g. Japan was actively preventing British nuclear tests on the Christmas Islands, and the West German Bundestag passed a resolution calling all three nuclear weapon States to cease nuclear testing by international agreement. (Robert A. Divine, Blowing on the Wind, p.125)

17 ibid

18 Official Documents of the Disarmament Commission, Supplement for January to December 1957, Document DC/112, Annex 12 (DC/SC.1/60).

19 ibid, Document DC/113, Annex 5 (DC/SC.1/66)

20 Harold Karan Jacobson and Eric Stein, Diplomats, Scientists, and Politicians, The United States and the Nuclear Test Ban Negotiations, p.16

which released little radiation, and which could be eventually produced without causing any radioactive fallout at all. Public pressure, however, was eased only to a limited extent.[21]

After an extensive testing program, the USSR passed a decree on 31 March 1958 to stop nuclear tests. It demanded that the U.S. and the UK do likewise but reserved the right to resume testing should they refuse to join the moratorium. This occurred shortly before the U.S. and the UK planned to start their own nuclear testing programs on an intensified scale.[22] Hence, the two western powers rejected the proposal and the U.S. in return suggested the establishment of the "Group of Experts" to study verification measures. The USSR later resumed testing.

2.4 The Conference of Experts

While the USSR boycotted the Subcommittee on Disarmament[23], the U.S. proposed meetings on the ministerial level. The USSR, on the other hand, advocated a summit of the leaders of the two States. No agreement was reached but an exchange of letters between the two leaders laid the groundwork for further discussions. On 28 April 1958, President Eisenhower agreed to a temporary suspension of testing after the completion of the running test series. Eisenhower reiterated the need for monitoring measures and the proposal for the establishment of a "Group of Experts" but he did not mention the need to link the test ban to a cessation of nuclear weapons production. The USSR responded on 9 May, and agreed to international monitoring procedures which it had refused since the time of the London disarmament discussions at the Lancaster House in 1957.[24] This exchange of letters led to agreement to hold a meeting entitled "Conference of Experts to Study the Possibility of Detecting Violations of a Possible Agreement on Suspension of Nuclear Tests", referred to as the "Conference of Experts". The Conference was composed of specialists from Canada, Czechoslovakia, France, Poland, Rumania, the UK, the USA and the USSR.[25] The mandate of the Conference covered negotiations of scientific aspects of monitoring nuclear explosions but not the negotiation of a test ban. This new body assured equal representation of political groups. It was no longer in the framework of the United Nations because parity was unattainable in the UN and a forum of limited membership was regarded as more efficient by the three nuclear weapons powers. Nevertheless, the UN provided the Secretariat and the meetings were held at the UN office in Geneva.

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21 See SIPRI Yearbook 1972 of World Armaments and Disarmament, Stockholm, SIPRI, 1972, p.391

22 Harold Karan Jacobson and Eric Stein, Diplomats, Scientists, and Politicians, The United States and the Nuclear Test Ban Negotiations, p.103; G. Allan Greb and Warren Heckrotte, The Long History: The Test Ban Debate, p.36

23 In late 1957 the USSR proposed to disband the five member "Subcommittee on Disarmament" which it perceived to be western dominated, and to expand the UN Disarmament Commission, which by then consisted of the eleven members of the Security Council, with all members of the UN. After the U.S. rejected this proposal, the USSR boycotted the Subcommittee until the group of socialist states were equally represented.

24 Harold K. Jacobson and Eric Stein, Diplomats, Scientists, and Politicians, The United States and the Nuclear Test Ban Negotiations, p.51

25 United Nations, Department of Political and Security Council Affairs, The United Nations and Disarmament 1945-1970, United Nations, New York, 1970, p.75

The "Conference of Experts" opened on 1 July 1958, and "gradually reached agreement on four technical methods for detecting nuclear tests - recording acoustical waves, measuring electromagnetic waves, collecting radioactive debris, and examining seismic signals".[26] Whereas, agreement on procedures for the first three methods was quickly reached, the distinction between natural earthquakes and underground nuclear explosions created problems but was finally resolved when the participants agreed on the U.S. concept of "first motion".[27] The real problem, however, became apparent when the inspection system was discussed. Although, the USSR had basically agreed to inspections, it was not willing to accept as many stations and international on-site inspections as the U.S. demanded. A compromise, proposed by the British delegation, was adopted for the Final Report of the Conference which was presented after almost two months of negotiations.

The Report stated that a workable monitoring system to detect nuclear explosions was "technically feasible"[28]. However the Conference recognized gaps and uncertainties in the control system which should be implemented by a network of 160-170 control posts on land and about 10 ships, each post staffed with 30 specialists whereas the collection of radioactive debris, was thought to require additional provisions for on-site and aerial inspections. The Report estimated that an elaborate control system could detect 90 per cent of earthquakes and, furthermore, could distinguish them from nuclear explosions. The Report was interpreted by many observers as indicating that a nuclear test ban was within reach. However, the factual content of the Final Report did not support such an optimistic evaluation since the problem of verification was not entirely solved. The proposed monitoring network would not be able to detect underground explosions of yields below 5 kilotons. Neither could it detect high altitude or space detonations above 50 kilotons. Also, the locations of the monitoring stations were not specified[29], and the issue of underground nuclear tests was considered but not solved.[30] In the final analysis, "this grotesquely elaborate verification scheme, which would have cost billions of dollars, was not only technically unwieldy and politically unacceptable to many; even from the scientific point of view it was untenable, because it was founded on the seismic experience of a single U.S. test"[31].

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26 Robert A. Divine, Blowing on the Wind, p.225

27 Based on data gathered from the first underground nuclear test, code-named "Rainier", it was assumed that man-made explosions could be distinguished from natural earth-movements since a nuclear underground explosion represents a symmetric source which generates an outward pressure that appears on seismometers with an outward motion no matter where the seismic station is located. Natural earthquakes, on the other hand, constitute a non-symmetrical source so the seismic stations detect upward or downward motions depending on their geographical location.

28 Document A/4078

29 Only an approximate distribution of control posts over the globe was agreed: Africa (16), Antarctica (4), Asia (37), Australia (7), Europe (6), North America (24), and South America (16) and additional 60 posts on islands and about 10 ships.

30 Robert A. Divine, Blowing on the Wind, p.227; see also Harold K. Jacobson and Eric Stein, Diplomats, Scientists, and Politicians, The United States and the Nuclear Test Ban Negotiations, pp.68-81

31 Jozef Goldblat, Banning Nuclear Tests: Can a CTB be Achieved ?, in *The Council for Arms Control*, Number 49, May 1990, p.1

2.5 The Conference on the Discontinuance of Nuclear Weapons Tests

The monitoring network elaborated by the "Conference of Experts" became known as the "Geneva system", and provided the basis for negotiations on a test ban. On 22 August 1958, President Eisenhower proposed, in view of the Report of the "Geneva Experts", that all nuclear weapons States meet on 31 October 1958, for negotiations of a test ban and the creation of an international verification system. In addition, he proposed the suspension of nuclear testing for one year, beginning with the first day of negotiations, and stated U.S. willingness to prolong the moratorium if the USSR did likewise. The Soviet Union accepted the U.S. proposal to start negotiations but did not take a clear position on the proposed suspension of nuclear tests. In time, the U.S. and the UK ceased nuclear testing. The USSR reserved the right to continue nuclear testing until it had exploded as many nuclear devices as the other two nuclear weapon States had done[32], but suspended nuclear testing on 3 November 1958.

2.5.1 First Phase of Negotiations

The Conference opened on 31 October 1958 in Geneva and immediately ran into two difficulties. The first controversy related to the name of the Conference. The Soviet Union argued that the Conference was to deal with the "cessation" of nuclear tests; the U.S. stated that it should deal with the "suspension" of tests. This indicated that the USSR pursued a permanent, and the U.S. a temporary test ban.[33] Finally, the neutral word "discontinuance" was used. Another disagreement concerned the agenda for negotiations. The USSR insisted that an agreement on the discontinuance of nuclear tests be achieved before verification was considered. The U.S. called for the reverse. The problem was resolved in an informal meeting, when both sides agreed to a "rotating agenda" which meant that the two parties would alter the order of the agenda in a two-day rhythm.[34]

The second controversy related to the verification issue. Among the problems here were the envisaged verification organization and the monitoring system. The U.S. and the UK advocated an "international organization, internationally staffed, with decisions made by a majority vote. Most importantly, on-site inspections could be made whenever a questionable event occurred"[35]. The USSR, on the other hand, stated that it had already made a concession by accepting international monitoring based on that outlined in the Final Report of the "Conference of Experts", and that it would accept only a comprehensive and permanent test ban. It expressed concerns that the proposed monitoring system could be abused for intelligence purposes, and therefore supported a system under which it could "retain control

32 Document A/3985

33 Christer Jönsson, Soviet Bargaining Behaviour, New York, Columbia University Press, 1979, p.26

34 ibid, p.26

35 G. Allen Greb and Warren Heckrotte, The Long History: The Test Ban Debate, p.37; see also Robert A. Divine, Blowing on the Wind, pp.243-244

of all operations on [its] own country"[36]. With respect to the envisaged "Control Commission", the USSR called for an equal number of seats for the western and socialist groups and no more than one seat for the group of non-aligned States. It also demanded that decisions be taken unanimously.[37] Two conflicting principles of verification, therefore, were presented. The *principle of impartial* verification, advocated by the U.S., to be implemented by "persons who are expected not to favour a principal party to the agreement"[38], and the *principle of reciprocal* verification, supported by the USSR, "which is applicable particularly when there are two parties to the agreement [which] control each other, and each party determines whether the other party is living up to the agreement"[39].

Another problem was raised by the U.S. which had obtained new seismic data from the last test series conducted before the Conference started. This data revealed "that it was more difficult to distinguish earthquakes from underground nuclear explosions than had previously been assumed"[40]. Additionally, the U.S. presented the "decoupling" theory[41] which indicated the possibility of hiding nuclear explosions from monitoring systems. The USSR refused to take this new seismic data into account since it participated in the negotiations on the basis of the results of the "Conference of Experts". However, the new data affected the U.S. position when it came to the discussion of the number of monitoring stations required. Since, due to these verification problems, an agreement on a comprehensive nuclear test ban did not appear possible, in February 1960 the U.S. suggested a ban on nuclear tests where, in its view, control seemed to be feasible, namely in the atmosphere, in outer space to the height controllable, under water, and underground above a seismic magnitude of 4.75.[42] Thirty per cent of all unidentified seismic events would be subject to on-site inspections. The USSR, on the other hand, maintained its position that for verification of a treaty, national technical means would suffice.[43] To overcome the stalemate it proposed a moratorium on underground nuclear explosions while all other nuclear tests were banned.

At the end of the first year of negotiations, several understandings were reached. The preamble of a preliminary draft treaty was agreed upon. It called for the "discontinuance of

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36 G. Allen Greb and Warren Heckrotte, The Long History: The Test Ban Debate, p.37

37 Christer Jönnson, Soviet Bargaining Behaviour, p.29

38 ibid, p.29

39 ibid

40 ibid, p.27

41 During the course of the HARDTACK test series conducted shortly before the beginning of the test ban talks, the new theory of decoupling nuclear explosions was developed, meaning "the muffling of the seismic signal by firing an explosion in a very large underground cavity". (G. Allen Greb and Warren Heckrotte, The Long History: The Test Ban Debate, p.37) Moreover, the concerns were reinforced when the study of Albert Latter was published, which showed that "seismic signals could be reduced up to 300 times" when it was detonated "in the centre of a large cavity". (See Robert A. Divine, Blowing on the Wind, p.282 and William Waldegrave, The Partial Test Ban - 25 Years Later, The Partial Test-Ban Treaty: A British View in *Disarmament*, 1988/89, New York, United Nations Publication, 1989, p.3)

42 The seismic magnitude of 4 corresponds to the present art of detection about 1 kiloton in hard rock, 10 kilotons in soft dry rock and about 100 kilotons if decoupled. (for practical reasons, however, a decoupled explosion of such high yield is unlikely to occur). (See Dennis C. Fakley, Paper 9, The Detection and Identification of Seismic Events, in Jozef Goldblat and David Cox, eds., Nuclear Weapon Tests: Prohibition or Limitation ?, p.165). At the time of its proposition, in 1965, it was assumed that a seismic magnitude of 4.75 would corespondent to roughly 15 kilotons in hard rock. (See SIPRI Yearbook 1975 of World Armaments and Disarmament, SIPRI, Stockholm, Almqvist & Wiksell and Cambridge, MIT Press, 1975, p.406)

43 ENDC/PV.8

all test explosions of nuclear weapons for all time".[44] Arrangements on a draft treaty were made, including two annexes and seventeen articles, one which expressed the principle of international inspection.[45] However, the main controversies remained. The one year moratorium declared by the U.S. expired and the U.S. announced that it would "feel free to resume testing [but] it would not do so without announcing its intention in advance"[46]. The UN General Assembly adopted two resolutions calling for the continuation of negotiating efforts while maintaining the voluntary test suspension.[47] The USSR harshly criticised the U.S. position but committed itself not to resume testing unless the U.S. and the UK did so.

2.5.2 Second Phase of Negotiations

Relations between the two superpowers deteriorated remarkably when the U-2 incident occurred on 1 May 1960[48], and when another American RB-47 reconnaissance plane was downed in July of the same year.[49] Moreover, France exploded its first nuclear device in February, in April 1961 the "Bay of Pigs" incident occurred, the "missile gap" was discovered to be inexistent, and the Berlin wall was erected on 13 August. The deteriorating climate also affected test ban negotiations and caused a standstill with only a few proposals and no concessions.

The talks were still focusing on a CTB but were blocked because of disagreement over whether the detection system should be controlled and operated nationally or internationally and on the numbers of on-site inspections. In 1959 the UK and the U.S. proposed an unspecified annual quota of on-site inspections which the USSR accepted. Negotiations went into recess on 5 December 1960. When they were resumed four month later, the USSR changed its position: It proposed that the control organization be headed by a "troika"[50] modeled on the 1960 proposal for reorganization of the UN Secretariat; to link the test ban issue to general and complete disarmament, and to include France in the negotiations. In April 1961 the U.S. and the UK submitted a draft treaty[51] and proposed twenty annual on-site inspections, eight less than originally suggested.[52] On 28 August 1961 the UK and the U.S. put forward proposals including an offer to abandon the threshold on underground nuclear

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44 Arthur H. Dean, Test Ban and Disarmament: The Path of Negotiation, New York, Harper & Row, 1966, p.87

45 ibid

46 Public Papers of the Presidents of the United States, Dwight D. Eisenhower 1959, p.883

47 A/RES/1577 (XV) and A/RES/1578 (XV)

48 On May 5, 1960, the eve of the summit conference in Paris, Khrushchev announced the shooting down of an U-2 American reconnaissance plane over Sverdlovsk which had violated Russian territorial sovereignty. This was the main reason for the cancellation of the Paris summit where the then four nuclear weapon powers should have met. Many observers had optimistically perceived that the summit would lead to the signing of a test ban.(See Walter LaFeber, America, Russia, and the Cold War 1945-1984, Fifth edition, New York, Newberry Award Records, 1985, p.206; John Lewis Gaddis, Strategies of Containment, A Critical Appraisal of Postwar American National Security Policy, New York, Oxford University Press, 1982, pp.196-197)

49 Walter LaFeber, America, Russia, and the Cold War 1945-1984, p.264

50 The "troika" concept was based on the equality (and veto power) of Communist, Western, and neutral interests. (See Arthur H. Dean, Test Ban and Disarmament: The Path of Negotiation, p.89)

51 ENDC/9, United Kingdom of Great Britain and Northern Ireland and the United States of America, "Draft Treaty on the Discontinuance of Nuclear Tests"

52 ENDC/PV.13

explosions if the number of control posts or on-site inspections was increased. On 30 August, the USSR announced that it would resume nuclear testing and started an extensive test series on the next day, including the largest nuclear explosion ever carried out, equivalent to 57 megatons.[53] In an attempt to redress this negative development, on 3 September the UK and the U.S. indicated their willingness to agree to a test ban on atmospheric tests without any international control. Subsequently, the U.S. and the UK resumed testing and the Conference was adjourned sine die on 29 January 1962.

On 4 March 1962, the test ban issue was put on the agenda of the **Eighteen-Nation Committee on Disarmament (ENDC) in Geneva**[54] which established a subcommittee for this purpose. The subcommittee included the United States, the UK, and the USSR. The ENDC, like its predecessor the Ten Nation Disarmament Committee (TNDC), represented a multilateral forum which engaged non-nuclear weapons States in nuclear arms control and disarmament talks. On 9 August 1962, the U.S. reduced their demand on the number of on-site inspections to twelve and the number of control posts to eighty[55], and on 27 August the UK and the U.S. submitted alternative draft treaties. One draft included a comprehensive test ban and verification measures according to the proposal of 9 August[56], and the other a partial test ban prohibiting nuclear explosions in the atmosphere, in outer space and underwater, without international verification[57].

2.5.3 Third Phase of Negotiations and the Partial Test Ban Treaty (PTBT)

The Cuban missile crisis of October 1962, when mankind faced the abyss of nuclear war, marked a turning point in superpower relations and also in the test ban issue. In the ENDC the USSR proposed the use of automatic seismic stations ("black boxes") to monitor compliance with a CTB[58] and to commence discussions on the number of on-site inspections. In February 1963 the USSR shifted its position considerably when it proposed two to three on-site inspections per year, the installation of three automatic seismic stations on the territory of each nuclear power, and the establishment of an international commission of scientists, as proposed by the eight non-aligned members of the ENDC.[59] In March, the

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53 G. Allen Greb and Warren Heckrotte, The Long History: The Test an Debate, p.38; the UN General Assembly approved a resolution on 27 October 1961. This resolution solemnly appealed to the Government of the USSR to refrain from carrying out its previously announced intention to explode a 50 megaton bomb in the atmosphere (A/RES/1632 (XVI)) On 30 October the USSR detonated a 57 Megaton nuclear explosion.

54 The ENDC was created in 1962 and included Burma, Brazil, Bulgaria, Canada, Czechoslovakia, Ethiopia, France, India, Italy, Mexico, Nigeria, Poland, Rumania, Sweden, United Arab Republic, UK, USA, USSR.

55 Department of Political and Security Council Affairs, The United Nations and Disarmament 1945-1970, p.235

56 ENDC/58, United Kingdom/United States, "Draft Treaty Banning Nuclear Weapons in all Environments"

57 ENDC/59, United Kingdom/United States, "Draft Treaty Banning Nuclear Weapons in the Atmosphere, in Outer Space, and Underwater"

58 ENDC/PV.90 (USSR)

59 ENDC/PV.101 (USSR); In August 1962 the eight non-aligned members of the ENDC submitted a joint memorandum which proposed the establishment of an international commission, comprising a limited number of highly qualified scientists, possibly from non-aligned States. The Commission was to be entrusted to process data on nuclear explosions, and to report suspicious events. Any Party to the Treaty could invite the Commission to inspect the territory or site where the event occurred. (ENDC/28, Brazil, Burma, Ethiopia, India, Mexico, Nigeria, Sweden and the United Arab Republic, "Joint Memorandum")

U.S. also changed its position but requested seven unmanned stations and seven annual on-site inspections[60]. In the wake of an ameliorating international climate, high level discussions took place from April to June 1963. They led to the U.S.-USSR "hotline agreement"[61] and to the agreement to convene a meeting on the test ban issue in Moscow on 15 July 1963. During this meeting which lasted for only ten days the UK, the U.S. and the USSR negotiated the Partial Test Ban Treaty (PTBT) which was signed by the Foreign Ministers of the three countries on 5 August 1963, in Moscow.[62]

The Treaty prohibited "any nuclear weapon test explosion, or any other nuclear explosion" (also PNEs) at any place under the jurisdiction or control of a Party[63] (Article I) in the following three environments: "the atmosphere; beyond its limits, including outer space; or underwater, including territorial waters or high seas" (Article I,1a). It did not prohibit nuclear underground explosions. Since no commonly agreed definition of "atmosphere" and "space" existed, the Treaty applied to the area "from the surface of the earth on, into outer space"[64] and any environment in between. The prohibition also applied to the underwater environment beyond territorial waters. Singling out the "high seas" was intended to prevent a party to the Treaty from testing in areas of the high seas where no State had any jurisdiction or control. Although Article I,1b explicitly stated that underground nuclear explosions were not subject to the Treaty, it respected environmental concerns by prohibiting nuclear explosions "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" (Article I,1b). This means that underground nuclear explosions which release radioactive debris are not outlawed if the debris remains within the territorial limits. This created an imbalance between States with large territories and States of small size.[65] The parties agreed "to refrain from causing, encouraging, or in any way participating in, the carrying out" (Article I,2) of any nuclear explosion in environments banned by the Treaty.

All States were invited to join the Treaty (Article III) which is of "unlimited duration" (Article IV). Each Party was given "the right to withdraw from the Treaty if ... extraordinary events, related to the subject matter of the Treaty, have jeopardized the supreme interests"

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60 ENDC/PV.108 (United States), ENDC/PV.110 (United States), ENDC/PV.113 (United States); The number of on-site inspections per year was initially lowered from 28 to 20 to 12 to ten to eight and finally to seven. (See also Christer Jönssen, Soviet Bargaining Behaviour, p.36)

61 The "hotline agreement" established a communication system to minimize the risk of nuclear war through an exchange of information.

62 Robert S. McNamara introduced another argument for the U.S. preference of a partial solution. He states that "the reason the Administration did not seek a complete ban on testing was not, as some have suggested, because it could not have been negotiated or adequately verified. Rather, it was President Kennedy's view, ..., that a comprehensive test ban (CTB) treaty would not have been ratified by two-thirds of the Senate" (Robert S. McNamara, Blundering into Disaster, Surviving the first century of the nuclear age, New York, Pantheon Books, 1986, p.65)

63 According to the prevailing interpretation this includes signatories as well as "non-self-governing territories administered by state parties, [and] territories under military occupation". (Jozef Goldblat, The Nuclear Explosion Limitation Treaties, in Jozef Goldblat and David Cox, eds., Nuclear Weapon Tests: Prohibition or Limitation ?, New York, Oxford university Press, 1988, p.121)

64 ibid, p.121

65 From 1963 through 1986 about 12 nuclear tests conducted by the USSR have vented radioactive debris into the atmosphere and beyond Soviet borders to Northern Europe and the Far East. During the same period two to three nuclear tests detonated from the U.S. released radioactivity across the borders to Mexico and Canada. (see SIPRI Yearbook 1986 of World Armaments and Disarmament)

(Article IV) of the State. Any amendment to the Treaty was to be "approved by a majority of the votes of all Parties ..., including the votes of all the Original Parties" (Article II, 2), namely the UK, the U.S. and the USSR. Herewith, the three nuclear weapons States preserved the right to veto an amendment. Although Article II,1 requires the Original Parties to convene a conference when one-third of the parties wish to do so, the procedures of the conference are not regulated. No provisions on verification of compliance were contained in the Treaty. National technical means[66] may therefore be used in accordance with international law. International monitoring procedures were not regarded necessary.

Although, the PTBT has only limited arms control and disarmament value, it represents the "first global agreement to protect the environment"[67]. The PTBT succeeded in saving the environment from major atmospheric fallout, but it failed in realizing the main objective of a test ban, namely to curb the nuclear arms race. Indeed, the numbers of tests increased after the conclusion of the Treaty and major improvements in nuclear weaponry were made (e.g. MIRV). The PTBT's greatest significance rested in the objectives outlined in the Preamble which called on the Original Parties to seek "to achieve the discontinuance of all test explosions of nuclear weapons for all time" and to be "determined to continue negotiations to this end". Although the Preamble is an integral part of the PTBT, the U.S. states that the Preamble does not represent a legal commitment.[68] Presently, 119 States are parties to the Treaty[69] and all of them have so far abided by its provisions. The remaining two nuclear weapons States, France and China, which are not parties to the Treaty, ceased atmospheric testing in 1975 and 1985, respectively.[70] Figure 2.1 shows the estimated number of nuclear explosions in the atmosphere and underground from 1945 to 1963 by the U.S. and the USSR.

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66 National Technical Means or NTM are often addressed in disarmament and arms control discussions and were even agreed upon in U.S.-USSR arms control treaties (e.g. Interim SALT I Agreement, SALT II, ABM Treaty, TTBT and PNET) but up to the present have not been defined. Widely accepted is the interpretation that NTM refer basically to remote sensing - by use of seismographs, satellites, etc. - and its main characteristic is not to intrude physically into the other party's territory. (See e.g. Serge Sur, A Legal Approach to Verification in Disarmament or Arms Control, Research Paper No.1, September 1988, UNIDIR, New York, United Nations, 1988, pp.12-14; Allan S. Krass, Verification, How Much is Enough ?, SIPRI, Taylor & Francis, London and Philadelphia, 1985, pp.182-183; Mark M. Lowenthal and Joel S. Wit, The Politics of Verification, in William C. Potter, ed., Verification and Arms Control, Lexington Books, D.C. Heath and Company/Lexington, Massachusetts/Toronto, pp.156-157)

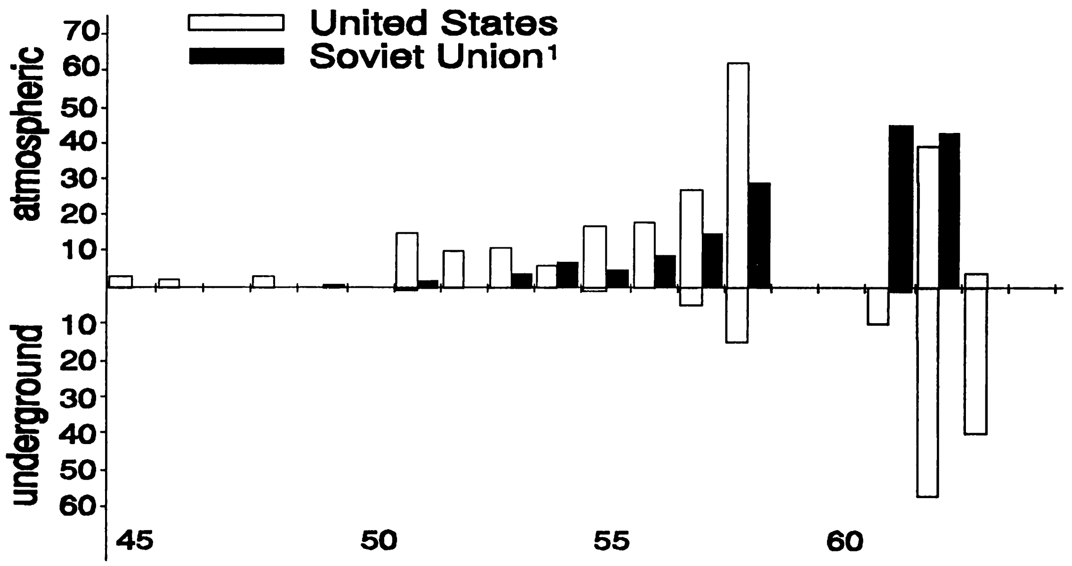
67 Raimo Väyrynen, From a Partial to a Comprehensive Test Ban in *Disarmament*, 1988/89, New York, United Nations Publication, 1989, p.18

68 ACDA, Arms Control and Disarmament Agreements: Texts and Histories of Negotiations, Washington D.C., 1982, p.41

69 As of January 1, 1990

70 Australia and New Zealand claimed to have suffered from radioactivity which was caused by French nuclear tests in the Pacific. Subsequently, they brought France before the International Court of Justice which indicated that France "should avoid nuclear tests causing the deposit of radioactive fallout" (A/RES/3077, XXVIII) on other countries. China on the other hand, was urged by its neighbours and some other countries to stop testing in the atmosphere, and subsequently followed this demand.

Figure 2.1: Estimated atmospheric and underground nuclear explosions of the U.S. and the USSR from 1945 - 1963



1 The exact years for additional 18 Soviet tests between 1949 and 1958 are not known.

Source: SIPRI Yearbook 1990 of World Armaments and Disarmament, SIPRI, Oxford, Oxford University Press, 1990, pp.56-57.

2.6 The Nuclear Non-Proliferation Treaty (NPT) and its Impact on the Test Ban Issue

The PTBT solved the most evident environmental problems caused by testing, and pacified the public pressure which had continuously pushed the testing States to the negotiation table. However, the problems of the qualitative and quantitative nuclear arms race and the danger of nuclear proliferation remained. The superpowers' interest in seeking a more comprehensive solution to the test ban issue subsided, as they perceived the spread of nuclear weapons to be a more urgent problem.[71]

In January 1967 the two superpowers submitted a revised version of their previous draft treaties[72] suggesting that safeguard arrangements would have to be negotiated with the IAEA.[73] Most of the non-nuclear weapons States perceived this treaty as discriminatory and sought to balance their renunciation of nuclear weapons with a superpower commitment to continue negotiations on nuclear disarmament in general, and on a CTBT in particular. The

[71] France exploded its first nuclear device in 1960, China in 1964.

[72] ENDC/192 and 193

[73] ENDC/192/Rev.1 and ENDC/193/Rev.1, United States of America and Union of Soviet Socialist Republics, "Draft Treaty on the Non-Proliferation of Nuclear Weapons"

superpowers, however, rejected such an explicit demand for nuclear disarmament but agreed in Article VI of the Treaty to the less committal obligation to "pursue negotiations in good faith on effective measures relating to cessation of the nuclear arms race at an early date". Furthermore, they agreed to have the obligation, contracted under the PTBT, to continue negotiations on a CTBT reiterated in the Preamble to the NPT. Ever since, a CTB has been linked to the NPT "would serve as an important measure of non-proliferation of nuclear weapons, both vertical and horizontal"[74]. So far, 141 states[75] have joined the NPT, which is considered one of the most important arms control and disarmament agreements.

2.7 Proposals Related to the Test Ban Issue in the ENDC/CCD 1965 - 1973

A comprehensive test ban remained high on the agenda of the ENDC and significant proposals were submitted to reach this goal. In 1965, Sweden submitted a paper suggesting a system of international cooperation in the detection of underground nuclear explosions by an exchange of seismic data[76] which became to be known as the "detection club". The United Arab Republic proposed a prohibition on underground nuclear explosions above a seismic magnitude of 4.75 and an agreement on a moratorium on tests below this threshold. For verification purposes, an exchange of data was suggested.[77] The U.S. and the UK rejected this proposal referring to the sudden resumption of Soviet tests in 1961 which, in their interpretation, was a violation of the agreed moratorium. The USSR, on the other hand, stated its willingness to halt nuclear tests by establishing a moratorium.[78]

One year later, in 1966, Sweden proposed an arrangement for on-site inspections, making a distinction between mandatory inspections and inspections by challenge or invitation.[79] The USSR insisted on its previous position that no international inspections were needed to verify the compliance with a treaty[80] whereas the UK and the U.S. stressed

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[74] Goldblat Report to the UN in 1979, CD/86, "Letter dated 24 March 1980 from the Secretary-General of the United Nations transmitting the Report on a Comprehensive Nuclear Test Ban prepared pursuant to General Assembly Decision 32/422 of 11 December 1979", p.40

[75] As of January 1, 1990

[76] ENDC/154, Sweden, "Memorandum on International Cooperation for the Detection of Underground Nuclear Explosions"

[77] ENDC/PV.224, 230, and 231 (United Arab Republic)

[78] ENDC/PV.230, 271, 286, 402, and 429 (USSR)

[79] The novelty of the Swedish proposal is the challenging character of the on-site inspections. The process for challenge inspections proceeds in two steps. In a first step, a party to the treaty that has recorded a suspicious event on the territory of another party would be expected to furnish documentation for its suspicion. The challenged party would be expected to have a vital interest in the establishment of its innocence and hence would provide new documentary evidence. Only if such a demand for clarification was not heeded or this procedure failed to remove suspicion, the requesting party would in a second step "challenge" the suspected party by demanding an on-site inspection. If such a challenge went unheeded, particularly if it went unheeded on several occasions, the requesting party could demonstrate its dissatisfaction by withdrawing from the treaty. "As that party must base such a decision on its strong conviction that clandestine testing by another Party had created the extraordinary event jeopardizing its national security, it must also be ready to provide the documentation for these suspicions that should accompany its 'explanatory memorandum' to the Security Council. ... It is that threat of withdrawal, amply supported by documentation, which should be considered as the decisive challenge that might induce an accused party to invite some inspection". (ENDC/PV.256 (Sweden)); see also ENDC/PV.147 (Sweden)

[80] ENDC/PV.286 (USSR) and ENDC/PV.413 (USSR)

their belief in the necessity of such inspections[81]. However, the USSR and the U.S. were prepared to take part in the international exchange of seismic data.[82] India submitted a proposal which called for a ban on underground nuclear tests above a seismic magnitude of 4.75 and stressed the need for further research on monitoring techniques so that this threshold could be lowered.[83] The UK suggested limiting the annual number of underground tests which in the vein of India's proposal would be "phased out over a period of four to five years"[84]. Japan submitted a similar proposal in 1969.[85]

In 1969, Sweden submitted a working paper containing suggestions for possible provisions of a comprehensive test ban treaty which reiterated the need for international verification methods and suggested an international exchange of seismic data and the application of inspections by challenge.[86] In 1970, Canada which had consistently advocated the establishment of an international network of seismological stations[87], used seismic information from 33 countries to assess the capability of an international system to detect seismic events and two years later, in 1972, it submitted a paper to the CCD, in cooperation with Sweden, "concerning an international experiment ... to distinguish shallow earthquakes from underground nuclear tests"[88]. In 1971, a joint memorandum of nine CCD members proposed that the PTBT be complemented so as to enlarge its scope.[89] Sweden submitted a revised version of its paper of 1969 calling for voluntary on-site inspections.[90] In another effort, made in 1972, Japan proposed a threshold of 5.25 seismic magnitude.[91] However, the U.S. refused to enter into negotiations citing inadequate verification means.[92] The USSR, on the other hand, argued that a restriction on the number or size of underground nuclear tests "would not put a stop to the building of nuclear arsenals"[93].

2.8 The Threshold Test Ban Treaty (TTBT)

Although, the test ban issue had remained on the disarmament agenda the focus of attention shifted to strategic nuclear weapons. During high times of the Cold War "nuclear testing had

81 ENDC/PV.415 (United Kingdom) and ENDC/PV.209 (United States)
82 ENDC/PV.286 (USSR), ENDC/PV.286 (United States)
83 ENDC/PV.269 (India)
84 ENDC/PV.232 (United Kingdom)
85 ENDC/PV.424 (Japan)
86 ENDC/242, Sweden, "Working Paper with Suggestions as to Possible Provisions of a Treaty Banning Underground Nuclear Weapon Tests"
87 See e.g. ENDC/PV.231, 332 and 389 (Canada)
88 CCD/380, Canada and Sweden, "Working Paper on an Experiment in International Cooperation: Short-Period Seismological Discrimination of Shallow Earthquakes and Underground Nuclear Explosions"
89 CCD/354, Burma, Egypt, Ethiopia, Mexico, Morocco, Nigeria, Pakistan, Sweden and Yugoslavia, "Joint Memorandum on a Comprehensive Test Ban"
90 CCD/348, Sweden, "Working Paper with Suggestions as to possible Provisions of a Treaty Banning Underground Nuclear Weapon Tests"
91 CCD/PV.553 (Japan)
92 A/C.1/PV.1829, A/C.1/PV.1830
93 A/C.1/PV.1841, A/C.1/PV.1847

come to symbolize, almost to embody, the nuclear arms race"[94] and negotiations to cease nuclear testing served as a means to reconcile the superpowers, whereas in times of detente arms control efforts were directed to more substantial cuts in armaments, especially bilaterally. Hence, the Strategic Arms Limitation Talks (SALT I) attracted more attention and were successfully completed in 1972. As a consequence of major roadblocks in the subsequent negotiations (SALT II), when President Nixon and General-Secretary Brezhnev held a summit meeting in July 1974, there was no agreement ready for signing. Under these circumstances, the test ban issue served to fill the gap. In only five weeks a bilateral treaty, the Threshold Test Ban Treaty, was hammered out and was signed on 3 July 1974 along with a verification protocol. Ratification of the TTBT, however, was postponed because the U.S decided that it could not rely on unverified information supplied by the other side as agreed under the Treaty.

From 1987 until 1990, the U.S. and the Soviet Union were engaged in negotiations on new protocols for the TTBT and the PNET (see 2.9). Different positions were taken on the subject of hydrodynamic yield measurements of nuclear explosions.[95] The United States requested the more intrusive on-site monitoring technique CORRTEX, whereas the Soviet Union maintained that remote seismological monitoring was sufficient. In an attempt to find common ground for a mutually acceptable method of verifying the limitation of yields, the two negotiating parties agreed to conduct a Joint Verification Experiment (JVE), to take place in 1988. According to the JVE agreement[96], scientists from both countries were to be present when nuclear underground tests were conducted at the Nevada test site in the U.S., and at the Semipalatinsk test site in the Soviet Union. Hydrodynamic as well as teleseismic techniques were used to measure the yield of the explosions which were near the 150 kilotons threshold.[97]

Significant impetus was provided to the negotiations by the Natural Resources Defence Council (NRDC), a private U.S. environmental group which, in conjunction with the Soviet Academy of Sciences, operated seismic monitoring stations near the Soviet test site. Their findings revealed that the bed-rock at the Soviet test site was considerably harder than at the Nevada test site. This explained why American seismologists had detected Soviet nuclear tests exceeding the threshold. An additional verification protocol was signed at the Washington summit in June 1990, and entered into force in December 1990, replacing the original protocol of 1974.

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94 Alan F. Neidle, The Rise and Fall of Multilateral Arms Control: Choices for the United States, in UNA-USA, Arms Control: The Multilateral Alternative, New York, New York University Press, 1983, p.11

95 Yield measurement by hydrodynamic means is based on the following principle: cables are placed in an emplacement hole containing the nuclear device or in "satellite" holes which are separately drilled nearby the emplacement hole. When the nuclear device explodes, seismic shock waves are generated and the associated overpressure crushes and shortens the cables with increasing expansion of the shock waves. A measuring instrument at the end of the cables registers the rate at which they are short-circuited. Based on this data the yield of the explosion can be determined. The U.S. version of this method is called CORRTEX (Continuous Reflectometry for Radius versus Time Experiments) whereas the Soviet model is named MIS (Method of Impulse Sensing).

96 The text of the JVE agreement is published in the SIPRI Yearbook 1989 of World Armaments and Disarmament, Oxford, Oxford University Press, 1989, pp.61-63

97 Jozef Goldblat, The Nuclear Test Limitations Treaties, in Serge Sur, ed., Verification of Current Disarmament and Arms limitation Agreements: Ways, Means and Practices, UNIDIR, Geneva, United Nations, (forthcoming).

The Treaty obliges the two superpowers "to prohibit, to prevent, and not to carry out any underground nuclear weapon test having a yield exceeding 150 kilotons" (Article I,1). It was agreed to "limit the number of ... underground nuclear weapon tests to a minimum" (Article I,2) and to continue negotiations on a cessation of all nuclear weapons tests (Article I,3). The diminution of the number of tests has been interpreted by some U.S. experts as keeping test programs "to the minimum national security needs"[98] and not as an actual reduction of the number of tests. In Article III, the Parties agreed that the Treaty was not to apply to nuclear explosions for peaceful purposes but they committed themselves to an early resolution of the matter. As with the PTBT, each Party may withdraw from the Treaty if it perceives that its security interests are jeopardized.

The TTBT was the first test limitation agreement to include verification provisions. In addition to verification based on National Technical Means (NTM) (Article II,1), mainly through seismic monitoring, the Treaty provides for an exchange of geological and seismological data for the calibration of yields (Protocol 1. a-d). Moreover, the Treaty obliges the Parties "not to interfere with the national technical means of verification" (Article II,2) which can be interpreted as a prohibition on conducting tests in such a way as to muffle the seismic signals.[99] In addition, it was agreed that all nuclear weapons tests should be conducted solely within the testing areas reported in the data exchange. Only peaceful applications of nuclear explosions were permitted outside of these areas.

The new protocol provided several additional verification measures such as on-site hydrodynamic measurement of the explosion and in-country seismic monitoring. The placement of three in-country seismic stations was agreed.[100] During a test, the verifying Party was permitted to be present at the seismic stations and to carry out seismic monitoring. The new protocol also permitted on-site inspections, including the sampling of geological material. On-site inspections were permitted if the planned yield of the explosion was to exceed 35 kilotons. (Section VII of the 1990 Protocol to the TTBT). The establishment of the Bilateral Consultative Commission (BCC) was also agreed to, meet at the request of either party to discuss the implementation of, or compliance with the Treaty, as well as possible amendments to the Treaty (Section XI of the 1990 Protocol to the TTBT).

The arms control value of the TTBT is limited although it complicates "certain stockpile-sampling"[101], and prevents explosions in the megaton range thereby reducing the risk of venting, artificial earthquakes, or tidal waves and "may pave the way for future ... reductions in the yield level of permitted nuclear weapon testing"[102]. According to many observers, however, the threshold of 150 kilotons is too high to have a significant impact on the nuclear arms race. They argue that at the time the Treaty was concluded, weapons development had already focused on development of nuclear warheads for smaller tactical

98 Jozef Goldblat, The Nuclear Explosion Limitation Treaties, p.129; In fact, the number of tests did not decrease. (See Figure 1.1. and 1.2)

99 ibid, p.130

100 The location of these designated stations are: Tulsa/Oklahoma, Black Hills/South Dakota and Newport/Washington in the U.S., and Arti, Novosibirsk and Obninsk in the USSR.

101 ibid, p.133

102 Robert W. Helm and Donald R. Westervelt, The New Test Ban Treaties: What do they mean ? Where do they lead ?, in *International Security*, vol.1, no.3, Winter 1977, p.176

weapons or for strategic weapons with yields lower than the established threshold.[103] Moreover, they hold that "given the ... state of seismology, the 150 kilotons limit has not been determined by verification capabilities but is rather a consequence of mutual interests in continuing tests at a level high enough to have a minimum impact on nuclear programs"[104]. In addition, the distinction between PNEs and nuclear weapons explosions has set a precedent which might complicate a comprehensive solution of the test ban issue.[105] Although the new protocol extended and strengthened the verification provisions of the Treaty, it did not increase its arms control value.

2.9 The Peaceful Nuclear Explosions Treaty (PNET)

The major problem encountered in the TTBT negotiations was the issue of peaceful nuclear explosions.[106] Whereas the U.S. had practically ceased conducting PNEs[107] the USSR was still operating an extensive program. To conclude the TTBT in time for the 1974 summit, the problem of PNEs was excluded and became the subject of negotiations held between October 1974 and April 1976. These talks resulted in the Peaceful Nuclear Explosion Treaty (PNET) which was signed on 28 May 1976. However, due to the U.S. request for additional verification provisions which were under negotiation between 1987 and 1990, the PNET and the TTBT were not ratified until 1990.

The PNET fulfilled the obligation expressed in Article III of the Threshold Test Ban Treaty (Article I,1) which committed the Parties to address the problem of PNEs. The scope of the Treaty was therefore closely connected to the TTBT. Both treaties were scheduled to enter into force on March 31, 1976 (Article I,2). The PNET consisted of nine articles, a protocol, an agreed statement and an additional protocol. It limited individual PNEs to 150 kilotons (Article III,2.a) and group explosions to 1.5 megatons (Article III,2.b.2) thereby limiting individual yields to 150 kilotons (Article III,2.b.1). Although the Treaty implicitly stated the right of the Parties to "carry out, participate or assist in carrying out explosions in the territory of another State at the request of such other State" (Article III,1.b) it was specified that these explosions should be conducted in conformity with Article V of the NPT and Article IV of its Protocol (Article VII,2).[108] It is noteworthy that the development of nuclear explosive devices was not considered to "constitute a 'peaceful application'" (Agreed Statement, a) and was therefore subject to the TTBT.

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103 Jozef Goldblat, The Nuclear Explosion Limitation Treaties, p.129

104 George Rathjens and Jack Ruina, Commentary on the New Test Ban Treaties, in *International Security*, vol.1, no.3, Winter 1977, pp.180-181

105 Robert W. Helm and Donald R. Westervelt, The New Test Ban Treaties: What do they mean ? Where do they lead ?, p.176

106 G. Allen Greb and Warren Heckrotte, The Long History: The Test Ban Debate, p.39

107 The last U.S. test in the Plowshare Program was conducted in 1973. The Program was officially terminated in 1977. (See 1.3)

108 Article V of the NPT demands that "potential benefits from any peaceful applications of nuclear explosions will be made available to non-nuclear-weapon States, Party to the Treaty". This was intended to diminish the inequality of the parties under the NPT. So far, only Egypt has requested assistance in the study of PNEs for building a canal through its desert region. There has been no follow-up.

Apart from NTM and data exchange, there was also agreement on the establishment of a "Joint Consultative Commission" (Article V). Under the 1990 Protocol, the JCC may be used to facilitate the implementation of treaty provisions. Additionally, under the JCC coordinating groups are to be established for each explosion carried out as part of the verification activities under the new Protocol (Section XI of the 1990 Protocol to the PNET). Section III of the 1990 Protocol provides for on-site inspections by "designated personnel" for any single or group explosion with a planned yield exceeding 35 kilotons. Furthermore, it was agreed that the hydrodynamic monitoring technique could be applied for explosions beyond the yield of 50 kilotons. In that case, however, the right to on-site inspections was to be forfeited. (Section II of the 1990 Protocol to the PNET)

The PNET "has not increased the very limited arms control value of the TTBT"[109]. It has not placed serious constraints on nuclear weapons development. Moreover, the PNET can be regarded as having had a negative impact on further efforts to reach a CTB because it stresses the importance of PNEs. Although the verification procedures of both Treaties mark progress in general disarmament negotiations, they lack a significant impact on the achievement of a test ban because the approach to verifying a threshold treaty differs substantially from the verification required for a CTBT. Verification of a threshold treaty focuses on measuring the yield of announced nuclear test explosions and thus, on-site inspections, permitted only in designated sites, can suffice. The monitoring of a CTBT, on the other hand, requires the ability to detect and identify clandestine nuclear explosions. A CTBT therefore requires verification that is not restricted to specified events or areas.

2.10 Resumption of Trilateral Talks

In 1976, the USSR put forward a draft resolution which demanded that all nuclear weapons States participate in negotiations on a CTB. The resolution was adopted by majority in the UN General Assembly.[110] A draft treaty for a CTB was annexed to the resolution. The U.S. and the UK voted against the resolution because they regarded the verification procedures outlined in the proposal as insufficient. The proposed verification procedures included only NTM and a voluntary exchange of seismic data. The problem of PNEs was not addressed. The UN Security Council, where the five nuclear weapons States maintain the right of veto, was to serve as the forum to lodge complaints.[111] In another effort in February 1977, the USSR expanded its previous draft treaty to include challenge inspections for suspected violations of the treaty.[112] Subsequent to this, the two superpowers agreed on an agenda for negotiations, and on the establishment of a working group to consider a CTB. They held preliminary meetings on a CTB with the participation of the UK. Trilateral negotiations began in July, and opened formally in October 1977.[113]

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109 Jozef Goldblat, The Nuclear Explosion Limitation Treaties, p.137

110 A/RES/3478 (XXX)

111 A/C.1/31/9

112 CCD/523, Union of Soviet Socialist Republics, "Draft Treaty on the Complete and General Prohibition of Nuclear-Weapon Tests"

113 April Carter, Success and Failure in Arms Control Negotiations, p.86

The negotiations focused on the issue of PNEs, verification, and on the desired participation of the two nuclear weapons States, France and China, which had not yet been parties to any test ban agreement.[114] In November, the USSR proposed a three year moratorium on PNEs with provisions for possible extension. The moratorium was intended as a period during which methods of distinguishing military from peaceful nuclear explosions would be explored. The Soviet Union also conceded that France and China need not be parties to a treaty for a three year period. The Soviet Union argued, however, that for a permanent treaty it would be indispensable to include all the nuclear weapons States. The U.S. for its part, conceded that voluntary on-site inspections would be as much of a deterrent as mandatory on-site inspections. In early 1978, the USSR declared its willingness to accept "black boxes" on its territory - unmanned seismic stations placed on the territory of nuclear weapons States which transmit seismic data to stations outside this country -, and to agree to on-site inspections with the right of refusal. The USSR was also willing to participate in research concerning the possibility of an international seismic monitoring system and to make available five of its own stations. At the same time, the U.S. acknowledged that not all requests for inspections could be binding.

Progress in negotiations began to slow down in 1978 when the U.S. requested additional seismic data and that ten national seismic stations be established in the U.S. and the USSR respectively, using improved equipment and foreign personnel to install and service the stations. The U.S. furthermore proposed to temporarily limit a CTBT to five years and finally to three years. Renewal of the treaty was to be subject to re-ratification, and very low-yield nuclear explosions were to be allowed.[115] Test ban opponents in U.S. scientific and military circles doubted the feasibility of monitoring very low-yield detonations and stressed the need to continue testing for assuring the reliability of existing weapons arsenals. In this manner, the reliability argument was introduced and remained one of the main obstacles to the completion of a CTBT. Another obstacle emerged when the U.S. delegation requested that the seismographs for the monitoring system be manufactured in the USA. Despite these obstacles, the three delegations presented a report to the CD in July 1980[116] which represented the framework of a "potential treaty"[117]. Part two of this guide provides a detailed analysis of the Tripartite Report.

Following the submission of the Tripartite Report, the negotiations came to a standstill for more than a year. In the meantime, the American position changed significantly. A comprehensive test ban was only "an element in the full range of long-term United States arms control objectives"[118]. The USSR, on the other hand, stated that its position remained unchanged.[119] On 20 July 1982, the U.S. formally ended the tripartite talks by announcing that it would not resume the negotiations.

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114 From the Soviet perspective China and France had to be included in a CTB for three reasons: Nuclear test explosions would have to be banned globally; China was at that time a hostile neighbour to the USSR and could have continued testing; and France could be suspected of conducting proxy tests for the U.S.. (ibid, p.87)

115 ibid, p.88

116 CD/130, United Kingdom, United States of America and Union of Soviet Socialist Republics, "Tripartite Report to the Committee on Disarmament"

117 April Carter, Success and Failure of Arms Control Negotiations, p.89

118 CD/PV.152 (United States)

119 CD/PV.156 (USSR)

2.11 Conclusions and Prospects

According to most experts "neither science nor technology stand in the way of a mutually verified agreement to limit testing; the problems are political"[120]. In four decades of negotiations the issue of verification has been represented as an obstacle to the completion of a comprehensive nuclear test ban. Whether verification has in fact, represented a meaningful obstacle, and to what extent governments were "'hiding' behind verification"[121] remains subject to debate. Experts agree that present detection technology is able to monitor seismic events of 1 kiloton and beyond.[122] On several occasions, the negotiating States have declared their willingness to establish an international seismic monitoring network, to install "black boxes" inside the territory of nuclear weapons States, to exchange detailed seismic data in order to facilitate detection and distinction between natural earthquakes and nuclear explosions, and to accept on-site inspections to check suspicious events. Against this background, a further lowering of the threshold of nuclear underground explosions[123] appears to be likely. Experts believe that a very low threshold test ban - a threshold of 1 kiloton[124] - could achieve the main goal of a CTB, which is to curb the qualitative nuclear arms race, however not all the benefits of a CTB would be achieved. Testing for research purposes could be continued allowing for "the development of exotic new sub-kiloton weapons"[125].

120 SIPRI Yearbook 1989 of World Armaments and Disarmament, SIPRI, Oxford, Oxford University Press, 1989, p.438

121 Jozef Goldblat, Banning Nuclear Tests: Can a CTB be Achieved ?, p.2

122 E.g. Lynn R. Sykes, Present Capabilities for the Detection and Identification of Seismic Events, in Jozef Goldblat and David Cox, eds., Nuclear Weapon Tests: Prohibition or Limitation ?, April Carter, Success and Failure of Arms Control Negotiations, Frank N. von Hippel, Harold A. Feiveson, and Christopher E. Paine, A Low-Threshold Nuclear Test Ban, in *International Security*, Fall 1987, vol.12, No.2

123 Presently, a significant portion of U.S. testing occurs in the yield range of 5-15 kilotons. (See Frank N. von Hippel, Harold A. Feiveson, and Christopher E. Paine, A Low-Threshold Test Ban, p.144)

124 Experts consider present monitoring capabilities sufficient to monitor a threshold of 1 to 5 kilotons. This threshold, they argue, would permit reliability tests but would prevent nuclear tests for the development of new types of nuclear weapons with yields over a few kilotons, hence thwarting advanced developments in strategic weaponry. Furthermore, they hold that a threshold of 1 kiloton a very low yield threshold would also prevent the development of tactical nuclear weapons. (See e.g. Lynn R, Sykes, Present Capabilities for the Detection and Identification of Seismic Events, in Jozef Goldblat and David Cox, eds, Nuclear Weapon Tests: Prohibition or Limitation ?; April Carter, Success and Failure of Arms Control Negotiations; Frank N. von Hippel, Harold A. Feiveson, and Christopher E. Paine, A Low-Threshold Nuclear Test Ban, Jozef Goldblat, Banning Nuclear Tests: Can a CTB be achieved ?)

125 Frank N. von Hippel, Harold A. Feiveson, and Christopher E. Paine, A Low-Threshold Nuclear Test Ban, p.151

PART TWO

DEBATE IN THE CONFERENCE ON DISARMAMENT
1980 - 1990

CHAPTER I

The Negotiating Body

The origin of the "Conference on Disarmament" (CD) dates back to the 1960s.[1] In 1959, the Foreign Ministers of France, the UK, the USA, and the USSR agreed to create a negotiating forum outside of, but linked to, the United Nations. The "Ten Nation Disarmament Committee" (TNDC) consisted of five members from NATO and five from WTO countries and convened for the first time in March 1960.[2] The TNDC was short-lived, folding just 3 months later.

In 1961, the UN General Assembly unanimously adopted resolution 1722 (XVI) which established the "Eighteen Nations Disarmament Committee" (ENDC).[3] The ENDC was convened for the first time in March 1962[4], contributing to the conclusion of the PTBT in 1963, and reaching the completion of the NPT in 1968[5].

In 1969, the forum was extended to include 26 members[6]. It was reorganized and renamed to "Conference of the Committee on Disarmament" (CCD).[7] The expansion to 31 members was agreed in 1975.[8] The achievements of the CCD included the Seabed Treaty in 1971, and the Convention on Bacteriological Weapons in 1972.

In 1978, the First Special Session of the UN General Assembly on Disarmament (UNSSOD I) recommended the establishment of the "Committee on Disarmament" (CD). The CD was comprised of 40 States and convened for the first time in January 1979. The latest change occurred in 1984 when, in accordance with the recommendation of the UN General Assembly[9], the forum was named "Conference on Disarmament" (CD).

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1 For a historical account of the development of the Conference on Disarmament see: United Nations, Department of Political and Security Council Affairs, The United Nations and Disarmament 1945 - 1970, New York, United Nations, 1970; United Nations, Department of Political and Security Council Affairs, The United Nations and Disarmament 1970 - 1975, New York, United Nations, 1975.

2 The members of the TNDC were:
- Canada, France, Italy, the UK, and the USA;
Bulgaria, Czechoslovakia, Poland, Rumania and the USSR;

3 A/4879 (XVI)

4 The ENDC was based on resolution 1378 (XIV) of 20 November 1959 and included Burma, Brazil, Bulgaria, Canada, Czechoslovakia, Ethiopia, France, India, Italy, Mexico, Nigeria, Poland, Rumania, Sweden, United Arab Republic, UK, USA, USSR. France, while technically a member, did not participate.

5 2373 (XXII), Annex

6 Argentina, Hungary, Japan, Mongolia, the Netherlands, Pakistan and Yugoslavia joined the Committee.

7 2602 B (XXIV)

8 The Federal Republic of Germany, the German Democratic Republic, Iran, Peru, and Zaire joined the CCD.(A/RES/3261 B (XXIH))

9 A/37/99 K III

The Conference on Disarmament is the single multilateral disarmament negotiating forum.[10] It has a limited size and universal representation and is open to the five declared nuclear weapons States and 35 other States[11]. Some changes occurred in 1990. The Group of Socialist States was renamed to Group of Eastern European and Other States, and the reunification of Germany dissolved the representation of the German Democratic Republic, reducing the number of members to 39.

The test ban issue has been a primary subject of discussions in all of these negotiating bodies from the TNDC to the CD. Presently, the question of a nuclear test ban is included on the agenda of the Conference on Disarmament as item one. Decisions on the establishment of ad-hoc committees and their rules of procedure must be taken by consensus. Within the Conference on Disarmament, an ad-hoc committee on the test ban was established in 1982, 1983, 1990 and 1991. Since 1976 an Ad-Hoc Group of Scientific Experts (GSE) has been established which meets for two weeks during each part of the CD session to consider international cooperative measures to detect and identify seismic events, as part of the work on verification of a nuclear test ban.

10 A/35/27, vol. I, Appendix I

11 Members of the Conference on Disarmament presently are:
Group of Eastern European and other States: Bulgaria; Czech and Slovak Federal Republic; Hungary; Mongolia; Poland; Rumania; Union of Soviet Socialist Republics.
Group of 21: Algeria; Argentina; Brazil; Cuba; Egypt; Ethiopia; India; Indonesia; Islamic Republic of Iran; Kenya; Morocco; Myanmar; Nigeria; Pakistan; Peru; Sri Lanka; Sweden; Venezuela; Yugoslavia; Zaire.
Group of Western countries: Australia; Belgium; Canada; Germany, Federal Republic of; France; Italy; Japan; Netherlands; United Kingdom of Great Britain and Northern Ireland; United States of America.
The People's Republic of China is member of the CD but does not belong to any political group. Although technically a member of the CD, it did not participate until 1980.

CHAPTER II

The Tripartite Report of 1980

2.1 Introduction

The Tripartite Report was the result of three years of negotiations on a comprehensive test ban treaty between the UK, the U.S. and the USSR and was submitted to the CD at the very end of the 1980 session. A number of States expressed their disappointment that due to the short remaining time, full consideration could not be given to the Report[1] which contained areas of agreement regarding a comprehensive test ban treaty and was considered a "potential treaty". The areas of agreement were on the scope and on some verification provisions of a test ban treaty. Although the negotiations were formally continuing, the Report marked their factual end. When the Report was submitted to the CD, symbolically, the issue of a nuclear test ban treaty was passed back to the multilateral negotiating body. The Report represented the first and only agreed outline of a comprehensive test ban treaty and served as a basis for further proposals in subsequent years.

2.2 Scope of the Envisaged Treaty

The Report stated that the envisaged treaty would require each party to prohibit, prevent and not to carry out any nuclear weapon test in any environment at any place under its jurisdiction or control, and to refrain from causing, encouraging or in any way participating in the carrying out of any nuclear weapons test anywhere. A protocol to the treaty would require the parties to establish a moratorium on PNEs "until arrangements for conducting them are worked out which would be consistent with the treaty"[2]. Such arrangements which would preclude military benefits would be considered without delay after the treaty had entered into force, and would be rendered effective by an amendment to the protocol. Procedures for amending the treaty would be provided. Any amendment would require the approval of a majority of all parties, including all permanent members of the UN Security Council that were parties to the treaty.

The negotiating parties considered formulations relating to the duration of a treaty but did not specify the duration. Furthermore, they envisaged a review conference at an appropriate time without, however, specifying its exact role. Decisions taken at the conference would require a majority of all parties including all permanent members of the UN Security

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1 See e.g. CD/PV.96 (Venezuela), CD/PV.97 (Algeria), CD/PV.97 (Netherlands), CD/PV.97 (Sri Lanka), CD/PV.97 (Sweden), CD/PV.98 (Japan)

2 CD/130, United Kingdom, United States of America and Union of Soviet Socialist Republics, "Tripartite Report to the Committee on Disarmament"

Council parties to the treaty. The treaty was to enter into force after the ratification by twenty governments including the UK, the U.S. and the USSR.

Pakistan and Venezuela criticized the distinction between a prohibition of nuclear weapons tests and a moratorium on nuclear explosions for peaceful purposes[3]. Pakistan commented that, according to the Report, a moratorium on PNEs would last only until an agreement on them was reached. It pointed out that no specifications for such an agreement were provided.[4] In this context, some States proposed a moratorium on all nuclear tests, that is both nuclear tests and nuclear explosions for peaceful purposes, until an agreement was reached to ban all nuclear explosions.[5] Sweden, on the other hand, explicitly welcomed the distinction between PNEs and nuclear weapons tests[6] without advocating the exclusion of PNEs from a nuclear test ban.

A number of States referred to the unspecified duration of a treaty.[7] They stated that a short duration could hardly gain international acceptance. Some States expressed their concern over a three-year limitation, considered at one point during the tripartite negotiations, and also over the fact that the Report mentioned only one review conference - possibly indicating that the duration of a treaty was intended to be short-termed.[8] A short-term CTBT, however, was inconsistent with the obligations outlined in the preamble of the PTBT and the NPT.[9]

Procedures for ratification, review and amendment of the treaty were also critically assessed.[10] Venezuela and Sweden pointed to the triple veto power of the three negotiating States: the approval of amendments, the entry into force of the treaty, and decisions taken by the review conference.[11] Japan, on the other hand, acknowledged that the negotiating parties had achieved progress on the question of ratification. An earlier proposal made by the USSR would have made the entry into force dependent on the ratification by all permanent members of the Security Council.[12] Nonetheless, Japan urged the two remaining nuclear weapons powers, France and China, to participate in such a treaty.[13]

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3 See e.g. CD/PV.96 (Venezuela), CD/PV.97 (Pakistan)

4 CD/PV.97 (Pakistan)

5 See e.g. CD/PV.95 (India), CD/PV.96 (Venezuela), CD/PV.98 (Japan)

6 CD/PV97 (Sweden)

7 See e.g. CD/PV.96 (Venezuela), CD/PV.98 (Japan), CD/PV.97 (Australia), CD/PV.97 (Pakistan), CD/PV.97 (Netherlands), CD/PV.97 (India), CD/PV.99 (Canada)

8 CD/PV.98 (Japan), CD/PV.96 (Venezuela), CD/PV.101 (Sweden)

9 CD/PV.101 (Sweden)

10 CD/PV.97 (Pakistan), CD/PV.96 (Venezuela), CD/PV.97 (Algeria), CD/PV.97 (India), CD/PV.97 (Sweden), CD/PV.99 (Canada)

11 CD/PV.96 (Venezuela), CD/PV.97 (Sweden)

12 CD/PV.98 (Japan)

13 ibid

2.3 Verification Provisions of the Envisaged Treaty

The Report included agreements on the verification of compliance with a comprehensive test ban treaty. It stated that verification measures were to be agreed in principle before they could be drafted in detail. In general, however, it was agreed that verification provisions should be based on national technical means (NTM). In addition, agreements were found on seismological monitoring techniques, verification techniques other than seismological, and institutional arrangements.

The principle of an international verification system as outlined by the Ad-Hoc Group of Scientific Experts (GSE) was welcomed by many States.[14] The Ad-Hoc Group of Scientific Experts was established in 1976 for the purpose of elaborating procedures for the establishment and maintenance of an international seismological monitoring network for the verification of a comprehensive nuclear test ban. Some member States, however, have expressed the conviction that the elaboration of an international monitoring system should be negotiated in the framework of the CD.[15]

Sweden has been critical of verification provisions that have focused exclusively on the monitoring of underground nuclear explosions, although a CTBT would apply to all environments. It stated that additional verification measures for the monitoring of atmospheric testing should be considered since the PTBT, which bans nuclear explosions in the atmosphere, in outer space and under water, contains no verification provisions at all.[16]

2.3.1 Seismological Monitoring

It was agreed in the Tripartite Report that, ninety days after the treaty had entered into force, a Committee of Experts would meet to establish an international exchange of seismic data, open to all States parties to the treaty. International data centers would be established in agreed locations in an appropriate geographical distribution. They would both receive and exchange seismic data. The Global Telecommunication System (GTS) of the World Meteorological Organization (WMO), or other agreed communication channels, would serve for the transmission of Level I seismic data[17].

Arrangements would be made for the development of standards for the technical and operational characteristics of the seismic stations and international data centres, for the form of the data to be transmitted from seismic stations to data centres. Procedures would also have to be established on how data centres would make seismic data available to the participants,

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14 See e.g. CD/PV.98 (Japan), CD/PV.97 (Swedèn), CD/PV.97 (Australia), CD/PV.99 (Canada)

15 See e.g. CD/PV.99 (Canada),

16 CD/PV.97 (Sweden)

17 Level I seismic data contain specific information for the detection and identification of seismic events. Unlike Level I data, Level II data contains the original recordings of a seismic event and can serve to clarify suspicious events.

and respond to their requests for additional seismic data regarding particular seismic events.

The three negotiating parties considered the possibility for two or more States parties to agree by mutual consent upon additional verification measures. They agreed on measures for themselves which would be established under separate agreements. Such measures would include an exchange of supplementary seismic data necessitating high-quality national seismic stations.

Several States expressed concern that the international monitoring system would not be fully operational for a long period of time since its elaboration was to start only three months after the treaty had entered into force, and the process of elaboration would need a considerable time.[18] In this connection, it was proposed that an international monitoring system be elaborated before the treaty was to enter into force. For this purpose a broadening of the mandate of the Group of Scientific Experts was suggested.[19]

Pakistan argued that until an international verification system was agreed and set in operation access to information about compliance with the treaty would be unequal because NTM would only be available to a limited number of States.[20]

Sweden failed to see why the negotiating parties wanted to agree on special arrangements keeping certain seismic data restricted only to themselves[21] whereas Japan considered such an approach as realistic[22].

2.3.2 Other Verification Measures

The three negotiating parties had also agreed on other cooperative measures such as direct consultations and an exchange of inquiries and responses among treaty parties. On-site inspections were considered for cases in which a party had questions regarding a specified seismic event on the territory of another party. The former would have to state the reasons for its request. The latter could accept the inspections or could refuse the request but would have to provide reasons for its rejection. The Report envisaged further elaboration of provisions for on-site inspections such as a list of rights and functions of personnel carrying out inspections, and a description of the role the host nation would play during the inspection. No institutional arrangements, however, were considered for these measures.

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18 See e.g. CD/PV.98 (Japan), CD/PV.97 (Sweden), CD/PV.97 (Netherlands)
19 CD/PV.97 (Sweden), CD/PV.97 (Netherlands)
20 CD/PV.97 (Pakistan)
21 CD/PV.97 (Sweden)
22 CD/PV.98 (Japan)

2.3.3 Institutional Verification Arrangements

As mentioned above, a Committee of Experts would be created to consider questions relating to the international seismic data exchange system. All parties to the treaty could appoint representatives to participate in the work of the Committee. The task of the Committee would be to develop detailed arrangements for the establishment and operation of the international data exchange network. Furthermore, it would have to facilitate the implementation and review of the operation of the data exchange.

The Netherlands acknowledged the institutional arrangements for the proposed seismic exchange system but hinted at the lack of a political body - a consultative committee - to deal with questions relating to the implementation of treaty obligations. It expressed its concern that the three negotiating parties seemed to intend on settling these questions among themselves.[23]

Australia recalled its proposal[24] to commence work in the CD on institutional and administrative arrangements for an international seismic network[25], and was supported by Japan and Canada[26].

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23 CD(PV.97 (Netherlands)

24 CD/95, Australia, "An Illustrative List of Subjects which Might Be Examined by the CD in Considering Agenda Item One, Nuclear Test Ban"

25 CD/PV.97 (Australia)

26 CD/PV.98 (Japan), CD/PV.99 (Canada)

CHAPTER III

Different Approaches to the Nuclear Test Ban Issue

3.1 Introduction

Until 1980, a comprehensive test ban had been a declared common objective by all members of the CD. Hence, negotiations focused on the scope and verification provisions of an envisaged treaty, such as outlined in the Tripartite Report. However, in the aftermath of the submission of the Tripartite Report, the U.S. and the UK changed their positions considerably.

The U.S. broke off the tripartite negotiations in 1982, and declared that "it seeks a CTB in the context of a time when we will not have to depend on nuclear deterrence to ensure international security and stability, and when we have achieved broad, deep and effectively verifiable arms reductions, substantially improved verification capabilities and greater balance in conventional forces"[1].

At the same time, the redefined position of the United Kingdom stated, that as long as its security depended on nuclear deterrence, it perceived the "requirement to conduct underground nuclear tests to ensure that [its] nuclear weapons remain effective and up-to-date"[2]. A CTB was seen as a long term goal to be achieved in a step-by-step approach thereby taking into account "technical advances on verification, as well as progress elsewhere in arms control and the attitude of other States"[3].

The notion of the time-frame in which a nuclear test ban treaty should be achieved has been reflected in the general approach to negotiations. Most Western countries, especially the U.S. and the UK, have advocated a long-term step-by-step approach, whereas most other States prefer an immediate entry into negotiations on a complete ban on nuclear tests. Another approach proposed establishing a moratorium on nuclear testing while negotiations were held.

3.2 Gradual Step-By-Step Approach

The gradual step-by-step approach, which was proposed by the U.S.[4], is characterized by its undetermined time-frame and seems to enjoy acceptance among the States of the Western

1 CD/PV.152 (United States), CD/PV.296 (United States), CD/PV.542 (United States)
2 CD/PV.186 (United Kingdom), CD/PV.202 (United Kingdom), CD/PV.162 (United Kingdom)
3 CD/PV.565 (United Kingdom)
4 CD/PV.209 (United States)

Group.[5] These States argue that a long-term approach is necessary for three reasons: they rely on nuclear deterrence which requires that nuclear weapons States keep their nuclear arsenals effective; nuclear arsenals can only be reduced if non-nuclear arsenals are reduced; and present verification capabilities and arrangements have not yet been sufficiently developed and discussed.

Two versions of the gradual approach can be distinguished. One version is the gradual reduction of yield limits[6], another is the phasing-out of the number of nuclear explosions[7].

Sweden noted the following risks which it perceived in a threshold approach: the approach could be interpreted as legitimizing nuclear weapons testing; it would permit further improvement of nuclear arms; efforts to strenghten the non-proliferation regime might be weakened; and it would create verification difficulties since detecting an explosion is easier than estimating its yield.[8] Nonetheless, Sweden expressed its willingness to consider such an approach if it would be directly linked to a comprehensive test ban and if a phase-out period of about three years was fixed.[9]

The phasing-out approach was described in detail by a working paper submitted by Japan in 1984[10]. The paper suggested a step-by-step approach as a second-best measure towards the achievement a comprehensive test ban treaty. Japan proposed, as a first step, the establishment of a threshold on underground nuclear explosions whose magnitude would be multilaterally verifiable. A second step would entail the search for methods of cooperation between States for improvements of detection and identification capabilities in order to gradually reduce the threshold level.[11] This proposal was supported by some Western States.[12] The Netherlands questioned the desirability of a threshold which would legitimise tests in a permitted yield-range.[13]

Pakistan stated that the gradual approach lacked a significant impact on the nuclear arms race and argued that it offered weak prospects to reach agreement on a comprehensive solution[14]. Sri Lanka perceived the same risks in a gradual approach but, despite these reservations, it held that all existing proposals must be fully discussed.[15]

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5 CD/PV.542 (United States), CD/PV.545 (United Kingdom), CD/PV.544 (Belgium), CD/PV.447 (Canada), CD/PV.389 (Germany, Federal Republic of), CD/PV.571 (Italy), CD/PV.548 (Japan), CD/PV.569 (Netherlands), CD/PV.550 (Sweden), CD/PV.555 (Sweden)

6 CD/PV.294 (Pakistan), CD/PV.548 (Japan), CD/PV.568 (Netherlands), CD/PV.555 (Sweden)

7 See CD/PV.389 (Germany, Federal Republic of), CD/PV.571 (Italy), CD/PV.548 (Japan), CD/PV.568 (Netherlands), CD/PV.550 (Sweden)

8 CD/PV.280 (Sweden), CD/PV.288 (Sweden), CD/PV.295 (Sweden), CD/PV.336 (Sweden)

9 CD/PV.280 (Sweden), CD/PV.288 (Sweden), CD/PV.297 (Sweden)

10 CD/524, Japan, "Step-by-Step Approach to a Comprehensive Test Ban"; see also CD/PV.263 (Japan)

11 ibid, p.2

12 CD/PV.271 (Belgium), CD/PV.271 (Germany, Federal Republic of), CD/PV.264 (Italy)

13 CD/PV.275 (Netherlands)

14 CD/PV.282 (Pakistan), CD/PV.294 (Pakistan)

15 CD/PV.308 (Sri Lanka)

Since 1987 the Soviet Union has agreed with the U.S. on the gradual step-by-step approach as a basis for negotiations on banning or limiting nuclear testing.[16]

3.3 Immediate Entry Into Negotiations

The aspiration to achieve a nuclear test ban treaty as soon as possible is reflected in proposals to immediately start negotiations on a CTBT. These proposals have been put forward mainly by the Group of 21 and several Eastern European States.[17] These countries hold that present verification capabilities are sufficient to check compliance with a CTBT and that only political will is needed to conclude such a treaty. Recent events, however, have revealed a changing attitude on the part of some Eastern European countries. At the PTBT Amendment Conference, held in January 1991, which aimed to amend the PTBT in such a way as to convert it into a CTBT, several Eastern European countries, which had previously favoured the conclusion of a CTBT at the earliest possible date, abstained from the vote on a Final Decision. This Decision mandated the President of the Conference to conduct consultations to resolve the points of disagreement and to reconvene the Amendment Conference at an "appropriate" time.[18]

3.4 Moratorium

A number of States have repeatedly proposed the establishment of a moratorium on nuclear testing, either bilaterally between the U.S. and the USSR[19], or multilaterally between all nuclear weapons States[20]. During the moratorium, negotiations were to be held. Except for the USSR, these proposals have not been supported by the nuclear weapons States.

On 29 July 1985, the USSR announced a unilateral moratorium on all nuclear explosions which was to last from 6 August until the end of the year.[21] The moratorium was to remain in effect beyond this date if the United States refrained from carrying out nuclear

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16 CD/PV.560 (USSR)

17 CD/PV.402 (Algeria), CD/PV.455 (Algeria), CD/PV.574 (Argentina and Brazil), CD/PV.508 (Australia), CD/PV.487 (Ethiopia), CD/PV.537 (German Democratic Republic), CD/PV.543 (German Democratic Republic), CD/PV.575 (India), CD/PV.538 (Indonesia), CD/PV.568 (Indonesia), CD/PV.484 (Mexico), CD/PV.503 (Poland), CD/PV.487 (Romania), CD/PV.545 (Sri Lanka), CD/PV.543 (Venezuela), CD/PV.538 (Yugoslavia)

18 The countries were Bulgaria, Czechoslovakia, Hungary, Poland and Romania.

19 See e.g. CD/PV.95 (India), CD/PV.96 (Venezuela), CD/PV.98 (Japan), CD/PV.560 (USSR), CD/701, Group of Socialist States, "Negotiations on the Complete and General Prohibition of Nuclear Weapon Tests"; see also NPT/CONF IV/SR.2 (USSR); the USSR also suggested a moratorium on a bilateral basis between the U.S. and the USSR, and then on an expanding basis, including all countries. (Press Bulletin, Permanent Mission of the Soviet Union, 1 November 1990, "Soviet Officials on Novaya Zemlya Nuclear Tests")

20 CD/629, People's Republic of Bulgaria, German Democratic Republic, "Working Paper on Item 1 of the Agenda of the Conference on Disarmament Entitled 'Nuclear Test Ban'"

21 CD/625, USSR, "Letter Dated 31 July 1985 Adressed to the President of the Conference on Diarmament from the Representative of the Union of Soviet Socialist Republics Transmitting the Text of the Statement Made by General Secretary of the CPSU Central Committee, Mikhail Gorbatchev, Concerning the Announcement by the Soviet Union of a Unilateral Moratorium on all Nuclear Explosions from 6 August 1985 to 1 January 1986"

explosions. However, the U.S. reiterated its position that a moratorium would not be verifiable and referred to the moratorium from 1958 to 1961, when the USSR had resumed testing despite on-going negotiations.[22] Despite the rejection by the U.S., the USSR extended the unilateral moratorium four times until February 1987. When the Soviet Union resumed nuclear testing in February 1987, the Group of 21 and the Group of Socialist States called for a bilateral moratorium on nuclear tests by the two superpowers.[23]

3.5 Other Approaches

The remaining two nuclear weapons powers, France and China, which have not so far, been involved in test ban negotiations, hold similar positions. They have both requested the two superpowers to start nuclear disarmament, including a ban on nuclear testing.

France has refused any participation in negotiations of a test ban because in its view the cessation of tests would be an integral part of nuclear disarmament[24]. It argues that it needs nuclear testing for the development of advanced weapons systems in order to maintain nuclear credibility.[25] France would enter into negotiations only if "a change of nature in the gap between [the French] strategic forces and those of the United States and the USSR, the halting of the race for defensive technologies, the elimination of conventional imbalances and the total prohibition of chemical weapons"[26] was achieved.

Since 1980, when China started to participate in the Conference on Disarmament, it has been advocating a Comprehensive Test Ban, but has demanded that the superpowers stop nuclear testing in the first place, cut 50 per cent of their nuclear arsenals, and withdraw their arms from foreign ground before it would also cease testing.[27]

In 1984, another approach was suggested by Austria, a non-member of the CD. Austria proposed that the two superpowers commit themselves voluntarily, during a three year period, to halve the number of tests conducted each year, taking as a common point of departure the mean figure between the United States' and the Soviet Union's yearly testing averages of the past twenty years.[28] In three years, this would reduce the number of tests by each to between two and three. Little attention was given to this proposal.

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[22] CD/PV.327 (United States); the UK would also be affected by a bilateral U.S.-USSR moratorium because it conducts nuclear tests jointly with the U.S. on the American national test site.

[23] CD/PV.386 (Peru), CD/PV.386 (German Democratic Republic); see also CD/743, Bulgaria, Czechoslovakia, German Democratic Republic, Hungary, Mongolia, Poland, Romania, Union of Soviet Socialist States, 'Nuclear Test Ban'"

[24] CD/PV.570 (France)

[25] See Prime Minister Fabius, speech, in *Politique de Defence*, 25. October 1985

[26] CD/PV.85 (France), CD/PV.178 (France), CD/PV.194 (France), CD/PV.518 (France)

[27] CD/PV.53 (China), CD/PV.292 (China), CD/PV.178 (China), CD/PV.538 (China)

[28] CD/PV.276 (Austria)

CHAPTER IV

The Search for a Mandate for an Ad-Hoc Committee

4.1 Introduction

The controversy over a time-frame in which a comprehensive test ban treaty should be negotiated has been reflected in the search for a mandate for an ad-hoc committee. The Conference on Disarmament establishes ad-hoc committees if it deems it advisable for the effective performance of its functions, or when it appears that a basis exists to negotiate a draft treaty or other draft texts.[1]

The establishment of an ad-hoc committee in the CD requires consensus.[2] During the past decade several draft mandates for an ad-hoc committee on a nuclear test ban have been submitted to the CD. Some have called for discussions, others for the negotiation of a treaty. None have found consenus. In order to overcome the stalemate, compromise mandates have been tabled. They enabled the CD to establish a subsidiary body on the test ban issue in 1982, 1983, 1990 and 1991.

4.2 Negotiating Mandates

Negotiating mandates were proposed by the Group of 21, the Group of Socialist States, and various other States. When it came to the question of finding consensus on a proposed mandate, the two political groups declared several times that they endorsed the draft mandate put forward by the other group.[3] The proposed mandates coincided in their main objective, to negotiate a test ban treaty, but differed in the way these negotiations were to be conducted.

Several general drafts called only for multilateral negotiations of a treaty on the prohibition of all nuclear weapons tests without specifying the conduct of the negotiations.

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1 See "Rules of Procedures of the Committee on Disarmament", in Official Records of the Genral Assembly, Thirty-fourth Session, Supplement No.27, (A/34/27), vol.I, Appendix I.

2 When no progress in the search for consensus on a mandate was achieved, several attempts were undertaken to change the rule of consensus in such a way as to enable the establishment of subsidiary organs for the effective performance of the functions of the CD. None of these attempts were successful. See e.g. CD/204, Mexico, Nigeria, Pakistan, Sweden and Yugoslavia, "Establishment of Subsidiary Organs", CD/PV.134 (Mexico), CD/PV.192, Group of 21, "Statement by the Group of 21 (Item 1: Nuclear Test Ban)".

3 See e.g. CD/PV.275 (German Democratic Republic), CD/PV.276 (Algeria), CD/PV.301 (USSR), CD/PV.351 (German Democratic Republic)

They were submitted by the G21 in 1984, 1985 and 1986[4], and by the Group of Socialist States in 1984 and 1985[5], the German Democratic Republic in 1982[6] and Mexico in 1984[7].

Other draft mandates set forth a specific structure of the negotiations to be held. In 1985, Bulgaria and the German Democratic Republic tabled a draft that provided for negotiations on the scope of a treaty, the main obligations of States parties, the implementation, and other provisions such as entry into force and amendments.[8] A draft mandate, first proposed by Mexico in 1986[9] and subsequently taken up by a group of member States of the CD in 1987[10] and the Group of 21 in 1988[11], provided for the conduct of negotiations in two working groups: one dealing with content and scope of the treaty, the other with verification and compliance.

Still other mandates were tabled while test ban negotiations were taking place outside the CD.[12] In 1981, the Group of 21 and the Group of Socialist States submitted draft mandates while the tripartite negotiations were formally still going on. The draft of the G21 contained the demand for parallel negotiations in the CD.[13] The proposal of the Group of Socialist States merely called for the consideration of the problem of nuclear weapons tests

4 CD/492, Group of 21, "Draft Mandate for the (Ad-Hoc Subsidiary Body) on a Nuclear Test Ban"; in its updated version CD/520, CD/520/Rev.1, CD/520/Rev.2, Group of 21, "Draft Mandate for the Ad-Hoc Committee on a Nuclear Test Ban"

5 CD/434, Memorandum of a Group of Socialist States, "Organizational Matters of the Work of the Conference on Disarmament", p.2; in its updated version CD/522, CD/522/Rev.1, Group of Socialist States, "Draft Mandate for an Ad-Hoc Committee on Item 1 of the Agenda of the Conference on Disarmament Submitted by a Group of Socialist States"

6 CD/259, German Democratic Republic, "Draft Mandates for Ad-Hoc Working Groups on a Nuclear Test Ban, and the Cessation of the Nuclear Arms Race and Nuclear Disarmament" was submitted in 1982 and was endorsed by Bulgaria, Czechoslovakia and Mongolia (CD/PV.166 (Bulgaria), CD/PV.167 (Czechoslovakia) and CD/PV.166 (Mongolia);

7 CD/438, Mexico, Draft Mandate For The (ad-hoc subsidiary body) On A Nuclear Test Ban"

8 CD/629, Bulgaria, German Democratic Republic of Germany, "Working Paper on Item One of the Agenda of the Conference on Disarmament Entitled Nuclear Test Ban'"

9 CD/PV.375 (Mexico); the proposal was based on the General Assembly resolution A/RES/40/80 A

10 CD/772, Indonesia, Kenya, Mexico, Peru, Sri Lanka, Sweden, Venezuela and Yugoslavia, "Draft Mandate for an Ad-Hoc Committee on Item One of the Agenda of the Conference on Disarmament"

11 CD/829, Group of 21, "Draft Mandate for an Ad-Hoc Committee on Item One of the Agenda of the Conference on Disarmament"

12 In 1987, the United States and the Soviet Union started bilateral negotiations on verification provisions for the TTBT and the PNET which were decisive for the entry into force of the two treaties. The negotiations were part of the bilateral U.S.-USSR nuclear testing experts meetings which had started in 1986. Although no formal mandate proposal was submitted, the USSR stated that bilateral efforts alone could not provide a final solution to the problem of nuclear tests and stressed that the preparation of a CTBT should be undertaken concurrently in the CD. (CD/PV.430 (USSR)) To that end the Soviet Union together with a Group of Socialist States submitted a draft treaty to the CD. A similar position was taken by a number of non-aligned States which felt that bilateral talks would not offer an acceptable substitute to negotiations in the Conference. (See e.g. CD/PV.406 (Pakistan), CD/PV.432 (Sweden)). The U.S., on the other hand, appealed to the Conference to complement these negotiations by establishing a subsidiary body with a non-negotiating mandate instead of competing with these bilateral efforts. (CD/PV.408 (United States, CD/PV.417 (United States))

13 CD/181, Group of 21, "Statement by the Group of 21 on Item 1 of the Agenda of the Committee on Disarmament Entitled: Nuclear Test Ban"; this statement was based on previous proposal of the Group of 21, namely CD/72 and CD/134.

in all its aspects with a view to rapidly concluding a treaty on the general and complete prohibition of nuclear weapons tests.[14]

4.3 Non-Negotiating Mandates

A non-negotiating mandate for an ad-hoc committee was proposed in 1984, by the Western Group without France.[15] The draft mandate called for discussions on specific issues relating to a comprehensive test ban, including scope, verification, and compliance, with a view to negotiating a treaty.[16] The mandate also requested the examination of institutional and administrative arrangements for an international seismic monitoring system.

The draft mandate was rejected by most States of the other political groups. Pakistan, however, believed that discussions under less than ideal conditions might be better than no discussion at all.[17] This view was welcomed by Sri Lanka and Sweden.[18] A simliar position had already been taken earlier by Australia. It had repeatedly declared that it would welcome a full negotiating mandate but due to the absence of consensus it was in favour of a mandate which would enable the Conference to carry out the work required for a treaty.[19]

In 1985, the same Group of Western States proposed a draft programme of work for an ad-hoc committee.[20] This attempt can be only seen as an attempt to clarify the purpose of the proposed non-negotiating mandate because the programme of work merely organizes the work of an ad-hoc committee, whereas the establishment of an ad-hoc committee requires a mandate. The proposed programme of work was divided into three major areas: scope, verification and compliance.

The scope of the envisaged treaty would ban all nuclear explosions in all environments and would include PNEs. The section on verification outlined items for discussions and comprised, among other points, NTM, capabilities and improvements of an international exchange of seismic data, an international exchange of data on airborne radioactivity, and on-site inspections. Under compliance, the program envisaged discussions on procedures for consultations and complaints, and institutional aspects of a Consultative Committee and a Committee of Experts.

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14 CD/194, Group of Socialist Countries, "Statement of a Group of Socialist Countries Concerning a Nuclear Test Ban"

15 See e.g CD/PV.65 (Canada), CD/PV.66 (Italy), CD/PV.81 (Netherlands), CD/PV.137 (United States), CD/PV.209 (United States), CD/PV.209 (Australia), CD/PV.209 (Belgium), CD/PV.209 (United Kingdom), CD/PV.209 (Italy)

16 CD/521, Australia, Belgium, Canada, Federal Republic of Germany, Italy, Japan, Netherlands, United Kingdom and United States of America, "Draft Mandate for the Ad-Hoc Subsidiary Body on Item 1 of the Agenda of the Conference on Disarmament entitled 'Nuclear Test Ban'"

17 CD/PV.194 (Pakistan)

18 CD/PV.308 (Sri Lanka), CD/PV.297 (Sweden)

19 CD/PV.279 (Australia), CD/PV.292 (Australia), CD/PV.294 (Australia)

20 CD/621, Australia, Belgium, Federal Republic of Germany, Italy, Japan, Netherlands, Norway, United Kingdom, United States of America, "Draft Program of Work for an Ad-Hoc Committee on Item One of the Agenda of the Conference on Disarmament Entitled 'Nucler Test Ban'"

4.4 Compromise Mandates

Proposals for non-negotiating mandates which aimed at a compromise led to the establishment of ad-hoc committees in 1982, 1983, 1990 and 1991.

In 1982, in informal consulations conducted by the Chairman of the Committee on Disarmament, agreement was reached on the establishment of a drafting group to formulate the mandate of a possible subsidiary body.[21] Within the drafting group, the differing positions over the negotiating character of the ad-hoc committee diverted and deadlocked the discussion. Mexico, however, submitted a compromise mandate which was finally adopted. This mandate served for the ad-hoc committees in 1982 and in 1983.[22] The relevant part of the mandate read:

> Considering that discussion of specific issues in the first instance may facilitate progress towards negotiation of a nuclear test ban, the Committee requests the ad-hoc working group to discuss and define, through substantive examination, issues relating to verification and compliance with a view to making further progress towards a nuclear test ban.[23]

Although all States had accepted the mandate, its limited scope caused dissatisfaction among many.[24] They reiterated their initial rationale for their agreement on a non-negotiating mandate and stated that they had seen this mandate as the only possibility to start the negotiating process.[25] They were not willing to continue the work in the Ad-Hoc Committee without a negotiating mandate. To this end, some countries expressed their desire to broaden the mandate so as to commence negotiations on a nuclear test ban treaty without further delay.[26] They were supported by the Chairmen of the ad-hoc working group in 1982 and 1983.[27] Since positions on a mandate remained inflexible, the CD was not able to establish an ad-hoc committee until 1990.

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21 CD/PV.164 (The Chairman); the drafting group comprised Brazil, Bulgaria, the German Democratic Republic, India, Japan, Nigeria, the United States of America and Yugoslavia.

22 In 1983, the CD adopted a decision to re-establish all ad-hoc committees of the previous year based on their former mandates. For the ad-hoc committee on a nuclear test ban, it was agreed to consider the possible revision of the mandate but this did not lead to consensus. The ad-hoc committee of 1983 therefore continued to work with its previous mandate of 1982. (CD/358, "Decision on the re-establishment of ad-hoc working groups for the 1983 session of the Committee on Disarmament"; see also CD/PV.209 (Chairman), CD/PV.212 (Chairman)).

23 CD/291, "Decision adopted by the Committee on Disarmament on the establishment of an ad-hoc working group under item 1 of its agenda entitled 'Nuclear Test Ban'"

24 CD/PV.178 (Burma), CD/PV.179 (German Democratic Republic), CD/PV.277 (Pakistan), CD/PV.180 (Romania), CD/PV.182 (Sweden), CD/PV.181 (USSR), CD/PV.180 (Venezuela)

25 See e.g. CD/PV.178 (Sweden)

26 See e.g CD/PV.187 (Bulgaria), CD/PV.237 (Australia), CD/PV.237 (Pakistan)

27 CD/PV.178 (Sweden), CD/PV.187 (Sweden), CD/PV.236 (German Democratic Republic).

4.4.1 The Ad-Hoc Committees in 1982 and 1983

The results of the work of the Ad-Hoc Committees in 1982 and 1983 were limited. The different approaches to a nuclear test ban treaty precluded the question of a mandate and also affected the issues of scope, verification and compliance.

The Ad-Hoc Committee of 1982 was not able to agree on a programme of work because of two conflicting approaches. One required an agreement on the scope of a treaty before discussing verification procedures, the other called for the elaboration of verification measures "on the basis of certain broad assumptions".[28] The consequence of the former approach would have been that although a test ban treaty would not have been negotiated, it would still have been discussed. Besides, it was argued that the consideration of the scope was not particularily mentioned in the mandate as a specific issue to be examined. The latter approach would have side-stepped any discussion of a treaty and would have focused abstractly on verification and compliance procedures. This approach reflected the gradual step-by-step approach and was outlined in a programme of work proposed by the Netherlands. The proposal presupposed a "comprehensive and world-wide"[29] scope for a treaty, and focused on consideration of the establishment and institutional aspects of an international monitoring system.

The Ad-Hoc Committee of 1983 agreed on a compromise programme of work. The relevant part of the programme of work read:

> In discharging its mandate, the Ad-Hoc Group on a Nuclear Test Ban will examine issues of verification and of compliance with a NTB with a view to making further progress towards a corresponding treaty which would be non-discriminatory and could attract the widest possible adherence.

The programme envisaged a general discussion on the subject matter followed by considerations of six items comprised of: 1. Requirements and elements of verification; 2. Means of verification, inter alia; (a) national technical means, (b) international exchange of seismic data; 3. Procedures and mechanisms for consultation and cooperation; 4. the Committee of Experts; 5. Procedures for complaints; and, 6. On-site inspection. This portion of the programme of work satisfied the requirement to discuss verification and compliance whereas the following statement included in the programme of work offered the possibilty to extend the discussions.

> In the examination of issues relating to verification and compliance consideration should be given to all relevant aspects of a treaty on a Nuclear Test Ban.

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[28] CD/332 "Report of the Ad-Hoc Working Group on a Nuclear Test Ban"

[29] CD/312 (CD/NTB/WP.1), Netherlands, "Nuclear Test Ban"

4.4.2 The Mandate of the Ad-Hoc Committees in 1990 and 1991

During informal consultations at the beginning of the 1987 session, the President of the CD, Ambassador Vejvoda of Czechoslovakia, submitted an informal draft mandate which provided for first steps leading towards a test ban treaty.[30] Although this informal proposal could not be adequately addressed within the 1987 session, the view prevailed that this draft could provide a basis for a future compromise on a mandate.[31] The same proposal was taken up by Czechoslovakia and submitted as a draft mandate to the CD in 1988.[32] Czechoslovakia stated, however, that this draft was a compromise and did not represent its own preferred mandate.[33] The Group of Socialist States agreed to the proposal[34], and delegations from the other two groups indicated interest. Japan, which had undertaken to find consensus on a mandate, stated at the end of the 1989 session that it was confident that agreement on the basis of the Czechoslovak proposal could be reached.[35] The representative of Japan continued consultations on an informal and individual basis.[36]

By the end of February 1990, most countries, except the Group of 21, were prepared to agree on the mandate contained in the proposal by Czechoslovakia. The Group of Eastern European and Other States, and the People's Republic of China declared that they accepted the draft mandate without any wording changes. The U.S. delegation was waiting for instructions from Washington. The Group of 21 wanted to know the Western position before proposing any amendments. On 3 July, the Western Group (without France, which had not participated in the informal consultations) declared that they accepted the draft mandate without any changes. Finally, the Group of 21 declared on 11 July their acceptance of the draft mandate which led to the adoption of the mandate.[37]

In the plenary, France restated that it was not willing to participate in an ad-hoc committee on the test ban in the framework of the CD but did "not obstruct the consensus of the Conference".[38] Nonetheless, France was willing to "participate in the parallel technical activities that in no way prejudge the political aspects of the question"[39]. China, on the other hand, which until 1985[40] had refused any participation in an ad-hoc committee on the test ban issue, participated for the first time.[41]

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30 CD/PV.410 (The President)
31 See e.g. CD/PV.421 (United Kingdom), CD/PV.429 (Japan), CD/PV.429 (Australia)
32 CD/863, Czechoslovakia, "Draft Mandate for the Ad-Hoc Committee on Item One 'Nuclear Test Ban'"
33 CD/PV.467 (Czechoslovakia)
34 CD/PV.507 (German Democratic Republic)
35 CD/PV.530 (Japan)
36 CD/PV.546 (Japan)
37 CD/PV.565 (Japan)
38 CD/PV.570 (France)
39 CD/PV.565 (France)
40 CD/PV.292 (China)
41 CD/PV.565 (China)

The relevant part of the mandate, namely paragraphs 2 through 4, which also served as the de facto programme of work, read:

> The Conference requests the Ad-Hoc Committee to initiate, as a first step towards achieving a nuclear test ban treaty, substantive work on specific and interrelated test ban issues, including structure and scope as well as verification and compliance.
>
> Pursuant to its mandate, the Ad-Hoc Committee will take into account all existing proposals and future initiatives. In addition, it will draw on the knowledge and experience that have been accumulated over the years in the consideration of a comprehensive test ban in the successive multilateral negotiating bodies and the trilateral negotiations.
>
> The Conference also requests the Ad-Hoc Committee to examine the institutional and administrative arrangements necessary for establishing, testing and operating an international seismic monitoring network as part of an effective verification system of a nuclear test ban treaty. The Ad-Hoc Committee will also take into account the work of the Ad-Hoc Group of Scientific Experts to Consider International Cooperative Measures to Detect and Identify Seismic Events.

The novelty of this mandate was the introduction of the term "structure" which was not defined but may be interpreted as the structure of a nuclear test ban treaty. Countries that were opposed to a negotiating mandate for an ad-hoc committee on a nuclear test ban, regarded their acceptance of the word "structure" as a concession to those States which preferred a negotiating mandate. The reason for this concession may have been the interest in the establishment of an ad-hoc committee to provide a sign of goodwill before the Fourth NPT Review Conference and the Amendment Conference. The NPT Review Conference put pressure on the U.S and the UK because some countries had indicated that they would link the adoption of a final document from the Review Conference, to a commitment by the nuclear weapons powers to conclude a CTBT within five years. The Amendment Conference aimed to amend the PTBT in such a way as to convert the PTBT into a CTBT, an approach that the U.S. and the UK rejected. It soon became evident that the term "structure" had been acceptable to the U.S. and the UK because of its ambiguity which permitted them to interpret the new mandate in a similar vein to previous compromise mandates. Those countries favouring a negotiating mandate, however, interpreted the word "structure" as a reference to discussions of a treaty. The ensuing controversy paralyzed, to a large extent, the work of the 1990 Ad-Hoc Committee, and is likely to continue in the re-established Committee in 1991.

CHAPTER V

Discussions About the Scope of a Nuclear Test Ban Treaty

5.1 Introduction

Discussions on the scope of a nuclear test ban treaty have focused on two issues: the inclusion of PNEs in a test ban agreement, and the requested participation of all declared nuclear weapons States for the entry into force of a nuclear test ban treaty.

5.2 Peaceful Nuclear Explosions (PNEs)

In 1974, the U.S. and the USSR agreed on the TTBT which limited only the yield of nuclear weapons tests, and excluded nuclear explosions for peaceful purposes from its scope. Although the same yield limitation was applied to PNEs in the PNET, signed in 1976, the differentiation was formally manifested in these agreements. Thereafter, the two superpowers declared that this distinction was artificial because PNEs can not be distinguished from nuclear weapons tests. Some States, however, insisted on this distinction because they felt that the peaceful application of nuclear explosions might be valuable for their economic development. If PNEs provide potential benefits, the NPT permits non-nuclear weapons States to use them, but requires that the PNE devices be provided by nuclear weapons States. Presently, however, the nuclear weapons States are not known to have active PNE programs, and no non-nuclear weapons State has asked for assistance. In the Conference on Disarmament three views emerged from the discussion on the issue of PNEs.

(a) One view considered that a comprehensive test ban treaty should cover all nuclear explosions without any distinction between nuclear weapons tests and the peaceful application of nuclear explosions.[1]

In 1983, the United Kingdom introduced a paper which pointed to the problems PNEs cause for a nuclear test ban treaty. It stated that the basic technologies for nuclear weapons and peaceful nuclear explosives are identical and, therefore, any nuclear explosive can be used as a weapon. Seismic recordings would show no distinction. The only difference would be in the declared purposes of explosions. Hence, if PNEs were not covered by a test ban treaty,

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[1] Another argument was raised that all possible methods and qualitative improvements for testing, such as laboratory tests and simulation techniques, should also be considered. Although some delegations acknowledged the advancements in laboratory technology, they rejected this view referring to a UN Study which stated that a CTB could not cover laboratory tests because they were beyond verification capabilities. (CD/86, "Letter dated 24 March 1980 from the Secretary-General of the United Nations to the Chairman of the Committee on Disarmament transmitting the Report on a Comprehensive Nuclear Test Ban, prepared pursuant to General) Assembly Decision 32/44 of 11 December 1979"

nuclear weapons States could use them to test their nuclear stockpile, and to prove the functioning of new warheads. Non-nuclear weapons States could develop basic nuclear explosives capabilities and therefore the ability to produce nuclear weapons. The paper concluded that the "uncontrolled use and development of nuclear explosions for peaceful purposes is incompatible with the objectives of a comprehensive test ban"[2].

Although the UK declared its preference to ban all nuclear explosions, it acknowledged the possiblity of a separate arrangement for peaceful nuclear explosions, as long as it prohibited PNEs at the time that the comprehensive test ban entered into force.[3] This view was shared by Sweden and Japan. They called for either a prohibition of all nuclear explosions, or an agreement on an international supervision and control system.[4] Some of the observers of the Conference also shared this view.[5]

In a less compromising position Australia stated that "the most effective and safest solution is to ban all nuclear tests"[6] and proposed a scope for a treaty which reads:

> Each Party to this Treaty undertakes not to carry out any nuclear weapons test explosion or any other nuclear explosion.
>
> 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 weapons test explosion or any other nuclear explosion.
>
> Each Party to this Treaty undertakes to take all necessary measures to prohibit and prevent any activity in violation of the provisions of the Treaty anywhere under its jurisdiction or control.[7]

(b) A second view that emerged in the discussion of PNEs was that a comprehensive test ban treaty should cover only nuclear weapons test explosions but a protocol should accompany the treaty establishing a moratorium on PNEs until a suitable arrangment could be found. This view was advocated mainly by States of the Socialist Group and was reflected in various proposals[8] for a subsidiary body, as well as in two draft treaties.

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2 CD/383 (CD/NTB/WP.3), United Kingdom, "Peaceful Nuclear Explosions in Relation to a Nuclear Test Ban", p.3

3 ibid, p.2; see also CD/PV.186 (United Kingdom), CD/PV.219 (United Kingdom), CD/PV.230 (United Kingdom), CD/PV.237 (United Kingdom)

4 CD/388, Japan, Verification and Compliance of a Nuclear Test Ban"; the Swedish draft treaty was submitted in 1983 as CD document CD/381 (CD/831, Sweden, "Draft Treaty Banning any Nuclear Weapon Test Explosion in Any Environment") and was based on a previous draft treaty which Sweden had tabled to the CCD in 1977 as CCD document CCD/526 and Rev.1 (CCD/526 and Rev.1, "Draft Treaty Banning Nuclear Weapon Test Explosions in all Environments")

5 See e.g. CD/PV.244 (Norway), CD/PV.296 (New Zealand), CD/PV.298 (Finland), CD/PV.342 (Finland), CD/PV.343 (Norway)

6 CD/PV.241 (Australia)

7 CD/405 (CD/NTB/WP.8), Australia, "Proposal for the Scope of a Comprehensive Nucler Test Ban Treaty"; see also CD/531, Australia, "Principles for the Verification of a Comprehensive Nuclear Test Ban Treaty"

8 See e.g. CD/629, People's Republic of Bulgaria, German Democratic Republic, "Working Paper on Item One of the Agenda of the Conference on Disarmement Entitled 'Nuclear Test Ban'"; CD/701, Socialist Countries, "Negotiations on a Treaty on the Complete and General Prohibition of Nuclear Weapon Tests"; CD/743, Bulgaria, Czechoslovakia, German Democratic Republic, Hungary, Mongolia, Poland, Romania, Union of Soviet Socialist Republics, "Nuclear Test Ban"; CD/746, German Democratic Republic, "Nuclear Test Ban"

The first draft treaty was submitted by the USSR in 1983.[9] Its scope required that:

> Each State party to this Treaty shall undertake to prohibit, to prevent, and not to carry out any nuclear weapon test explosion at any place under its jurisdiction and control, in any environment - in the atmosphere, beyond its limits, including outer space, under water or under ground.
>
> A moratorium shall be declared on nuclear explosions for peaceful purposes, under which the parties to this Treaty shall refrain from causing, encouraging, or in any other way participating in carrying out such explosions until the relevant procedure has been evolved.

The second draft treaty was submitted in 1987 by a Group of Socialist States including the Soviet Union.[10] The envisaged scope differed from the previous Soviet draft in the broader formulation of the paragraph concerning PNEs:

> Provisions 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.

The UK hinted at the fact that although an agreement for PNEs had been envisaged, there were no verification proposals which would offer the prospect of agreement being reached on measures permitting the continuation of PNEs under a CTBT.[11]

(c) A third view considered that a comprehensive test ban treaty should only cover nuclear weapons test explosions. This view was held mainly by certain members of the Group of 21. It was never clarified whether any form of control should be applied to PNEs. In 1990, Argentina and Brazil altered their positions in favour of a ban on all nuclear explosions.[12] This has left India[13] as the only member of the CD favouring the exclusion of PNEs from the scope of a CTBT.

The arguments for separating PNEs from nuclear weapons tests were based on the reference under the PTBT to discontinue "all test explosions of nuclear weapons for all time"; Article V of the NPT which reads that any "potential benefits from any peaceful applications of nuclear explosions will be made available to non-nuclear weapons States"; the TTBT and PNET which distinguished between nuclear weapons and peaceful test explosions; and, the Tripartite Report of 1980 which agreed on a protocol establishing a moratorium on PNEs until other arrangements had been made.

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9 CD/346 "Letter Dated 14 February 1983 from the Representative of the Union of Soviet Socialist Republics to the Committee on Disarmament Transmitting the 'Basic Provisions of a Treaty on the Complete and General Prohibition of Nuclear Weapon Tests'"

10 CD/756, "Letter Dated 8 June 1987 from the Representatives of Bulgaria, Czechoslovakia, the German Democratic Republic, Hungary, Mongolia, Poland, Romania and the Union of Soviet Socialist Republics, Addressed to the President of the Conference on Disarmament, Transmitting the Text of the 'Basic Provisions of a Treaty on the Complete and General Prohibition of Nuclear Weapon Tests'"

11 CD/383 (CD/NTB/WP.3), United Kingdom, "Peaceful Nuclear Explosions in Relation to a Nuclear Test Ban", see also CD/402 (CD/NTB/WP.7), United Kingdom, "Verification Aspects of a Comprehensive Test Ban Treaty (CTBT)"

12 CD/PV.574 (Argentina and Brazil)

13 CD/PV.575 (India)

5.3 Entry into Force of a Nuclear Test Ban Treaty

Since 1976, the USSR has insisted that a nuclear test ban treaty enter into force only if all declared nuclear weapons powers participate. Since France and China have not been parties to any of the existing test limitation treaties, a number of countries felt that for an efficient nuclear test ban treaty, all nuclear weapons powers must cease testing. Four approaches have been proposed to include all nuclear weapons States in a comprehensive test ban treaty.

(a) The first approach was advocated by the Soviet Union which, after the failure of the tripartite negotiations in 1982, returned in part to its previous position and demanded that all nuclear weapons States participate in a test ban agreement.[14]

(b) The second approach represented a modification of this position and was reflected in a draft treaty that the USSR submitted in 1983.[15] The draft envisaged a treaty that would enter into force after its ratification by twenty governments, "including the Governments of all States permanent members of the Security Council"[16] which are the five declared nuclear weapons powers. However, the treaty might enter into force for a limited period, once the UK, the U.S., and the USSR had ratified the treaty.

(c) The third approach represents the latest position of the Soviet Union which, together with a Group of Socialist States, presented a draft treaty in 1987.[17] The draft conceived the entry into force of the treaty following the ratification by an unspecified number of States (to be negotiated) but including the U.S.A. and the USSR. Five years after the entry into force of the treaty, a review conference would be convened that would decide whether the treaty was to remain in force and if other nuclear weapons States would have to accede to the treaty if they had not done so.

(d) Sweden tabled a draft treaty in 1983[18] which envisaged a treaty that would enter into force after the ratification by twenty governments, including the Governments of the UK, the U.S. and the USSR. However, the most recent statement of the Swedish delegation noted that an effective nuclear test ban required universal adherence.[19] Similar statements were made by a number of other States.[20]

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14 See e.g. CD/PV.181 (USSR), CD/PV.222 (USSR)

15 CD/346 "Letter Dated 14 February 1983 from the Representative of the Union of Soviet Socialist Republics to the Committee on Disarmament Transmitting the 'Basic Provisions of a Treaty on the Complete and General Prohibition of Nuclear Weapon Tests'"

16 ibid, 33.

17 CD/756, "Letter Dated 8 June 1987 from the Representatives of Bulgaria, Czechoslovakia, the German Democratic Republic, Hungary, Mongolia, Poland, Romania and the Union of Soviet Socialist Republics, Addressed to the President of the Conference on Disarmament, Transmitting the Text of the 'Basic Provisions of a Treaty on the Complete and General Prohibition of Nuclear Weapon Tests'"

18 CD/381 "Draft Treaty Banning any Nuclear Weapon Test Explosion in any Environment"

19 CD/PV.555 (Sweden)

20 CD/PV.574 (Argentina and Brazil), CD/PV.497 (Australia), CD/PV.537 (Hungary), CD/PV.575 (India), CD/PV.506 (Pakistan), CD/PV.487 (Romania)

CHAPTER VI

Monitoring a Nuclear Test Ban Treaty

6.1 Introduction

Among the members of the CD, it has been generally recognized that the basic elements of a monitoring system for a nuclear test ban treaty include: national technical means, an international exchange of seismic data, and procedures for on-site inspections.[1] The Group of Scientific Experts, an ad-hoc working group of the CD, has proposed and elaborated an international seismic monitoring system which is considered the most important component of test ban monitoring. In addition, various proposals have been made for improvements of this system. The proposed seismic monitoring system was outlined in principle in three draft treaties submitted to the CD by the USSR (1983), Sweden (1983) and a Group of Socialist Countries (1987).[2] In addition to seismological techniques, the monitoring of airborne radioactivity and on-site inspections have also been considered. The physical and technical aspects of test ban monitoring are discussed in Annex III of this guide.

6.2 The Group of Scientific Experts

The idea of a system of international cooperation for detecting underground nuclear explosions through an exchange of seismic data, dates back to a Swedish proposal of 1965.[3] This resulted in informal consultations which became know as the "detection club". These discussions, however, only provided information of national views on a seismic monitoring systems. In 1976, as a result of a Swedish initiative, the CCD held several informal meetings on verification focusing particularly on a global seismic monitoring system. In recognizing the vital importance of technical expertise in addressing the issue of verification Sweden proposed the establishment of an ad-hoc committee of government-appointed experts.[4] This

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1 CD/412, p.6; see also CD/384 (CD/NTB/WP.4) Australia, "Institutional Arrangements for a CTB Verification System: An Illustrative List of Questions"), and CD/388, Japan, "Verification and Compliance of a Nuclear Test Ban"

2 CD/346 "Letter Dated 14 February 1983 from the Representative of the Union of Soviet Socialist Republics to the Committee on Disarmament Transmitting the 'Basic Provisions of a Treaty on the Complete and General Prohibition of Nuclear Weapon Tests'"; CD/381 "Draft Treaty Banning any Nuclear Weapon Test Explosion in any Environment"; CD/756, "Letter Dated 8 June 1987 from the Representatives of Bulgaria, Czechoslovakia, the German Democratic Republic, Hungary, Mongolia, Poland, Romania and the Union of Soviet Socialist Republics, Addressed to the President of the Conference on Disarmament, Transmitting the Text of the 'Basic Provisions of a Treaty on the Complete and General Prohibition of Nuclear Weapon Tests'"

3 ENDC/154, Sweden, "Memorandum on International Cooperation for the Detection of Underground Nuclear Explosions"

4 CCD/482, Sweden, "Working Paper on Cooperative International Measures to Monitor a CTB"; CCD/495, Sweden, "Terms of Reference for a Group of Scientific Governmental Experts to Consider International Cooperative Measures to Detect and Identify Seismic Events"; see also CCD/PV.704 (Sweden)

proposal was adopted by the CCD towards the end of the session and was entitled "The Scientific Group of Experts to Consider International Cooperative Measures to Detect and Identify Seismic Events".

This group of scientists and representatives from several countries was mandated to elaborate procedures for the establishment and maintenance of an international seismological monitoring network for the verification of a comprehensive nuclear test ban. The Group proposed an international seismic monitoring network and experimented with the possibility of transmitting data on a global scale in 1984. The results of a second global test will be available in 1991/1992.

6.2.1 The Institutional Framework of the Ad-Hoc Group

The Group of Scientific Experts was established in 1976 for the purpose of developing a concept of an international seismic monitoring system. This concept was presented in the Group's first report in 1978.[5] Subsequently, the CCD decided to continue the work of the Ad-Hoc Group.[6] Its terms of reference were redefined on the assumption that a test ban treaty would prohibit all nuclear explosions:

> ... the Ad-Hoc Group should continue its work by studying the scientific and methodological principles of a possible experimental test of a global network of seismological stations of the kind which might be established in the future for the international exchange of seismological data under a treaty prohibiting nuclear weapon tests, and a protocol covering nuclear explosions for peaceful purposes which would be an integral part of the treaty.

In 1979, the CD decided on a mandate which has remained in force until present.[7] The relevant part of the mandate reads:

> This work should, inter alia, include:
> - further elaboration, with the second report of the Group as a basis, of detailed instructions for an experimental test of the global system for international cooperative measures to detect and identify seismic events;
> - further development of the scientific and technical aspects of the global system;
> - cooperation in the review and analysis of national investigations into relevant matters such as:
>   + the conditions for using the WMO Global Telecommunication Systems for seismic data exchange;
>   + procedures to obtain desired data at individual stations under a range of conditions;
>   + the analysis and data handling procedures at the envisaged data centres; and
>   + methods of rapid exchange of waveform data.

The work of the Group is carried out on an informal basis. After each of the sessions a formal progress report is submitted to the CD. The Group is open to scientific experts

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5 CCD/558, "Letter dated 9 March from the Chairman of the Ad-Hoc Group of Scientific Experts to Consider International Cooperative Measures to Detect and to Identify Seismic Events to the Co-Chairman of the Conference of the Committee on Disarmament Transmittinmg the Final Report of the Ad-Hoc Group"

6 The CCD followed the advice of the Ad-Hoc Group stated in their final report, a Japanese suggestion (CCD/PV.733 (Japan)) and a Swedish proposal (CD/562, Sweden, "Terms of Reference for the Contiunued Work ofthe CCD Ad-Hopc Group of Scientific Experts to Consider International Cooperative Measures to Detect and to Identify Seismic Events").

7 CD/PV.48

nominated by any CD member State, or upon invitation by the CD to any UN member State. It was agreed to also invite a representative of the World Meteorologcal Organization (WMO).[8] Along with the extension of the members of the CD in 1979, the number of States participating in the Ad-Hoc Group also increased.[9] The Group, however, has consisted mainly of countries with strong national seismological verification programs, and thus Africa and South America have been under-represented.[10]

In 1982, the Ad-Hoc Group agreed to establish five study groups. In 1987, the study groups were adapted to meet the requirements of an updated version of the proposed seismic monitoring system.[11] The study groups are:

Study Group 1:	Seismograph stations and station networks
Study Group 2:	National Data Centres (NDCs)
Study Group 3:	Data exchange between National Data Centres (NDCs) and International Data Centres (IDCs) using the Global Telecommunication System of the World Meteorological Organization (WMO/GTS)
Study Group 4:	Data exchange between National Data Cetres (NDCs) and International Data Centres (IDCs) using communications channels other than WMO/GTS
Study Group 5:	International Data Centres (IDCs)

Several proposals have been made to expand the mandate of the Scientific Group of Experts. A broader mandate might include technical questions of a global system for monitoring airborne radioactivity, satellite imagery or on-site inspections. Presently, there is no consensus in the Scientific Group of Experts for the consideration of verification techniques other than seismological.

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8 CD/PV.11; at the eighth congress of the WMO in 1979 it was agreed, in principle, that the WMO should assist the United Nations in the use of the Global Telecommunication System (GTS), and to direct its Executive Committee to study the matter.

9 Australia, Bulgaria, Canada, Czechoslovakia, German Democratic Republic, Federal Republic of Germany, Egypt, Hungary, India, Italy, Japan, Mexico, Netherlands, Poland, Sweden, Union of Soviet Socialist Republics, United Kingdom and United States of America sent scientists or representatives to the Ad-Hoc Group. In subsequent sessions Argentina, Belgium, China, India, Iran, Kenya, Pakistan and Romania joined the Ad-Hoc Group temporarily or permanently.
Upon their request Austria, Denmark, Finland, New Zealand and Norway, Switzerland and Turkey participated as observers in the Ad-Hoc Group temporarily or permanently.

10 Only India, Egypt and Peru sent experts.

11 CD/318, "Progress Report to the Committee on Disarmament on the Fourteenth Session of the Ad-Hoc Group of Scientific Experts to Consider International Cooperative Measures to Detect and Identify Seismic Events"; CD/778, "Progress Report to the Committee on Disarmament on the Fourteenth Session of the Ad-Hoc Group of Scientific Experts to Consider International Cooperative Measures to Detect and Identify Seismic Events"

6.2.2 The Proposed International Seismic Monitoring System

In 1978, the Ad-Hoc Group submitted its first report to the CCD. It proposed the concept of a global network of stations for the international exchange of seismological data.[12] Within one year, this proposal was scientifically substantiated and presented in a second report.[13] From 1980 until 1982, three experiments[14] were conducted. They tested the transmission capability of the Global Telecommunications System (GTS) of the World Meteorological Organization (WMO), on a limited scale, and concluded that the GTS/WMO had the potential to fully satisfy requirements for transmitting Level I data. Level I data is a set of parameters extracted from the initial recordings of seismic events and serve the location of seismic events.

In 1984, the capability to transmit Level I data via the GTS/WMO was again tested, this time on a global scale, for a two months period, what was called the "Group of Scientific Experts Technical Test" (GSETT).[15] Seventy-five Technical National Facilities (TNFs) were established in thirty-seven countries[16], and Experimental International Data Centers (EIDCs) were created in Moscow, Stockholm and Washington, D.C.. The GSETT was generally assessed a success but it revealed some significant shortcomings such as the lack of equipment, standardization, unsophisticated equipment, the delay, and the partial or complete loss of information due to the limited capacity of the GTS/WMO, and the inability to associate data with a defined event due to the limited set of parameters.[17] Thereafter, the

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12 CCD/558, "Letter dated 9 March from the Chairman of the Ad-Hoc Group of Scientific Experts to Consider International Cooperative Measures to Detect and to Identify Seismic Events to the Co-Chairman of the Conference of the Committee on Disarmament Transmittinmg the Final Report of the Ad-Hoc Group"

13 CD/43 and Add 1., "Letter dated 25 July 1979 from the Chairman of the Ad-Hoc Group of Scientific Experts to Consider International Cooperation Measures to Detect and Identify Seismic Events to the Chairman of the Committee on Disarmament Transmitting the Second Report of the Ad-Hoc Group"

14 CD/318, "Progress Report to the Committee on Disarmament on the Fourteenth Session of the Ad-Hoc Group of Scientific Experts to Consider International Cooperative Measures to Detect and Identify Seismic Events"; CD/448, "Letter dated 9 March 1984 from the Chairman of the Ad-Hoc Group of Scientific Experts to Consider International Cooperative Measures to Detect and Identify Seismic Events to the President of the Conference on Disarmament transmitting the Third Report of the Ad-Hoc Group"

15 CD/535, "Progress Report to the Committee on Disarmament on the Eighteenth Session of the Ad-Hoc Group of Scientific Experts to Consider International Cooperative Measures to Detect and Identify Seismic Events"

16 When the original plan for the technical test was submitted to the CD the following countries had declared their participation: Australia, Austria, Belgium, Bulgaria, Canada, Czechoslovakia, Denmark, Egypt, Finland, German Democratic Republic, Federal Republic of Germany, Hungary, India, Indonesia, Islamic Republic of Iran, Italy, Japan, Netherlands, New Zealand, Norway, Peru, Romania, Sweden, Union of Soviet Socialist Republics, United Kingdom, United States of America, and Zambia. (CD/534, Letter Dated 10 August 1984 from the Chairman of the Ad-Hoc Group of Scientific Experts to Consider International Cooperative Measures to Detect and Identify Seismic Events to the President of the Conference on Disarmament Transmitting a Paper Entitled 'Procedures for the GSE Technical Test (GSETT) 1984' Adopted at the Eighteenth Session of the Ad-Hoc Group")
Following the appeal for wider participation in the technical test (CD/534) the following countries joined the exercise: Argentina, Bolivia, Brazil, Colombia, France, Ireland, Kenya, Pakistan, Thailand, and Zimbabwe.

17 CD/681, "Provisional Summary of the Fourth Report to the Conference on Disarmament of the Ad-Hoc Group of Scientific Experts to Consider International Cooperative Measures to Detect and Identify Seismic Events, Report on the Group of Scientific Experts' Technical Test (GSETT) 1984", CD/720 "Fourth Report to the Conference on Disarmament of the Ad-Hoc Group of Scientific Experts to Consider International Cooperative Measures to Detect and Identify Seismic Events, Report on the Group of Scientific Experts' Technical Test (GSETT) 1984"

Group of Scientific Experts made considerable improvements by taking into account modern communication channels which enable the transmission of more data in a shorter time.

The latest version of the proposed international seismic monitoring system which emerged from these improvements includes four elements: Seismograph Stations, National Data Centers (NDCs), International Data Centres (IDCs) and international data communication.

(a) **Seismograph Stations:**

Seismometers - the most important components of a seismograph station - are electro-mechanic instruments which detect seismic waves that are generated by seismic events (mainly natural earthquakes or nuclear explosions). Seismograph stations use different types of seismometers. Each of them is particularly sensitive to a specific type of seismic wave. The quality of the instrumentation of seismograph stations determines their detection capability. The proposed system envisages more than 50 existing or planned high-quality seismograph stations distributed world-wide which would be located on so-called "quiet sites" which are sites where seismic noise disturbances are minimal. Such disturbances are referred to as "background noise" and are caused by natural sources such as storms and winds, as well as human and industrial activities.

In order to participate in the proposed system, it is necessary to use either a three component single seismograph station which is capable of extracting data in both the short period (the range of nuclear explosions) and the long period bands (the range of earthquakes), or a seismic array station where a number of seismographs are arranged in a certain geometrical pattern, or both operating together. Both types of stations must contain a data acquisition system for the detection of seismic events, and a technical unit for the operation of the station as well as the recording, preparation and processing of data. The Group of Scientific Experts acknowledged that for an optimal global coverage, high-quality seismic stations must also be established in Africa and South America.

The Group conceives as the next step in the modernization of the global network, the development of the "CD-Station". This station is planned as the standard station in the global network. It will be able to collect and expeditiously exchange high-quality waveform data from seismic events at all distances, and to provide preliminary data on the location of detected events. The exact specifications of such a system has not yet been developed, but will be a major subject in the future work of the Scientific Group of Experts.

(b) **National Data Centers (NDCs):**

Each participating State is to be responsible for the establishment and operation of a National Data Center (NDC) in conformity with agreed procedures, through which it is to communicate with the international system.[18] The seismic data collected by seismograph stations is to be transmitted either from the stations or the NDCs, to International Data Centres (IDCs). The data must correspond to two internationally standardized levels:

Level I: Basic parameters of detected seismic signals which contain two types of parameters:

+ the period of one cycle, frequency, wavelength, amplitude and arrival time of the principal seismic phases that enables the location and assignment of the seismic event;

+ "identification" parameters which provide an approximate characterization of the seismic event, and which would enable a party with an interest in the seismic event to form a preliminary impression of the nature of the event; that is, a natural earthquake or a potentially man-made explosion.

Level II: Waveform data for events requiring further study. The more voluminous Level II data are the original reportings of a seismic event and allow further interpretation of the event.

Unlike previous versions of the proposed system, the transmission of Level II data is to be conducted on a routine basis, and Level I data is to be transmitted containing a smaller set of parameters than originally planned. Each NDC is to archive both levels of data, provide additional data on request, and receive bulletins of events from IDCs, and Level I or II data from any other NDC in the global network.

(c) International Data Centres (IDCs):

Special International Data Centers (IDCs) are to be established. Presently, plans exist to establish IDCs in Canberra, Australia; Stockholm, Sweden; Moscow, USSR; and Washington, D.C., U.S.. IDCs are to be equipped with equivalent computer software in order to process Level I and II data by applying agreed automatic procedures for the estimation of the origin time, location, magnitude and depth of seismic events. IDCs are to compare their results on a regular basis in order to eliminate any inconsistencies. The processing of identification data should merely encompass the compilation and association of data to seismic events, but should not assess the nature of the event.[19] Moreover, all data received and the results of their analysis should be stored in a data bank with on-line access for 15 days, and should thereafter be

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18 CD/903, "Fifth Report to the Conference on Disarmament of the Ad-Hoc Group of Scientific Experts to Consider Cooperative Measures to Detect and Identify Seismic Events; Technical Concepts for a Global System for International Seismic Data Exchange"

19 CD/43 and Add 1., "Letter dated 25 July 1979 from the Chairman of the Ad-Hoc Group of Scientific Experts to Consider International Cooperation Measures to Detect and Identify Seismic Events to the Chairman of the Committee on Disarmament Transmitting the Second Report of the Ad-Hoc Group"

available off-line. The data is to be made available in three types of reports on seismic event:

+ Each IDC is to prepare:

++ an initial event list (IEL) by using Level I data within 18 hours after the end of a daily reporting period; the purpose of IELs is to provide a preliminary list of events containing geographical coordinates, depth, magnitude and origin time of each identified seismic event.

++ a current event list (CEL) by using Level I and II data; the purpose of CELs is to provide a basis for the interpretation of a seismic event.

+ All IDCs are to prepare together a final event bulletin (FEB) which is to be circulated to participants within seven days of the data collection.

It has been questioned whether the proposed number of IDCs is necessary. Improved high-speed communication channels may enable any NDC to obtain the necessary data from any other NDC without the assistance of IDCs. Therefore it appears that in the course of further elaboration, the number of IDCs may be reduced, or IDCs may be eliminated entirely.

(d) **International data communication:**

The global network envisages the transmission of information, messages and seismological data via rapid, reliable, high capacity international channels, using modern technology. Communication channels are to be established between seismograph stations and NDCs, NDCs and IDCs, and among IDCs.

The data links between seismic stations and NDCs are to be provided by each participating State.

For the communication between NDCs and IDCs, the most efficient communication is to be chosen from commercially available means which include the international Packet-Switched Data Network[20] and the Global Telecommunication System (GTS) of the World Meteorological Organization (WMO)[21]. The latter played the most significant role in the original concept because it was based on Level I data exchange and, at that time, the GTS was the only existing telecommunication system that reached essentially every country on the globe. Presently, however, it has lost its significance due to its limited capacity regarding data load, efficiency of data transmission, and transmission time. Two conflicting approaches are proposed for the communication between NDCs and IDCs which will be subject of further deliberations:

20 The International Packet-Switched Data Network offers reliable, rapid, and practically error free transmission from and to more than 70 countries.

21 The WMO/GTS is operated jointly by 155 member States of the World Meteorological Organization and is basically used by the World Weather Watch to exchange meteorological data.

- Regional approach: each IDC receives data from NDCs in the region and automatically and instantaneously transmits this data to other IDCs.
- Integrated approach: all IDCs receive data from all NDCs.

For the transmission of data among IDCs, satellite communication is to be used. Such communication channels are also to be made available to NDCs. Real-time and high-capacity communication links have gained major importance in the latest version of the proposed system and continues to give the main impetus for further changes in the proposed system.

The latest version of the proposed system is currently undergoing another global experiment - GSETT 2. The experiment is mainly focusing on the methods and procedures developed by the Group of Scientific Experts to expeditiously extract and transmit Level II data from stations to EIDCs, to process this data at EIDCs, and to transmit the results back to participants. The results of the test will be available in 1991/1992.[22] This and the previous full-scale experiment aimed at the transmission capability of communication channels. However, nothing is known about the performance of the system under conditions that would persist in the presence of a comprehensive test ban treaty, taking into account the geographical distribution of seismic stations and their technological standards.

6.3 The Capacity of an International Seismic Monitoring System

The evaluation of the capacity of an international seismic monitoring system is to a large extent a political problem because the adequacy of a verification system is governed by political requirements. In principle, a monitoring network can be developed to meet any political requirements. In 1982, the U.S. and the UK clarified their understanding of "adequacy" as not only technical, but as a "matter for political decision by each government in light of its national requirements and the circumstances prevailing at the time the decision was called"[23]. A number of non-aligned countries, on the other hand, have considered verification capabilities to be adequate and feel that the absence of negotiations on a test ban depicts a lack of political will to reach agreement.[24]

Since the Group of Scientific Experts introduced their initial concept in 1978, the capacity of the system has been evaluated for seismological detection and identification

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22 CD/853, "Progress Report to the Conference on Disarmament on the Twenty-Sixth Session of the Ad-Hoc Group of Scientific Experts to Consider International Cooperative Measures to Detect and Identify Seismic Events", CD/904, "Progress Report to the Conference on Disarmament on the Twenty-Seventh Session of the Ad-Hoc Group of Scientific Experts to Consider International Cooperative Measures to Detect and Identify Seismic Events", CD/944, "Progress Report to the Conference on Disarmament on the Twenty-Eighth Session of the Ad-Hoc Group of Scientific Experts to Consider International Cooperative Measures to Detect and Identify Seismic Events", CD/981, "Progress Report to the Conference on Disarmament on the Twenty-Ninth Session of the Ad-Hoc Group of Scientific Experts to Consider International Cooperative Measures to Detect and Identify Seismic Events"

23 CD/332, "Report of the Ad Hoc Working Group on a Nuclear Test Ban", p.6

24 See e.g. CD/PV.107 (Sri Lanka), CD/PV.108 (Yugoslavia), CD/PV.545 (Argentina), CD/PV.315 (Brazil), CD/PV.342 (India),

capabilities. These evaluations contributed to the improvement of the proposed system which, in 1989, was assessed by the Scientific Group of Experts as technically feasible but beyond what is presently available on a global scale.[25] The capability of a seismic monitoring network depends on the ability to detect and identify weak seismic signals. The detection of a seismic signal is simpler than its identification. A small amount of data is sufficient for detection, but for identification, more information is required. Seismic signals are recorded by the magnitude of seismic waves which can be expressed in terms of the yield of an explosion. The seismic magnitude-yield relationship, however, depends on the tectonical and geological environment in which an explosion is conducted. In hard rock, a magnitude of 5.0 corresponds to a yield of 10 to 5 kilotons, whereas in dry unconsolidated rock, the same magnitude corresponds to 100 to 50 kilotons. Correspondingly, a magnitude of 4.0 corresponds to about 1 kiloton in hard rock, and 10 to 5 kilotons in dry unconsolidated rock. The Scientific Group of Experts has estimated a detection threshold of 4.0 for the proposed system.[26]

In 1984, the Federal Republic of Germany estimated that the detection of seismic events was between the body wave magnitude 3.8 and 4.2 in the northern, and 4.0 to 4.6, in the southern hemisphere with a probability of 90 per cent.[27] After the GSETT had demonstrated that the detection capability varies between 3.8 and 4.9, the Federal Republic of Germany estimated the detection capability of the present state of the art at a magnitude of roughly 5.0.[28] This estimation was criticized by Sweden which stated that, by taking into account the detection of seismic signals at regional distances, the detection threshold was a magnitude of 2.0-2.5. Furthermore, Sweden referred to studies proving that some twenty stations installed on the territory of the Soviet Union and the U.S. succeeded in lowering the detection threshold to a magnitude of 3.0, with a probability of 90 per cent.[29]

In a broader context, namely the immediate establishment of an international seismic verification system (See 6.5), a German proposal[30] distinguished between the global and the regional level. For teleseismic monitoring it proposed a two step approach. The first step was to use the inherent capabilities of the present system which would improve the level of detection from a magnitude of 5.0 to 4.7. In a second step, the threshold could be lowered to a magnitude of 4.0 by establishing an optimal geographical distribution of seismic stations and the regular transmission of Level II data via modern telecommunication systems. On the regional level, yields of 10 kilotons could be detected and identified by array stations and, if placed in boreholes, the detection and identification threshold could be lowered to as low as 1 kiloton.

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25 CD/903, "Fifth Report to the Conference on Disarmament of the Ad-Hoc Group of Scientific Experts to Consider Cooperative Measures to Detect and Identify Seismic Events; Technical Concepts for a Global System for International Seismic Data Exchange"

26 Interview on 14.02.1991 with Dr. Frode Ringdahl who acts as the Ad-Hoc Group's Scientific Secretary.

27 CD/491, Federal Republic of Germany, "Working Paper on Aspects of Modern Developments in Seismic Event Recording Techniques"

28 CD/624, Federal Republic of Germany, "A System Design for the Gradual Improvement of Seismic Monitoring and Verification Capabilities for a Comprehensive Test Ban", p.1

29 CD/712, Sweden, "Nuclear Test Ban Verification"

30 ibid; CD/624, Federal Republic of Germany, "A System Design for thr Gradual Improvement of Seismic Monitoring and Verification Capabilities for a Comprehensive Nuclear Test Ban"

The United Kingdom added the distinction between detection and identification thresholds. It estimated that a global network of seismic stations would have a threshold of 4.0 for the former and 4.5 for the latter. Hence, the United Kingdom concluded that nuclear explosions above the yield of some tens of kilotons could be discovered, but that militarily significant testing could be carried out below this level. In addition, the UK argued that confidence in the availability of valid data could not be assured for all areas of the world where nuclear explosions could be carried out.[31] In Japan' view, however, the capability to detect a magnitude of 4.0, with a confidence of 90 per cent, would suffice as an initial target.[32]

6.4 Proposals on the Improvement of an International Seismic Monitoring System

Since the Group of Scientific Experts presented the original concept of an international seismic monitoring network in 1978, continous proposals on seismic monitoring techniques have added to the improvement of the network. Considerable progress has been achieved on seismic stations and communication channels.

The costs of such improvements were calculated by Japan. It was not clear, however, whether these costs were to be shared, or if they would be covered by individual countries.[33] The Federal Republic of Germany stated that this question deserved separate consideration at the appropriate time.[34] The Group of 21 has not submitted any technical proposals for the seismic monitoring of a nuclear test ban treaty, but has stated that it envisages a verification system that is universal in its application, non-discriminatory in its nature, and guaranteeing equal access to all States.[35] The Group has pointed to the fact that only those countries that are capable of affording the costs for national seismic stations, their upgrading and maintenance can participate in the international exchange system. Moreover, the problem of financing seismic stations not only prevents a universal participation of State parties but also impinges on the optimal geographical distribution of the entire network. In this context, Sweden suggested making advanced and modern monitoring systems available to all States and not only to a limited number of well-equipped countries.[36] Six States of the G21 proposed that the costs should be mainly shared among the parties.[37]

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31 CD/610, United Kingdom, "Seismic Monitoring for a Comprehensive Nuclear Test Ban"; the UK had drawn a similiar conclusion already in a paper in 1983. (CD/402 (CD/NTB/WP.7), United Kingdom, "Verification Aspects of a Comprehensive Test Ban Treaty (CTB)")

32 CD/389, Japan, "Views on a System of International Exchange of Seismic Data".

33 CD/626, Japan, "Concrete Measures for the Realization of the International Seismic Data Exchange System"

34 CD/621, Federal Republic of Germany, "Working Paper on A Proposal for the Establishment and Progressive Improvement of an International Seismic Monitoring and Verification System Relating a Comprehensive Nuclear Test Ban"

35 CD/PV.(565 (India)

36 CD/PV.182 (Sweden)

37 CD/1054, Letter Dated 4 February 1991 from the Representatives of Indonesia, Mexico, Peru, Yugoslavia and Sri Lanka Addressed to the President of the Conference on Disarmament Transmitting Draft Protocol II of Amendment to the Treaty Banning Nuclear Weapons Tests in the Atmosphere, in Oter Space and Under Water"

6.4.1 Proposals on a CD-Station

Seismic background noise has been one of the main reasons for the unsatisfactory detection and identification threshold of the proposed global system. However, in principle, it is possible to lower the threshold to any magnitude by increasing the density of seismic stations.[38] In this context "CD monitoring stations" were suggested. A CD-Station is a well-equipped standard station that provides high quality data for monitoring seismic events at both teleseismic (3000 to 10000 kilometers) and regional distances (less than 3000 kilometers).

The need for CD-stations has been expressed by the Federal Republic of Germany[39], the United Kingdom[40], Japan[41], Sweden[42] and the Scientific Group of Experts[43]. This type of station has been accepted for the proposed system. In their assessment, all stations must be equipped with standardized digital seismographs and computer processing, especially stations in Africa, the South Pacific, South America which are underequipped. Such stations are also required on the ocean floor where they do not, at present, exist at all.

6.4.2 Proposals on Array Stations

Array stations have increasingly received attention since they are particularly capable of detecting and identifying very low yield seismic events at regional distances (less than 3000 km) although their range can reach teleseismic distances (up to 10000 kilometers). This capability appears to be effective with respect to evasion scenarios. Evasion scenarios include the conduct of a nuclear explosion shortly after the start of a large earthquake, the conduct of several nuclear explosions to simulate an earthquake, or conducting an explosion in a large underground cavity thereby reducing the generation of seismic waves.[44]

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38 CD/624, Federal Republic of Germany, "A System Design for the Gradual Improvement of Seismic Monitoring and Verification Capabilities for a Comprehensive Nuclear Test Ban", pp.36-37; Japan suggested as a starting point a number of 50 stations which, along with improvements in communication and data processing, can be increased. (CD/389, Japan, Views on a System of International Exchange of Seismic Data"

39 CD/621, Federal Republic of Germany, "Working Paper on A Proposal for the Establishment and Progressive Improvement of an International Seismic Monitoring and Verification System Relating a Comprehensive Nuclear Test Ban"; CD/624, Federal Republic of Germany, "A System Design for the Gradual Improvement of Seismic Monitoring and Verification Capabilities for a Comprehensive Nuclear Test Ban"

40 CD/610, United Kingdom, "Seismic Monitoring for a Comprehensive Test Ban Treaty"

41 CD/389, Japan, Views on a System of International Exchange of Seismic Data"; CD/626, Japan, "Concrete Measures for the Realization of the International Seismic Data Exchange System"

42 CD/712, Sweden, "Nuclear Test Ban Verification"

43 CD/681/Rev.1, "Summary of the Fourth Report to the Conference on Disarmament of the Ad-Hoc Group of Scientific Experts to Consider International Cooperative Measures to Detect and Identify Seismic Events (CD/720)"

44 Presently array stations exist in Australia (2), Brazil (1), Canada (1), Finland (1), Germany (2), India (1), Norway (3), Sweden (1), the United Kingdom (1), United States (1).

The importance of array stations was buttressed by reports from the UK, Japan, Sweden and the Federal Republic of Germany.[45] A preliminary analysis of the capabilities of array stations gave a detection threshold of about 2.0-2.5 at a 1000 kilometer distance from the epicenter which is a magnitude of 2 units lower than that given by traditional seismic stations.[46]

Norway, an observer to the CD, has been pursuing a national research program on seismic array stations.[47] For this reason, in 1968, it established in cooperation with the United States, the Norwegian Seismic Array (NORSAR). NORSAR is an observatory comprising 49 seismometers spread over an area of 60 kilometers in diameter which has been in operation since 1970.[48] It is primarily designed for the detection and location of seismic events at teleseismic ranges (3000 to 10000 kilometers). In 1983, the Norwegian Government declared its willingness to make NORSAR available to the envisaged global seismological network.[49]

In 1985, under the cooperative research agreement with the United States, Norway constructed a small aperture array named the Norwegian Experimental Regional Array (NORESS). The main purpose of NORESS is detection and location of seismic events at regional distances (less than 3000 kilometers).[50] Compared to traditional seismic stations, the NORESS array station demonstrated that for regional distances a detection threshold of 2.5 can be achieved, and even for teleseismic distances, significant improvements in detection can be achieved to a magnitude of 0.5 units superior to traditional seismograph stations.[51] Furthermore, array stations provide advantages by using automatic data processing, seismic phase identification, and location estimations.[52] Therefore, Norway stated that small-aperture array stations would offer a possible basis for standardization and modernization of a global seismic network and proposed to incorporate this technology into the proposed seismic

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[45] CD/610, United Kingdom, "Seismic Monitoring for a Comprehenisve Nuclear Test Ban"; CD/390, Japan, "Working Paper on a Contribution to an International Monitoring System Using a Newly Installed Small Seismic Array of Japan"; CD/712, Sweden, "Nuclear Test Ban Verification"; CD/491, Federal Republic of Germany, "Aspects of Modern Developments in Seismic Event Recording Techniques"; CD/610, Federal Republic of Germany, "A Proposal for the Establishment and Progressive Improvement of an International Seismic Monitoring and Verification System relating to a Comprehensive Nuclear Test Ban"; CD/624, Federal Republic of Germany, "A System Design for the Gradual Improvement of Seismic Monitoring and Verification Capabilities for a Comprehensive Nuclear Test Ban"

[46] CD/712, Sweden, "Nuclear Test Ban Verification"

[47] CD/310, Norway, "Working Paper on a Prototype Sytem for International Exchange of Seismological Data Under a Comprehensive Test Ban Treaty", CD/395, Norway, "The Role of International Seismic Data Exchange Under a Comprehensive Nucler Test Ban"

[48] CD/507, Norway, Working Paper on Seismic Verification of a Comprehensive Nuclear Test Ban: Future Directions", CD/599, Norway, "Working Paper on Seismological Verification of a Comprehensive Nuclear Test Ban: Report on the Workshop in Oslo, Norway, 4-7 June 1985"

[49] CD/395, Norway, "The Role of International Seismic Data Exchange Under a Comprehensive Nucler Test Ban", p.2

[50] CD/507, Norway, Working Paper on Seismic Verification of a Comprehensive Nuclear Test Ban: Future Directions"

[51] CD/862, Norway, "Verification of a Comprehensive Nuclear Test Ban: Establishing a Global Seismological Network Incorporating Small-Apperture Arrays"

[52] CD/763, Norway, "Verification of a Comprehensive Nuclear Test Ban: Principles for a Modern Seismic Data Exchange System

monitoring system.[53] In 1987, Norway built another array on a smaller scale called the Arctic Experimental Seismic System (ARCESS) containing 25 seismometers in four concentric rings, with a maximum diameter of 3 kilometers.

Norway held workshops in 1985 and 1990 on the verification of a comprehensive nuclear test ban. They included demonstrations of Norwegian seismological facilities which demonstrated the advancement in seismology, but also the shortcomings of present technological capabilities in detecting and identifying very low-yield explosions, explosions in environments that produce very weak seismic signals, and the limited seismic detection capability after the occurrence of large earthquakes.[54]

6.4.3 Proposals on In-Country Seismic Stations

In-country seismic stations are unmanned seismic stations on the territory of nuclear weapons States, or in regions with high seismic activity, which transmit seismic data to outside institutes. However, the Scientific Group of Experts is not permitted to consider in-country seismic stations because they are considered national technical means of verification (NTM) which are explicitly excluded from the Group's mandate.

Sweden has estimated that 15 to 20 of such stations in the U.S. or the USSR would have a detection threshold of 3.0 corresponding to a yield of 0.1 kilotons in hard rock. If array stations were used, this threshold could be further lowered.[55] A similar view was taken by the Federal Republic of Germany which argued that the detection of yields down to 1 kiloton might be possible when in-country networks were spaced over distances of 500 to 1000 kilometers in areas where decoupled testing was feasible.[56] Japan added that in-country seismic stations should also be placed around test sites, and should be included in the international data exchange system.[57]

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[53] CD/714, Norway, "Working Paper on Seismological Verification of a Comprehensive Nuclear Test Ban: Utilization of Small-Aperture Seismic Arrays in a Global Seismological Network"; CD/935, Norway, "Verification of a Comprehensive Nuclear Test Ban: The Norwegian Seismic Verification Programme; Summary of Research Results 1988/89"

[54] CD/599, Norway, "Working Paper on Seismological Verification of a Comprehensive Nuclear Test Ban: Report on the Workshop in Oslo, Norway, 4-7 June 1985"; CD/1010, Norway, "Verification of a Comprehensive Nuclear Test Ban: Report on the Workshop on Seismological Aspects of Nuclear Test Ban Verification in Oslo, Norway, 14-17 February 1990".

[55] CD/712, Sweden, "Nuclear Test Ban Verification"

[56] CD/612, Federal Republic of Germany, "Working Paper on a Proposal for the Establishment and Progressive Improvement of an International Seismic Monitoring and Verification System Relating to a Comprehensive Nuclear Test Ban", CD/624, Federal Republic of Germany, A System Design for the Gradual Improvement of Seismic Monitoring and Verification Capabilities for a Comprehensive Nuclear Test Ban"

[57] CD/626, Japan, "Concrete Measures for the Realization of the International Seismic Data Exchange System"

6.4.4 Proposals on Communication Channels

Communication channels mark a significant component in the proposed global seismic monitoring system because the rapid transmission of data is essential to the effectiveness of the entire system.

For the transmission of Level I data the GTS/WMO has been the only major communication channel proposed for the network. Since the establishment of a completely new communication system would require considerable costs, it was proposed to improve and additionally equip the existing system.[58] Japan noted that the western and southern part of Africa, the south-west part of Asia, some parts in South America, and some parts of the South-West Pacific region require improvements in low-speed circuits, and equipment in Africa, South America and Eastern Europe needed to be automatized. In addition, Japan suggested that the personnel working at the GTS stations should be familiar with the handling of Level I data.[59] The mishandling of data was one of the main sources that led to data loss or miscommunication of messages in the GSETT exercise. Furthermore, Japan argued that each State was to be responsible for the maintenance of communication between seismic stations and GTS stations.[60] Nonetheless, the significance of the WMO/GTS in the proposed global network has decreased because the regular exchange of the voluminous Level II data is practically only feasible via high-capacity communication channels.

Until 1986, the USSR argued that Level II data was only needed in a small number of cases, and only in a volume sufficient to permit identification of the nature of a given event.[61] Thereafter it agreed to the regular exchange of Level II data.[62] Level II data contains a much larger amount of information and is therefore more difficult to transmit. Hence, communication channels are required which are quick and capable of dispatching large quantities of information. One proposal is the use of a low-cost microprocessor which could easily transmit Level I and II data via ordinary telephone lines.[63] The Federal Republic of Germany suggested, as a transitional measure, that those stations which currently do not have this technology available, transmit Level II data on magnetic tape via mail service.[64] The final goal, however, would be the transmission of Level II data via international packet switch

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58 CD/389, Japan, "Views on a System of International Exchange of Seismic Data"

59 CD/626, Japan, "Concrete Measures for the Realization of the International Seismic Data Exchange System"

60 CD/389, Japan, "Views on a System of International Exchange of Seismic Data"

61 CD/PV.183 (USSR), CD/PV.197 (USSR), CD/346 "Letter Dated 14 February 1983 from the Representative of the Union of Soviet Socialist Republics to the Committee on Disarmament Transmitting the 'Basic Provisions of a Treaty on the Complete and General Prohibition of Nuclear Weapon Tests'"

62 CD/724 "Seismic Verification of the Non-Conducting of Nuclear Tests (Proposal Concerning the Exchange of Level II Seismic Data); see also CD/PV.372 (USSR)

63 CD/310, Norway, "Working Paper on a Prototype System for International Exchange of Seismological Data Under a Comprehensive Test Ban Treaty"; CD/389, Japan, Views on a System of International Exchange of Seismic Data"; CD/624, Federal Republic of Germany, "A System Design for the Gradual Improvement of Seismic Monitoring and Verification Capabilities for a Comprehensive Nuclear Test Ban"

64 CD/624, Federal Republic of Germany, "A System Design for the Gradual Improvement of Seismic Monitoring and Verification Capabilities for a Comprehensive Nuclear Test Ban"

boards[65] or satellites[66]. With respect to satellite communication, the Federal Republic of Germany proposed the use of INTELSAT whereas Norway favoured INMARSAT.[67]

6.5 The Immediate Establishment of an International Verification Network

As with most arms control and disarmament treaties, verification measures for a nuclear test ban treaty confront a dilemma. On the one hand, the Group of Scientific Experts is elaborating an international monitoring network for a test ban treaty although only parties to such a treaty are legally permitted to decide on its verification procedures. There are, however, no parties until a test ban treaty is at hand. On the other hand, the potential parties to such a treaty may want to have the verification system in place at the time the treaty enters into force. However, various elements of the verification system would first have to be negotiated and made operational.

In the view of Socialist countries, an international data exchange system could only be established after the succesful negotiation of a comprehensive test ban treaty.[68] Moreover it was argued that the establishment of such a system without consideration to on-site inspections, or monitoring of other than underground events, would create artificial problems which do not in practise exist.[69]

Other countries, however, such as the Federal Republic of Germany, Japan, and Australia, argued that the immediate establishment and improvement of such a system would foster the negotiating process for a comprehensive test ban treaty.

(a) In 1985, the Federal Republic of Germany suggested the establishment of an international seismic monitoring network which would be gradually improved.[70] The system would be comprised of an international seismic monitoring network, in-country seismic stations and a verification authority consisting of a Consultative Committee, a Committee of Experts and a Secretariat. The institutional arrangements will be separately presented in Chapter VII.

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65 ibid

66 CD/491, Federal Republic of Germany, "Aspects of Modern developments in Seismic Event Recording Techniques"; CD/395, Norway, "The Role of International Seismic Data Exchange Under a Comprehensive Nuclear Test Ban"

67 ibid

68 CD/PV.183 (USSR), CD/756, "Letter Dated 8 June 1987 from the Representatives of Bulgaria, Czechoslovakia, the German Democratic Republic, Hungary, Mongolia, Poland, Romania and the Union of Soviet Socialist Republics, Addressed to the President of the Conference on Disarmament, Transmitting the Text of the 'Basic Provisions of a Treaty on the Complete and General Prohibition of Nuclear Weapon Tests'"

69 CD/PV.327 (German Democratic Republic)

70 CD/612, Federal Republic of Germany, "Working Paper on A Proposal for the Establishment and Progressive Improvement of an International Seismic Monitoring and Verification System Relating to a Comprehensive Nuclear Test Ban" and CD/624, Federal Republic of Germany, "A System Design for the Gradual Improvement of Seismic Monitoring and Verification Capabilities for a Comprehensive Nuclear Test Ban "

For the international monitoring network the paper suggested as a first step, to use 50 to 100 existing seismic installations. It was estimated that such a system would be operational in about two years. In its first phase, the network would only report Level I data while the transmission of Level II data was concurrently tested. In a second step, the system would be upgraded using inherent capabilities whereas, in a third step, the network would be upgraded by standardizing the seismic stations, distributing them optimally around the globe, regularly exchanging Level II data, and using satellite communication. This would increase the detection capability from an initial magnitude of 5.0 to 4.0 corresponding to a yield of 5 to 10 kilotons in dry rock. In-country networks would be placed on the territory of nuclear weapons states. A rough time-frame of 4 to 8 years was estimated.

(b) Japan proposed the establishment of a multilateral verification network on the basis of existing facilities and equipment. The proposal was based on the international monitoring network proposed by the Group of Scientific Experts. A computer simulation would assess the capability of the system and provide information for improvements. Thereafter, a continous refinement in the verification capabilities would be pursued until a system was developed that was capable of detecting and identifying with a high degree of confidence, an underground nuclear explosion of any kind, at any place.[71]

Regarding the current capabilities, Japan placed special emphasis on the standardization of the hard- and software of seismic stations, the improvement of current capabilities in the detection of seismic events, and the transmission of seismic data, especially in under- or poorly equipped regions, as well as the installation of seismic stations on the ocean floor. It suggested an additional monitoring network in areas where the impact of explosions could be significantly reduced due to geological or tectonic circumstances. These are particularly areas of high seismic activity at the borders of the tectonic plates. For the extraction of Level I data, the Japanese proposal called for a specification of parameters and an automatization of extracting data. With respect to Level II data, the form of communication was to depend on the technological circumstances of the individual countries. The data, however, should be transmitted in digital form.

(c) In 1986, Australia referred to the proposals made by the Federal Republic of Germany and Japan, and stressed its view that "the best way of taking forward the CD's work on a global seismic monitoring network would be to begin building it"[72]. Hence, it formally proposed to the Conference on Disarmament to agree on the establishment of a global monitoring network based on existing facilities and equipment, to make available appropriate national facilities and equipment, in member as well as non-member countries, and to mandate the Group of Scientific Experts to prepare within six months a plan of action for the further development of the global seismic network.[73]

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[71] CD/626, Japan, "Concrete Measures for the Realization of the International Seismic Data Exchange System"

[72] CD/717, Australia, "Proposal for the Immediate Establishment of a Global Seiasmic Network as Part of a Monitoring and Verification System for the Future Comprehensive Nuclear Test Ban"

[73] In 1983, Australia had proposed that the seismic monitoring system elaborated by the Scientific Group of Experts should be operational at the time that the envisaged nuclear test ban treaty entered into force.

(d) The latest proposal for the immediate establishment of an international verification network was tabled by some States of the Group of 21 in 1991.[74] The proposal was initially intended as a protocol to the PTBT, to be considered at the PTBT Amendment Conference. It was subsequently tabled as a CD paper. If the PTBT had been successfully amended, its provisions would have had to be verified using existing monitoring capabilities. This would have meant the immediate establishment of a verification network. The group's proposal envisaged a monitoring system comprised of seismic monitoring, monitoring of airborne radioactivity, and monitoring of outer space. Monitoring stations were to be placed on the territory of the parties, on international territory, and on the territory of nuclear weapons States. More than 300 seismic stations were to be used. The proposed system was to achieve a monitoring capability equal to a seismic magnitude of 3.5 world-wide, which corresponds to a yield of 0.5 kiloton in hard rock and a magnitude of 1.7 (0.005 kiloton) on the territory of nuclear weapons States. Some experts consider the detection threshold of 0.5 kilotons feasible, but a threshold of 0.005 kilotons unrealistic.[75]

6.6 The Missing Link Between Seismic Monitoring and Verification Systems

Monitoring describes an intelligence function that provides information on compliance. The Group of Scientific Experts has elaborated scientific and technical aspects of a seismic monitoring system for a nuclear test ban. Verification, on the other hand, describes a process of making political judgements on the compliance behaviour of a party to a particular agreement.[76] Discussions at the CD have treated those two topics separately under the headings verification and compliance, but not much attention has been paid to measures and procedures linking the two. Nonetheless, several attempts were undertaken to clarify the integration of an international seismic monitoring system with a verification system.[77] In draft treaties by Sweden and the USSR in 1983, and in a proposal by six States in 1991, the link between a seismic monitoring and a verification system became somewhat clearer.[78]

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[74] CD/1054, Letter Dated 4 February 1991 from the Representatives of Indonesia, Mexico, Peru, Yugoslavia and Sri Lanka Addressed to the President of the Conference on Disarmament Transmitting Protocol II of Amendment to the Treaty Banning Nuclear Weapons Tests in the Atmosphere, in Outer Space and Under Water"

[75] Indonesia, Mexico, Peru, Venezuela, Yugoslavia and Sri Lanka are not participating in the work of the Scientific Group of Experts.

[76] See e.g. Stephen M. Meyer, Verification and Risk in Arms Control, in *International Security*, Spring 1984, p.80; Ellis Morris, The Verification Issue in United Nations Disarmament Negotiations, UNIDIR, New York, United Nations, 1987, pp.1-3.

[77] See e.g. CD/95, Australia, "An Illustrative List of Subjects which might be Examined by the Committee on Disarmament in Considering Agenda Item 1 'Nuclear Test Ban'", CD/531, Australia, "Principles for the Verification of a Comprehensive Nuclear Test Ban Treaty", CD/PV.157 (Australia)

[78] CD/381, Sweden, Draft Treaty Banning Any Nuclear Weapon Test Explosion in Any Environment", CD/346, Soviet Union, "Letter Dated 14 February 1983 From the Representative of the Union of Soviet Socialist Republics to the Committee on Disarmament Transmitting the 'Basic Provisions of a Treaty on the Complete and General Prohibition of Nuclear Weapon Tests'", CD/612, Federal Republic of Germany, "A Proposal for the Establishment and Progressive Improvement of an International Seismic Monitoring and Verification System Relating to a Comprehensive Nuclear Test Ban", CD/1054, "Letter Dated 4 February 1991 from the Representatives of Indonesia, Mexico, Peru, Venezuela and Sri Lanka Addressed to the President of the Conference on Disarmament Transmitting Draft Protocol II of Amendment to the Treaty Banning Nuclear Weapons Tests in the Atmosphere, in Outer Space and Under Water"

In proposals it was envisaged that each participating State would designate an appropriate National Body to handle communication. This would consist of not only the exchange of seismic data between NDCs and IDCs, as suggested by the Group of Scientific Experts, but also managing the contacts with other institutions in the verification system.[79] (See Chapter VII).

Unlike previous versions, the latest version of the proposed global seismic monitoring system added NDCs as a fourth component. The NDCs would perform a multitude of technical functions and procedures, and could therefore serve as a basis for a National Body which also handle political aspects such as complaints and on-site inspections.

6.7 Monitoring Techniques other than Seismological

6.7.1 Airborne Radioactivity

The detection of airborne radioactivity has been discussed as a complement to seismic monitoring within the framework of an international monitoring system. Seismological monitoring focuses mainly on underground seismic events whereas the monitoring of airborne radioactivity covers the above ground environment. The only existing test ban treaty, the PTBT, prohibits nuclear explosions in all environments except underground. It assumes, however, only national technical means of verification (NTM). Therefore, in 1982, Sweden proposed an international system for the detection of airborne radioactivity which consist of fifty to one hundred well-distributed data collection stations and international analysing centres located on each continent. It argued that the costs involved were moderate.[80] In addition, it held that the surveillance of the atmosphere would also make a valuable contribution to confidence-building in existing agreements such as the PTBT and the NPT, and would contribute to the identification of possible nuclear explosions carried out by countries not parties to these treaties.[81] This proposal was also reflected in a draft treaty that Sweden submitted in 1983.[82]

In 1984, the Swedish proposal was taken up by the USSR[83] and, in 1987, a Group of Socialist States tabled a draft treaty which included the establishment of an international exchange of data on atmospheric radioactivity that would include aerosol monitoring stations

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79 CD/381, Sweden, Draft Treaty Banning Any Nuclear Weapon Test Explosion in Any Environment", CD/346, Soviet Union, "Letter Dated 14 February 1983 From the Representative of the Union of Soviet Socialist Republics to the Committee on Disarmament Transmitting the 'Basic Provisions of a Treaty on the Complete and General Prohibition of Nuclear Weapon Tests'", CD/1054, "Letter Dated 4 February 19991 from the Representatives of Indonesia, Mexico, Peru, Venezuela and Sri Lanka Addressed to the President of the Conference on Disarmament Transmitting Draft Protocol II of Amendment to the Treaty Banning Nuclear Weapons Tests in the Atmosphere, in Outer Space and Under Water"

80 CD/257, Sweden, "An International System for the Detection of Airborne Radioactivity from Nuclear Explosions"; see also CD/PV.161 (Sweden); CD/403 (CD/NTB/WP.9), Sweden, "International Surveillance of Airborne Radioactivity"

81 CD/PV.161 (Sweden), CD/PV.182 (Swden)

82 CD/381, Sweden, "Draft Treaty Banning Any Nuclear Weapon Test Explosion in Any Environment"

83 CD/PV.260 (USSR)

on the territory of States parties.[84] The issue has been treated only peripherically so far but is gaining importance in the discussion on the future plans of the Scientific Group of Experts.[85]

6.7.2 On-Site Inspection

The issue of on-site inspections was a stumbling block in negotiations on the PTBT. During the past ten years on-site inspections have been treated only marginally in the discussions in the CD on a nuclear test ban. In the context of a CTBT, on-site inspections could be applied to check the source of an unidentified seismic event. Other purposes could include verifying the non-functioning of nuclear weapons test sites[86], or invited visits to observe large non-nuclear explosions to dispell possible suspicions.[87] Regarding the verification of unidentified seismic events, the main problem with on-site inspections may be the difficulty in identifying a sufficiently small area where the inspection would take place. During the past ten years three sorts of on-site inspections have been considered in respect to the test ban issue: on-site inspections with the right of refusal by the requested party; on-site inspections without the right of refusal; and on-site inspections initiated by a secretariat.

(a) **On-site inspection with the right of refusal:** This option would allow any party that wishes to clarify a suspicious event on the territory of another party to request additional data either from an institution established under a test ban treaty[88], or through bilateral consultations with the other party.[89] If the situation could not be satisfactorily clarified, the requesting party could ask for an international on-site inspection. If the requested party rejected this request, it would have to state the reasons for its decision.

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84 CD/756, "Letter Dated 8 June 1987 from the Representatives of Bulgaria, Czechoslovakia, the German Democratic Republic, Hungary, Mongolia, Poland, Romania and the Union of Soviet Socialist Republics, Addressed to the President of the Conference on Disarmament, Transmitting the Text of the 'Basic Provisions of a Treaty on the Complete and General Prohibition of Nuclear Weapon Tests'"

85 Norway, an observer to the CD, expressed its support for this additional verification measure (CD/PV.343 (Norway)) whereas Cuba questioned the necessity of additional monitoring of airborne radioactity and referred to the PTBT which had worked effectively without international control mechanisms (CD/PV.221 (Cuba)). More support was expressed by CD/NTB/WP.5, Belgium, "Analysis of 20 Years' Observation of Atmospheric Radioactivity in Belgium", CD/531, Australia, "Principles for the Verification of a Comprehensive Nuclear Test Ban Treay", CD/746, German Democratic Republic, "Nuclear Test Ban", CD/902, Letter Dated 16 March 1989 Addressed to the President of the Conference on Disarmament from the Representative of the German Democratic Republic Transmitting a Working Paper on the Verification of a Nuclear Test Ban".

86 CD/756, "Letter Dated 8 June 1987 from the Representatives of Bulgaria, Czechoslovakia, the German Democratic Republic, Hungary, Mongolia, Poland, Romania and the Union of Soviet Socialist Republics, Addressed to the President of the Conference on Disarmament, Transmitting the Text of the 'Basic Provisions of a Treaty on the Complete and General Prohibition of Nuclear Weapon Tests'"; the German Democratic Republic proposed the same in a separate paper, CD/902, German Democratic Republic, "Letter Dated 16 March 1989 Addressed to the President of the Conference on Disarmament from the Permanent Representative of the German Democratic Republic Transmitting a Working Paper on the Verification of a Nuclear Test Ban"

87 CD/381 "Draft Treaty Banning any Nuclear Weapon Test Explosion in any Environment"

88 CD/346 "Letter Dated 14 February 1983 from the Representative of the Union of Soviet Socialist Republics to the Committee on Disarmament Transmitting the 'Basic Provisions of a Treaty on the Complete and General Prohibition of Nuclear Weapon Tests'"

89 CD/381 "Draft Treaty Banning any Nuclear Weapon Test Explosion in any Environment"

(b) **On-site inspections without the right of refusal:** Under this formula a party could request an international on-site inspection if a suspicous event could not be clarified through consultations. The requested party would be obliged to grant access to the location(s) specified by the requesting State. This formula has been advocated by some Western States.[90] A similar proposal was set forth in a draft treaty submitted by a Group of Socialist States to the CD in 1987[91], and marked a significant shift in the Soviet position on this issue.[92]

(c) **On-site inspections initiated by a Secretariat:** This recently proposed option calls for the establishment of a Secretariat, an Assembly of the parties, and a global monitoring system within the framework of a verification system.[93] The Secretariat would initiate an on-site inspection if data from a global monitoring system provided evidence of a suspicious event, or if a party to the treaty suggested that an inspection be carried out. There would be no right of refusal but the inspected party could appeal to the Assembly to cancel the inspection. If the Assembly agreed by at least a two-third majority vote, the inspection would be cancelled immediately.

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90 See e.g. CD/388, Japan, "Verification and Compliance of a Nuclear Test Ban", CD/531, Australia, "Principles for the Verification of a Comprehensive Nuclear Test Ban Treay"

91 CD/756, "Letter Dated 8 June 1987 from the Representatives of Bulgaria, Czechoslovakia, the German Democratic Republic, Hungary, Mongolia, Poland, Romania and the Union of Soviet Socialist Republics, Addressed to the President of the Conference on Disarmament, Transmitting the Text of the 'Basic Provisions of a Treaty on the Complete and General Prohibition of Nuclear Weapon Tests'"; see also CD/531, Australia, "Principles for the Verification of a Comprehensive Nuclear Test Ban Treaty"

92 For the evolution of the Soviet position on on-site inspections see the following in the ensuing order: CD/649, Soviet Union, "Letter Dated 20 January Addressed to the President of the Conference on Disarmament by the Representative of the Union of Soviet Socialist Republics Transmitting the Statement of the General Secretary of the CPSU Central Committee, Mikhail Gorbatchev, Made on 15 January 1986", CD/PV.341 (USSR), CD/PV.340 (Federal Republic of Germany), CD/676, "Letter Dated 10 March 1986 from the Representatives of Argentina, India, Mexico and Sweden Addressed to the President of the Conference on Disarmament Transmitting the Joint Message Dated 28 February 1986 Addressed to the President of the United States of America and the General Secratary of the Central Committee of the Communist Party of the Soviet Union by the Signatories of the Dehli Declaration of 28 January 1986", CD/PV.347 (Netherlands), CD/PV.348 (USSR), CD/PV.350 (USSR), CD/PV.364 (USSR), CD/PV.381 (USSR)

93 CD/1054, Letter Dated 4 February 1991 from the Representatives of Indonesia, Mexico, Peru, Venezuela, Yugoslavia and Sri Lanka Addressed to the President of the Conference on Disarmament Transmitting Drfat Protocol II of the Amendment to the Treaty Banning Nuclear Weapons Tests in the Atmosphere, in Outer Space and Under Water"

CHAPTER VII

Institutional Verification Arrangements

7.1 Introduction

For the verification of a nuclear test ban treaty, different versions of institutional arrangements have been developed for consultations and cooperation. These institutions serve two main purposes: the supervision of the agreed verification procedures and their improvement, and the political and technical handling of complaints. All proposals which have been made in this context specify a Group of Experts which is the technical body of the verification system.[1] For the political body which would serve mainly for lodging complaints, it was suggested that the United Nations Security Council or a body which represents all parties of the treaty could perform this function. Such a body, however, has a variety of functions and the handling of complaints is only one them. Therefore, all proposals containing the establishment of a such a body attached a secretariat with an assisting or implementing function.

The following analysis of institutional arrangements is mainly based on draft treaties submitted by the Soviet Union[2], Sweden[3], and a Group of Socialist States[4], as well as a proposal by the Federal Republic of Germany[5]. Whereas the former three have elaborated institutional arrangements for an envisaged nuclear test ban treaty, the Federal Republic of Germany developed an institutional framework for the immediate establishment of an international seismic verification system in the absence of a treaty. Another approach was

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1 CD/346, Soviet Union, "Letter Dated 14 February 1983 from the Representative of the Union of Soviet Soicialist Republics to the Committee on Disarmament Transmitting the 'Basic Provisions of a Treaty on the Complete and General Prohibition of Nuclear Weapon Tests", CD/381, Sweden, "Draft Treaty Banning Any Nuclear Weapon Test Explosion in Any Environment", CD/384 (CD/NTB/WP.4), Australia, Institutional Arrangements for a CTB Verification System: An Illustrative List of Questions", CD/388, Japan, "Verification and Compliance of a Nuclear Test Ban", CD/400 (CD/NTB/WP.6), Australia, "International Management Panel", CD/612, Federal Republic of Germany, "A Proposal for the Establishment and Progressive Improvement of an International Seismic Monitoring and Verification System Relating to a Comprehensive Nuclear Test Ban", CD/756, Letter Dated 8 June 1987 from the Representative of Bulgaria, Czechoslovakia, the German Democratic Republic, Hungary, Mongolia, Poland, Romania, and the Union of Soviet Socialist Republics, Addressed to the President of the Conference on Disarmament, Transmitting the Text of the 'Basic Provisions of a Treaty on the Complete and Genral Prohibition of Nuclear Weapon Tests'"

2 CD/346, Soviet Union, "Letter Dated 14 February 1983 from the Representative of the Union of Soviet Soicialist Republics to the Committee on Disarmament Transmitting the 'Basic Provisions of a Treaty on the Complete and General Prohibition of Nuclear Weapon Tests"

3 CD/381, Sweden, "Draft Treaty Banning Any Nuclear Weapon Test Explosion in Any Environment"

4 CD/756, Letter Dated 8 June 1987 from the Representative of Bulgaria, Czechoslovakia, the German Democratic Republic, Hungary, Mongolia, Poland, Romania, and the Union of Soviet Socialist Republics, Addressed to the President of the Conference on Disarmament, Transmitting the Text of the 'Basic Provisions of a Treaty on the Complete and Genral Prohibition of Nuclear Weapon Tests'"

5 CD/612, Federal Republic of Germany, "A Proposal for the Establishment and Progressive Improvement of an International Seismic Monitoring an Verification System Relating to a Comprehensive Nuclear Test Ban"

chosen by a group of six States[6] which proposed to convert, through amendment, the PTBT into a CTBT which would be immediately effective.

Figures 7.1-7.4 present the individual proposals of the Soviet Union, Sweden, the Federal Republic of Germany and a group of six States. The presentation is intended to facilitate the comparison of their complex institutional proposals.

7.2 Consultative Committee

All proposals which explicitly outlined the institutional framework for a verification system - except the Soviet draft treaty of 1983 - conceived the establishment of a Consultative Committee.[7] This Committee would be the principal organ with decision-making powers and would have two subsidiary bodies: a Group of Experts and a Secretariat.

All parties to the verification arrangement would be included in the Consultative Committee. The duties of the Committee would encompass the supervision of the Group of Experts and the Secretariat which would be subordinated organs and to decide on their annual budget, to supervise the implementation and operation of the verification system, and to suggest qualitative and quantitative improvements of the international seismic data exchange system. In addition, it would serve as a clearing-house for inquiries from parties and a forum where complaints would be lodged and on-site inspections could be requested.[8]

The Consultative Committee would take decisions by consensus on the review and analysis of the over-all operation of the Treaty, and on changes in the equipment and technical procedures for the verification system. Majority rule would be applied for financial and personnel matters. The Committee would assemble once per year. In the view of Sweden, any party should have the right to request an extraordinary meeting if considered necessary for the implementation of the treaty.[9] The Federal Republic of Germany, on the other hand, suggested that an Executive Group be established which would represent the Committee during the intersessional period. The Executive Group would comprise a chairman and 15 members, including the five nuclear weapons States as permanent members. The remaining

6 CD/1054, "Letter Dated 4 February 1991 from the Representatives of Indonesia, Mexico, Peru, Venezuela, Yugoslavia and Sri Lanka Transmitting Protocol II of Amendment to the Treaty Banning Nuclear Weapons Tests in the Atmosphere, in Outer Space and Under Water"

7 CD/381, Sweden, Draft Treaty Banning Any Nuclear Weapon Test Explosion in Any Environment", CD/388, Japan, Verification and Compliance of a Nuclear Test Ban", CD/400 (CD/NTB/WP.6), Australia, "Internatiuonal Management Panel", CD/612, Federal Republic of Germany, "A Proposal for the Establishment and Progressive Improvement of an International Seismic Monitoring and Verification System Relating to a Comprehensive Nuclear Test Ban"

8 CD/381, Sweden, Draft Treaty Banning Any Nuclear Weapon Test Explosion in Any Environment", CD/612, Federal Republic of Germany, "A Proposal for the Establishment and Progressive Improvement of an International Seismic Monitoring and Verification System Relating to a Comprehensive Nuclear Test Ban"

9 CD/381, Sweden, "Draft Treaty Banning Any Nuclear Weapon Test Explosion in Any Environment"

ten members would be elected by the Consultative Committee for a two year term, taking into account an adequate geographical distribution.[10]

The group of six States proposed the establishment of an Assembly instead of a Consultative Committee.[11] The Assembly was to be comprised of all parties to the treaty and would deal mainly with organizational questions.

7.3 Group of Experts

In various proposals the Group of Experts was referred to as a Technical Expert Group (Sweden), a Committee of Experts (USSR, Group of Socialist States, Japan, Federal Republic of Germany), an International Management Panel (Australia) or a Technical Committee (Indonesia, Mexico, Peru, Venezuela, Yugoslavia, Sri Lanka). In order to avoid confusion, only the term "Group of Experts" will be used.

(a) Assignment:

Two views have been expressed regarding the functional character of the Group of Experts:

One view perceives the Group of Experts as serving an assisting function. Specific assignments would include arranging, regulating and facilitating the international exchange of seismic data. Furthermore, the Group would have to evaluate the technical performance of verification arrangements including techniques and procedures for on-site inspections, and provide the Consultative Committee with technical studies and submit an annual report to the Consultative Committee.[12] In another proposal, the Group of Experts would be a subsidiary body of the Assembly with the function of assessing, evaluating and improving the work of the Secretariat, the implementing body of the verification system.

Yet another view sees the Group of Experts working independently on scientific and technical aspects of the verification system, which would include the development and improvement of standards for all components of the international seismic monitoring network, and identifying on-site inspection techniques, and serving as a forum for technical discussions.[13]

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10 CD/612, Federal Republic of Germany, "A Proposal for the Establishment and Progressive Improvement of an International Seismic Monitoring an Verification System Relating to a Comprehensive Nuclear Test Ban"

11 CD/1054, "Letter Dated 4 February 1991 from the Representatives of Indonesia, Mexico, Peru, Venezuela, Yugoslavia and Sri Lanka Transmitting Protocol II of Amendment to the Treaty Banning Nuclear Weapons Tests in the Atmosphere, in Outer Space and Under Water"

12 In the Soviet view, questions such as organization and procedures of the Group, its possible subsidiary bodies, and its role in on-site inspections were still to be elaborated. CD/346, Soviet Union, "Letter Dated 14 February 1983 from the Representative ofthe Union of Soviet Socialist Republics to the Committee on Disarmament Transmitting the 'Basic Provisions of a Treaty on the Complete and General Prohibition of Nuclear Weapon Tests"

13 See e.g. CD/388, Japan, "Verification and Compliance of a Nuclear Test Ban", CD/400 (CD/NTB/WP.6), Australia, "International Management Panel", CD/381, Sweden, "Draft Treaty Banning Any Nuclear Weapon Test Explosion in Any Environment", CD/612, Federal Republic of Germany, "A Proposal for the Establishment and Progressive Improvement of an International Seismic Monitoring and Verification System Relating to a Comprehensive Nuclear

(b) Participation and Procedures:

The Swedish and Soviet draft treaties as well the proposal by six States, conceived of an Expert Group that was open to experts by all parties to the treaty whereas the Federal Republic of Germany and Australia[14] suggested that the Expert Group was to comprise 15 members who would be appointed by the Consultative Committee and who were be elected for a five year term, with three experts replaced every year.

Sweden suggested at least one annual meeting of the Expert Group, while the Federal Republic of Germany and Australia suggested two or that meetings be held on request of the Consultative Committee. The proposal by the six States suggested at least four meetings. The USSR felt the meetings should be held when necessary. In the German, Australian and Swedish proposals, the Expert Group would be responsible for the election of its chairman and the establishment of its own rules of procedures.[15]

All proposals addressing the question of decision-making stated that the Group of Experts was to work on the basis of consensus.[16] The Federal Republic of Germany, Australia and Sweden, however, added that in case no consensus could be reached, the Group's reports should reflect all views expressed.[17]

7.4 Secretariat

All proposals (except for the one submitted by the group of six States) were in agreement that the Secretariat should assist the Consultative Committee and the Group of Experts in all organizational, administrative and financial matters.[18] Different positions are taken on the exact functioning of the Secretariat. One position viewed the Secretariat as playing a subordinate, assisting role while another perceived a more supervisory role over the operation of IDCs, the designation of seismological stations, the exchange of data on atmospheric radioactivity, and the elaboration of arrangements for international on-site inspection in cooperation with the party to be inspected.[19]

Test Ban"

14 CD/400 (CD/NTB/WP.6), Australia, "International Management Panel", CD/612, Federal Republic of Germany, "A Proposal for the Establishment and Progressive Improvement of an International Seismic Monitoring an Verification System Relating to a Comprehensive Nuclear Test Ban"

15 CD/381, Sweden, "Draft Treaty Banning Any Nuclear Weapon Test Explosion in Any Environment", CD/400 (CD/NTB/WP.6), Australia, "International Management Panel", CD/612, Federal Republic of Germany, "A Proposal for the Establishment and Progressive Improvement of an International Seismic Monitoring an Verification System Relating to a Comprehensive Nuclear Test Ban"

16 The proposal by six States has not stipulated under which conditions the Group of Experts can submit decisions, recommendations or assessments to the Assembly.

17 ibid

18 Minor differences exist in the proposals on the staff of the Secretariat. The Federal Republic of Germany, which advocates an assisting role for the Secretariat, proposed a director and a small staff. Sweden, on the other hand, which proposed a supervisory role, suggested that the Secretariat be comprised of a Director and a Deputy Director who would be elected by the Consultative Committee for a four year term, and a staff.

19 CD/381, Sweden, "Draft Treaty Banning Any Nuclear Weapon Test Explosion in Any Environment"

The group of six States proposed that the Secretariat function as the main body of the verification system. The Secretariat would establish subsidiary bodies for the development of verification procedures; it would establish, supervise or, in some cases, operate and maintain a global monitoring network; and conduct temporary on-site verification including seismic monitoring and on-site inspections.

7.5 Complaint Procedures

Two bodies were proposed where complaints could be lodged: the United Nations Security Council and the Consultative Committee.

(a) In the scenario involving the UN Security Council for this purpose, on-site inspections and complaint procedures would be on different tracks; one purely technical (the Group of Experts) and one purely political (the UN Security Council). In case of a suspicious event, a party would request additional data, and scientific expertise from the Group of Experts. Furthermore, it could directly request the party in question to permit an on-site inspection. The party could in turn refuse the request, but would have to state its reasons for this decision to the Group of Experts.

Alternatively, simultaneously or subsequently, a complaint could be lodged to the UN Security Council presenting all relevant information and evidence leading to the suspicion that one party had violated the provisions of the treaty. Thereafter, the Security Council could initiate investigations of the suspicious event. Each party would undertake to cooperate with the Security Council in the conduct of any investigation that it might undertake.[20]

(b) In the scenario including the Consultative Committee, complaints and requests for international on-site inspections would be brought before the Consultative Committee. Requests would have to contain technical or other evidence that the suspected party had violated the provisions of the treaty and the area to be inspected would have to be specified. If the requested party rejected the request, it would have to state the reasons for this decision. If, however, the requested party accepted an on-site inspection, two different procedures have been suggested:

Secretariat: The Secretariat would make arrangements in cooperation with the party to be inspected. International on-site inspections would be conducted by experts who would be chosen by the Chairman of the Consultative Committee taking into account adequate geographical and political representation. Furthermore, the Secretariat would provide the head of the inspection team and the necessary technicians, interpreters and secretaries.[21]

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20 CD/346, Soviet Union, "Letter Dated 14 February 1983 from the Representative of the Union of Soviet Soicialist Republics to the Committee on Disarmament Transmitting the 'Basic Provisions of a Treaty on the Complete and General Prohibition of Nuclear Weapon Tests"

21 CD/381, Sweden, "Draft Treaty Banning Any Nuclear Weapon Test Explosion in Any Environment"

Group of Experts: The Group of Experts would conduct an international on-site inspection after the Consultative Committee had made arrangements with the party to be inspected. These arrangements would include the time, duration, location and verification techniques for the inspection.[22]

(c) Another scenario, would include both bodies. If the nature of the complaint related to a lack or insufficiency of cooperation on the part of States parties preventing the effective implementation of the treaty, the complaint would be brought before the Consultative Committee. If, however, the nature of the complaint related to suspicion of a grave violation of the treaty, the Consultative Committee could be asked to investigate. The investigation could include on-site icpection. If the results of the investigation failed to meet the concern of the State, it could direct its complaint to the United Nations Security Council.[23]

(d) The group of six States proposed the establishment of a Secretariat that would be the authority on the implementation of on-site verification measures.[24] The States parties would have only limited possibilities to influence the implementation of verification measures. In case of suspicious events, States parties would not have the right to request but could merely suggest that the Secretariat conduct an on-site inspection. If the Secretariat decided to carry out the inspection, the State to be inspected would have the right to appeal to the Assembly.

7.6 Time of Operation

Different views have been presented regarding the time it would take to make the institutional verification system operative. The Soviet Union has suggested that the Group of Experts - the only institution to be established according to its draft treaty - was to meet for the first time ninety days after the treaty had entered into force.[25] Sweden and Australia, on the other hand, advocated that the institutional verification system be operative at the time the treaty was to become effective.[26]

The Federal Republic of Germany proposed the immediate establishment of an international seismic verification system. It suggested that until a nuclear test ban treaty entered into force, the Conference on Disarmament could take on the responsibilities of the Consultative Committee, the Scientific Group of Experts could carry out the work of the

22 CD/400 (CD/NTB/WP.6), Australia, "International Management Panel", CD/388, Japan, "Verification and Compliance of a Nuclear Test Ban"

23 CD/388, Japan, "Verification and Compliance of a Nuclear Test Ban"

24 CD/1054, "Letter Dated 4 February 1991 from the Representatives of Indonesia, Mexico, Peru, Venezuela, Yugoslavia and Sri Lanka Transmitting Protocol II of Amendment to the Treaty Banning Nuclear Weapons Tests in the Atmosphere, in Outer Space and Under Water"

25 CD/346, Soviet Union, "Letter Dated 14 February 1983 from the Representative of the Union of Soviet Soicialist Republics to the Committee on Disarmament Transmitting the 'Basic Provisions of a Treaty on the Complete and General Prohibition of Nuclear Weapon Tests"

26 CD/381, Sweden, "Draft Treaty Banning Any Nuclear Weapon Test Explosion in Any Environment", CD/400 (CD/NTB/WP.6), Australia, "International Management Panel"

Group of Experts[27], and the Secretariat of the Disarmament Department of the United Nations, the work of the Secretariat.[28]

The group of six States aimed at a similar goal. They proposed the immediate establishment of a verification system in connection with the conversion of the existing PTBT into a CTBT.[29]

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27 For this purpose, the Federal Republic of Germany proposed to expand the mandate of the Scientific Group of Experts.

28 CD/612, Federal Republic of Germany, "A Proposal for the Establishment and Progressive Improvement of an International Seismic Monitoring and Verification System Relating to a Comprehensive Nuclear Test Ban"

29 CD/1054, "Letter Dated 4 February 1991 from the Representatives of Indonesia, Mexico, Peru, Venezuela, Yugoslavia and Sri Lanka Transmitting Protocol II of Amendment to the Treaty Banning Nuclear Weapons Tests in the Atmosphere, in Outer Space and Under Water"

Figure 7.1: The International Verification System of the Soviet Draft Treaty in 1983

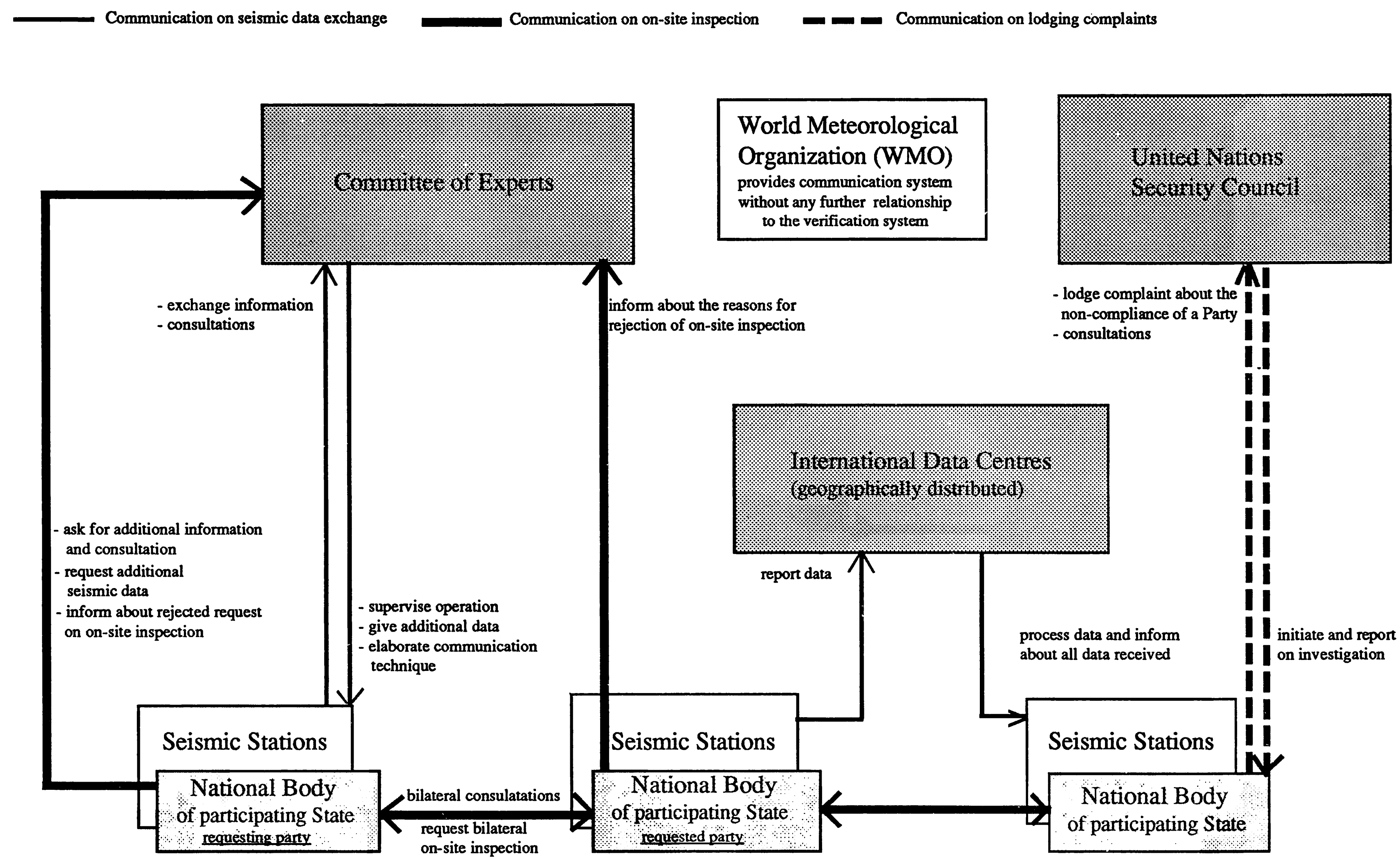


Figure 7.2: The International Verification System of the Swedish Draft Treaty in 1983

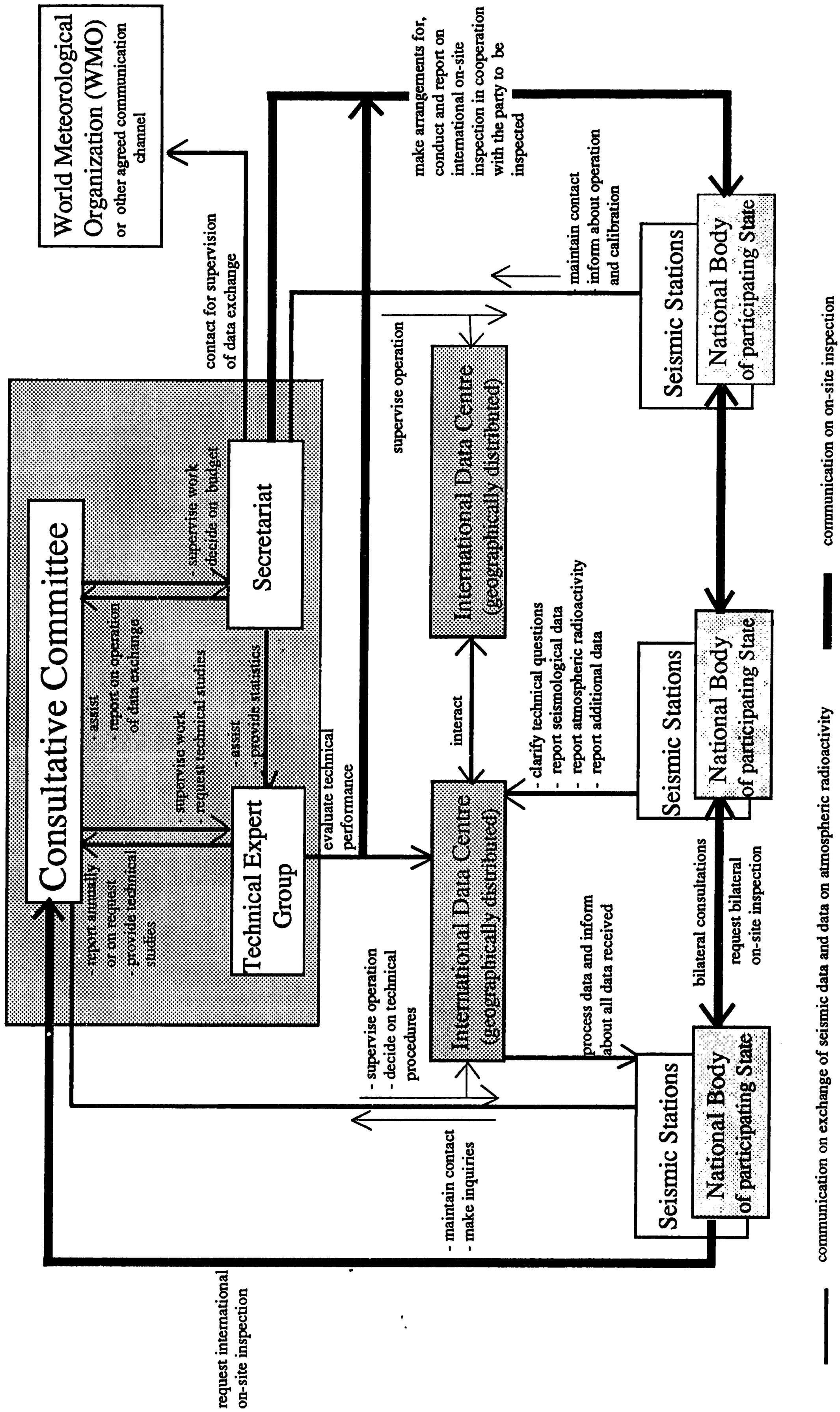


Figure 7.3: The International Seismic Verification System Proposed by the Federal Republic of Germany in 1985

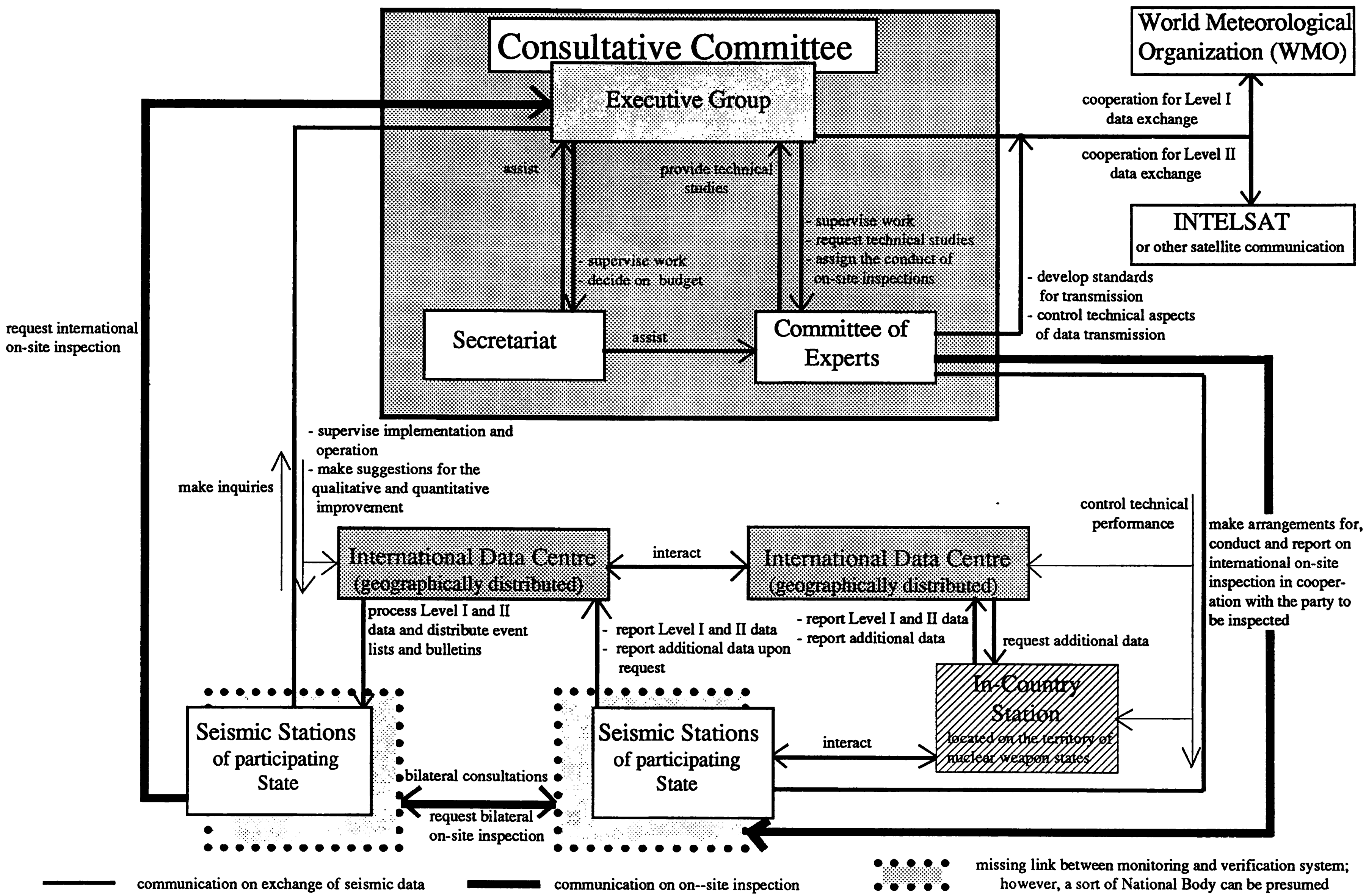
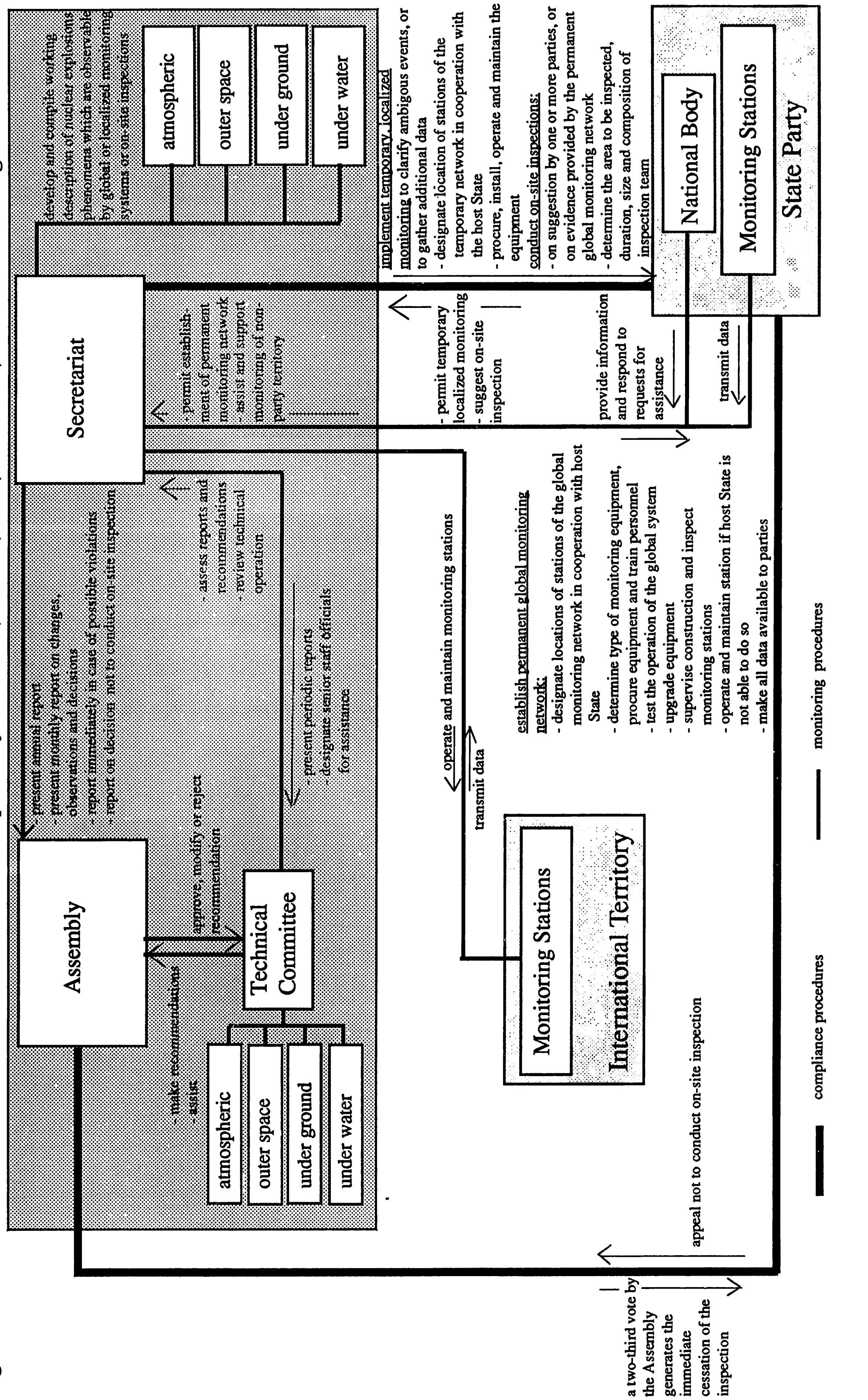


Figure 7.4: The International Verification Network Proposed by Indonesia, Mexico, Peru, Sri Lanka, Venezuela and Yugoslavia in 1991



CHAPTER VIII

Recent Developments and Outlook

It seems that, in 1991, the Conference on Disarmament will again be centre stage for the nuclear test ban issue. Two major events detracted attention from the CD in 1990: the Fourth NPT Review Conference and the Amendment Conference of the PTBT.

The Fourth NPT Review Conference

The Fourth NPT Review Conference was held from 20 August to 15 September 1990 in Geneva. Although the Conference produced a number of positive results, they were not recorded since the Conference failed to agree on a final document. The area of disagreement was the compliance with Article VI and the preamble of the NPT. Article VI of the NPT obligates the parties to pursue negotiations on effective measures relating to the cessation of the nuclear arms race and to nuclear disarmament. The preamble of the NPT recalls the determination of the parties to the PTBT to achieve the "discontinuance of all test explosions for all time and to continue negotiations to this end".

Those States which positively assessed the implementation of Article VI referred to the conclusion of the INF Treaty in 1987, the signature of the additional verification protocols to the TTBT and the PNET in 1990, the CFE negotiations which at that time were almost completed (it was signed in November 1990), and the progress that had been achieved in the START negotiations. Other countries stated that Article VI had not been implemented in a satisfactory manner because in their view none of these agreements had led to the cessation of the nuclear arms race. They held that there could be no effective cessation of the nuclear arms race without a comprehensive test ban treaty.[1] Some of these States, headed by the delegation of Mexico, held out for wording in the final document that would commit the U.S., the UK, and the USSR to conclude a CTBT within the next five years. The U.S. and the UK rejected such an explicit commitment. This development led to a deadlock and its impact on the prolongation of the NPT in 1995 is still unclear.[2] An immediate impact on the CD' work on the test ban issue was considered by many observers as dependent on the outcome of the Amendment Conference held five months later in January, 1991.

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1 Jozef Goldblat, The Fourth Review of the NPT, in *Bulletin of Peace Proposals*, Vol. 21, No.4, December 1990, pp.413-415; see also Charles N. Van Doren and George Bunn, Progress and Peril at the Fourth NPT Review Conference, in *Arms Control Today*, October 1990, p.9-12.

2 See Programme for Promoting Nuclear Non-Proliferation, in *PPNNN Newsbrief*, No. 11, Autumn 1990; see also Disarmament Times, Vol. XIII, No.2, May 1990, "NPT Review Set" and Michael Heylin, The Politics and Future of Nuclear Weapons Testing, C & EN, 8 October 1990, pp.7-9.

The PTBT Amendment Conference

The initiative to convene an Amendment Conference for the PTBT was launched in 1985 by Mexico, Indonesia, Peru, Sri Lanka and Yugoslavia. These States co-sponsored a resolution in the UN General Assembly, recalling the determination to negotiate a comprehensive test ban treaty as outlined in the PTBT.[3] In 1986, after consultations among the co-sponsors, a proposal was submitted to the UN General Assembly. This proposal contained, as a first step, a recommendation to States parties to the PTBT to undertake practical steps leading to the convening of an Amendment Conference and, in a second step, a requirement to the States parties to report on the progress of their efforts.[4] In 1987, Venezuela joined the co-sponsors and, together they proposed to convene an Amendment Conference.[5]

The process of amendment as provided for in Article 2 of the PTBT requires that a proposed amendment be submitted to the Depositary Governments, the Soviet Union, the U.S., and the UK. The Depositaries are to circulate the proposal to all parties to the Treaty. A conference must be convened if requested by one third of all States parties. The conference is to consider the amendment proposal. Approval of the proposal requires a simple majority vote. The three Original Parties, the UK, the U.S., and the USSR, have the right to veto the proposal. In August 1988, an Amendment proposal was submitted to the Depositary Governments by the co-sponsors of the the Conference.[6] In April 1989, the latter reported that 39 States had formally requested the convening of an Amendment Conference.[7] After a Preparatory Conference in May 1990, the Amendment Conference was held in New York from 7 to 18 January 1991. The Conference was attended by 94 States including most CD member States.

The proposed amendment included two protocols which were to convert the PTBT into a Comprehensive Test Ban Treaty.[8] Protocol I entailed the prohibition of testing nuclear weapons and banned any other underground nuclear explosion. This Protocol was to complement Article 1 of the PTBT which prohibits nuclear explosions in the atmosphere,

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3 A/RES/40/80; this resolution was adopted by the General Assembly with 121 in favour, 3 against (France, UK, U.S.) and 24 abstentions.

4 A/RES/41/46B; this resolution was adopted by the General Assembly by 127 in favour, 3 against (France, UK, U.S.) and 21 abstentions. This time, Argentina changed its position from an abstention to an affirmative vote.

5 A/RES/42/26B; this resolution was adopted by the General Assembly by a vote of 128 in favour, 3 against (France, UK, U.S.) and 22 abstentions. Israel changed its position from an abstention to an affirmative vote but returned to its previous position in a later resolution (A/RES/43/63).

6 CD/852, "Letter Dated 5 August 1988 Addressed to the Secretary-General of the Conference on Disarmament by the Representatives of Indonesia, Mexico, Peru, Sri Lanka and Yugoslavia Concerning a Proposed Amendment to the Treaty Banning Nuclear Weapons Tests in the Atmosphere, in Outer Space and Under Water, on the Twenty-Fifth Anniversary of Its Signing"

7 The States were: Bahamas, Bangladesh, Bolivia, Bulgaria, Costa Rica, Cyprus, Democratic Republic of Yemen, Dominican Republic, Ecuador, Egypt, German Democratic Republic, Ghana, Guatemala, Honduras, India, Indonesia, Iran, Iraq, Jordan, Liberia, Malaysia, Mexico, Mongolia, Nepal, Nicaragua, Nigeria, Pakistan, Panama, Peru, Philipines, Romania, Sri Lanka, Sudan, Thailand, Togo, Venezuela, Yogoslavia, Zaire, and Zambia.

8 CD/852, "Letter Dated 5 August 1988 Addressed to the Secretary-General of the Conference on Disarmament by the Representatives of Indonesia, Mexico, Peru, Sri Lanka and Yugoslavia Concerning a Proposed Amendment to the Treaty Banning Nuclear Weapons Tests in the Atmosphere, in Outer Space and Under Water, on the Twenty-Fifth Anniversary of Its Signing"

underwater, and in outer space. Protocol II comprised verification provisions which had not been considered at all in the PTBT.[9]

From the very beginning it was clear that the Conference would fail to agree on the proposed amendment because the U.S. and the UK re-affirmed their opposition to an immediate CTBT. Nonetheless, the co-sponsors of the proposed amendment expected that the Conference would expose the test ban debate to a wider public and therefore lead to further initiatives. Partly due to the Gulf crisis, however, the Amendment Conference did not attract the expected attention. Moreover, many delegates criticized a draft decision submitted by a number of States which included the establishment of working groups to deal with the unresolved issues outside the CD, therefore bypassing the work of the Conference on Disarmament. The working groups were to be composed of 15 to 20 countries which were to continue to consider verification of compliance with a CTBT until 1993, the time the Conference was to reconvene.[10] Many States had been concerned that the Amendment Conference would divert the work of the CD. The Conference put to vote a compromise Final Decision which was adopted by 74 to 2 (United States, United Kingdom), with 19 abstentions.[11]

> Acknowledging the complex and complicated nature of certain aspects of a CTB, especially those with regard to verification of compliance and possible sanctions against non-compliance, the States Parties were of the view that further work needed to be undertaken. Accordingly, they agreed to mandate the President of the Conference to conduct consultations with a view to achieving progress on those issues and resuming the work of the Conference at an appropriate time.

In practical terms this decision returned the issue to the CD. The outcome of the vote on the Final Decision may demonstrate that the general step-by-step approach (which regards a nuclear test ban treaty as a long term goal) has gained more support. Notably, a number of Eastern European countries which are members of the CD abstained on the Final Decision of the Amendment Conference pointing to a possible change in their position regarding the general approach to a nuclear test ban treaty.[12] Back in the CD, the test ban issue is being considered in a re-established Ad-Hoc Committee based upon the 1990 mandate.

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9 See also CD/PV.581 (Mexico)

10 PTBT/CONF/L.1, "Indonesia, Mexico, Nigeria, Philipines, Sri Lanka, United Republic of Tanzania, Venezuela and Yugoslavia: draft decision"

11 PTBT/CONF/L.1; see also DC/2349

12 They were Bulgaria, Czechoslovakia, Hungary, Poland and Romania.

ANNEXES

ANNEX I

Physical Aspects of Nuclear Test Explosions

A fission process is the starting point for all generations of nuclear weapons. Hence the main aim of nuclear test explosions is to test the fission behaviour of first generation weapons and the trigger of second and third generation weapons. The fission behaviour is determined by: (a) the *neutronics* and the *hydrodynamics* which determine the capability of a nuclear explosive device to produce an unprecedented energy density[1]; (b) the exact *ignition of the chain reaction* and (c) the *calibration of the yield* of an explosion which determine the efficiency of the nuclear explosive device. Neutronics and hydrodynamics, can be analyzed and tested under laboratory conditions whereas for the ignition and calibration of nuclear weapons, field tests are unavoidable.

(a) The problem of *neutronics* (the dynamics of releasing neutrons from a mass) must be resolved so that neutrons, which are bound in the nuclei by cohesive forces, are released.[2] The problem of *hydrodynamics* (dynamics of incompressible fluids in motion) must be solved so as to obtain the correct force and moment on the neutrons, which are moving through the fluid, to generate a fission otherwise the neutrons will be absorbed or lost.[3] Together, neutronics and hydrodynamics determine the behaviour of a mass.[4]

A mass is *"subcritical"* when it releases fewer neutrons than are required to sustain a fission reaction; it is *"critical"* when the required number of neutrons are produced to sustain a chain reaction. A mass is *"supercritical"* when it releases a sufficient number of neutrons to turn a fission reaction into a nuclear explosion: if a *supercritical* mass is held together long enough, the neutrons released will generate additional fissioning which will keep the chain reaction going.

A chain reaction "can only occur if enough fissionable material, in the proper geometry, is present".[5] Uranium 235 (U^{235}) and plutonium 239 (Pu^{239}) are the best materials for this purpose because they have a high fission probability. In natural uranium, however, only 0.7 per cent is U^{235} and must, therefore, be enriched. Enrichment of uranium requires

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1 J. Carson Mark, The Purpose of Nuclear Weapon Test Explosions, in Jozef Goldblat and David Cox, eds., Nuclear Weapon Tests: Prohibition or Limitation ?, SIPRI, CIIPS, New York, Oxford University, 1988, p.32

2 McGraw-Hill Encyclopedia of Science & Technology, 6th edition, New York, McGraw-Hill Book Company, 1987, vol.11, p.638-640

3 ibid, vol.8, pp.578-580

4 Donald R. Westervelt, The Role of Laboratory Tests, in Jozef Goldblat and David Cox, eds., Nuclear Weapon Tests: Prohibition or Limitation ?, p.48

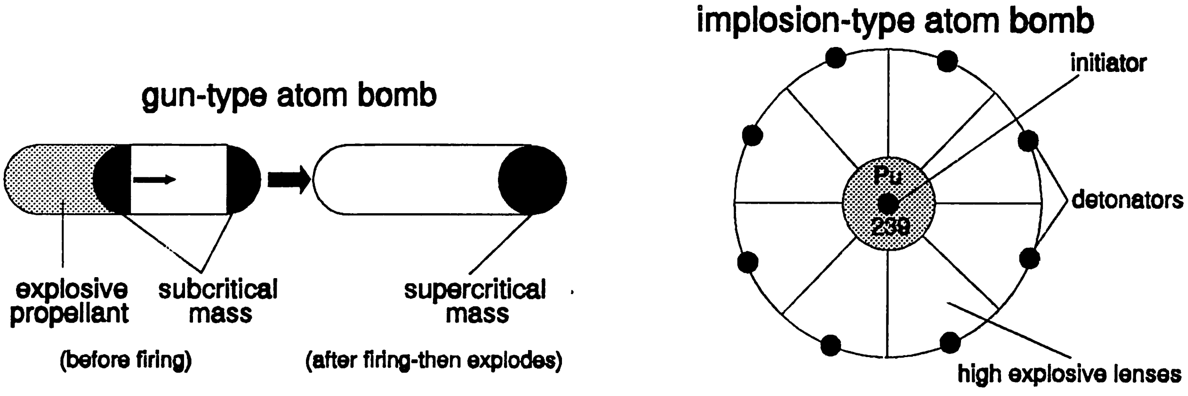
5 Paul P. Craig and John A. Jungerman, Nuclear Arms Race, Technology and Society, New York, McGraw-Hill Book Company, 1986, p.114;

that, through several methods of isotope separation, the highly fissionable material is extracted.[6] Plutonium does not occur naturally, it must be produced. Plutonium (Pu^{239}) is obtained from the natural uranium (U^{238}) processed in nuclear reactors: U^{238} captures a neutron forming U^{239}; U^{239} decays into neptunium 239 which decays within several days to form Pu^{239}. U^{235} and Pu^{239} are both weapons-grade materials.[7]

(b) To test the *ignition mechanism* two types of fission devices have been developed: the "gun-type mechanism" and the "implosion mechanism". The gun-type mechanism consists of two subcritical masses of U^{235} which are fired at each other using conventional explosives. This forms a supercritical mass which results in a nuclear explosion. The weakness of the gun-type mechanism is the danger that a "fizzle" might occur, i.e., spontaneous neutrons might initiate a premature chain reaction therefore reducing the energy release. This type of ignition mechanism was used by the U.S. in the bomb dropped on Hiroshima in 1945, but for reasons of safety and reliability, it is no longer manufactured.

The implosion mechanism works with Pu^{239} and is meant to avoid the risk of a premature chain reaction by using only one subcritical mass. The mass is surrounded by conventional explosives which must detonate symmetrically at the same time. The subcritical mass becomes compressed into a smaller volume - decreasing the surface to mass ratio - and rendering the material supercritical. A mechanism of this type was first tested by the U.S. in the "Trinity test" in 1945 before it was used over Nagasaki a few weeks later. Present fission devices are based on the implosion mechanism.

Figure 1.1: Schematic diagram of gun-type and implosion fission bomb mechanisms



Source: Paul P. Craig and John A. Jungerman, Nuclear Arms Race, Technology and Society, New York, McGraw-Hill Book Company 1986, p.182

6 Several methods to separate isotopes are known: electromagnetic separation (using a calutron or an ion cyclotron); distillation and gas centrifugation which were among the first techniques but for reasons of inefficiency are no longer used; electrolysis and chemical exchange (applying solvent extraction or ion exchange) are mostly applied for the production of heavy water; thermal or gaseous diffusion, aerodynamic separation (using nozzle or Helikon processes), and laser isotope separation (either molecular or atomic) which are used mainly for the extraction of U^{238}. (McGraw-Hill Encyclopedia of Science & Technology, 6th edition, New York, McGraw-Hill Book Company, 1987, vol.9, pp.437-439; Allan Krass, Peter Boskma, Boelie Elzen, and Wim A. Smit, Uranium Enrichment and Nuclear Weapon Proliferation, SIPRI, Taylor & Francis, London and New York 1983, pp.120-192)

7 For the construction of a very sophisticated nuclear bomb, some scientists regard a minimum of 1 kilogram of weapons-grade material as sufficient. (ibid, p.175; see also, Frank N. von Hippel, Harold A. Feiveson, and Christopher E. Paine, A Low-Threshold Nuclear Test Ban, in *International Security*, vol.12, no.2, Fall 1987)

(c) The *calibration of the yield* is necessary to assure the most effective use of a nuclear explosive device whether it is conducted for peaceful applications or for military purposes. Uncalibrated nuclear explosive devices may surpass or, on the other hand, fail to produce the predicted yield. In addition, any further development of nuclear devices in terms of yield, size, or effect requires exact information about the yield.

ANNEX II

Restraints on Nuclear Testing

	Signature and Entry into force, Duration	Provisions of the Treaty Limiting or Banning Nuclear Testing	Ratificationn by Nuclear Weapons States
Antarctic Treaty	Signed at Washington on 1 December 1959. Entry into force on 23 June 1961. Initial duration is thirty years.	Prohibition of the testing of any type of weapons and any nuclear explosions in Antarctica. (Article V)	China France Soviet Union United Kingdom United States
Partial Test Ban Treaty	Signed at Moscow on 5 August 1963. Enty into force on 10 October 1963. Duration unlimited.	Prohibition of any nuclear weapons test explosion, or any other nuclear explosion, in the atmosphere beyond its limits, including outer space; or under water, including territorial waters or high seas, or any other environment if such explosions cause radioactive debris outside the territory of the testing State. (Article I)	Soviet Union United Kingdom United States
Treaty of Tlatelolco	Signed at Mexico, Federal District, on 14 February 1967; Entry into force on 22 April 1968; Duration is unlimited.	Prohibition of the testing of any nuclear weapons within the specified area. (Article 1) The conduct of PNEs must be notified to the Agency established under the Treaty and to the IAEA and must be conducted under observation of these institutions. (Article 18) Protocol I of the Treaty provides for nuclear weapons States to refrain from testing nuclear weapons within the limits of the defined area. (Protocol I)	Protocol I: France (signed but not ratified) United Kingdom United States

	Signature and Entry into force, Duration	Provisions of the Treaty Limiting or Banning Nuclear Testing	Ratification by Nuclear Weapons States
Non-Proliferation Treaty	Signed at London, Moscow and Washington on 1 july 1968. Entry into force on 5 March 1970. Initial duration 25 years during which review conferences are to be held every five years.	Determination to seek to achieve the discontinuance of all test explosions of nuclear weapons for all time and to continue negotiations to this end. (Preamble)	Soviet Union United Kingdom United States
Threshold Test Ban Treaty (bilateral)	Signed at Moscow on 3 July 1974. Entry into force on 11 December 1990. Duration is unlimited.	Prohibition of any underground nuclear weapons test having a yield exceeding 150 kilotons. Determination to limit the number of underground nuclear tests to a minimum. Determination to continue negotiations towards achieving a solution of the problem of the cessation of all underground nuclear weapons tests. (Article 1)	Soviet Union United States
Peaceful Nuclear Explosions Treaty (bilateral)	Signed at Moscow and Washington on 28 May 1976. Entry into force on 11 December 1990. Duration is unlimited.	Prohibition of any underground nuclear explosion for peaceful purposes having an individual yield exceeding 150 kilotons, or an aggregate yield of group explosions exceeding a yield of one and a half megatons.(Article 3)	Soviet Union United States
Treaty of Rarotonga	Signed at Rarotonga on 6 August 1985; Entry into force on 11 December 1988; Duration is unlimited.	Parties are obliged to prevent the testing of any nuclear explosive device in the territory specified under the Treaty. (Article 5, 6) Protocol III of the Treaty invites the nuclear weapons States to abjure nuclear weapons testing in the zone.	Protocol III: China Soviet Union

ANNEX III

Technical Aspects of Verifying Compliance with a Comprehensive Test Ban Treaty

Contents

ANNEX III

Technical Aspects of Verifying Compliance with a Comprehensive Test Ban Treaty

1. Introduction

The main issue in the debate on the verification of a comprehensive test ban treaty has been on seismic monitoring which, according to most scientists, is the only means of detecting and identifying underground nuclear explosions. For a comprehenisve test ban treaty, very high standards of reliability and precision in seismic monitoring are required. In addition, monitoring techniques for other environments might be necessary such as an international verification regime for detection of airborne radioactivity and for satellite monitoring. This chapter will provide information on possible monitoring techniques, their technical aspects and the problems encountered.

2. Seismic Monitoring

Seismic monitoring represents the most important monitoring technique for the verification of a comprehenisive nuclear test ban treaty. The main difficulty of seismological monitoring is the detection and location of low-yield seismic events and the distinction between natural earthquakes and man-made explosions. Thus, an outline on the physical aspects of seismology will be presented before focusing on the detection and identification of seismic events, and finally on in-country seismic stations.

2.1 Background

Simply described, the earth consists of three main parts: the crust, the mantle and the core. The dense part, down to a depth of about 100 kilometers, consists of the crust and the solid portion of the outer mantle, and is called lithosphere. The lithosphere consists of a small number of rigid tectonic plates which are riding on a partially molten zone of the mantle. These plates are in motion with an average speed of a few centimeters per year.[1] Thereby, the tectonic plates are colliding, drifting apart, or sliding along each other. It is this movement that results in earthquakes. Areas where significant shifting of these plates occur also register high levels of seismic activity.

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[1] Ola Dahlman and Hans Israelson, Monitoring Underground Nuclear Explosions, National Defense Research Institute, New York, Elsevier Scientific Publishing Company, 1977, pp.52-58

The vast majority of earthquakes occur at the boundaries of the tectonic plates. The stress resulting from these plates' motion accumulates until the elastic strength of the geological structure is exceeded. The stress is released through frictional heat and various elastic waves.[2] The energy release occurs in a zone along a preexisting or newly created geological fault. The point where the earthquake originates is called the hypocenter. The vertical projection of the hypocenter onto the earth's surface is called epicenter. The depth of an earthquake ranges from 0 to more than 700 kilometers. However, more than 50 per cent of earthquakes occur beneath the ocean and about 90 per cent are observed between 20 and more than 100 kilometers.[3] Nuclear explosions, on the other hand, are presently conducted on test sites within or near earthquake zones.[4] They are presently conducted not deeper than 3 kilometers, and, cannot due to restricted drilling capabilities, be placed deeper than 10 to 15 kilometers.[5] The depth of earthquakes differs geographically. Whereas in the USSR 40 per cent of all earthquakes occur at an estimated depth of more than 100 kilometers, earthquakes in the U.S. are rarely observed deeper than 30 kilometers.[6] (See Figure 2.1)

Earthquakes and underground nuclear explosions are seismic events. They generate several types of seismic waves which can be distinguished by their kinematic and dynamic properties. Kinematic characteristics refer to the travel-time and -path of the seismic wave whereas dynamic characteristics describe the amplitude, period, particle motion and wave form. Kinematic charateristics are the same for earthquakes and underground nuclear explosions whereas dynamic characteristics differ. These characteristics can be measured in three sorts of waves: body, surface and crustal waves. (See Figure 2.2)

2 ibid, p.97; see also Eva Johannisson, Annex 3. Seismological Means of Nuclear Test Ban Verification: Techniques and Equipment, in Jozef Goldblat and David Cox, eds., Nuclear Weapon Tests: Prohibition or Limitation ?, SIPRI, CIIPS, New York, Oxford University Press, 1988, pp.379-381

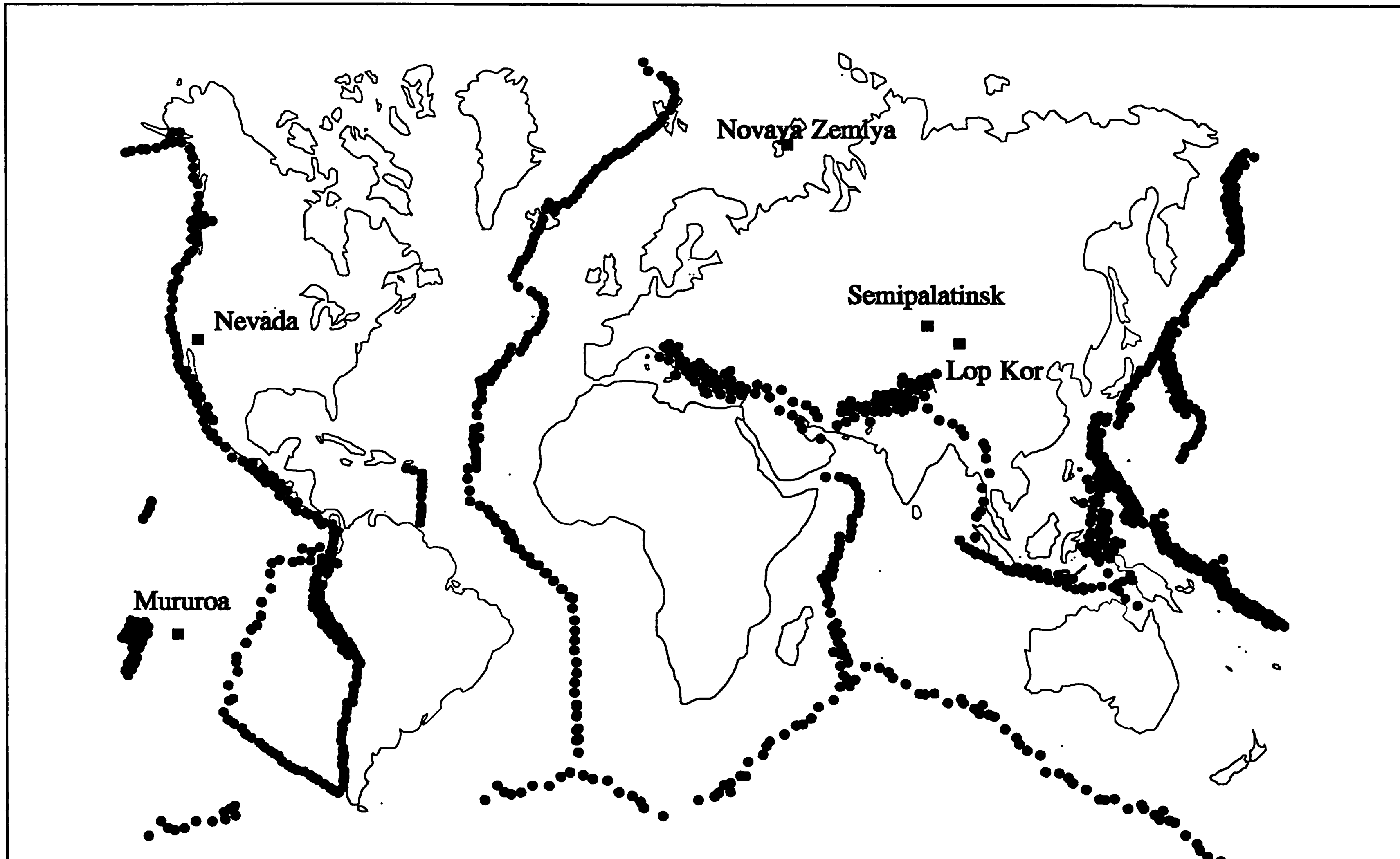
3 Ola Dahlman and Hans Israelson, Monitoring Underground Nuclear Explosions, p.190

4 The Soviet Union is currently deliberating on whether to move its main test activity from Semipalatinsk to the test site in Novaya Zemlya. The latter would not be near an active seismic zone.

5 Eva Johannison, p.392

6 Ola Dahlman and Hans Israelson, p.190

Figure 2.1: Geographical distribution of seismic active regions and placement of present main test sites



Based on: Ola Dahlmann and Hans Israelson, Monitoring Underground Nuclear Explosions, National Defense Research Institute, New York, Elsevier Scientific Publishing Company, 1977, p.48,74

(a) Body waves: Body waves can be detected at seismic stations at distances from 1000 to 10.000 kilometers from the seismic source. The principal types of body waves are *compressional* and *shear* waves.

For compressional or *P (primary) waves,* the particle motion coincides with the direction of wave propagation. P waves travel at a speed of about 8-12 kilometers and have frequencies of about one second (0.5-5 Hz).[7] However, P waves can change their direction at boundaries with a sharp velocity discontinuity:

- Boundaries in the core-mantle cause reflection (PCP) or refraction (PKP) of P waves and create a shadow zone between the angular distance of 100 to 140 degrees from the source where no seismic signal can be detected.

  The surface of the earth causes:
  + Reflection of P waves when they travel straight upwards from their source. They are reflected back into the interior of the earth and continue a path similiar to direct P waves. These reflected waves are called depth phases (pP, sP). They are important for the depth estimation.
  + Conversion of P waves into S waves and vice versa.

For shear waves or *S (second) waves* the particle motion is at right angles to the direction of wave propagation. The S wave travels at about 60 per cent of the velocity of the P wave and therefore arrives after the P wave.

(b) Surface waves: Similar to body waves, surface waves can be detected at distances of 1000 to 10.000 kilometers from the seismic source. The principle types of surface waves are the *Raleigh* and *Love* waves.

Raleigh waves are caused by the discontinuity of the earth's surface and travel in the direction of the wave propagation with a retrograde, elliptical particle motion. *Love waves,* on the other hand, are generated due to the horizontal stratification of the earth's crust which makes them travel in the direction of the wave propagation with a perpendicular particle motion. Surface waves are less sensitive than P waves since they travel at a speed of 3-4 kilometers and have relatively long periods of usually 20 seconds (0.05 Hz).

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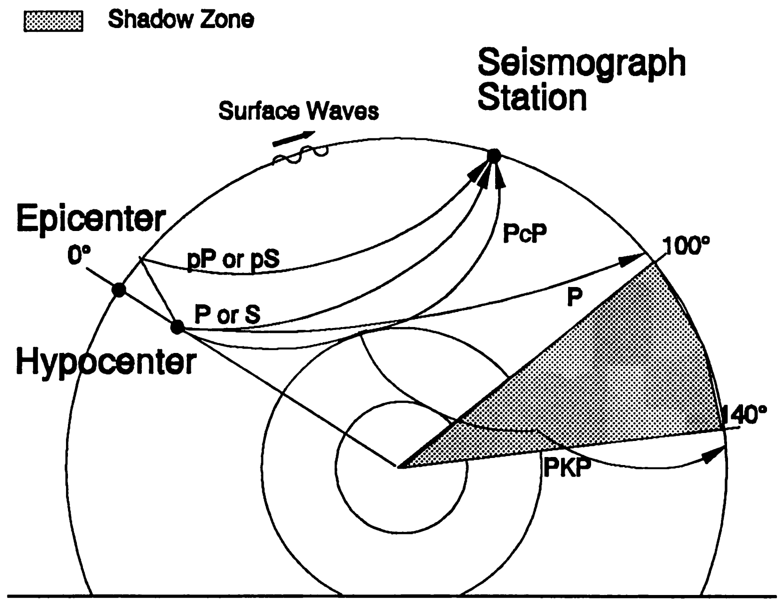
7 Allan S. Krass, Verification: How Much is Enough ?, SIPRI, London, Taylor & Francis, 1985, p.66

Figure 2.2: Seismic waves that can be found in a recording of a seismic event



Based on: Eva Johannisson, Annex 3: Seismological Means of Nuclear Test Ban Verification: Techniques and Equipment, in Jozef Goldblat and David Cox, eds., Nuclear Weapon Tests: Prohibition or Limitation ?, SIPRI, CIIPS, New York, Oxford University Press, 1988, pp.382-385; Ola Dahlman and Hans Israelson, Monitoring Underground Nuclear Explosions, National Defense Research Institute, New York, Elsevier, 1977, pp.58-73;

(c) Crustal waves: Crustal waves involve primarily P and S waves but also to some extend surface waves. They are characterized by their wave propagation over short distances of up to about 1000 kilometers.

For the monitoring of seismic events, different types of waves contain the data which is needed to detect, locate, estimate the yield, and finally, identify the nature of seismic events.

2.1.1 Detection

Detecting seismic events requires the observation of seismic noise, made visible and measurable through the application of seismometers. A seismometer is a relatively small electro-mechanic instrument of the size and form of a canister. Its main components are a magnet fixed to the ground and a spring-suspended mass with an electric coil.[8] The seismic waves move the ground and thereby the magnet which is attached to it, whereas the mass

[8] It is also possible to use the inverse model which fixes the coil to the ground and leaves the magnet spring-suspended.

remains unaffected. The small relative motions of the magnet and the coil induce a weak electrical current which is proportional to their velocity and which can be recorded on paper, on analogue magnetic tape, digitally stored on magnetic tape, or on disk media for immediate computer analysis.

Modern seismograph stations apply a three component system of seismometers: one is sensitive to the vertical motion of the ground, the other two are sensitive to the horizontal motion of the ground and therefore, one is placed in a north-south the other in an east-west direction.[9] The seismometers are designed for the detection of short-periods of about one second (P waves), long-periods of about 20 seconds (Raleigh waves), and frequencies in a wide range of periods.

The capability to detect weak seismic signals is limited since natural sources such as storms and winds, as well as human and industrial activities also cause background or microseismic noise. In order to detect weak seismic signals, background noise has to be minimized.[10]

2.1.2 Identification

Identifying seismic events involves a process of analysing seismic data, including estimations of location and depth of a seismic event. This information makes it possible, in simple cases, to distinguish between earthquakes and nuclear explosions. In more complex cases, specific characteristics of nuclear explosions and earthquakes serve to help identifying the nature of a seismic event.

The location of seismic events can be determined by information on latitude, longitude, depth and time of origin. The distance of the event can be analyzed by the period of P waves or by the different arrival times of body and surface waves. For the estimation of the velocity and the arrival directions of incoming waves, only a modern three component system provides satisfactory accuracy. Its accuracy, however, also depends on the distance between the seismometers and on their precision.

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9 Eva Johannisson, Annex 3: Seismological Means of Test Ban Verification: Techniques and Equipment, p.389

10 Background noise can be minimized by:

Designing seismometers which are insensitive to such noise and by placing them at "quiet sites". This satisfies mainly local requirements;

Establishing array stations consisting of several seismometers which are connected to each other. The detection capability of an array station is determined by the number of seismometers installed, the configuration used and the geographical dimension of the array as well as the way the seismometers are connected in respect to the data transmission. Seismic array stations which satisfy mainly regional requirements are presently in operation in many countries;

Establishing seismic station networks which are distributed nationally or internationally and include single and array stations. The application of a global network makes it possible to locate seismic events with an accuracy of approximately 20-30 kilometers through an international exchange of seismic data. National networks presently exist in several countries whereas the establishment of an international seismic monitoring system is suggested but has not yet been established.

For the estimation of the depth of a seismic event, two main methods are used. One technique, which is the most accurate, determines the time delay between the first detected P wave and the surface reflected P and S waves (pP, sP). If no surface-reflected waves are recorded, another technique can be applied which compares the depth estimate with the arrival time of short-period P waves. There remains, however, a remarkable uncertainty. The identification of the seismic event is simple when the location of the seismic event is a place where nuclear explosions could not reasonably be carried out, or when the hypocenter is too deep to originate from man.

If location and depth of an seismic event do not exclude the possibility of a nuclear explosion, some characteristics specific to earthquakes and nuclear explosions enable their distinction. In a theoretical model, nuclear explosions radiate only P waves and their first motion is therefore only compressional. Thus, all stations which detect this event have seismogram recordings which display vertical initial motions. Earthquakes, on the other hand, emit P and S waves and the initial P wave can be compressional and dilatational. Consequently, seismological stations record first motions which are directed upwards or downwards, depending on the placement of the station. Another difference is manifested in the relatively simpler phenomena of nuclear explosions which radiate waves which are shorter in period and less complex than an earthquake of comparable yield. By taking these characteristics into account, several methods to distinguish earthquakes from nuclear explosions have been developed. The most frequently applied techniques are:

- The M_b:M_s disrciminant compares the magnitude of short-period P waves with the magnitude of long-period surface (Raleigh) waves. If an earthquake and a nuclear explosion generate P wave amplitudes of comparable size, the Raleigh wave amplitude of the earthquake is ten times higher. This method can make distinctions down to an estimated magnitude of 4.0.
- For the distinction of seismic events below the threshold of 4.0, the complexity and frequency of short-period signals are compared. Signals from earthquakes change with magnitude and are more complex and of longer duration than signals from explosions.

2.1.3 In-Country Seismic Monitoring

In-country monitoring systems are considered a supplement to national and international seismic monitoring networks. The idea of in-country seismic stations was addressed on several occasions in past test ban discussions. In the early 1960s the concept of "black boxes" was suggested which meant the lodging of unmanned seismic stations on the territory of a testing country. The black boxes transmit seismic data to outside seismological institutes.[11] The establishment and operation of seismic equipment within the territory of another country, however, encountered political problems. In order to circumvent these obstacles, it was suggested to create "white boxes" or unclassified stations that would exchange seismic data

[11] Ola Dahlman and Hans Israelson, Monitoring Underground Nuclear Explosions, pp.132-133

on an international basis.[12] Although, this suggestion received little attention, it described essentially the concept of international seismic data exchange.[13] In 1980, the Tripartite Report referred to "the installation and use by the three parties of high-quality national seismic stations of agreed characteristics"[14]. The subject received a new impetus in 1986 when six nations suggested an internationalization of national seismic stations.[15] Furthermore, since 1986 the Natural Resources Defense Council (NRDC), a private American environmental organization, has been conducting an exchange of scientists in cooperation with the Soviet Academy of Science. The scientists have worked in the vicinity of American and Soviet test sites operating seismic monitoring stations and calibrating them for the comparison of seismic data which had been recorded in the U.S. and in the USSR. One of the conclusions drawn from this exercise was that the detection and identification of low-yield explosions and explosions detonated in large underground cavities was possible.[16]

In-country monitoring systems are located in the territory of the country to be monitored. Thus, each party to a comprehenisve test ban treaty would monitor other parties and would in turn, be monitored by other parties. In-country stations would be located at agreed sites selected on the basis of the seismological activity of the surrounding region, and geological and tectonic features that could be exploited for evasion. The instrumentation of stations might range from standard equipment to highly sophisticated facilities such as arrays or detectors in boreholes which avoid surface noise. Their function would be basically the same as those of usual seismic stations, namely to detect and identify seismic events. Their advantage, however, would be their proximity of the stations to the sources. Distances of less than 2000 kilometers enable the detection of relatively weak seismic signals which otherwise might evade teleseismic detection (more than 2000 kilometers) and they offer the possibility of improved discrimination of seismic events. For the verification of a comprehensive test ban treaty, the main value of in-country seismic stations would be their ability to discern evasion methods such as the detonation of multiple explosions to simulate an earthquake, the explosion of a nuclear device simultaneously with an earthquake, and the conduct of a nuclear test in a cavity of dry and porous material. Although, in-country seismic stations have a higher capability to detect and identify seismic events, their detection threshold is currently estimated in the range of 5 to 10 kilotons.

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12 ibid

13 Manfred Schneider, A Supplement to the Global Seismograph Network - Behind the Quest for "Internationalized" and "In-Country" Stations, in Proceedings to the Conference on Nuclear Test Ban Verification, Linköping, Sweden, May 17-19, 1988, Swedish Defence Research Establishment (FOA), Linköping, Sweden, 1988, p.109

14 CD/130, United Kingdom, United States of America and Union of Soviet Socialist Republics, "Report to the Committee on Disarmament"

15 The Six-Nation Initiative was founded in 1983 by the governments of Argentina, Greece, India, Mexico, Sweden and Tanzania. In 1986 and 1988, these States offered to assist the U.S. and the USSR in the monitoring of a comprehenisve nuclear test ban. Part of the offer was to send observers from the six countries to a number of selected seismic stations in the U.S. and the USSR which were to verify that the instrumentation and transmission of data was properly handled.

16 Jozef Goldblat, The Nuclear Test-Limitation Treaties, in Serge Sur, ed., Verification of Current Disarmament Limitation Agreements: Ways, Means and Practices, UNIDIR, Geneva, (forthcoming); see also SIPRI Yearbook of World Armaments and Disarmament 1989, SIPRI, Oxford, Oxford University Press, 1989, p.55

3. Other Verification Techniques

Although seismological monitoring represents the most crucial technique for the verification of compliance with a test ban treaty, several other monitoring techniques might be required for the detection and identification of nuclear explosions in other environments, such as the atmosphere or outer space. Furthermore, the more comprehensive verification system, the more difficult is its evasion. Other monitoring techniques which will be addressed in this context are the detection of airborne radioactivity, monitoring by satellite, and on-site verification. These methods could enhance the capability of seismological facilities and also improve the over-all capability of the verification system. Radar and infra-red monitoring are intentionally omitted since these techniques do not seem capable, in the forseeable future, of contributing significantly to the verification of a comprehensive test ban treaty.

3.1 Monitoring of Airborne Radioactivity

Nuclear explosions conducted in the atmosphere produce radioactive isotopes which rise high in the atmosphere where they are diffused around the globe. Within days or weeks, these isotopes fall back to the earth where they can be detected in this fashion. However, not only atmospheric nuclear explosions can be detected. Underground nuclear explosions are usually conducted some hundred meters below the earth's surface. Nonetheless, accidental atmospheric venting occurs. If the yield of an explosion surpasses estimates, or if the environment is porous, or the drill hole where the nuclear explosive device is placed is not properly filled, radioactive debris might be released and detected subsequently.

For the satisfactory monitoring of airborne radioactivity, the establishment of an international surveillance of atmospheric radioactivity (ISAR) was proposed, consisting of some 50 ground stations which were to be distributed around the globe according to atmospheric circulation patterns.[17] Furthermore, it was proposed that the stations would monitor specific radionuclides for atmospheric and underground nuclear explosions respectively. The monitoring of atmospheric nuclear tests would focus on Barium 140, for underground nuclear explosions radioactive noble gases would be detected.[18] It was estimated that within 15 days following a nuclear explosion, the event could be detected with a 25 per cent probability.[19] The practical experience of monitoring airborne radioactivity, however, has demonstrated a much higher capability. Although monitoring of airborne radioactivity could detect clandestinely conducted nuclear explosions, their location would remain undetermined. Therefore, international cooperation and coordination with international

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[17] H. Rodhe and M. Hamrud, On the Design of a Global Detection System for Airborne Radioactivity, Report CM-68, January 1985, Department of Meteorology, University of Stockholm

[18] Allan M. Din, Means of Nuclear Test Ban Verification Other than Seismological, in Jozef Goldblat and David Cox, Nuclear Weapon Tests: Prohibition or Limitation ?, p.242

[19] ibid

seismic monitoring facilities would be indispensable.[20] Presently, most stations that detect radioactivity in the atmosphere are located in the North, only a very limited number of facilities exist in the southern hemisphere.

3.2 Satellite Monitoring

Satellites are able to take high resolution pictures of practically all parts of the world. However, exhaustive monitoring by a satellite-based system is not likely to be feasible because of the amount of information that would have to be processed. Satellites, therefore, would serve mainly as a complement to seismic monitoring by providing additional information on a suspicious event detected and located through seismic means. Satellites would apply two techniques: photographic reconnaisance and radiation sensors. Present photographic reconnaisance technology is able to produce pictures with a resolution of a few tens of centimeters. This capability could detect the preparation of test sites[21] or surface craters which are frequently created by underground nuclear explosions. Satellite-based radiation sensors might detect x- and gamma-rays, as well as the electromagnetic pulses (EMP) which are generated when a nuclear explosion is detonated in the atmosphere or in space. Nuclear explosions detonated in these environments might also be detected by *bhangmeters* which detect the flash of a nuclear explosion.[22] Since satellite technology is complicated and expensive to develop and operate, only a few countries are able to deploy their own systems. Hence, an international verification system would require the distribution of acquired data to all parties requesting such information.

3.3 On-Site Verification

On-site verification is the most intrusive verification technique and includes political as well as technical aspects. On-site inspections have been under discussion since 1958 in the Conference of Experts. The Final Report of the Conference stated that it was technically feasible to set up a workable and effective verification system based on seismic monitoring. On-site inspections were suggested for seismic events which remained unidentified or suspicious.[23] Hence, the role of on-site inspections to complement seismic monitoring was established. Technical procedures, however, remained to be negotiated.

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20 Lars-Erik De Geer, International Surveillance of Atmospheric Radioactivity an Integral Part of a CTBT Verification Regime, in Proceedings of the Conference on Nuclear Test Ban Verification, Linköping, Sweden, May 17-19, 1988, p.55

21 In 1977, signs were discovered which indicated the preparation of a test site in South Africa. The removal of large amounts of material can indicate an evasion scenario in which a test site is prepared in a large excavation.

22 Ola Dahlman and Hans Israelson, Monitoring Underground Nuclear Explosions, pp.332-334; Allan M. Din, Means of Nuclear Test Ban Verification Other than Seismological, pp.238-240; Trevor Findlay, Nuclear Test Ban Verification: A Status Report, Working Paper No.35, Peace Research Center, Australian National University, Canberra, 1988, p.20

23 Document A/4078

In the negotiations following the Conference of Experts, different views on on-site inspections became apparent. The two Western nuclear weapons powers, the U.S. and the UK, perceived on-site inspections as a mandatory measure for suspicious seismic events. Hence, they regarded on-site inspections as an indispensable monitoring technique. The USSR, on the other hand, viewed inspections as a device to demonstrate compliance, beyond mere monitoring, and demanded consultations in the case of an unidentified seismic event, which could lead to voluntary on-site inspections. In this view, on-site inspections had the character of confidence-building measures based solely on the political goodwill of the country to be inspected. The impasse on this subject was partially broken when the negotiating parties agreed to a yearly quota of mandatory inspections. However, no agreement was reached on the number of yearly inspections and the negotiating parties returned to their previous positions. (See Part One, Chapter II) Although the basic positions remained unchanged, another proposal was put forward by Sweden suggesting challenge inspections.[24] If country A has reason to suspect a nuclear explosion in the territory of country B, it can request an on-site inspection. Country B can accept or refuse the request. If one or several requests were rejected, country B can choose to withdraw from the treaty. The latest formula was found during the tripartite negotiations of the UK, the U.S. and the USSR when they agreed to voluntary on-site inspections.[25] Country A requests an inspection from country B, stating the reasons for the request. Country B can accept or refuse an inspection. In the case of rejection, it must provide the reasons for its decision.

Although on-site inspections are considered to be the adjunct to seismic monitoring, they cannot remedy any shortcomings of the seismic monitoring system. Only if the seismic monitoring system is capable of locating and identifying almost all seismic events, can on-site inspections represent a useful tool to monitor the few remaining unidentified cases. However, on-site inspections can only be carried out when the location of the site to be inspected is accurately determined and does not exceed an area of some tens of square kilometers.[26] Since solely seismic detection is not likely to define such a precise location, the above mentioned non-seismic monitoring means have to serve for clarification. Only if these monitoring techniques enable the determination of a specified location, can on-site inspections be requested.

When discussions went beyond the political aspects of on-site inspections, their monitoring techniques were discussed. As a first step, an aerial survey would be conducted applying photography, infra-red and radiation measurements, as well as electromagnetic and magnetic surveys to identify traces of nuclear explosions. Subsequently, a visual and geological survey on the ground would look for indications of an explosion. A local seismic network of some 10 to 20 seismometers would be spread over an area of a few square kilometers to detect after-shocks. After-shocks are generated from nuclear explosions and earthquakes alike. However, the depth estimation might hint as to the nature of the event. The major activity of an on-site inspection would be the monitoring of radiation. Radiation

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24 ENDC/PV.256 (Sweden)

25 CD/130, United Kingdom, United States of America and Union of Soviet Socialist Republics, "Tripartite Report to the Committee on Disarmament"

26 Warren Heckrotte, On-Site Inspection to Check Compliance, in Jozef Goldblat and David Cox, eds., Nuclear Weapon Tests: Prohibition or Limitation ?, p.255

measurment of the surface as well as samples of soil, rock, water, vegetation or small animals could indicate a nuclear explosion.[27]

[27] See e.g. Ola Dahlman and Hans Israelson, Monitoring Underground Nuclear Explosions, p.327; Warren Heckrotte, On-Site Inspection to Check Compliance, p.256; Trevor Findlay, Nuclear test Ban Verification: A Status Report, p.23; Allan S. Krass, Verification: How Much is Enough ?, pp.218-223.

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