1971

DISARMAMENT COMMISSION

OFFICIAL RECORDS

SUPPLEMENT FOR 1971

UNITED NATIONS
New York, 1973

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DISARMAMENT COMMISSION

Supplement for 1971

DISARMAMENT COMMISSION DOCUMENTS

issued during the period 1 January to 31 December 1971

DOCUMENT DC/234*

Report of the Conference of the Committee on Disarmament (23 February 1971-30 September 1971)

[*Original: English/Russian*]
[*6 October 1971*]

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INTRODUCTION

1. The Conference of the Committee on Disarmament submits to the General Assembly of the United Nations and to the Disarmament Commission a progress report on the Committee's deliberations on all questions before it for the period from 23 February 1971 to 30 September 1971, together with the pertinent documents and records.

2. Included in this report is a detailed account of the negotiations, to which the Conference devoted an

* Originally circulated as document A/8457-DC/234.

important part of its work in 1971, regarding the question of chemical and bacteriological (biological) weapons and, in particular, regarding a draft convention on the prohibition of the development, production and stockpiling of bacteriological (biological) and toxin weapons and on their destruction. The text of the draft convention is contained in annex A below.

3. This report also includes accounts of the work of the Conference during 1971 on further effective measures relating to the cessation of the nuclear arms race at an early date and to nuclear disarmament, non-nuclear measures, other collateral measures, and general and complete disarmament under strict and effective international control.

4. A special report on the question of a treaty banning underground nuclear weapon tests is set forth in section III below.

I. Organization of the Conference

A. *Procedural arrangements*

5. The Conference reconvened on 23 February 1971.

6. Two sessions were held, the first from 23 February to 13 May 1971, and the second from 29 June to 30 September 1971. During this period the Conference held 50 formal plenary meetings during which members set forth their Government's views and recommendations for progress on the questions before it. The Conference also held four informal meetings without records.

7. In addition to the plenary meetings described above, members of the Conference met frequently for informal multilateral consultations on disarmament questions of common interest.

8. The representatives of the Union of Soviet Socialist Republics and the United States of America, in their capacity as Co-Chairman of the Conference also held meetings to discuss procedural and substantive questions before the Conference.

B. *Participants in the Conference*

9. Representatives of the following States continued their participation in the work of the Conference: Argentina, Brazil, Bulgaria, Burma, Canada, Czechoslovakia, Egypt,[1] Ethiopia, Hungary, India, Italy, Japan, Mexico, Mongolia, Morocco, Netherlands, Nigeria, Pakistan, Poland, Romania, Sweden, Union of Soviet Socialist Republics, United Kingdom of Great Britain and Northern Ireland, United States of America and Yugoslavia.

II. Work of the Committee during 1971

10. In a letter dated 16 February 1971 (CCD/318), the Secretary-General of the United Nations transmitted to the Conference of the Committee on Disarmament the following resolutions adopted at the twenty-fifth session of the General Assembly: resolution 2661 (XXV), entitled "General and complete disarmament", together with document A/8191, containing the comprehensive programme of disarmament referred to in the resolution; resolution 2662 (XXV), entitled "Question of chemical and bacteriological (biological) weapons"; resolution 2663 (XXV), entitled "Urgent need for suspension of nuclear and thermonuclear tests"; resolution 2667 (XXV), entitled "Economic and social consequences of the armaments race and its extremely harmful effects on world peace and security"; the following resolutions dealing with disarmament matters were also transmitted: resolution 2660 (XXV), entitled "Treaty on the Prohibition of the Emplacement of Nuclear Weapons and Other Weapons of Mass Destruction on the Sea-Bed and the Ocean Floor and in the Subsoil Thereof"; resolution 2664 (XXV), entitled "Implementation of the results of the Conference of Non-Nuclear-Weapon States"; resolution 2665 (XXV), entitled "Establishment, within the framework of the International Atomic Energy Agency, of an international service for nuclear explosions for peaceful purposes under appropriate international control"; and resolution 2666 (XXV), entitled "Status of the implementation of General Assembly resolution 2456 B (XXIII) concerning the signature and ratification of Additional Protocol II of the Treaty for the Prohibition of Nuclear Weapons in Latin America (Treaty of Tlatelolco). Members of the Committee were assisted in their examination and analysis of possible disarmament measures by numerous messages, working papers and other documents that were submitted to the Conference (see annexes B and C below), and by the statements made in plenary meetings by Committee members.

11. On 23 February 1971 the Special Representative of the Secretary-General of the United Nations delivered a message from the Secretary-General to the Conference (see CCD/PV.495) recalling that the General Assembly, in its Declaration on the Occasion of the Twenty-Fifth Anniversary of the United Nations,[2] while welcoming the important international agreements that had already been achieved in the limitation of armaments, called for the early negotiation of further agreements and expressed the hope that negotiations would move forward from arms limitation to a reduction of armaments and disarmament everywhere. The message stated that the Conference of the Committee on Disarmament, which had contributed so much to the successful negotiations of those treaties during the past decade and which was continuing to perform a major role in the difficult search for ways to halt and reverse the arms race, should take due notice of the urgent call of the General Assembly at its commemorative session.

12. In accordance with its provisional agenda the Conference continued work on the following measures in the field of disarmament:

(*a*) Further effective measures relating to the cessation of the nuclear arms race at an early date and to nuclear disarmament;

(*b*) Non-nuclear measures;

(*c*) Other collateral measures;

(*d*) General and complete disarmament under strict and effective international control.

A. *Further effective measures relating to the cessation of the nuclear arms race at an early date and to nuclear disarmament*

13. Members of the Committee continued their work in 1971 on questions relating to the cessation of the nuclear arms race.

[1] On 2 September 1971 the name of the United Arab Republic was changed to Egypt.

[2] General Assembly resolution 2627 (XXV).

14. In accordance with General Assembly resolution 2663 (XXV), which requested the Conference to continue, as a matter of urgency, its deliberations on a treaty banning underground nuclear weapon tests and to submit to the Assembly at its twenty-sixth session a special report on the results of its deliberations, a special report on the results of the Committee's deliberations on this question has been prepared and is set forth as part III of this document.

15. The delegations of Poland (see CCD/PV.501 and 510), Hungary (see CCD/PV.502), Morocco (see CCD/PV.504), Canada (see CCD/PV.507 and 517) and the USSR (see CCD/PV.517) called for the accession to the 1963 Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and under water[3] by as many countries as possible.

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16. A number of delegations made reference to the bilateral discussions between the Governments of the USSR and the United States on the limitation of strategic armaments. While expressing the hope that these talks would reach early agreement on significant measures to restrain and turn back the nuclear arms race, many members stressed that the Conference of the Committee on Disarmament should continue to accord the highest priority to measures in the field of nuclear disarmament. A number of delegations also stressed the importance of qualitative as well as quantitative limitations and reductions of strategic armaments and urged that the Conference receive adequate information about the progress of these negotiations. The USSR delegation outlined to the Committee the programme of disarmament put forward by the Soviet Union in the spring of 1971, which provided, *inter alia,* for the conclusion of treaties banning nuclear and other weapons of mass destruction; the cessation of nuclear weapon tests, including underground tests, everywhere and by all; the promotion of the establishment of nuclear-free zones in various parts of the world; and nuclear disarmament of all nuclear-weapon States (see CCD/PV.507, 517 and 536).

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17. The subject of nuclear-free zones was also discussed.

18. The delegation of Mexico submitted a working paper (CCD/342), containing some basic facts relating to the Treaty for the Prohibition of Nuclear Weapons in Latin America (Treaty of Tlatelolco) and its Additional Protocol II.[4]

19. The representative of Romania reaffirmed the support of his Government for the creation of a nuclear-weapon-free zone in the Balkans (see CCD/PV.526).

20. The delegation of Sweden, citing the Antarctic Treaty[5] and the Treaty of Tlatelolco, suggested that countries in defined regions consider taking independent initiatives towards establishing nuclear-free zones (see CCD/PV.535).

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21. The USSR delegation drew the attention of the Conference to the draft convention on the prohibition of the use of nuclear weapons[6] submitted by the USSR to the United Nations General Assembly at its twenty-second session in 1967 (see CCD/PV.495, 507).

22. The delegation of Czechoslovakia suggested an undertaking by nuclear-weapon States not to use nuclear weapons as a means of launching an attack (see CCD/PV.512, 519).

23. The delegation of Romania stressed the importance of elaborating an agreement aimed at the prohibition of the use of nuclear weapons (CCD/PV.526).

24. Proposals regarding the prohibition of the use of nuclear weapons were also advanced by the delegations of Hungary (CCD/PV.502 and 542), Mongolia and Poland (see CCD/PV.501), and Bulgaria (CDD/PV.500).

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25. The representative of Japan proposed that fissionable material for use in weapons should be transferred to peaceful purposes (see CCD/PV.497).

26. The United States delegation called attention to its proposal for a cut-off of the production of fissionable materials for weapons purposes and said that the adoption of inspection by the International Atomic Energy Agency (IAEA) for the cut-off would be a step towards a more universal system of safeguards on fissionable material production (see CCD/PV.516).

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27. A number of delegations expressed the hope that additional countries would accede to the Treaty on the Non-Proliferation of Nuclear Weapons.[7]

28. A number of delegations expressed satisfaction with the progress made by the International Atomic Energy Agency in elaborating a safeguards system in accordance with article III of the Treaty on the Non-Proliferation of Nuclear Weapons and with the work already accomplished by the Agency with respect to its role in the implementation of that Treaty.

29. The representative of Italy informed the Conference of the unanimous approval by the Council of Ministers of the European Commmunities of the mandate given to the European Commission to begin negotiations on verification with the Agency as provided for in article III of the Treaty on the Non-Proliferation of Nuclear Weapons (cee CCD/PV.541).

B. *Non-Nuclear Measures*

Question of chemical and bacteriological (biological) weapons

30. During the 1971 session of the Conference, members continued their efforts to achieve progress on all aspects of the problem of the elimination of chemical and bacteriological (biological) weapons.

31. In pursuing their work on this question, members kept in mind the recommendations of General Assembly resolution 2662 (XXV), which had taken note of:

(*a*) The revised draft convention for the prohibition of biological methods of warfare, submitted on 18 August 1970 to the Conference of the Committee on Disarmament by the United Kingdom of Great Britain and Northern Ireland (CCD/255/Rev.2);[8]

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[3] United Nations, *Treaty Series,* vol. 480 (1963), No. 6964.
[4] *Ibid.*, vol. 634 (1968), No. 9068.
[5] *Ibid.*, vol. 402 (1961), No. 5778.
[6] See *Official Records of the General Assembly, Twenty-second Session, Annexes,* agenda item 96, document A/6834.
[7] General Assembly resolution 2373 (XXII), annex.
[8] *Official Records of the Disarmament Commission, Supplement for 1970,* document DC/233, annex C, sect. 2.

(*b*) The revised draft convention on the prohibition of the development, production and stockpiling of chemical and bacteriological (biological) weapons and on the destruction of such weapons,[9] submitted on 23 October 1970 to the General Assembly at its twenty-fifth session by Bulgaria, the Byelorussian Soviet Socialist Republic, Czechoslovakia, Hungary, Mongolia, Poland, Romania, the Ukrainian Soviet Socialist Republic and the Union of Soviet Socialist Republics; and

(*c*) The working papers, expert views and suggestions put forward in the Conference of the Committee on Disarmament and in the First Committee of the General Assembly.

32. In resolution 2662 (XXV) the General Assembly had commended the following basic approach for reaching an effective solution to the problem of chemical and bacteriological (biological) methods of warfare, which was contained in the joint memorandum submitted on 25 August 1970 by the delegations of Argentina, Brazil, Burma, Ethiopia, India, Mexico, Morocco, Nigeria, Pakistan, Sweden, the United Arab Republic and Yugoslavia:[10]

(*a*) It was urgent and important to reach agreement on the problem of chemical and bacteriological (biological) methods of warfare;

(*b*) Both chemical and bacteriological (biological) weapons should continue to be dealt with together in taking steps towards the prohibition of their development, production and stockpiling and their effective elimination from the arsenals of all States;

(*c*) The issue of verification was important in the field of chemical and bacteriological (biological) weapons, and verification should be based on a combination of appropriate national and international measures, which would complement and supplement each other, thereby providing an acceptable system that would ensure the effective implementation of the prohibition.

33. Possible steps for progress in that field were discussed in detail by members of the Committee in their plenary statements. In addition, an informal meeting on the question of the prohibition of chemical and bacteriological (biological) warfare was held on 7 July 1971 at the request of the delegations of Canada, Italy, Japan and Sweden.

34. In connexion with the prohibition of chemical and bacteriological methods of warfare, working papers were presented to the Conference on the following subjects: the prohibition of chemical warfare agents, submitted by the Netherlands (CCD/320); a model comprehensive agreement on the prohibition of chemical and biological means of warfare, submitted by Sweden (CCD/322); the destruction of chemical and biological means of warfare, submitted by Sweden (CCD/324); verification techniques relating to safety features, the sealing and monitoring of plants formerly producing nerve agents, and sampling of nerve agent production, submitted by the United States (CCD/332); the definition of toxins, submitted by Sweden (CCD/333); atmospheric sensing and verification of a ban on the development, production and stockpiling of chemical weapons, submitted by Canada (CCD/334); some problems concerning the compiling of a list of chemical weapons to be banned and indirect control of the production and destruction of stockpiles of such agents, submitted by Italy (CCD/335); a biological approach to the question of verification in connexion with the prohibition of chemical weapons, submitted by Japan (CCD/343); verification of compliance with the prohibition of chemcial weapons, submitted by Japan (CCD/344).

35. On 30 March 1971 the delegations of Bulgaria, Czechoslovakia, Hungary, Mongolia, Poland, Romania and the USSR submitted a draft convention on the prohibition of the development, production and stockpiling of bacteriological (biological) weapons and toxins and on their destruction (CCD/325/Rev.1).

36. On behalf of the sponsors of the draft, the USSR delegation reaffirmed its position regarding the need to achieve the complete prohibition and elimination of both chemical and bacteriological weapons and indicated readiness, as a first possible step, to reach agreement on the prohibition on bacteriological (biological) and toxin weapons (see CCD/PV.505).

37. A general consensus emerged in the ensuing discussion of the proposals which had been placed before the Conference. While a number of Committee members had advocated a comprehensive approach to the question of prohibition of chemical and biological weapons, it was recognized that in the new situation it would be possible at this time to negotiate, as a first step, a draft convention on biological and toxin weapons; that in taking this step the Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare[11] of 17 June 1925 should be safeguarded and that nothing should be done that might in any way cast doubt on the validity of that instrument, and that the Committee should continue to work urgently for concrete progress on effective measures for the prohibition of the development, production and stockpiling of chemical weapons.

38. A number of specific suggestions with respect to the draft texts proposed in documents CCD/255/Rev.2 and CCD/325/Rev.1 were made by members in plenary statements, and a working paper proposing modifications in document CCD/325/Rev.1 was submitted by the delegation of Egypt (CCD/328). The delegation of Mexico reiterated its preference for a comprehensive approach and suggested that unilateral renunciation of biological weapons would be sufficient while a treaty banning both chemical and biological weapons was negotiated (see CCD/PV.513). The delegation of Yugoslavia suggested that the convention reflect the idea that savings from disarmament should be channelled to social and economic development, taking into account primarily the requirements of developing countries (see CCD/PV.518).

39. After consultation with Committee members and consideration of views expressed in plenary sessions and relevant working papers, the delegations of Bulgaria, Czechoslovakia, Hungary, Mongolia, Poland, Romania and the USSR and the delegation of the United States submitted on 5 August identical texts of a draft convention on the prohibition of the development, production and stockpiling of bacteriological (biological) and toxin weapons and on their destruction (CCD/337 and 338 respectively).

[9] *Official Records of the General Assembly, Twenty-fifth Session, Annexes*, agenda items 27, 28, 29, 30, 31, 93 and 94, document A/8136.

[10] *Official Records of the Disarmament Commission, Supplement for 1970*, document DC/233, annex C, sect. 39.

[11] League of Nations, *Treaty Series*, vol. XCIV (1929), No. 2138.

40. All members of the Conference engaged in intensive discussions regarding possible changes and amendments to the proposed text of the convention. A number of specific suggestions were placed before the Conference.

41. The delegations of Hungary, Mongolia and Poland submitted a draft Security Council resolution relating to the Convention (CCD/339).

42. After intensive consultations the representatives of Brazil, Burma, Ethiopia, India, Mexico, Morocco, Nigeria, Pakistan, Sweden, the United Arab Republic and Yugoslavia submitted a working paper (CCD/341) suggesting a number of amendments to the text of the draft convention. The paper suggested a preambular paragraph regarding savings from disarmament and recommended several changes in the preamble designed to reflect the common basic approach of its sponsors that a link be maintained in respect of the prohibition of chemical and bacteriological (biological) weapons. It also recommended changes in article VIII (subsequently article IX) designed to strengthen the undertaking on further negotiations concerning chemical weapons and to reflect the position of the delegations mentioned above regarding the principle of complete prohibition of chemical weapons, and additions to article V and article IX (subsequently article X).

43. The delegation of Mexico submitted an additional amendment suggesting a moratorium on the development, production and stockpiling of highly toxic chemical agents for weapons until agreement was reached on a comprehensive treaty (CCD/346).

44. Other amendments were proposed in a working paper submitted by the representative of Morocco (CCD/347).

45. A number of suggestions were made in plenary statements by the representatives of Argentina (see CCD/PV.512), Brazil (see CCD/PV.510), Canada (see CCD/PV.528), Egypt (see CCD/PV.516), Italy (see CCD/PV.512), Japan (see CCD/PV.532), the Netherlands (see CCD/PV.502 and 525), Nigeria (see CCD/PV.522), Sweden (see CCD/PV.499 and 522), and the United Kingdom (see CCD/PV.507, 510 and 528) regarding the strengthening of the procedures for ensuring fulfilment of the provision and purposes of the convention.

46. In order to accommodate as many of the specific suggestions for changes in the convention as possible, and in order to develop formulations which would result in broad support for the convention, intensive discussions were held within and among various groups in the Committee.

47. While work proceeded on the convention on bacteriological (biological) and toxin weapons, the delegations of Argentina, Brazil, Burma, Egypt, Ethiopia, India, Mexico, Morocco, Nigeria, Pakistan, Sweden and Yugoslavia formulated a joint memorandum on the prohibition of the development, production and stockpiling of chemical weapons and on their destruction (CCD/352). The memorandum was presented to the Committee on 28 September. Emphasizing the immense importance and urgency of reaching agreement on the elimination of chemical weapons, the memorandum offered elements on which negotiations should be based.

48. With respect to the convention on bacteriological (biological) and toxin weapons, the intensive discussions within the Committee resulted in the submitting, on 28 September, of a revised draft of the convention by the delegations of Bulgaria, Canada, Czechoslovakia, Hungary, Italy, Mongolia, the Netherlands, Poland, Romania, the Union of Soviet Socialist Republics, the United Kingdom and the United States of America (see annex A below).

49. Article I provided that parties undertake never in any circumstances to develop, produce, stockpile or otherwise acquire or retain biological agents or toxins whatever their origin or method of production, of types and in quantities that have no justification for prophylactic, protective or other peaceful purposes, as well as weapons, equipment or means of delivery designed to use such agents or toxins for hostile purposes or in armed conflict. The preamble referred to the determination of the Parties, for the sake of all mankind, to exclude completely the possibility of bacteriological (biological) agents and toxins being used as weapons.

50. The broad definition of toxins was included at the suggestion of the Swedish delegation (see CCD/P.522). The phrase "never in any circumstances," contained in article I of the United Kingdom draft convention (CCD/255/Rev.2) was included at the suggestion of the delegation of Egypt (CCD/328). In that connexion the delegations of the United States and the Soviet Union made statements concerning reservations to the Geneva Protocol in so far as they applied to weapons covered by the convention (see CCD/PV.542). Statements to the effect that the convention would continue to be effective in wartime were made by the delegations of the United States, the Soviet Union and the United Kingdom (*ibid.*). The word "protective" was inserted as a result of suggestions by the delegations of the Netherlands (see CCD/PV.525) and Italy (see CCD/531). The delegations of the United States and the Soviet Union made statements to the effect that this word in no sense provided a basis for circumventing the convention; it made clear that the development of devices or methods for protecting individuals or populations against biological agents was not prohibited (see CCD/PV.542).

51. Article II set forth the requirements for destruction of the agents, toxins, weapons and equipment prohibited by article I within nine months after entry into force of the convention. The delegations of Canada (see CCD/PV.528) and Morocco (see CCD/PV.531 and CCD/347) proposed that depositary Governments should be notified of the implementation of article II. Statements calling on parties to give notice of fulfilment of the obligations of this provision were made by the delegations of the Soviet Union and the United States (see CCD/PV.542).

52. Provisions designed to prevent the spread of biological and toxin weapons were contained in article III.

53. To ensure the effectiveness of the treaty, article IV established the responsibility of each party to the convention to take any necessary measures to ensure that the activities prohibited in article I did not take place within its territory, under its jurisdiction or under its control anywhere.

54. Article V provided that parties should consult one another and co-operate regarding any problems that might arise in relation to the objective of, or in the application of the provisions of, the convention.

At the suggestion of the number of delegations, as contained in working paper CCD/341, that article also provided that consultation and co-operation pursuant to that article might also be undertaken through appropriate international procedures within the framework of the United Nations and in accordance with its Charter.

55. Article VI provided that any State party to the convention which found that any other State party was acting in breach of the obligations deriving from the provisions of the convention might lodge a complaint with the Security Council of the United Nations.

56. Article VII, concerning the provision of assistance, was included at the suggestion of the delegations of Argentina and Italy (CCD/PV.512), Morocco (CCD/PV.514), Nigeria (CCD/PV.522), the Netherlands (CCD/PV.525) and the United Kingdom (CCD/PV.507 and 510). Statements were made by the delegations of the United Kingdom, (CCD/PV.528 and 542), the Soviet Union and the United States (see CCD/PV.542) to the effect that assistance should be provided only at the request of the endangered party and that medical and other humanitarian assistance would be fitting in light of the character of the convention. In addition, the delegation of the United Kingdom stated that it would be for each party to decide whether it could or was prepared to supply the assistance requested (*ibid*).

57. Article VIII provided that nothing in the convention should be interpreted as limiting or detracting from the obligations assumed by States under the Geneva Protocol. The preamble contained clauses whereby the parties noted the important significance of the Protocol, reaffirmed their adherence to its purposes and principles, called upon all States to comply strictly with them and recalled that the General Assembly had condemned actions contrary to the Protocol's principles and objectives.

58. Article IX reaffirmed the recognized objective of effective prohibition of chemical weapons and, to that end, contained an undertaking to continue negotiations in good faith with a view to reaching early agreement on effective measures regarding chemical weapons, The preamble referred to the importance and urgency of eliminating, through effective measures, such dangerous weapons of mass destruction as those using chemical or bacteriological (biological) agents and recognized that the convention represented a first possible step towards the achievement of agreement on effective measures regarding prohibition of chemical weapons.

59. Article X set forth provisions designed to facilitate international co-operation regarding peaceful applications in the field of bacteriology (biology).

60. Article XII provided for a conference to review the operation of the convention with a view to assuring that the purposes of the preamble and the provisions of the convention, including the provision concerning negotiations on chemical weapons, were being realized.

61. Provisions concerning amendments, withdrawal, entry into force and formal clauses were contained in articles XI, XIII, XIV and XV.

62. Delegations expressed satisfaction with the general consensus achieved and with the process of negotiation and the spirit of accommodation which resulted in the inclusion of amendments responsive to their suggestions. A number of delegations pointed out that final decisions of their Governments would be taken at a later stage. Hope was widely expressed that the draft convention would be commended by the General Assembly and opened for signature at an early date.

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63. The representative of the United States (see CCD/PV.533) proposed that, while continuing work on measures pertaining to weapons of mass destruction, the Conference of the Committee on Disarmament also devote intensified discussions to the question of conventional arms control. The delegations of Argentina (see CCD/PV.501), Italy (see CCD/PV.500), Sweden (see CCD/PV.497 and 535), Romania (see CCD/PV.499) and Czechoslovakia (see CCD/PV.535) expressed their respective views on the question of conventional weapons.

C. *Other collateral measures*

64. In his message to the Conference at the beginning of its 1971 session, the Secretary-General of the United Nations welcomed the signature on 11 February in London, Moscow and Washington of the Treaty on the Prohibition of the Emplacement of Nuclear Weapons and Other Weapons of Mass Destruction on the Sea-Bed and the Ocean Floor and in the Subsoil Thereof and stated that the Treaty deserved universal adherence and full implementation. The representatives of the USSR (see CCD/PV.517), Japan (see CCD/PV.518), Mongolia (see CCD/PV.538), the United Kingdom (see CCD/PV.541) and Hungary (see CCD/PV.542) informed the Conference that their countries had ratified the Treaty. The representatives of Sweden (see CCD/PV.497), Argentina and Brazil (see CCD/PV.536) made statements in connexion with their Governments' signature of the Treaty.

65. A number of delegations spoke about the importance they attached to continuing negotiations in good faith, in accordance with article V of the Treaty, concerning further measures in the field of disarmament for the prevention of an arms race on the sea-bed and the ocean floor and in the subsoil thereof. The delegation of Poland proposed that at the proper time and under suitable conditions discussion begin on further steps in the demilitarization of the sea-bed and the ocean floor and recalled that the question of the prevention of an arms race on the sea-bed remained on the agenda of the Conference (see CCD/PV.501). The representative of the Soviet Union proposed a thorough examination of all aspects of the problem of further demilitarization of the sea-bed, with due regard to the various proposals that had been put forward by members of the Committee (see CCD/PV.532). The delegation of Sweden stressed the importance of acting without delay to preserve the sea-bed for peaceful purposes (see CCD/PV.535).

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66. The delegation of Yugoslavia devoted a statement to the question of a European security conference and expressed the views of the Yugoslav Government on the preparations for such a conference (see CCD/PV.505). The delegation of Czechoslovakia drew the Committee's attention to the importance of convening a conference on European security and co-operation at which, besides all aspects of European security, the problem of disarmament, including the question of

reduction of conventional armaments, could be discussed (see CCD/PV.519 and 535). The question was also touched upon by the delegations of Hungary (see CCD/PV.502), Poland (see CCD/PV.501 and 510) and Sweden (CCD/PV.535).

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67. The delegation of Romania proposed that the Conference examine the question of the freezing and reduction of military budgets (see CCD/PV.526).

D. *General and complete disarmament*

68. Discussion of the question of general and complete disarmament continued during the 1971 sessions of the Conference, taking into account General Assembly resolution 2661 C (XXV).

69. The delegation of Mexico recommended (see CCD/PV.496) that special attention should be given to the comprehensive programme of disarmament submitted to the General Assembly by the delegations of Ireland, Mexico, Morocco, Pakistan, Sweden and Yugoslavia.[12]

70. The delegation of India suggested (see CCD/PV.504) that an appropriate balance should be maintained among measures to prevent armament, measures to limit armament and measures of disarmament; that it would be useful for the Soviet Union and the United States to submit revised draft treaties on general and complete disarmament; that the joint statement of agreed principles for disarmament negotiations[13] be considered the basis for concrete work in the Committee; and that the general order of the Conference's priorities be on the lines suggested in the declaration on disarmament issued by the Third Conference of Heads of State or Government of Non-Aligned Countries, held at Lusaka in September 1970.

71. The delegation of Hungary suggested (see CCD/PV.502) that the Conference should pay special attention to the joint statement when dealing with or elaborating on general and complete disarmament. The delegations of Bulgaria (see CCD/PV.500), Mongolia (see CCD/PV.501), Hungary (see CCD/PV.502), Romania (see CCD/PV.499 and 526) and the Soviet Union (see CCD/PV.516) declared their readiness to continue their efforts with a view to achieving a positive solution of the problem of general and complete disarmament.

72. On 11 March 1971 the representatives of Mexico, Sweden and Yugoslavia submitted as a Conference document (CCD/321) the "Declaration on peace and disarmament", presented to the President of the General Assembly and the Secretary-General of the United Nations by the Nobel Peace Prize Laureates on 21 September 1970.

73. The delegation of Italy suggested the possibility of establishing a small working group to examine the principles of an organic programme of disarmament (see CCD/PV.500) and proposed that the Committee resume work on the problem of general and complete disarmament as the main item on its agenda at its next session, also taking into account the organic method proposed by Italy (CCD/309)[14] and the suggestions contained in the other documents mentioned in General Assembly resolution 2661 C (XXV) (see CCD/PV.537).

74. The delegation of Romania suggested that progress towards general disarmament could best be ensured by starting negotiations on the drafting of a treaty and that official and informal meetings of the Conference be devoted to a thorough study of all aspects of the problem (see CCD/PV.526).

75. The delegations of Japan (see CCD/PV.497 and 518), Romania (see CCD/PV.499 and 526), Mongolia and Argentina (see CCD/PV.501), Pakistan (see CCD/PV.503 and 529), Canada (see CCD/PV.507) and Egypt (see CCD/PV.509) made statements regarding the desirability of participation in disarmament negotiations by all militarily important states, including all nuclear weapon states.

III. Special report on the question of a treaty banning underground nuclear weapon tests

76. Since resolution 1252 (XIII) was adopted by the General Assembly in 1958, the Assembly at subsequent sessions has repeatedly adopted resolutions on the urgent need for suspension of nuclear and thermonuclear tests. Following the signature of the Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and under Water in 1963, General Assembly resolutions have referred to the determination expressed by the parties in the preamble to that Treaty to continue negotiations "to achieve the discontinuance of all test explosions of nuclear weapons for all time".

77. General Assembly resolution 2663 (XXV) requested the Conference of the Committee on Disarmament to continue, as a matter of urgency, its deliberations on a treaty banning underground nuclear weapon tests and to submit to the Assembly at its twenty-sixth session a special report on the results of its deliberations, it also invited members of the Conference to cooperate in further study of the question of facilitating the achievement of a comprehensive test ban through the international exchange of seismic data.

78. Having in mind the General Assembly's recommendation, members of the Committee continued to work in 1971 on the question of a treaty banning underground nuclear weapon tests. A number of delegations stated that there was growing concern regarding nuclear testing because of its relationship to the continuing nuclear arms race and to the further proliferation of nuclear weapons. Many members stressed in their plenary statements the great importance they continued to attach to the early achievement of a comprehensive prohibition of the testing of nuclear weapons. A number of possible approaches towards progress in this field were presented and considered.

General discussion on a comprehensive test ban

79. Specific recommendations were made by members of the Committee regarding the nature of a possible comprehensive test-ban agreement.

80. The delegation of India called for the full observance of the partial test-ban Treaty and adherence to it by States which were not yet parties; the nego-

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[12] *Official Records of the General Assembly, Twenty-fifth Session, Annexes*, agenda items 27, 28, 29, 30, 31, 93 and 94, document A/8191.

[13] *Ibid., Sixteenth Session, Annexes*, agenda item 19, document A/4879.

[14] *Official Records of the Disarmament Commission, Supplement for 1970*, document DC/233, annex C, sect. 38.

tiations of a separate treaty to prohibit all underground nuclear weapon tests; and a simultaneous agreement on underground nuclear explosions for peaceful purposes (see CCD/PV.504).

81. The delegation of Egypt called for the inclusion in any comprehensive test-ban of some form of verification by challenge, recourse to the Security Council, mention of a review conference, and the traditional withdrawal clause; it expressed the view that a comprehensive test-ban treaty should ultimately bear the signature of all nuclear Powers and called for adherence to the partial test-ban treaty by those of them who had not yet adhered to it (see CCD/PV.509).

82. The representative of the Netherlands called for consideration by the Conference of the arms control aspects of the question of peaceful nuclear explosions, parallel to the studies done by the International Atomic Energy Agency on other aspects. He drew attention to the need to develop a system to prevent explosions from being used for weapon testing under the guise of peaceful purposes, and suggested that an international body should be authorized to satisfy itself that only nuclear devices already tested were being used for peaceful nuclear explosions (see CCD/PV.512).

83. The delegation of Sweden outlined six questions regarding the negotiation of a comprehensive test-ban and asked delegations to provide answers to clarify the directions in which negotiations might proceed (see CCD/PV.513).

84. The delegation of Canada (see CCD/PV.517), the Netherlands (see CCD/PV.537) and the Soviet Union (see CCD/PV.536) expressed views regarding these questions.

85. The delegation of Pakistan submitted a working paper (CCD/340) which stated that there was no difference between nuclear weapons and peaceful nuclear explosive devices and proposed that an underground test-ban treaty include two kinds of provisions: for the nuclear-weapon States such a treaty would prohibit all underground nuclear weapon test explosions, but permit explosions for peaceful purposes in conformity with an international agreement to be negotiated separately; for the non-nuclear-weapon States it would prohibit all underground explosions.

86. The delegation of Japan requested the nuclear-weapon States, particularly the United States and the Soviet Union, to make active contributions to the formulation of a treaty on the comprehensive prohibition of nuclear weapons tests, including concrete proposals relating to verification, and urged that the participation of all nuclear-weapon States should not be made a precondition for the negotiation of such a treaty (see CCD/PV.530).

87. The delegation of Sweden presented (see CCD/PV.524) a revised version of suggestions, put forward in its earlier working paper (ENDC/242)[15] on possible provisions of a treaty banning underground nuclear weapon tests; as annexes to any such treaty, three protocols were proposed which would provide for a phasing-out period for nuclear weapon tests, for the administration of peaceful nuclear explosions and for the development of an international seismological data system. The text of the revised draft treaty was incorporated in a working paper presented by the Swedish delegation (CCD/348).

88. The delegation of the Soviet Union stated that the Soviet Union favoured the cessation of nuclear weapon tests, including underground tests, everywhere and by all, and that it was ready to sign an agreement on the prohibition of underground nuclear weapon tests on the basis of the use of national means of detection (see CCD/PV.495, 507 and 536).

89. The Secretary of State for External Affairs of Canada suggested that the Conference could no longer delay a determined effort to reach a total ban on underground nuclear testing and also appealed to those Governments conducting nuclear tests to put restraints on the size and number of tests in their testing programme and to announce such restraints (see CCD/PV.536).

90. The delegation of the Soviet Union suggested that it would be preferable to elaborate an independent treaty without any renegotiation of the partial test-ban treaty, and stated that one important and complicated task would be to work out an appropriate international agreement whereby the benefits accruing from the peaceful application of nuclear explosions could be made available to the non-nuclear-weapon States parties to the Treaty on the Non-Proliferation of Nuclear Weapons (*ibid*).

91. The delegations of Burma, Egypt, Ethiopia, Mexico, Morocco, Nigeria, Pakistan, Sweden and Yugoslavia presented a joint memorandum on a comprehensive test-ban treaty (CCD/354), in which they noted that concrete proposals and suggestions relating to a treaty banning underground nuclear weapon tests had been made by several Committee members, including some members of the group of 12 countries. The memorandum stated that the nine delegations requested the nuclear-weapon States to submit their own proposals as matter of urgency so that purposeful negotiations could be undertaken immediately. The memorandum was submitted on the final day of the session and was not discussed.

92. A number of delegations made suggestions regarding a treaty to ban underground tests above a certain threshold and regarding certain interim measures pending completion of a comprehensive ban.

Discussion on threshold or partial measures

93. Several delegations expressed views on the threshold concept.

94. The delegation of Japan suggested that the Committee study the merits and demerits of prohibiting, first of all, underground nuclear weapon tests above a certain level of magnitude (see CCD/PV.497).

95. The delegation of Ethiopia suggested that a threshold approach might lead to a situation in which tests for the perfection of smaller nuclear weapons could continue for a long time to come (see CCD/PV.498).

96. The representative of Czechoslovakia expressed support for the proposal submitted by Egypt in 1964[16] calling for negotiation of a treaty banning underground tests above the seismological magnitude of 4.75, to-

[15] *Ibid., Supplement for 1969*, document DC/232, annex C, sect. 6.

[16] *Ibid., Supplement for 1964*, document DC/209, annex I, sect. N.

gether with a moratorium on all other explosions below that limit (see CCD/PV.500), and favoured an immediate ban on all underground nuclear weapon tests irrespective of whether the explosions were strong or weak (see CCD/PV.535).

97. The delegation of Egypt suggested that it would seem unnecessary to discriminate between various sizes of yield or to embark upon a partial and preliminary agreement and proposed an immediate and comprehensive solution of the problem (see CCD/PV.509).

98. The delegation of the Netherlands discussed difficulties in connexion with the threshold approach even in combination with a voluntary moratorium on explosions beneath the threshold, and suggested that the Committee should head for a complete rather than for a partial solution. The threshold approach should be kept in mind as a possible solution to fall back upon (see CCD/PV.512).

99. The delegation of Sweden expressed the view that a threshold approach could lead to a half measure that would leave open the possibility of improving nuclear weapons (see CCD/PV.513), and suggested that tests of all levels should be encompassed in one treaty (see CCD/PV.524).

100. The delegation of the Soviet Union stated that it supported the Egyptian proposal for the prohibition of underground tests above the magnitude of 4.75 together with a moratorium on underground nuclear explosions under that limit. It suggested that the establishment of a certain threshold for underground nuclear tests, if not linked to a moratorium on all underground tests below that threshold, would not lead to a solution of the problem banning underground nuclear tests and could create conflict between parties about whether the yields of nuclear explosions were above or below the threshold (see CCD/PV.536).

Discussion of interim measures or restraints

101. Several delegations also expressed views on interim measures or restraints on nuclear testing programmes.

102. The delegation of Italy recalled its previous suggestion that advance notification of all underground nuclear explosions for peaceful purposes be provided to the International Atomic Energy Agency (CCD/331).

103. The delegation of Canada submitted a working paper (CCD/336) recommending that, pending the achievement of a total ban on nuclear testing, consideration be given to measures to reduce underground testing and guard against its harmful effects through: (*a*) an undertaking to reduce underground testing, beginning with high-yield testing as an earnest on the part of the nuclear testing Powers of their intention to work towards a complete test-ban; and (*b*) consideration of further measures to guard against environmental risks connected with underground testing.

104. The delegation of Sweden suggested that there should be a link between transitional measures and the treaty banning underground nuclear weapons (see CCD/PV.524).

105 The delegation of Italy expressed the view that a series of interim and partial measures would create an atmosphere of confidence and facilitate subsequent progress towards a complete ban on testing and suggested that interim measures leading to a progressive reduction of underground tests even before the conclusion of a formal agreement would be useful and timely (see CCD/PV.528).

106. The delegation of Japan suggested that the major nuclear-weapon States, either through unilateral action or through joint action, reduce the number and scale of underground tests, with particular emphasis on the high-yield tests detectable and identifiable by extra-territorial means (see CCD/PV.530).

107. The delegation of the Soviet Union stated that a transitional period of descending quotas would only complicate the achievement of a treaty banning underground test explosions since existing obstacles would remain and new difficulties would arise in connexion with establishment of quotas for various States and the periods of their validity (see CCD/PV.536).

Discussion on verification of an underground test ban

108. Members of the Committee devoted detailed attention to the question of verification of a prohibition on underground nuclear weapon tests.

109. The delegation of Ethiopia suggested that progress in the last several years in the development of national and international means of detecting and identifying underground tests was narrowing the differences that had so far persisted on the verification issue, and that it was therefore becoming necessary to consider seriously the question of on-site inspections. He recalled that the nuclear-weapon States were, in 1963, on the verge of agreement regarding the question of on-site inspections and proposed that, until further progress in the field of verification made them obsolete, at least one on-site inspection a year be accepted by the nuclear Powers as a confidence-building undertaking (see CCD/PV.498).

110. The delegations of Poland (see CCD/PV.501) and Hungary (see CCD/PV.502) expressed the view that States had at their disposal sufficient means for the detection and identification of nuclear explosions and that what was needed now was a political decision.

111. The delegation of Mexico suggested that renewed consideration be given to the role of automatic seismic stations ("black boxes"), proposed in 1962 for verification of an underground test ban, and asked whether the delegations of the USSR and the United States would be ready to accept in principle such a proposal as a basis for negotiation to solve the verification problem without on-site inspections (see CCD/PV.504).

112. The delegation of the Netherlands invited the Committee to consider the question of what was more important, banning all tests with a risk that small explosions would go on undetected by whatever means of verification were used or the continuation of underground tests without restriction. The delegation also noted that verification should be based on a combination of appropriate national and international measures and that any comprehensive test ban should take into account all available national means of verification—seismic and non-seismic (see CCD/PV.512, 537).

113. The delegation of Egypt suggested an immediate and comprehensive solution based on means of

verification other than on on-site inspections (see CCD/PV.509).

114. The delegation of Sweden suggested that adequate deterrence could be achieved without on-site inspections and that inspection by invitation carried out in the manner prescribed by the inviting party was sufficient (see CCD/PV.513).

115. The delegation of the United States stated its continued belief that adequate verification of a comprehensive test ban required on-site inspection (see CCD/PV.516).

116. The delegation of Italy proposed the continuation on systematic bases of the exchange of views among experts in order to co-ordinate their studies on all the problems linked to verification and, to that end, suggested the establishment of a subcommittee or a working group of experts, within the committee and under its direction, taking into account the precedent already established by the Conference in 1962 (see CCD/PV.528).

117. The delegation of the Soviet Union, recalling earlier discussion of "black boxes", expressed doubt whether the resumption of the discussion of that proposal would lead to progress towards the solution of the problem of underground nuclear explosions (see CCD/PV.536).

Discussion on international co-operation in the exchange of seismic data

118. International co-operation in the exchange of seismic data, the improvement of world-wide seismological capabilities, and further study of detection and identification of underground nuclear tests were also discussed.

119. The delegation of Canada submitted a working paper (CCD/336) recommending that, pending achievement of a total ban on nuclear testing, consideration be given to measures to help develop seismological identification techniques and facilities which could contribute to the effective verification of a comprehensive test ban through: (*a*) advance notification of details of planned underground nuclear explosions in order to assist in further research on seismological identification methods; and (*b*) undertakings to co-operate in the use, development and improvement of facilities for the monitoring of underground tests by seismological means.

120. At the request of the delegations of Canada, Ethiopia, Italy, Japan, Mexico, Morocco, the Netherlands, Nigeria, Pakistan, Sweden, the United Kingdom and Yugoslavia, an informal meeting was held on 30 June 1971 regarding the question of the cessation of the testing of nuclear weapons. The experts present at that meeting discussed seismological methods of monitoring a comprehensive test ban.

121. In that connexion, delegations presented working papers to the Conference on the following subjects: a summary of existing and potential seismic capabilities for detection and identification of underground nuclear explosions, submitted by the Netherlands (CCD/323); results of a seismological study of 90 earthquakes and 33 underground nuclear explosions in Eurasia from 1968 to 1970, reported by Canada (CCD/327); a summary of six scientific papers and hitherto unreported research on problems related to the seismological verification of a ban on underground nuclear explosions, submitted by Sweden (CCD/329); progress made in the study of the seismic detection, location and identification of earthquakes and explosions and the inherent limitations to seismic techniques for the verification of a comprehensive test-ban treaty, reported by the United States (CCD/330); an outline of the problems of teleseismic detection in the Mediterranean area and suggestions for an international centre for co-ordination of research and exchange of seismic study and for the completion of the existing world network with a new centre in the Mediterranean area, provided by Italy (CCD/331); a discussion of the usefulness of ocean bottom seismographs and a universally acceptable means of determining the magnitude of seismological events by Japan (CCD/345); the seismicity of the United States, the USSR and China, submitted by the Netherlands (CCD/349); and improvements in the existing seismic network which could result from further special studies, described by the United Kingdom (CCD/351).

122. The delegation of Egypt affirmed that a comprehensive test-ban treaty should ensure that all countries would be able to obtain seismological data of concern to them and also provide procedures in case the data raised a question of, or pointed conclusively to, a violation (see CCD/PV.509).

123. The delegation of the Soviet Union suggested that the publication of underground testing programmes would facilitate the acquisition of information by military services of other States and would not assist in the solution of the problems of halting underground nuclear tests. It favoured co-operation in the field of seismological data exchange in the context of an agreement prohibiting underground nuclear weapon tests, on the understanding that control over its observance would be exercised without any international inspection (see CCD/PV.536).

124. The United Kingdom delegation drew attention to certain seismological scientific findings which cast grave doubt on the adequacy of purely national means of verification; further research was required to see to what extent it was possible to improve present seismic capabilities (see CCD/PV.541).

125. The Conference will, in its continued negotiations on this matter as a priority item, take into consideration the discussion of possible approaches to a treaty banning underground nuclear weapon tests and the various proposals that were put forward during the 1971 sessions of the Committee.

* * * * *

126. The Committee agreed to reconvene on a day to be established by the Co-Chairman in consultation with all members of the Committee.

127. This report is transmitted by the Co-Chairmen on behalf of the Conference of the Committee on Disarmament.

(*Signed*) A. A. ROSHCHIN
Union of Soviet Socialist Republics

James F. LEONARD
United States of America

ANNEX A

Draft convention on the prohibition of the development, production and stockpiling of bacteriological (biological) and toxin weapons and on their destruction

[CCD/353 of 28 September 1971]
[Original: English/Russian]

The States Parties to this Convention,

Determined to act with a view to achieving effective progress towards general and complete disarmament, including the prohibition and elimination of all types of weapons of mass destruction, and convinced that the prohibition of the development, production and stockpiling of chemical and bacteriological (biological) weapons and their elimination, through effective measures, will facilitate the achievement of general and complete disarmament, under strict and effective international control,

Recognizing the important significance of the Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare, signed at Geneva on 17 June 1925, and conscious also of the contribution which the said Protocol has already made, and continues to make, to mitigating the horrors of war,

Reaffirming their adherence to the principles and objectives of that Protocol and calling upon all States to comply strictly with them,

Recalling that the General Assembly of the United Nations has repeatedly condemned all actions contrary to the principles and objectives of the Geneva Protocol of 17 June 1925,

Desiring to contribute to the strengthening of confidence between peoples and the general improvement of the international atmosphere,

Desiring also to contribute to the realization of the purposes and principles of the Charter of the United Nations,

Convinced of the importance and urgency of eliminating from the arsenals of States, through effective measures, such dangerous weapons of mass destruction as those using chemical or bacteriological (biological) agents,

Recognizing that an agreement on the prohibition of bacteriological (biological) and toxin weapons represents a first possible step towards the achievement of agreement on effective measures also for prohibition of the development, production and stockpiling of chemical weapons, and determined to continue negotiations to that end,

Determined, for the sake of all mankind, to exclude completely the possibility of bacteriological (biological) agents and toxins being used as weapons,

Convinced that such use would be repugnant to the conscience of mankind and that no effort should be spared to minimize this risk,

Have agreed as follows:

Article I

Each State Party to this Convention undertakes never in any circumstances to develop, produce, stockpile or otherwise acquire or retain:

(1) Microbial or other biological agents, or toxins whatever their origin or method of production, of types and in quantities that have no justification for prophylactic, protective or other peaceful purposes;

(2) Weapons, equipment or means of delivery designed to use such agents or toxins for hostile purposes or in armed conflict.

Article II

Each State Party to this Convention undertakes to destroy, or to divert to peaceful purposes, as soon as possible but not later than nine months after the entry into force of the Convention, all agents, toxins, weapons, equipment and means of delivery specified in article I of the Convention, which are in its possession or under its jurisdiction or control. In implementing the provisions of this article all necessary safety precautions shall be observed to protect populations and the environment.

Article III

Each State Party to this Convention undertakes not to transfer to any recipient whatsoever, directly or indirectly, and not in any way to assist, encourage, or induce any State, group of States or international organizations to manufacture or otherwise acquire any of the agents, toxins, weapons, equipment or means of delivery specified in article I of the Convention.

Article IV

Each State Party to this Convention shall, in accordance with its constitutional processes, take any necessary measures to prohibit and prevent the development, production, stockpiling, acquisition or retention of the agents, toxins, weapons, equipment and means of delivery specified in article I of the Convention, within the territory of such State, under its jurisdiction or under its control anywhere.

Article V

The States Parties to this Convention undertake to consult one another and to co-operate in solving any problems which may arise in relation to the objective of, or in the application of the provisions of, the Convention. Consultation and co-operation pursuant to this article may also be undertaken through appropriate international procedures within the framework of the United Nations and in accordance with its Charter.

Article VI

1. Any State Party to this Convention which finds that any other State Party is acting in breach of obligations deriving from the provisions of the Convention may lodge a complaint with the Security Council of the United Nations. Such a complaint should include all possible evidence confirming its validity, as well as a request for its consideration by the Security Council.

2. Each State Party to this Convention undertakes to co-operate in carrying out any investigation which the Security Council may initiate, in accordance with the provisions of the Charter of the United Nations, on the basis of the complaint received by the Council. The Security Council shall inform the States Parties to the Convention of the results of the investigation.

Article VII

Each State Party to this Convention undertakes to provide or support assistance, in accordance with the United Nations Charter, to any Party to the Convention which so requests, if the Security Council decides that such party has been exposed to danger as a result of violation of the Convention.

Article VIII

Nothing in this Convention shall be interpreted as in any way limiting or detracting from the obligations assumed by any State under the Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare, signed at Geneva on 17 June 1925.

Article IX

Each State Party to this Convention affirms the recognized objective of effective prohibition of chemical weapons and, to this end, undertakes to continue negotiations in good faith with a view to reaching early agreement on effective measures for the prohibition of their development, production and stockpiling and for their destruction, and on appropriate measures concerning equipment and means of delivery specifically designed for the production or use of chemical agents for weapons purposes.

Article X

1. The States Parties to this Convention undertake to facilitate, and have the right to participate in, the fullest possible exchange of equipment, materials and scientific and technological information for the use of bacteriological (biological) agents and toxins for peaceful purposes. Parties to the Convention in a position to do so shall also co-operate in contributing individually or together with other States or international organizations to the further development and application of scientific discoveries in the field of bacteriology (biology) for prevention of disease, or for other peaceful purposes.

2. This Convention shall be implemented in a manner designed to avoid hampering the economic or technological development of States Parties to the Convention or international co-operation in the field of peaceful bacteriological (biological) activities, including the international exchange of bacteriological (biological) agents and toxins and equipment for the processing, use or production of bacteriological (biological) agents and toxins for peaceful purposes in accordance with the provisions of the Convention.

Article XI

Any State Party may propose amendments to this Convention. Amendments shall enter into force for each State Party accepting the amendments upon their acceptance by a majority of the States Parties to the Convention and thereafter for each remaining State Party on the date of acceptance by it.

Article XII

Five years after the entry into force of this Convention, or earlier if it is requested by a majority of Parties to the Convention by submitting a proposal to this effect to the Depositary Governments, a conference of States Parties to the Convention shall be held at Geneva, Switzerland, to review the operation of the Convention, with a view to assuring that the purposes of the preamble and the provisions of the Convention, including the provisions concerning negotiations on chemical weapons, are being realized. Such review shall take into account any new scientific and technological developments relevant to the Convention.

Article XIII

1. This Convention shall be of unlimited duration.

2. Each State Party to this Convention shall in exercising its national sovereignty have the right to withdraw from the Convention if it decides that extraordinary events, related to the subject matter of the Convention, have jeopardized the supreme interests of its country. It shall give notice of such withdrawal to all other States Parties to the Convention and to the United Nations Security Council three months in advance. Such notice shall include a statement of the extraordinary events it regards as having jeopardized its supreme interests.

ARTICLE XIV

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

2. This Convention shall be subject to ratification by signatory States. Instruments of ratification and instruments of accession shall be deposited with the Governments of . . . , which are hereby designated the Depositary Governments.

3. This Convention shall enter into force after the deposit of instruments of ratification by twenty-two Governments, including the Governments designated as Depositaries of the Convention.

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

5. The Depositary Governments shall promptly inform all signatory and acceding States of the date of each signature, the date of deposit of each instrument of ratification or of accession and the date of the entry into force of this Convention, and of the receipt of other notices.

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

Article XV

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

IN WITNESS WHEREOF the undersigned, duly authorized, have signed this Convention.

DONE in . . . copies at . . . , this . . . day of . . . , . . .

ANNEX B

List of documents issued by the Conference of the Committee on Disarmament*

On 16 February 1971, the Secretary-General of the United Nations transmitted to the Co-Chairmen a letter containing the resolutions adopted by the General Assembly at its twenty-fifth session (CCD/318).

On 23 February 1971, the representative of the United States of America submitted a message from President Nixon to the Conference of the Committee on Disarmament (CCD/319).

On 2 March 1971, the representative of the Netherlands submitted a working paper on the prohibition of chemical warfare agents (CCD/320).

On 11 March 1971, the representatives of Mexico, Sweden, and Yugoslavia submitted as a Conference document the Declaration on Peace and Disarmament presented to the President of the General Assembly and the Secretary-General of the United Nations by the Nobel Peace Prize Laureates on 21 September 1970 (CCD/321).

On 16 March 1971, the representative of Sweden submitted a working paper on a model for a comprehensive agreement on the prohibition of chemical and biological means of warfare (CCD/322).

On 18 March 1971, the representative of the Netherlands submitted a working paper on seismic detection and the identification of underground nuclear explosions (CCD/323).

On 30 March 1971, the representative of Sweden submitted a working paper on the destruction of chemical and biological means of warfare (CCD/324).

On 30 March 1971, the representatives of Bulgaria, Czechoslovakia, Hungary, Mongolia, Poland, Romania and the Union of Soviet Socialist Republics submitted a draft convention on the prohibition of the development, production and stockpiling of bacteriological (biological) weapons and toxins and on their destruction (CCD/325/Rev.1).

On 6 April 1971, the representative of the Union of Soviet Socialist Republics submitted a letter to the Special Representative of the Secretary-General of the United Nations (CCD/326).

On 29 June and 7 July 1971, the representative of Canada submitted a working paper on the seismological detection and identification of underground nuclear explosions (CCD/327 and Add.1).

On 29 June 1971, the representative of Egypt submitted a working paper containing suggestions in regard to the draft convention on the prohibition of the development, production, and stockpiling of bacteriological (biological) weapons and toxins and on their destruction (CCD/328).

On 29 June 1971, the representative of Sweden submitted a working paper on the seismological verification of a ban on underground nuclear weapon tests (CCD/329).

On 30 June 1971, the representative of the United States of America submitted a working paper containing remarks by Dr. Stephan Lukasik, Director of the United States Advanced Research Projects Agency, regarding research on seismic detection and the location and identification of earthquakes and explosions (CCD/330).

On 1 July 1971, the representative of Italy submitted a working paper on the problems of underground nuclear explosions (CCD/331).

On 5 July 1971, the representative of the United States of America submitted a working paper on the verification of chemical warfare agents (CCD/332).

On 6 July 1971, the representative of Sweden submitted a working paper on some aspects of the definition of toxins (CCD/333).

On 8 July 1971, the representative of Canada submitted a working paper on atmospheric sensing and verification of a ban on the development, production and stockpiling of chemical weapons (CCD/334).

On 8 July 1971, the representative of Italy submitted a working paper dealing with problems related to the prohibition of chemical weapons (CCD/335).

On 22 July 1971, the representative of Canada submitted a working paper on possible progress towards the suspension of nuclear and thermonuclear tests (CCD/336).

On 5 August 1971, the representatives of Bulgaria, Czechoslovakia, Hungary, Mongolia, Poland, Romania and the Union of Soviet Socialist Republics submitted a revised draft convention on the prohibition of the development, production and stockpiling of bacteriological (biological) and toxin weapons and on their destruction (CCD/337).

On 5 August 1971, the representative of the United States of America submitted a draft convention on the prohibition of the development, production and stockpiling of bacteriological (biological) and toxin weapons and on their destruction (CCD/338).

On 10 August 1971, the representatives of Hungary, Mongolia and Poland submitted a draft Security Council resolution relating to the draft convention on the prohibition of the development, production and stockpiling of bacteriological (biological) and toxin weapons and on their destruction (CCD/339).

On 12 August 1971, the representative of Pakistan submitted a working paper paper suggesting some provisions of a treaty banning underground nuclear weapon tests (CCD/340).

On 17 August 1971, the representatives of Brazil, Burma, Egypt, Ethiopia, India, Mexico, Morocco, Nigeria, Pakistan, Sweden and Yugoslavia submitted a working paper containing suggestions on desirable changes in the draft convention on the prohibition of the development, production and stockpiling of bacteriological (biological) and toxin weapons and on their destruction contained in documents CCD/337 and 338 (CCD/341).

On 19 August 1971, the representative of Mexico submitted a working paper dealing with certain basic facts regarding the Treaty for the Prohibition of Nuclear Weapons in Latin America (Treaty of Tlatelolco) and its Additional Protocol II (CCD/342).

On 24 August 1971, the representative of Japan submitted a working paper on a biological approach to the question of verification in connexion with the prohibition of chemical weapons (CCD/343).

On 24 August 1971, the representative of Japan submitted a working paper containing remarks by Professor Shunichi Yamada, of the University of Tokyo, on the verification of compliance with the prohibition of chemical weapons, presented at the informal meeting on 7 July 1971 (CCD/344).

On 24 August 1971, the representative of Japan submitted a working paper containing remarks by Dr. Shigeji Suyehiro

* With the exception of documents CCD/326 and 350, which have not been reproduced, and CCD/356, which appears as annex A, all the documents listed are printed in annex C.

of the Japanese Meteorological Agency, on the usefulness of employing ocean-bottom seismographs and a universally acceptable means of determining the magnitude of seismic events, presented at the informal meeting held on 30 June 1971 (CCD/345).

On 24 August 1971, the representative of Mexico submitted a working paper containing a proposal for the inclusion of an additional article in the draft convention on the prohibition of the development, production and stockpiling of bacteriological (biological) and toxin weapons and on their destruction contained in documents CCD/337 and 338 (CCD/346.)

On 24 August 1971, the representative of Morocco submitted a working paper suggesting improvements in the draft convention on the prohibition of the development, production and stockpiling of bacteriological (biological) and toxin weapons and on their destruction contained in documents CCD/337 and 338 (CCD/347).

On 2 September 1971, the representative of Sweden submitted a working paper with suggestions for possible provisions of a treaty banning underground nuclear weapon tests (CCD/348).

On 7 September 1971, the representative of the Netherlands submitted a working paper on the seismicity of the United States of America, the Union of Soviet Socialist Republics and China (CCD/349).

On 7 September 1971, the representative of the Soviet Union submitted a letter to the Special Representative of the Secretary-General of the United Nations (CCD/350).

On 23 September 1971, the representative of the United Kingdom submitted a working paper containing comments on the Canadian study of the seismological detection and identification of underground nuclear explosions (CCD/327) and on its implication for the expanded seismic array system outlined in the United Kingdom working paper CCD/296 (CCD/351).

On 28 September 1971, the representatives of Argentina, Brazil, Burma, Egypt, Ethiopia, India, Mexico, Morocco, Nigeria, Pakistan, Sweden and Yugoslavia submitted a joint memorandum on the prohibition of the development, production and stockpiling of chemical weapons and on their destruction (CCD/352).

On 28 September 1971, the representatives of Bulgaria, Canada, Czechoslovakia, Hungary, Italy, Mongolia, Netherlands, Poland, Romania, Union of Soviet Socialist Republics, United Kingdom, and United States of America submitted a draft convention on the prohibition of the development, production and stockpiling of bacteriological (biological) and toxin weapons and on their destruction (CCD/353).

On 30 September 1971, the representatives of Burma, Egypt, Ethiopia, Mexico, Morocco, Nigeria, Pakistan, Sweden and Yugoslavia submitted a joint memorandum on a comprehensive test-ban treaty (CCD/354).

ANNEX C

Documents of the Conference of the Committee on Disarmament annexed to the report

Section	*Title*	*Document No.*
1.	Letter dated 16 February 1971 from the Secretary-General of the United Nations to the Co-Chairmen of the Conference of the Committee on Disarmament transmitting the resolutions on disarmament and other resolutions relating thereto adopted by the General Assembly at its twenty-fifth session	CCD/318
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9.	Canada: working paper on the seismological detection and identification of underground nuclear explosions	CCD/327 and Add.1
10.	United Arab Republic: working paper containing suggestions in regard to the draft convention on the prohibition of the development, production and stockpiling of bacteriological (biological) weapons and toxins and on their destruction, contained in document CCD/325/Rev.1	CCD/328
11.	Sweden: working paper on the seismological verification of a ban on underground nuclear weapon tests	CCD/329
12.	United States of America: working paper containing remarks by Dr. Stephan Lukasik, Director of the United States Advanced Research Projects Agency, regarding research on seismic detection and the location and identification of earthquakes and explosions, presented at an informal meeting on 30 June 1971	CCD/330
13.	Italy: working paper on the problem of underground nuclear explosions	CCD/331
14.	United States of America: working paper on the verification of chemical warfare agents	CCD/332
15.	Sweden: working paper on some aspects of the definition of toxins	CCD/333
16.	Canada: working paper on atmospheric sensing and verification of a ban on the development, production and stockpiling of chemical weapons	CCD/334
17.	Italy: working paper dealing with problems related to the prohibition of chemical weapons	CCD/335
18.	Canada: working paper on possible progress towards the suspension of nuclear and thermonuclear tests	CCD/336
19.	Bulgaria, Czechoslovakia, Hungary, Mongolia, Poland, Romania and Union of Soviet Socialist Republics: revised draft convention on the prohibition of the development, production and stockpiling of bacteriological (biological) and toxin weapons and on their destruction	CCD/337
20.	United States of America: draft convention on the prohibition of the development, production and stockpiling of bacteriological (biological) and toxin weapons and on their destruction	CCD/338
21.	Hungary, Mongolia and Poland: draft Security Council resolution relating to the draft convention on the prohibition of the development, production and stockpiling of bacteriological (biological) and toxin weapons and on their destruction	CCD/339
22.	Pakistan: working paper suggesting some provisions of a treaty banning underground nuclear weapon tests	CCD/340
23.	Brazil, Burma, Ethiopia, India, Mexico, Morocco, Nigeria, Pakistan, Sweden, United Arab Republic and Yugoslavia: working paper containing suggestions on desirable changes in the draft convention on the prohibition of the development, production and stockpiling of bacteriological (biological) and toxin weapons and on their destruction (CCD/337 and 338)	CCD/341
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Section	Title	Document No.
27.	Japan: working paper containing remarks by Dr. Shigeji Suyehiro, of the Japanese Meteorological Agency, on the usefulness of employing ocean-bottom seismographs and a universally acceptable means of determining the magnitude of seismic events, presented at the informal meeting held on 30 June 1971	CCD/345
28.	Mexico: working paper containing a proposal for the inclusion of an additional article in the draft convention on the prohibition of the development, production and stockpiling of bacteriological (biological) and toxin weapons and on their destruction (CCD/337 and 338)	CCD/346
29.	Morocco: working paper on the draft convention on the prohibition of the development, production and stockpiling of bacteriological (biological) and toxin weapons and on their destruction (CCD/337 and 338)	CCD/347
30.	Sweden: working paper suggesting possible provisions of a treaty banning underground nuclear weapon tests	CCD/348
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33.	Argentina, Brazil, Burma, Egypt, Ethiopia, India, Mexico, Morocco, Nigeria, Pakistan, Sweden and Yugoslavia: joint memorandum on the prohibition of the development, production and stockpiling of chemical weapons and on their destruction	CCD/352
34.	Burma, Egypt, Ethiopia, Mexico, Morocco, Nigeria, Pakistan, Sweden and Yugoslavia: joint memorandum on a comprehensive test-ban treaty	CCD/354

1.

Letter dated 16 February 1971 from the Secretary-General of the United Nations to the Co-Chairmen of the Conference of the Committee on Disarmament transmitting the resolutions on disarmament and other resolutions relating thereto adopted by the General Assembly at its twenty-fifth session

[*CCD/318 of 23 February 1971*]
[*Original: English*]

I have the honour to transmit herewith the following resolutions adopted by the General Assembly at its twenty-fifth session entrusting specific responsibilities to the Conference of the Committee on Disarmament: resolution 2661 (XXV), entitled "General and complete disarmament", together with document A/8191, containing the comprehensive programme of disarmament referred to in the resolution; resolution 2662 (XXV), entitled "Question of chemical and bacteriological (biological) weapons", resolution 2663 (XXV), entitled "Urgent need for suspension of nuclear and thermonuclear tests"; and resolution 2667 (XXV), entitled "Economic and social consequences of the armaments race and its extremely harmful effects on world peace and security".

I wish to draw particular attention to the following specific references to the Conference of the Committee on Disarmament.

In resolution 2661 C (XXV), paragraph 1 urges the Conference to make more intensive efforts to bring about a faster pace towards the achievement of disarmament measures; paragraph 2 expresses the General Assembly's appreciation of documents submitted at the Conference, including the working papers on a comprehensive programme of disarmament submitted by the Netherlands and Italy, and the draft comprehensive programme of disarmament submitted by Mexico, Sweden and Yugoslavia, and of the comprehensive programme of disarmament submitted to the General Assembly by Ireland, Mexico, Morocco, Pakistan, Sweden and Yugoslavia in document A/8191; and paragraph 3 recommends to the Conference that it take into account in its future work and its negotiations the comprehensive programme of disarmament contained in A/8191 as well as other disarmament suggestions presented or to be presented in the future.

In resolution 2662 (XXV), paragraph 6 requests the Conference of the Committee on Disarmament to continue its consideration of the problem of chemical and bacteriological (biological) methods of warfare, with a view to prohibiting urgently the development, production and stockpiling of those weapons and to eliminating them from the arsenals of all States paragraph 7 requests the Conference to submit a report on the results achieved to the General Assembly at its twenty-sixth session, and paragraph 8 requests the Secretary-General to transmit to the Conference all documents and records of the First Committee relating to questions connected with the problem.

In resolution 2663 A (XXV), paragraph 2 urges Governments to consider methods of improving their capability to contribute seismic data, taking into account the suggestions contained in the documents annexed to the 1970 report of the Conference of the Committee on Disarmament; and paragraph 3 invites members of the Conference to co-operate in further study of this issue.

In resolution 2663 B (XXV), paragraph 3 requests the Conference of the Committee on Disarmament to continue, as a matter of urgency, its deliberations on a treaty banning underground nuclear weapon tests, taking into account the proposals already made in the Conference as well as the views expressed at the twenty-fifth session of the General Assembly, and to submit to the Assembly at its twenty-sixth session a special report on the results of its deliberations.

In resolution 2667 (XXV), paragraph 2 requests the Conference of the Committee on Disarmament to continue to pay urgent attention to all questions meant to put an end to the arms race, particularly in the nuclear field.

In connexion with resolution 2662 (XXV), paragraph 8, the relevant documents and records of the First Committe of the General Assembly are: A/8059-DC/233,[17] A/8136,[18] the draft resolutions contained in document A/8179,[18] and the records of the 1748th to 1762nd and 1765th meetings (A/C.1/PV.1748-1762, and A/C.1/PV.1765). All these documents and records were distributed during the twenty-fifth session of the General Assembly to all Members of the United Nations, including all members of the Conference of the Committee on Disarmament.

I also have the honour to transmit herewith, for the information of the members of the Conference of the Committee on Disarmament, the following resolutions adopted by the General Assembly at its twenty-fifth session which deal with disarmament matters: resolution 2660 (XXV), entitled "Treaty

[17] *Official Records of the Disarmament Commission, Supplement for 1970*, document DC/233.
[18] See *Official Records of the General Assembly, Twenty-fifth Session, Annexes*, agenda items 27, 28, 29, 30, 31, 93 and 94.

on the Prohibition of the Emplacement of Nuclear Weapons and Other Weapons of Mass Destruction on the Sea-Bed and the Ocean Floor and in the Subsoil Thereof"; resolution 2664 (XXV), entitled "Implementation of the results of the Conference of Non-Nuclear-Weapon States"; resolution 2665 (XXV), entitled "Establishment, within the framework of the International Atomic Energy Agency, of an international service for nuclear explosions for peaceful purposes under appropriate international control"; and resolution 2666 (XXV), entitled "Status of the implementation of General Assembly resolution 2456 B (XXIII) concerning the signature and ratification of Additional Protocol II of the Treaty for the Prohibition of Nuclear Weapons in Latin America (Treaty of Tlatelolco)".

I am also annexing, for the information of the Conference, a list of other resolutions adopted by the General Assembly at its twenty-fifth session in which reference is made to disarmament matters in each instance mentioning the relevant paragraphs.

[*For the text of General Assembly resolutions 2660 (XXV) to 2667 (XXV), see* Official Records of the General Assembly, Twenty-fifth Session, Supplement no. 28.

[*For the text of document A/8191, see* ibid., Annexes, *agenda items 27, 28, 29, 30, 31, 93 and 94*]

Annex

OTHER RESOLUTIONS ADOPTED BY THE GENERAL ASSEMBLY AT ITS TWENTY-FIFTH SESSION IN WHICH REFERENCE IS MADE TO DISARMAMENT

Resolution 2627 (XXV), entitled "Declaration on the Occasion of the Twenty-fifth Anniversary of the United Nations": operative paragraph 5;

Resolution 2734 (XXV), entitled "Declaration on the Strengthening of International Security": third preambular paragraph and operative paragraphs 19 and 20;

Resolution 2749 (XXV), entitled "Declaration of Principles Governing the Sea-Bed and the Ocean Floor, and the Subsoil Thereof, beyond the Limits of National Jurisdiction": operative paragraph 8;

Resolution 2626 (XXV), entitled "International Development Strategy for the Second United Nations Development Decade": paragraph (5) of the preamble;

Resolution 2685 (XXV), entitled "Economic and Social Consequences of Disarmament": *in toto*;

Resolution 2674 (XXV), entitled "Respect for human rights in armed conflicts": operative paragraphs 2, 3 and 5;

Resolution 2677 (XXV), entitled "Respect for human rights in armed conflicts": first and third preambular paragraphs and operative paragraph 1;

Resolution 2625 (XXV), entitled "Declaration on Principles of International Law concerning Friendly Relations and Co-operation among States in accordance with the Charter of the United Nations": eleventh paragraph of the first principle;

Resolution 2707 (XXV), entitled "Question of Territories under Portuguese administration": operative paragraph 9.

[*For the texts of the resolutions,* see Official Records of the General Assembly, Twenty-fifth Session, Supplement No. 28.]

2.

United States of America: message from the President of the United States of America, Mr. Richard M. Nixon, to the Conference of the Committee on Disarmament

[*CCD/319 of 23 February 1971*]
[*Original: English*]

Today the Conference of the Committee on Disarmament begins a new session of work in the vital fields of arms control and disarmament.

On this occasion, once again I want to convey my thoughts to you directly because of my conviction that few areas of endeavour go so deeply to the heart of the concerns and the aspirations of all nations as the search for restraints on armaments. Sound limitations on armaments can enhance international stability and increase the security of all countries; they can reduce the economic burden of armaments; and they can lay the ground-work for productive international co-operation in other areas.

The achievements of this Committee during the past decade have been significant, including, notably, the negotiation of the Treaty on the Non-Proliferation of Nuclear Weapons,[19] and most recently a sea-bed arms control Treaty[20] which was overwhelmingly commended by the United Nations General Assembly and signed earlier this month by a substantial number of States.

The tasks before the Committee are very important to world security. As in the past, genuine progress can best be made through patient and careful work toward mutually beneficial measures. Opportunities for such progress can and must be realized.

I believe that an opportunity for progress exists in the field of chemical and biological weapons. Despite differences of approach, there appears to be a fundamental area of agreement and common interest in the Conference of the Committee on Disarmament regarding this problem. All members desire the greatest possible advance in achieving effective restraints on these weapons. All members are aware that such progress will enhance their own security and international security in general.

An agreement prohibiting the development, production and stockpiling of biological weapons should serve these objectives. Because of the rapid transmission of contagious diseases, particularly with modern means of communications, any use of biological weapons—by any State in any conflict anywhere in the world—could endanger the people of every country. Additional restraints on biological weapons would thus contribute to the security of all peoples. A prohibition of the possession of biological weapons could also have far-reaching benefits of another character. It could encourage international co-operation in the peaceful application of biological research, a field which may lead to immeasurable advances in the health and well-being of peoples everywhere.

With respect to chemical weapons the objective situation is different. Unless countries can have assurance that other parties to an agreement will no longer possess chemical weapons, there will not be a basis for a sound and reliable arms control measure. It is this basic fact that determines the approach of the United States.

The common task with respect to chemical weapons now is to find solutions to the difficult problems of verification. We are determined to pursue this task. And, in any biological weapons convention, we will support an unambiguous commitment engaging all parties to undertake further negotiations regarding limitations on chemical weapons.

Important efforts are being made to move ahead in other areas of arms limitation. The need for restraints on nuclear arms is universally recognized. Negotiations to achieve limitations are continuing through the bilateral Strategic Arms Limitation Talks. It is our earnest hope that these crucial talks will result in positive and substantial arms limitations.

The General Assembly has requested this Committee to continue as a matter of urgency its deliberations on a treaty banning underground nuclear weapon tests. It also called attention to the need to improve worldwide seismological capabilities in order to facilitate such a ban. The United States will continue to support these efforts, particularly those designed to achieve a greater understanding of the verification issue.

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[19] General Assembly resolution 2373 (XXII), annex.

[20] Treaty on the Prohibition of the Emplacement of Nuclear Weapons and Other Weapons of Mass Destruction on the Sea-Bed and the Ocean Floor and in the Subsoil thereof (General Assembly resolution 2660 (XXV), annex).

At the same time, I hope that increasing attention will be given to the question of arms limitation with respect to conventional weapons. When such a vast proportion of all expenditures on armaments is being devoted to these weapons, all States, in all stages of development, share a common interest in exploring the possible paths towards sound agreements consistent with their security interests. The sea-bed Treaty has demonstrated, as have other arms control agreements negotiated during the past decade, that steadfastness in the pursuit of common goals can lead to tangible results. When we have worked toward measures in the interests of all, we have succeeded in resolving differences and overcoming obstacles that seemed great. Let us continue to do so.

3.

Netherlands: working paper on the prohibition of chemical warfare agents

[*CCD/320 of 2 March 1971*]
[*Original: English*]

One of the problems in prohibiting the development, production and stockpiling of chemical warfare agents and chemical weapons is the necessity for distinguishing between agents which have and agents which do not have legitimate uses for civilian purposes. Whereas the former category is likely to be suitable for conditional prohibition only, the latter category could, in principle, be prohibited unconditionally.

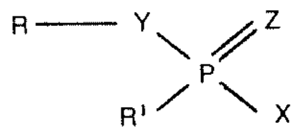
The aim of this paper is to contribute to the formulation of a basis for delineating the chemical compounds that should be included in such an unconditional prohibition. It concentrates on the nerve gases because, according to the reports of the Secretary-General of the United Nations[21] and of the World Health Organization,[22] of all the chemical warfare agents they constitute the most serious threat, mainly owing to their superior toxic properties.

At the informal meeting of the Conference of the Committee on Disarmament on 22 April 1970, the Swedish delegation circulated a tentative list comprising a number of agents which could be subject to an unconditional prohibition. In spite of the comprehensiveness of the list, which includes *inter alia* several nerve agents, it may well be incomplete, since it limits itself to a restricted number of examples of the different types of agents.

In its working paper of 6 August 1970[23] the Japanese delegation suggested that the lethal dose be used as a criterion for the purpose of a reporting system on the statistics of certain chemical substances. This criterion seems to be a very useful approach to the problem of formulating a prohibition. In the opinion of the Netherlands delegation the proposed subcutaneous toxicity of 0.5 milligram per kilogram of body weight would be an acceptable level provided that the animal(s) referred to and the method of application are very well standardized. However, the fact that several compounds with very useful and legitimate medical applications also show the proposed or a higher toxicity level, makes it difficult to use the lethal dose as the sole criterion for defining a range of agents that could be subject to an unconditional prohibition.

The lists of compounds forming part of the aforementioned Swedish and Japanese proposals contain some representatives of the nerve gases. Rather than present some well-known examples as a basis for prohibition purposes, the Netherlands delegation suggests using a general chemical formula which, at least for the moment, covers as completely as possible the spectrum of organophosphorus compounds with suspected nerve agent properties.

This general formula may be represented by



in which:

Y = O or S

Z = O or S

X = F, CN, N_3, SR″, $S(CH_2)_nSR''$, $S(CH_2)_nS^+(R'')_2$, $S(CH_2)_nN(R'')_2$, $S(CH_2)_nN^+(R'')_3$

R = (Substituted) alkyl, cycloalkyl or hydrogen

R′ = Alkyl, dialkylamino

R″ = Alkyl

The formula should be handled in connexion with a toxicity level (LD_{50}) of 0.5 mg/kg determined subcutaneously (e.g. on rats), in such a way that compounds which are covered by the general formula should be subject to unconditional prohibition if they show a toxicity level of 0.5 milligram or less per kilogram of body weight.

It seems to be unlikely that compounds covered by the proposed criterion will be used for civilian purposes (e.g. as insecticides), at least for the time being. However, in order to take account of future developments in the field of organophosphorus compounds, it is suggested that the criterion be reviewed periodically.

The Netherlands delegation is aware of the fact that the suggestion worked out in this paper shows some imperfections. In the first place it includes only one type of chemical warfare agents. If proven promising, the same approach might perhaps be extended to other types of chemical warfare agents in the near future. It is, however, recommended to consider organophosphorus compounds first because of the very serious threat originating from nerve agents.

Secondly the proposal does not incorporate chemical compounds which may be used for so-called "binary" nerve gas weapons, in which the nerve gas is formed by mixing two components during the delivery of the weapon to its target.

Nevertheless the Netherlands delegation hopes that the proposal may serve as a contribution to the formulation of a prohibition of the development, production and stockpiling of chemical warfare agents.

4.

Letter dated 10 March 1971 from the representatives of Mexico, Sweden and Yugoslavia addressed to the Special Representative of the Secretary-General

[*CCD/321 of 11 March 1971*]
[*Original: English*]

On the occasion of the 500th meeting of the Conference of the Committee on Disarmament, we should be grateful if you would issue as a document of the Conference the attached Declaration on Peace and Disarmament by the Nobel Peace Prize Laureates, which was presented to the President of the General Assembly and the Secretary-General on 21 September 1970.

(*Signed*) Alfonso García Robles
Mexico

Alva Myrdal
Sweden

Milorad Božinović
Yugoslavia

[*For the text of the Declaration,* see Official Records of the General Assembly, Twenty-fifth Session, Annexes, *agenda items 27, 28, 29, 30, 31, 93 and 94, document A/C.1/1001.*]

[21] *Chemical and Bacteriological (Biological) Weapons and the Effects of Their Possible Use* (United Nations publication, Sales No. E.69.I.24).

[22] World Health Organization, *Health Aspects of Chemical and Biological Weapons* (Geneva, 1970).

[23] *Official Records of the Disarmament Commission, Supplement for 1970*, document DC/233, annex C, sect. 30.

5.

Sweden: working paper on a model for a comprehensive agreement on the prohibition of chemical and biological means of warfare

[*CCD/322 of 16 March 1971*]
[*Original: English*]

I. *Introduction*

In the intervention by the Swedish delegation on 9 March 1971 (see CCD/PV.499), a model comprehensive convention prohibiting the development, testing, production and stockpiling of chemical and biological means of warfare was tentatively described in general terms. In order to make the suggestions contained therein more easily comprehensible, they are outlined below in an abbreviated form. A "skeleton" of our ideas is thus presented. It should be stressed that the model is not complete—it deals primarily with the thorny issues of the scope of the prohibitions and procedures for verification—and that some of the suggestions are still very tentative. As a matter of fact both the intervention itself and this abbreviated presentation should primarily be regarded as stages in the "mapping expedition", covering the whole field of chemical and biological weapons, in which the Conference of the Committee on Disarmament has been engaged for more than a year.

II. *Scope of the prohibition*

1. In the treaty under discussion, no prohibitory rules should be included concerning the use of chemical and biological weapons, which is dealt with comprehensively in the Geneva Protocol of 1925.[24]

2. The treaty should contain a principal overriding regulation, indicating the undertaking by the Parties "not to develop, test, produce, stockpile or otherwise acquire chemical and biological weapons".

3. This general undertaking ought to be complemented with a prohibitory rule against all transfers of weapons between Parties.

4. Two corollary obligations to the general prohibition concerning weapons would follow: (*a*) concerning the destruction or other disposal of existing stocks of chemical and biological means of warfare; and (*b*) concerning the training of troops in offensive combat with chemical and biological weapons, instructions on such methods in military manuals, etc.

5. A subsidiary set of prohibitions would follow, concerned with the agents which constitute C and B weapons or are integral components of such weapons. These prohibitions would refer to production, testing and stockpiling, as well as transfers (export) of the agents.

6. The agents would be separated into two categories according to two technical criteria: Category (*a*) would compromise those agents, whether chemical, toxins or biological which have a practically exclusive use as potential means of warfare. They would, at the same time, be super-toxic agents. In the chemical field this category would include all substances more toxic than 1 mg per kg body weight. It would thus comprise, *inter alia*, the chemical components of nerve gases and mustards, as well as all toxins. Category (*b*) would comprise all remaining chemical agents, less toxic than indicated by the above mentioned formula, which could be used as means of warfare but which also have recognized peaceful uses. This would be the main category, comprising such chemicals as hydrogen cyanide, phosgene, tear gases and defoliants. Also most biological agents would belong to this category in so far as they are produced for non-military purposes e.g. for immunization.

7. There would, finally, be a third category, category (*c*), comprising ancillary equipment or vectors, specifically designed for using chemical and biological agents as means of warfare.

III. *Verification*

1. The verification procedures would probably have to be largely concentrated in the area of the agents. Suspicions of violations of the over-all prohibition of chemical and bacteriological weapons would have to be taken care of within the framework of a detailed complaints procedure. The same procedure would cover suspicions of violations of the corollary prohibitions regarding military training, army manuals etc.

2. The details of the complaints procedure would have to be worked out carefully. It should take the form of a system of successive steps, including consultations between the parties and other fact-finding measures. The final step would consist of the possibility of lodging a complaint with the United Nations Security Council.

3. The destruction and disposal of existing stocks of chemical and biological weapons would also have to be verified, preferably through an international procedure.

4. The more specific verification procedures would be concentrated on the agents. They would comprise a combination of national and international control measures. The most rigorous methods of control would be those dealing with category (*a*) above, i.e. chemicals more toxic than 1 mg per kg body weight, toxins and biological agents without any recognized peaceful use. The production of these compounds would in principle be prohibited. Any deviation from this general rule would have to be reported to an international agency, the report giving the reasons for the production (scientific use, protective measures etc.). In case of any large-scale production (i.e. over one kg) or in case of suspected undeclared production, the international agency might be entitled to conduct an on-site inspection, either on the invitation of the producing or suspected party, or obligatory.

5. The compounds comprising category (*b*) as well as the ancillary equipment and vectors in category (*c*) would be controlled by national means only, such national control possibly complemented, in some cases by statistical reporting by the parties to an international agency; they would further be subject, if suspicion was aroused, to the sequence of processes foreseen in the complaints procedure, i.e. through consultation and challenge and, in the final instance, by a reference of the dispute to the Security Council of the United Nations.

6. If and when new technical developments allow more stringent verification procedures for categories (*b*) and (*c*), agreement should be sought to shift them to category (*a*).

6.

Netherlands: working paper on seismic detection and the identification of underground nuclear explosions

[*CCD/323 of 18 March 1971*]
[*Original: English*]

1. *Introduction*

The Netherlands delegation at the Conference of the Committee on Disarmament has considered the materials presented to this body regarding the detection, location and identification of underground nuclear explosions, together with the relevant data from open literature. The delegation thought it worthwhile to summarize the most pertinent data in order to facilitate discussions. It has summarized a substantial part of these data in two figures reproduced in this paper.

The excellent Canadian report of November 1970, entitled "Seismological detection and identification of underground nuclear explosions", by P. W. Basham and K. Whitham,[25] has been the main source of the information presented in the figures, including the magnitude-yield relation.

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[24] Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare (League of Nations, *Treaty Series*, vol. XCIV (1929), No. 2138).

[25] *Publications of the Earth Physics Branch* (Canadian Government publication), vol. 41, No. 9.

2. *Existing capabilities*

A summary of the existing seismic capabilities for the identification of underground nuclear explosions, especially in the northern hemisphere, is given in the upper part of figure 1. More detailed information for the different test sites is given in figure 2.

In both figures a detection and location capability for earthquakes (Q) and explosions (E) is indicated where there is a 90 per cent probability that each of at least four seismic monitoring stations can detect and locate the earthquake or explosion by measuring the body P wave. In the northern hemisphere the lower limit of this detection and location capability (indicated by 4P90) for earthquakes and explosions is between magnitude m_B-values of 4.2 and 4.4. This corresponds to an explosion yield of about 3 kiloton in hard rock. The P wave detection capability is shown by the thin lines in figure 1.

The capability to identify earthquakes and explosions is presented in the form of bars in the figures. This discrimination between earthquakes and explosions is based on the surface R wave/body P wave ratio, which is quite different for the two kinds of events. Positive identification of earthquakes is possible for m_B-values of 4.8-5.1, while for explosions this is 5.8-6.1. The possibility of positive identification is interpreted here as a 90 per cent probability that each of at least four seismic monitoring stations can identify at this threshold value the earthquake or explosion as such by measuring the amplitudes of the R wave and P wave. This capability is indicated by 4R90 in the figures.

In connexion with a comprehensive test ban, lower identification probabilities for explosions are also considered. In figure 1 these are presented in the form of bars for a 50 per cent and a 20 per cent probability of identification by four stations each. For example, the identification threshold is lowered to m_B 5.1-5.4 at the 20 per cent probability level for each of four stations (4R20). In figure 2 other identification probabilities are also given.

Another possibility of identifying an explosion can be found by using a "negative" criterion, that is, the absence of R waves when one would expect these in the case of an earthquake. An estimate of this identification capability is indicated in figure 1.

From the upper part of figure 1 it can be concluded that the present seismic monitoring system in the northern hemisphere can identify with a reasonable probability explosions with a magnitude m_B 5.5 or a yield of about 50 kilotons in hard rock. Earthquakes can be identified above m_B 4.8-5.1 with a high degree of confidence.

3. *Potential capabilities*

Several methods of increasing the identification capabilities for underground nuclear explosions have been proposed and/or are investigated at present (see the lower part of figure 1).

(*a*) Specific studies of events at the Nevada test site have made it clear that, by a study of R_g waves, an identification threshold of m_B 5.0 may actually be reached. R_g is the surface wave, guided within the continental part of the earth crust only, and consequently restricted to purely continental source-receiver pathways. It seems likely that with the existing station network this type of wave could effectively be used for other continental test-site/station combinations.

(*b*) In theory the ratio of the body P wave frequencies can be used down to the level of its detection, which should mean to magnitude m_B-values of 4.2-4.4. In practice this method, which makes use of the (spectral) characteristics of the measured body P wave itself (thus not using a combination of body P and surface R waves), has at least been realized down to m_B 4.9 for certain test-site/station combinations. It seems likely that the highly successful work on this P wave spectral ratio discriminant, as developed by the United Kingdom research group, could be extended by additional studies to magnitude values nearer to the threshold of P wave detection. In any case the method can be used without undue extension of the present seismic monitoring system.

(*c*) An important capability increase could be achieved by the use of the new high-gain long-period vertical seismometer (LPZ), as developed by research groups in the United States of America. Using these instruments the surface R wave spectral ratio criterion can be extended down to a magnitude of 5.3 and the R wave/P wave ratio method down to m_B 4.9. Moreover, the absence of surface R waves in the records of this instrument may constitute an important indication for the explosion character of an event down to m_B values of 4.4, which corresponds with a hard-rock yield of about 4 kilotons. The installation of a limited number of high quality, high-gain LPZ recorders could thus become of major significance in improving the identification system.

(*d*) The last-mentioned threshold values are of the same order as those envisaged for the 26 extended seismic arrays described by the United Kingdom delegation in document CCD/296.[26] It can be expected however that the 26-array system will be much more expensive than the installation of a limited number of LPZ instruments.

In the lower part of figure 1, estimates of the potential capabilities of the different systems are indicated. At present no exact identification probabilities can be given.

4. *Additional identification improvements*

(*a*) A better and more detailed structural analysis of the crust and upper mantle of the earth should help to lower the existing threshold values by a more effective use of the "matched filtering" process. A gain of 0.2 magnitude units has been obtained for some of the test-site/station combinations. Eventually this same gain could be achieved for any other place in the northern hemisphere, which would mean a lowering of the threshold yield value by a factor of 2/3.

(*b*) Knowledge of the predominant type of radiation of seismic waves in the seismic zones of the earth could be of great importance in the interpretation of the records of an event of unknown type. The identification of earthquakes, and therewith their discrimination from underground nuclear explosions, will be made more effective.

(*c*) For the understanding of the processes of energy transfer in earthquakes and explosions additional studies on the magnitude-yield relation of explosions in different types of media are needed. The question has already been raised whether the use of surface wave magnitudes is not to be preferred to the body wave magnitude-scale m_B normally used in this work. It seems likely that a more consistent explanation of the data, and therewith of the identification of suspected events, might be reached.

(*d*) Other, non-seismic, methods of detection of underground nuclear explosions, have been envisaged. Cratering occurs for explosions of about 20 kilotons or more in thick layers of dry soil, as mentioned in the report by the Stockholm International Peace Research Institute[27] (see also fig. 1). Extensive mining works are necessary for the seismic decoupling of underground explosions in hard rock, although it is unclear whether such decoupling is possible for interesting yields. Both cratering and mining can probably be detected by satellites.

A multi-variate analysis of the whole scale of possibilities mentioned above will inevitably lead to an increase in the weight of the conclusions based on the individual methods.

5. *Suggestions*

The work on the P wave spectral ratio, as developed by the United Kingdom, should be elaborated and extended to lower magnitude events.

The installation of an appropriate limited network of high-gain LPZ instruments, as developed by the United States of America, could be particularly helpful.

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[26] See *Official Records of the Disarmament Commission, Supplement for 1970*, document DC/233, annex C, sect. 25.

[27] *Seismic Methods for Monitoring Underground Explosions*, Stockholm Paper No. 2 (Stockholm, Almqvist & Wiksell).

Additional study of crust and upper mantle structure, and of the radiation characteristics of shallow earthquakes in regions that in future could be used as test-sites, should be encouraged.

Support should be given to studies directed towards solving the magnitude/yield relation in different types of media, and to the question of seismic efficiency.

6. *Conclusions*

It has been shown that the existing, more or less routine-based, facilities can identify 50-kiloton events in hard rock. By the inclusion of other types of discriminants this identification could in principle be extended to hard-rock yields of 10 to 20 kilotons, using the present monitoring system. With an additional installation at selected places of high gain LPZ seismometers another threshold reduction of a factor of two might be realized.

However, in that case too, a supposed test-ban treaty could be evaded by a test programme of yields of 10 kilotons or less in dry soil that, in the case of sufficient thickness of the layer, would remain undetected and unidentified by seismological means or by observations of cratering.

With the most optimistic views in mind on the future development of seismic identification techniques, it can still be said that this 10-kiloton threshold will not be lowered within the next five years.

7.

Sweden: working paper on the destruction of chemical and biological means of warfare

[*CCD/324 of 30 March 1971*]
[*Original: English*]

The Secretary-General of the United Nations has called upon all States to reach agreement to halt the development, production and stockpiling of all chemical and bacteriological (biological) agents for purposes of war and to achieve their effective elimination from the arsenals of weapons. One aspect of this elimination is destruction of already existing chemical and biological means of warfare as foreseen both in the nine countries' revised draft convention on the prohibition of the development, production and stockpiling of chemical and bacteriological (biological) weapons and on the destruction of such weapons[28] and in the revised text of the United Kingdom draft convention for the prohibition of biological methods of warfare (CCD/255/Rev.2).[29]

Different attempts have been made to solve the problem of disposing of chemical and biological means of warfare. Recently, an operation whereby chemical munitions (rockets) containing nerve gas were sunk in the Atlantic became widely known and was extensively reported on (see "Hearings before the Sub-committee on Oceanography of the Committee on Merchant Marine and Fisheries; House of Representatives, August 3-7 1970, Washington, D.C."). This report dealt thoroughly with several means of disposal and destruction and also provided the information that some types of equipment for destruction was under construction.

In the present working paper the principles of the destruction of both chemical and biological means of warfare are outlined. An element of importance that has been taken into account is that the effectiveness of the destruction should be easily observed and verified.

Chemical agents

The following is applicable to nerve and mustard gases, which are considered to be representative of the most dangerous compounds and, furthermore, are stockpiled in various parts of the world in great quantities. Such agents may be stockpiled in various ways, which raise different technical problems when it comes to destruction. They may, for example be stockpiled in: (*a*) containers in which the agents are easily accessible; (*b*) munitions, containing explosives and perhaps propellants, from which the agents are accessible without prior defusing; (*c*) munitions, the explosive part of which has to be defused before the agent can be released.

In cases (*b*) and (*c*), the explosive part of the munitions causes special problems, particularly in the latter case, where simultaneous destruction of the explosive part and the agents seems unavoidable. Thus, from the point of view of destruction, two alternatives can be anticipated: first, pure agents; and second, agents which are inseparable from munitions.

In the case of a pure agent, two principally different methods of destruction can be conceived.

One is by means of reactive chemicals (in a water solution) which detoxify the agent; the second, which is also more likely to be generally applicable, is by thermal destruction, i.e., decomposition by heating, pyrolysis or combustion.

The chemical method may involve the use of alkali or oxidants (e.g., bleach). Chemical destruction generally yields nontoxic end-products, but the nature of the products makes them an environmental hazard if introduced directly into the open, the ground, sea, lakes or rivers. The question of how to dispose of large quantities of the end-products, derived from the different chemical destruction methods, will have to be investigated further. Special facilities may have to be constructed.

Heating the agents themselves in autoclaves is technically feasible but may lead to some complex end-products about which relatively little is known.

Combustion, in combination with the absorption of potential pollutants from the exhaust gases, appears to be the most promising method—technically and from the point of view of environmental pollution. A suitable combustion process would require specially constructed facilities.

The advantage of the thermal destruction methods would be that smaller destruction units might be used for a given amount of the agents and that the end-products are more easily handled. Actual experiments would have to be performed to evaluate the order of the most feasible technical steps.

In the case of munitions from which the agent cannot be separated easily, much more drastic procedures seem to be necessary. The use of underground nuclear explosions has been discussed and found technically feasible but in the earlier mentioned case the idea was discarded for a number of reasons, among them the risks involved in handling the defective munitions, as was brought out at the above-mentioned hearings. Instead, the formerly widely used method of disposal by sinking the munitions in the sea was applied. The agents, when released from their containers, will in due time be destroyed by chemical reactions with the sea water. However, this method will be less attractive in the case of some of the nerve gases and the mustard gases, which need a considerably longer period to react with water.[30] In addition, attention should be paid to the provisions of the recent sea-bed Treaty, which *inter alia*, prohibit the storing of chemical and biological weapons on the seabed.

Another less attractive alternative is treatment of the munitions with lime or bleach in old mines or underground in places chosen with great care.

Underwater detonation in closed-off water-filled pools together with facilities to take care of the toxic gases that may escape from the water surface might be feasible. All of the methods mentioned are cumbersome. However, the greatest part of the existing chemical warfare agents can apparently be destroyed as such and according to the procedures suggested for pure agents.

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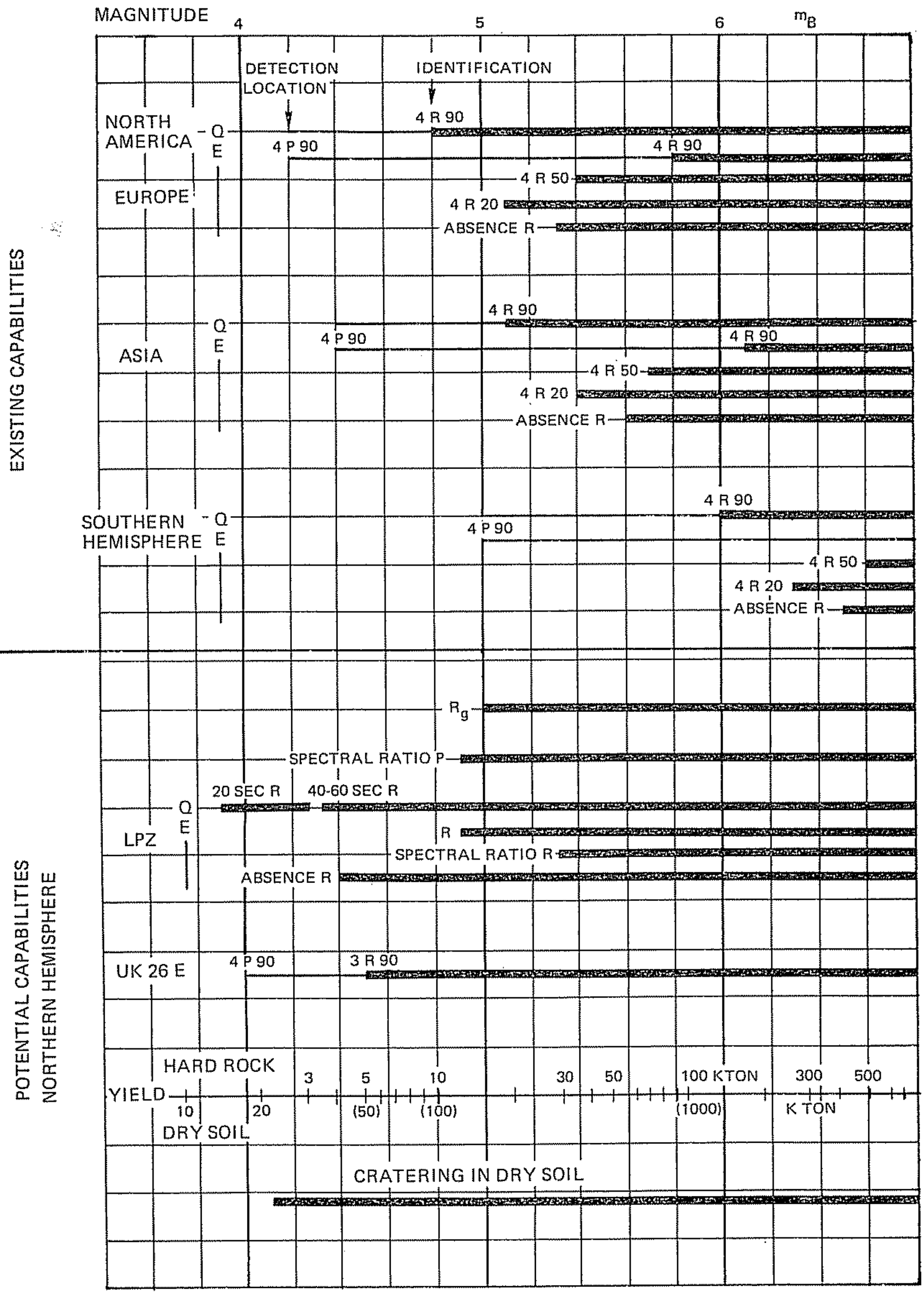
[28] See *Official Records of the General Assembly, Twenty-fifth Session, Annexes*, agenda items 27, 28, 29, 30, 31, 93 and 94, document A/8136.

[29] *Official Records of the Disarmament Commission, Supplement for 1970*, annex C, sect. 2.

[30] Treaty on the Prohibition of the Emplacement of Nuclear Weapons and Other Weapons of Mass Destruction on the Sea-Bed and the Ocean Floor and in the Subsoil thereof (General Assembly resolution 2660 (XXV), annex).


MAGNITUDE
4
5
6
m_B
EXISTING CAPABILITIES
DETECTION
LOCATION
IDENTIFICATION
NORTH AMERICA
Q
E
4 R 90
4 P 90
4 R 90
4 R 50
EUROPE
4 R 20
ABSENCE R
4 R 90
Q
E
ASIA
4 P 90
4 R 90
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ABSENCE R
4 R 90
SOUTHERN HEMISPHERE
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SPECTRAL RATIO R
ABSENCE R
UK 26 E
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HARD ROCK
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YIELD
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(50)
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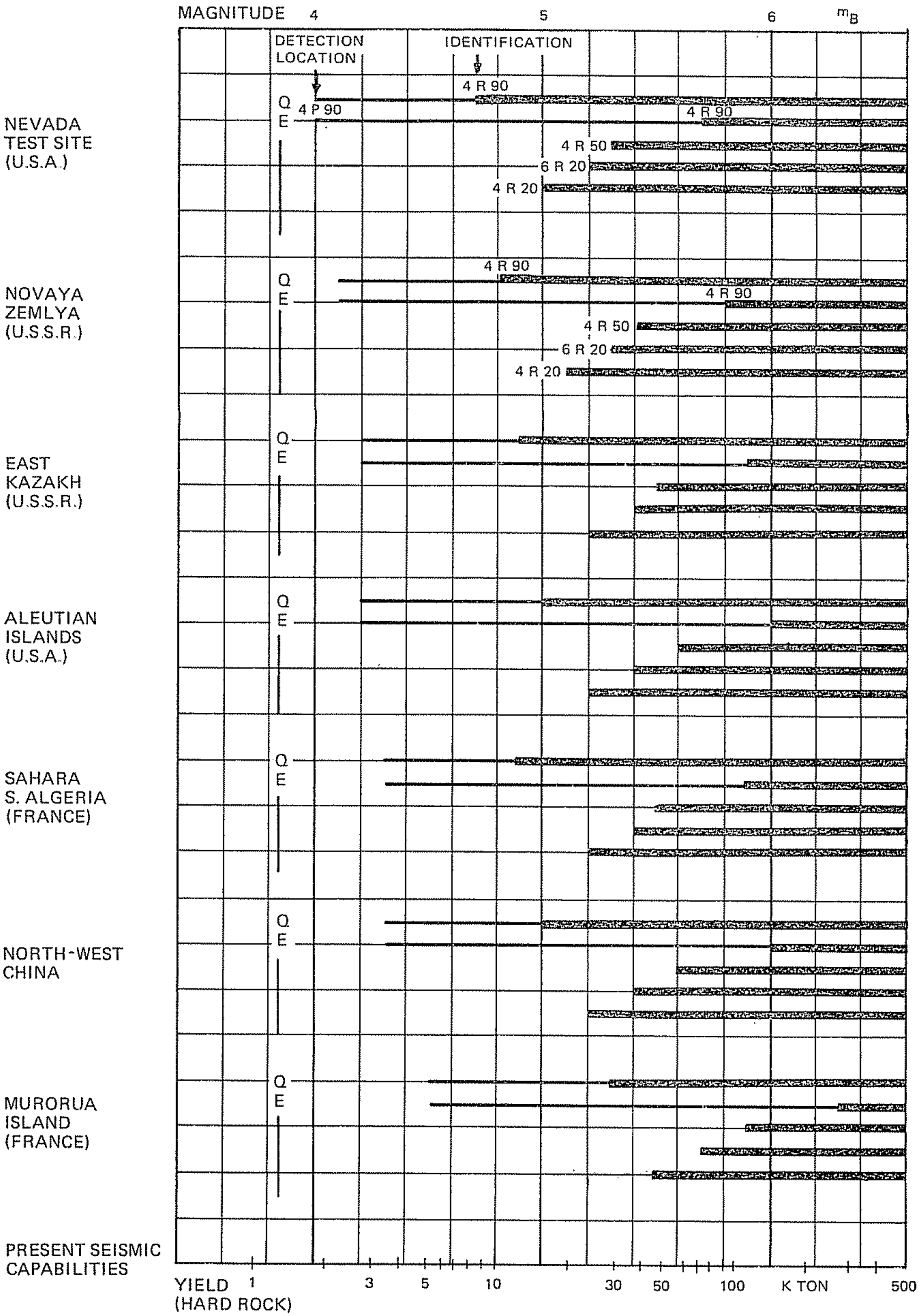
K TON
DRY SOIL
CRATERING IN DRY SOIL

Figure 1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EAST
KAZAKH
(U.S.S.R.)
ALEUTIAN
ISLANDS
(U.S.A.)
SAHARA
S. ALGERIA
(FRANCE)
NORTH-WEST
CHINA
MURORUA
ISLAND
(FRANCE)
PRESENT SEISMIC
CAPABILITIES
YIELD
(HARD ROCK)
1 3 5 10 30 50 100 K TON 500

Figure 2

Biological agents

Biological agents may be destroyed by combustion, in autoclave or by means of disinfectants. The destruction of biological agents also has its hazards, but in general poses lesser problems than the destruction of chemical agents, especially since the quantities to be destroyed, and accordingly the quantities of end products, should be much smaller than is the case with the chemical warfare agents. Various destruction facilities intended for ordinary peaceful purposes already exist.

Conclusion

The destruction of munitions and agents intended for chemical and biological warfare is technically feasible. Because of the high toxicity and infectiousness of the agents, hazards may in certain cases cause considerable destruction costs owing to the need for special technical facilities. The destruction methods recommended above may be subject to verification without major technical difficulties, but apparently only with inspectors present at the site of destruction.

8.

Bulgaria, Czechoslovakia, Hungary, Mongolia, Poland, Romania and Union of Soviet Socialist Republics: draft convention on the prohibition of the development, production and stockpiling of bacteriological (biological) weapons and toxins and on their destruction*

[*CCD/325/Rev.1** of 15 April 1971*]
[*Original: Russian*]

The States Parties to this Convention,

Determined to act with a view to achieving effective progress towards general and complete disarmament and, above all, with a view to prohibiting and eliminating nuclear, chemical, bacteriological (biological) and all other types of weapons of mass destruction,

Convinced that the prohibition of the development, production and stockpiling of bacteriological (biological) weapons and toxins and their elimination will facilitate the achievement of general and complete disarmament,

Convinced of the immense importance and urgent necessity of eliminating from the arsenals of States such dangerous weapons of mass destruction as weapons using bacteriological (biological) agents and toxins,

Desiring to contribute to the strengthening of confidence between peoples and the general improvement of the international atmosphere,

Believing that scientific discoveries in the field of bacteriology (biology) must in the interests of all mankind be used solely for peaceful purposes,

Recognizing nevertheless that in the absence of appropriate prohibitions the development of scientific knowledge throughout the world would increase the risk of the use of bacteriological (biological) methods of warfare,

Convinced that such use would be repugnant to the conscience of mankind and that no effort should be spared to minimize this risk,

Recognizing the important significance of the Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare, signed at Geneva on 17 June 1925,[31] and conscious also of the contribution which the said Protocol has already made, and continues to make, to mitigating the horrors of war,

Reaffirming their adherence to the purposes and principles of that Protocol and calling upon all States to comply strictly with them,

Guided by the resolutions of the United Nations General Assembly, which has condemned all actions contrary to the Geneva Protocol of 17 June 1925 as well as the use in international armed conflicts of any chemical and any biological means of warfare,

Noting the conclusions contained in the report submitted to the United Nations General Assembly and to the Conference of the Committee on Disarmament on the grave consequences for mankind that might result from the use of chemical and bacteriological (biological) weapons,

Convinced that an agreement on bacteriological (biological) weapons will facilitate progress towards the achievement of agreement on effective measures for the complete prohibition of chemical weapons, on which negotiations will be continued,

Anxious to contribute to the realization of the purposes and principles of the Charter of the United Nations,

Have agreed as follows:

Article I

Each State Party to this Convention undertakes not to develop, produce, stockpile or otherwise acquire:

1. Microbiological or other biological agents or toxins of such types and in such quantities as are not designed for the prevention of disease or for other peaceful purposes;

2. Auxiliary equipment or means of delivery designed to facilitate the use of such agents or toxins for hostile purposes.

Article II

Each State Party to this Convention undertakes to destroy within a period of three months after the entry into force of the Convention—observing all the necessary precuations—or to divert to peaceful uses all previously accumulated weapons in its possession as well as the equipment and means of delivery mentioned in article I of the Convention.

Article III

Each State Party to this Convention undertakes not to assist, encourage or induce any particular State, group of States or international organizations to take action contrary to the provisions of the Convention.

Article IV

Each State Party to this Convention shall be internationally responsible for compliance with its provisions by legal or physical persons of that State.

Article V

Each State Party to this Convention undertakes to take as soon as possible, in accordance with its constitutional procedures, the necessary legislative and administrative measures for prohibiting the development, production and stockpiling of the weapons, equipment and means of delivery mentioned in article I of the Convention, and for destroying them.

Article VI

The States Parties to this Convention undertake to consult one another and to co-operate in solving any problems which may arise in the application of the provisions of the Convention.

Article VII

(1) Any State Party to this Convention which finds that actions of any other State Party constitute a breach of the obligations assumed under the provisions of the Convention may lodge a complaint with the Security Council of the United Nations. Such a complaint should include all possible evidence confirming its validity, as well as a request for its consideration by the Security Council. The Council shall inform the States Parties to the Convention of the result of the investigation.

(2) Each State Party to this Convention undertakes to co-operate in carrying out any investigations which the Security Council may undertake, in accordance with the provisions of

* The draft convention was also submitted on behalf of the Byelorussian Soviet Socialist Republic and the Ukrainian Soviet Socialist Republic.

** Replaces document CCD/325 of 30 March 1971.

[31] League of Nations, *Treaty Series*, vol. XCIV (1929), No. 2138.

the Charter of the United Nations, on the basis of the complaint received by the Council.

Article VIII

Nothing in this Convention shall be interpreted as in any way limiting or detracting from the obligations assumed by any State under the Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare, signed at Geneva on 17 June 1925, an instrument which embodies generally recognized rules of international law.

Article IX

Each State Party to this Convention undertakes to conduct negotiations in good faith on effective measures for prohibiting the development, production and stockpiling of chemical weapons and for their destruction, and on appropriate measures concerning the equipment and means of delivery specifically designed for the production or use of chemical weapons as means of warfare.

Article X

(1) The States Parties to this Convention undertake to facilitate, and have the right to participate in, the fullest possible exchange of equipment, materials and scientific and technological information for the use of bacteriological (biological) agents and toxins for peaceful purposes.

(2) This Convention shall be implemented in a manner designed to avoid hampering the economic or technological development of States Parties to the Convention or international co-operation in the field of peaceful bacteriological (biological) activities, including the international exchange of bacteriological (biological) agents and toxins and equipment for the processing, use or production of bacteriological (biological) agents and toxins for peaceful purposes in accordance with the provisions of the Convention.

Article XI

Any State Party may propose amendments to this Convention. Amendments shall enter into force for each State Party accepting the amendments upon their acceptance by a majority of the States Parties to the Convention and thereafter for each remaining State Party on the date of acceptance by it.

Article XII

(1) This Convention shall be of unlimited duration.

(2) Five years after the entry into force of this Convention, a conference of States Parties to the Convention shall be held at Geneva, Switzerland, to review the operation of the Convention, so as to be sure that the purposes of the preamble and the provisions of the Convention, including the provisions concerning negotiations on chemical weapons, are being realized. Such review shall take into account any new scientific and technological developments relevant to the Convention.

Article XIII

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

(2) This Convention shall be subject to ratification by signatory States. Instruments of ratification and instruments of accession shall be deposited with the Governments of . . . . . , which are hereby designated the Depositary Governments.

(3) This Convention shall enter into force after the deposit of instruments of ratification by . . . . . Governments, including the Governments designated as Depositaries of the Convention.

(4) For States whose instruments of ratification or accession are deposited subsequent to the entry into force of this Convention, it shall enter into force on the date of the deposit of their instruments of ratification or accession.

(5) The Depositary Governments shall promptly inform all signatory and acceding States of the date of each signature, the date of deposit of each instrument of ratification or of accession and the date of the entry into force of this Convention, and shall transmit other notices to them.

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

Article XIV

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

IN WITNESS WHEREOF the undersigned, duly authorized, have signed this Convention.

DONE in . copies at , this day of , . . .

9.

Canada: working paper on the seismological detection and identification of underground nuclear explosions

[*CCD/327 and Add.1* of 29 June and 7 July 1971*]
[*Original: English*]

1. *Introduction*

In December 1970, at the twenty-fifth session of the United Nations General Assembly, the Canadian delegation distributed a technical report on the seismological detection and identification of underground nuclear explosions. This was a final assessment of world-wide seismological capabilities for this purpose, based on information submitted by co-operating countries in accordance with General Assembly resolution 2604 A (XXIV)[32]. A preliminary analysis of the problem was distributed to members of the Conference of the Committee on Disarmament in August 1970, and summarized in the Canadian working paper CCD/305, of 10 August 1970.[33]

These analyses of the problem were, of necessity, substantially theoretical, although empirical data on actual events were used whenever available. One of the most important conclusions and recommendations was that extensive practical studies of discrimination capability should be undertaken and published using the records from conventional seismograph stations on the same continental mass as earthquake and explosion sources, in order to determine whether the detection and identification thresholds achieved in North America from a limited deployed network (the Canadian network) might be acheived elsewhere using currently deployed equipment. In particular, the technical report noted that the demonstrated threshold of explosion identification in North America could not, without further definitive research, be extrapolated to continental regions in Eurasia.

In North America it was demonstrated that geological conditions along the propagation paths between the Nevada test site and a particular network of conventional seismograph stations produce sufficiently efficient propagation of Rayleigh surface waves that the underground explosion identification threshold was 10 to 20 kilotons in hardrock using the Canadian standard seismograph network alone. It should be lower if all available continental data were used, but such an extensive study on actual events has never been done or, at least, published. No comparable claim could be proved for Eurasian test sites using conventional seismograph stations operating in Eurasia and reported in the returns submitted in accordance with resolution 2604 A (XXIV).

The purpose of this working paper is to outline the results of a study of Eurasian earthquakes and underground explosions

* Document CCD/327/Add.1 of 7 July 1971 contained the explanatory comments reproduced at the end of this section.
[32] See document A/7967/Rev.1.
[33] *Official Records of the Disarmament Commission, Supplement for 1970*, document DC/233, annex C, sect. 34.

made using seismic records from the currently deployed Eurasian standard seismograph stations. The results are a clear demonstration that the identification threshold for these events that can be routinely achieved without the deployment of further equipment is about 20 kilotons yield in competent rock. Furthermore, the new results can be used in association with the material published in our 1970 technical report to predict with more certainty the significance of any proposals to deploy different instrumentation with different characteristics, or to merge currently available data in a more effective way. The scientific study has also suggested an improved way of taking into account the influence of gross geological effects on surface wave propagation. When this is done, seismic data acquired on the same continent as an event can be usefully and simply compared with seismic data acquired at a station on a different continent from that of the event, for perhaps the first time and with considerable clarification. These data are referred to as continental and intercontinental data, respectively. Finally, in order to clarify the yield limits and to demonstrate the above-mentioned point, comparisons are made with available previously published North American data, although these are not optimum data in terms of the returns submitted to the United Nations.

2. *Events, stations and data*

The North American data consist of those collected for a series of Canadian research papers published in the past few years and will be presented in a modified unified form. The map of North America in figure 1 shows the locations of the pertinent conventional Canadian seismograph stations and the events that will be discussed. The United States explosions include 24 at the Nevada test site, two in the Aleutian Islands, one in New Mexico and one in Colorado. The earthquakes selected for comparison are 28 shallow-focus earthquakes in the regions southwestern United States and northwestern Mexico.

The Eurasian data are collected specifically for this study: the data distribution services of the National Oceanic and Atmospheric Administration (NOAA) of the USA, previously known as the Environmental Science Services Administration (ESSA), were used. This provides, at cost, microfilm copies of records from stations of the World Wide Standard Seismograph Network (WWSSN). The locations of the 42 Eurasian stations employed are shown on the map of Eurasia in figure 2. The events selected for analysis were 90 shallow-focus Eurasian earthquakes of 1969, restricting the choice of earthquakes to those reported in the five arbitrary regions shown in figure 2, and 33 underground explosions in 1968, 1969 and the first half of 1970. All events were located by the NOAA service, using abstracted seismic readings of P- or body-wave seismic phases from co-operating observatories and institutions throughout much of the world, i.e., in general, the ensemble of stations studied in our 1970 technical report, but without P-wave data from most of the seven short-period arrays also considered in that report. The number of explosions in the data sample at each of the eight separate Eurasian test sites are shown adjacent to the site location in figure 2.

It should be emphasized that all the discrimination results to be presented were achieved from analysis of recordings from standard conventional seismograph stations (Canadian and WWSSN), most of which have been in operation for more than five years. The improvements to be expected from the inclusion of seismic arrays and improved single stations are in some cases documented and predictable, and in other cases need urgent study. These points will be discussed further in later sections.

3. *Surface-wave magnitude (M_s) versus body-wage magnitude (m_b) discrimination*

Variations in the geological structure of the upper layers of the earth have two related but separate effects on surface wave magnitudes (M_s) relevant to discrimination: first, the propagation of Rayleigh surface waves is more efficient with more laterally homogeneous propagation paths, and, secondly, distinctly different propagation paths over different regions of the earth's surface often result in different absolute levels of M_s computed for the same or an equivalent seismic event. The first effect determines the "size" of the seismic surface wave observed after propagation over a particular path length and therefore the "size" of the event that produces the smallest signal that can be observed. The second effect becomes important when comparisons are to be made between different test sites and events (earthquakes and explosions) and data from a world-wide ensemble of stations are to be used in combination.

The scientific analysis, which will be published later in full in the scientific literature, quantitatively defined the relative effects of four general types of Rayleigh wave propagation paths. These were continental Eurasia, continental North America, mixed continental-oceanic (i.e., propagation from Eurasia to North America or vice versa) and purely oceanic (i.e., propagation from an oceanic source to a coastal station). These path propagation effects were reduced to path-dependent corrections, which depend on the period of the surface wave and can be simply applied to the computed surface wave magnitude. Additional modifications to the Rayleigh surface wave computation formula include a revised distance correction term, combined with measurements of the maximum in the signal independent of its period, and a correction for focal depth, determined from the Rayleigh wave frequency content in the record. This latter correction produces a distinct improvement in M_s versus m_b discrimination when it can be applied.

The improvements achieved from the derivation and use of this revised M_s formula the discrimination success of the revised M_s versus m_b method will be illustrated using the stations and events shown in figures 1 and 2. Although much of the emphasis in this paper is placed on M_s (the Rayleigh wave magnitude), similar regional variations can be attributed to m_b (the P-wave magnitude). These variations are reduced as much as possible by averaging a large number of station values to determine a final m_b; for those cases where only a small number of P-wave readings are available, corrections are applied to provide m_b values that are accurate relative to larger, more widely recorded events. The path propagation and distance effects are not as critical for m_b; the most sensitive stations for P-wave detection are often at large distances from the source; for example, many of the stations used to define m_b values for Eurasian events are outside Eurasia.

Figure 3 illustrates an M_s versus m_b plot for the North American events recorded at Canadian stations (see figure 1) using both the previously established and the newly refined M_s formulae. Figure 3(*a*) shows earlier published results and figure 3(*b*) the same data on the revised M_s scale. The dominant effect of the refined M_s formula is to shift all continental events to the left, i.e. to lower M_s values. This is the intended purpose of the refined formula, in that it shifts M_s to values that would be observed over long, complex world-wide paths, whilst continuing to employ the optimum seismogram measurements of the efficiently propagating, shorter-period Rayleigh waves that have propagated over the purely continental North American path. These events were not remeasured on the original seismograms and the M_s values, therefore, do not contain the newly established depth correction, which requires Rayleigh wave measurements at a range of frequencies.

Two other effects are apparent in figure 3. The Aleutian explosions, Longshot and Milrow (L and M), which fall far to the left of the continental USA explosion trend on figure 3 (*a*), because of their complex path to the Canadian stations, now agree much better in figure 3(*b*) with the other explosions. Thus, although these two Aleutian explosions remain above the other explosions in m_b (a matter discussed later), the path correction has normalized the explosions to an equivalent M_s. Secondly, the refined M_s has the additional effect of reducing the scatter in the earthquake population so that, in figure 3(*b*), there is a more distinct separation (i.e., discrimination) from the explosion population. These events will be compared to the Eurasian events later in this paper.

Figure 4 shows revised M_s versus m_b plots for events in the three regions of Eurasia containing explosion sites (see figure 2). This illustrates the smallest scale regionalization that is feasible for Eurasia because of the isolated locations of the explosions and restricted natural ocurrence of earthquakes in the active seismic zones. There are only five events available for region V in the time periods covered. Although the two Novaya Zemlya explosions and three Laptev Sea earthquakes are widely separated in M_s versus m_b relationships, there is not sufficient data to define the trends over a wide magnitude range. The majority of the past USSR explosions have been detonated at the eastern Kazakh test site; these, plus the one Sinkiang explosion (denoted "C"), are compared with the earthquakes from the general area of Tadzhik-Kirgiz-Sinkiang in the region III plot in figure 4. The earthquakes and explosions are clearly separated over the entire range of available data, i.e. down to about M_s3.0, explosion m_b5.0 and earthquake m_b4.2.

Region II in figure 2 contains three explosions from three sites near the Caspian Sea and three explosions from two sites west of the Ural Mountains. These explosions are compared with earthquakes from the general region of Caucasia-Iran-Turkmen in the region II plot in figure 4. The three larger Caspian explosions are clearly separated from the earthquake population and have M_s versus m_b relationships very similar to the larger eastern Kazakh and Novaya Zemlya explosions. The three smaller Ural explosions tend to be much nearer the earthquake population and have m_b values significantly lower than the eastern Kazakh explosions of equivalent M_s. They do, however, retain a clear separation from the earthquakes, and are discussed further later in this report.

The data plotted for the three regions in figure 4 represent the events collected specifically for this study of an analysis of M_s versus m_b discrimination using the WWSSN stations in Eurasia. In figure 4, a correction to M_s for the focal depth of an event has been included wherever the correction could be determined by measurement of the spectral content of the Rayleigh waves in the seismogram. In order to apply an identical procedure to all events for discrimination purposes, the depth correction was retained in M_s calculations for explosions. This process is sufficiently accurate for a majority of the explosions to have been assigned depth corrections equivalent to surface or very shallow-focus events. However, the procedure which has been devised is not perfect. Subsequent to the explosion identification (by the M_s versus m_b criterion illustrated in figure 4), the explosion M_s values can be adjusted to the surface focus equivalent. This was done where necessary for Eurasian explosions appearing in the following diagram (figure 5).

4. *Comparison of North American and Eurasian events*

The refinements made to M_s were designed to standardize the M_s magnitude so that the Rayleigh waves of maximum amplitude at any period within the standard long-period seismograph passband would yield magnitudes that are independent of the large first order effects of the propagation path. The refined M_s scale has been shown to reduce scatter and improve separation for North American events, and to produce a reliable discriminant for Eurasian events. Next, the two sets of data are combined in an attempt to explain the major residual differences in M_s versus m_b relationships within each of the general earthquake and explosion populations.

Figure 5 shows the intercomparison with separate plots of M_s versus m_b for the total suites of earthquakes and explosions. It clearly demonstrates that access to seismological data recorded by world-wide stations is necessary to reduce the threshold of identification of events in Eurasia. Thus, the six large Eurasian explosions shown as solid triangles in figure 5(*a*) are explosions in 1966-68 using data recorded only in Canada. The smallest of these six explosions for which Rayleigh wave measurements were possible on the Canadian standard network had M_s4.1, m_b5.8. The smallest explosion is reduced by approximately one unit in M_s if data are examined using equivalent stations on the Eurasian continent. For North American events, the argument is reversed and it is advantageous to have access to North American data.

The Aleutian explosions (L and M) which remained above the continental United States explosions in figure 3(*b*) are shown in figure 5(*a*) to conform very closely to the larger Eurasian explosions.

The trend of the majority of the Eurasian explosions is slightly above the trend of the continental United States explosions, i.e. to have a larger m_b for the same M_s. The exceptions are the three Ural explosions (noted in figure 4) which lie at the lower edge of the continental United States explosion trend. It is considered that these differences are related to the influence of the detonation environment on the m_b values; the eastern Kazakh, Novaya Zemlya and Caspian explosions detonated in older, more competent rock are, on the average, more efficient in P-wave coupling and produce higher relative m_b values than are the continental USA explosions in generally younger, less competent rock

The three Ural explosions (the lowest three Eurasian explosions shown closely grouped in figure 5(*a*) agree in M_s versus m_b trend with two special United States explosions, Gasbuggy and Rulison, detonated in sedimentary rock environments for purposes of natural gas stimulation. These Ural explosions are also located in a region of deep sedimentary rocks and it therefore appears that explosions of similar size in similar detonation environments on the two continents produce similar M_s versus m_b trends.

In contrast to the different average trends of explosions on the two continents, figure 5(*b*) suggests that North American and Eurasian earthquakes have similar average M_s versus m_b trends and general scatter. This suggests similar average tectonic conditions (as they affect M_s versus m_b) for the seismic regions sampled on the two continents, and similar degrees of perturbation from these average tectonic conditions. The pertinent point with respect to discrimination is whether these small populations are truly representative of the numerous earthquakes in these seismic regions. Consideration of near-field observations by United States seismologists of earthquakes in the same seismic regions of North America suggests that they are representative, so that it is not expected that the earthquake occurring, say, next week or next year in these regions will deviate significantly from the trends established by the earthquake sample studied. Of course, studies of more extensive earthquake samples should be encouraged as a matter of some urgency.

5. *Standard seismograph station detection and discrimination thresholds*

(a) *Rayleigh wave thresholds*

It is important to consider redefining the concept of a positive identification threshold directly in terms of M_s without converting later to an m_b value using some assumption concerning the appropriate M_s versus m_b trend. There are three logical reasons for doing so: first, there has been justifiable confusion in the minds of non-seismologists with calculated or claimed identification thresholds at an m_b value, say m_b5.0, where the detection of P-waves is still comparatively straightforward; secondly, the threshold for explosion identification has heretofore been controlled by the capability of detecting the surface Rayleigh waves, and therefore defining the threshold in terms of M_s naturally avoids the difficulty with conversion back to m_b values; thirdly, the refinements made in the M_s formula have, for the first time, normalized all Rayleigh wave observations to the same absolute scale. In terms of M_s versus m_b discrimination, an M_s detection threshold is equivalent to the identification threshold (assuming, of course, that earthquakes and explosions remain separated at the M_s threshold) whenever sufficient location or detection capability exists.

The M_s detection threshold for Eurasian Rayleigh waves by the Eurasian WWSSN stations employed in this analysis has been determined. It is M_s3.2 and corresponds to that level at which there is greater than 90 per cent probability of having measurable Rayleigh waves at four or more of the stations of the network. The explosion identification threshold for these stations and explosions in Eurasia is therefore M_s3.2.

This clearly defined M_s3.2 threshold can now be viewed in terms of the regional plots in figure 4. The threshold is slightly to the left (i.e. to smaller magnitudes) of the Sinkiang explosion in region III and slightly to the left of the three Ural explosions in region II. It is important to note that it is near this magnitude range that the actual explosion data, from the NOAA source and for the time periods employed, are becoming scarce. Only three of the available explosions during the time period (all in eastern Kazakh) do not appear on the plots in figure 4; one, m_b5.0, had Rayleigh waves totally obscured by an interfering earthquake and two, m_b4.3 and m_b4.7, had no observable Rayleigh waves on the available Eurasian seismograms. An extrapolation of the trend of the explosions in region III in figure 4 to lower magnitudes shows that the latter two explosions are significantly below the M_s3.2 threshold.

The earlier published North American data, revised to the new scale and summarized here in figure 3, did not make use of all the potentially available standard station and other recordings. All that can be said is that the threshold corresponding to the smallest explosion size for which there is a greater than 90 per cent probability of measuring the corresponding surface waves at four stations of the Canadian standard network is also M_s3.2. However, technical considerations which follow from the path corrections, which have now been numerically defined, and the United States contribution to the returns submitted to the United Nations make it highly probable that the North American threshold that would be obtained by a new similar analytical experiment should be about M_s2.6.

In other words, it is considered that the present situation, which produces the same proven threshold, M_s3.2, for Eurasian and North American events, is artificial: because of the extensive continental United States contribution to the United Nations returns, it is higly probable that the intrinsic threshold for continental North American events is near M_s2.6, using these techniques.

The refined version of the M_s scale is a more stable indicator of event "size" and a more useful scale for defining both threshold and yield than is the previously employed m_b scale. The concept of defining a surface-wave magnitude/yield relationship has been developing over the past year or two. It was discussed in working paper CCD/306, submitted by the Swedish delegation on 12 August 1970,[34] and in the Canadian technical report. The matter has been considered at length in scientific papers by United Kingdom, United States and Swedish seismologists. Yields for 16 of the United States explosions in figure 3 are available. An empirical fit of yield versus M_s for these 16 explosions results in the relationship $M_s = 1.2 \log Y + 1.6$. The mean error in yield that would result from the application of this equation to these 16 explosions, and thus the expected error, when applied to other explosions, is about 33 per cent. Assuming the empirical stability of M_s with respect to the explosion detonation environment, and the success of the refined M_s scale in removing first order path propagation effects, the application of this equation to the Eurasian explosions will result in yields of similar accuracy. For example, the yields of the three Ural explosions would be 27 $\pm$ 9 kilotons; the United States explosions, Gasbuggy and Rulison, in similar environments had reported yields of 29 and 40 kilotons, respectively; these five explosions are juxtaposed in figure 5(*a*).

Applying this M_s versus yield formula directly, the yield equivalent to the M_s3.2 Eurasian explosion identification threshold is about 20 kilotons. The intrinsic threshold of M_s2.6 discussed above for continental North America, and discussed below assuming improved capabilities in Eurasia, is about 7 kilotons.

[34] *Ibid.*, sect. 35.

(b) *P wave threshold and earthquake location*

The problem of the general availability of explosion data has been noted briefly above; this, of course, is related to the scheduling, size and number of explosions in the various testing programmes. The availability of earthquake data, on the other hand, is, within rather broad limits, predictable on the basis of well-established earthquake recurrence relationships for any general seismic region. It is, for example, possible to predict within about a factor of two how many earthquakes within a certain magnitude range will occur within these regions of Eurasia in the period of one year. Statistical prediction of this kind has been employed to estimate that the Eurasian earthquakes in the critical magnitude range m_b4.2-m_b4.7 employed here represent approximately 25 per cent of the total Eurasian earthquakes for the same regions within this range that actually occurred during the year 1969. This lack of availability of relatively complete earthquake occurrence data is due to the rapidly diminishing capability of locating earthquakes as m_b values fall below about m_b4.7, using P-wave data routinely transmitted to the NOAA epicentre location centre, which, with the voluntary information supplied to it, is restricted to the documentation on a world-wide basis of the larger and more socially significant earthquakes.

The 1970 technical report demonstrated, however, that, using all data guaranteed within the context of General Assembly resolution 2604 A (XXIV), the capability exists, using the short-period arrays in addition to the more sensitive standard stations, to locate a high percentage of all Eurasian (in general, northern hemisphere) earthquakes in the m_b4.2-4.7 range. Until such time as this is achieved routinely, or a special study is made of the detection and location of small earthquakes for a period of, say, one year for critical regions such as those in Eurasia, it can only be assumed that the earthquake trends and scatter will persist to low magnitudes. The total earthquake M_s versus m_b data available in various technical and scientific publications suggests that the small Eurasian earthquakes in the M_s2.7-3.5 range employed in this study are, because of P-wave detection limitations, earthquakes with relatively large m_b values for this M_s range. That is, few of the remaining unreported earthquakes that undoubtedly occurred in the same time period are expected to have m_b values nearer to the explosion populations. This limitation on earthquake reporting, although not completely absent, is less severe in the seismic regions near the continental United States test sites because of the dense network of nearby United States stations routinely reporting data to the NOAA earthquake location agency.

6. *Discussion*

The principal purpose of this working paper has been to make delegations to the Conference of the Committee on Disarmament aware of the Canadian interpretation of the value of existing conventional seismograph stations on the continents of Eurasia and North America for purposes of identifying underground explosions on these two continents. A comparison will now be made between the present capabilities demonstrated in the body of this paper and the practical potential capabilities that can be achieved with modest improvements. An attempt will be made to distinguish between what can be considered as practically achievable at present (by consolidating available data, redeploying improved seismograph systems where necessary, modifying existing systems with modest but proven techniques, etc.), and what might be theoretically achievable with massive additional investment in highly sophisticated integrated systems.

(a) *The detection and location problem*

Using the documented capabilities of the short-period array stations reported in the United Nations returns, the capability at present exists, although not achieved routinely, of locating the additional small earthquakes in the critical magnitude range near the M_s3.2 identification threshold. To the extent that the complete (M_s versus m_b) definition of the earthquake population above the M_s3.2 threshold is at present limited by this lack of earthquake location capability, establishing procedures to routinely achieve detection and location of more of these earthquakes should be given first priority. At least two nations to our knowledge the (United States and Sweden) routinely compute locations of additional small earthquakes for their own research purposes, the United States by integrating data from two large-aperture, short-period arrays (LASA and NORSAR), and Sweden by supplementing their own array data with additional data from several high quality standard stations throughout the world. A means is required of completing the data co-ordination and making the results available to the broader international seismological community.

In any case, this problem of event location is solved in principle down to m_b4.2 or so: to go lower may require the suitable development of more well-sited, short-period, medium-aperture arrays, and even then a lower general limit much below m_b4.0 will be very difficult to achieve at all locations in the northern hemisphere. In all cases, we are using 90 per cent interval probability figures.

(b) *The surface-wave detection problem*

There are a number of long-period facilities in existence throughout the world whose capabilities for Rayleigh wave detection are considerably better than the standard stations employed in the analysis discussed in this paper. These stations have not been employed in the analysis presented because it is only now, having defined standard station capabilities, that an accurate assessment of the requirements for improved long period facilities can be made. The 1970 technical report discussed in detail the capabilities of the more sophisticated individual long period facilities. For purposes of direct extrapolation from the standard station capabilities discussed in this paper, the following, rather over-simplified, assumption will be made concerning improvements to be gained from such systems: a single station with facilities for microseismic noise rejection and modest signal enhancement processing is assumed to be a factor of 4 better in Rayleigh wave signal amplitude detection than the standard station; a large-aperture, long-period array is assumed to gain an additional factor of 4 from beam-forming, for a total factor of 16 better than the standard station. These factors represent potential M_s threshold reductions of 0.6 and 1.2 for the improved single station and the large-aperture array, respectively.

An assumption required for direct comparison of these improvements with the standard stations employed is that, in order to take advantage of the efficient continental propagation, similarly located improved systems will apply their signal enhancement techniques to the equivalent maximum amplitude signals, and will not restrict consideration to 20-second or some other fixed-period waves. Then the threshold reductions described above can be applied directly to the M_s3.2 threshold of the standard stations; it is further assumed that the improved systems will be deployed in such numbers and locations that will yield the equivalent 4 or more station detections.

The advantages of observations at nearer distances over purely continental paths can be illustrated by making a similar threshold reduction calculation for intercontinental propagation. The standard station Rayleigh wave detection threshold for the intercontinental case is about M_s4.3. This is estimated from the Canadian standard station capabilities for Rayleigh waves from Asian earthquakes and explosions, but will be roughly equivalent for other intercontinental paths. The threshold is considerably higher than the continental case because of the greater average distances and the geological restriction which corresponds to working with Rayleigh waves with periods of 20 seconds or greater. The threshold reductions achievable by the improved systems can again be applied directly to this standard station M_s4.3 threshold. A summary of the M_s thresholds for the two cases and the three different types of systems is given in the following table.

M_s THRESHOLDS FOR CONTINENTAL AND INTERCONTINENTAL CASES EMPLOYING THE THREE DIFFERENT SEISMOGRAPH SYSTEMS

Long-period station system	*Continental (within North America or Eurasia; average distance 3.000 km)*	*Intercontinental (between North America and Eurasia; average distance 8.000 km)*
Standard (WWSSN or Canadian network equivalents)	M_s3.2	M_s4.3
Improved single stations	M_s2.6	M_s3.7
Large-aperture arrays	M_s2.0	M_s3.1

It is apparent from this table that large aperture arrays at intercontinental distances will only slightly improve on the performance of standard stations situated on the same continent as the seismic events of interest. Furthermore, intercontinental arrays cannot match the performance of the continental improved single stations. The lowest threshold is, of course, attributed to the arrays for the continental case.

(c) *Detection, location and identification*

At present, we have complete detection and location information from NOAA of events down to about m_b4.7; although the data is not complete, numerous events are detected and located below this level (see figures 4 and 5). At m_b4.2 only a small percentage of events are routinely detected and located. All explosions at or above the M_s3.2 identification threshold have m_b values above the NOAA detection and location threshold and no problems of locating explosions at the present M_s3.2 threshold arise.

The next simplest step, in principle, might consist of the reduction of the M_s threshold from M_s3.2 to M_s2.6 by employing improved Rayleigh wave detection systems on the same continent, coupled with the data-merging described above to bring the detection and location capability of events down to m_b4.2 in the northern hemisphere. All the explosions at the M_s2.6 threshold will remain above the m_b4.2 lower limit and can be detected, located and assigned m_b values. A majority of the earthquakes at the M_s2.6 threshold will be below the m_b4.2 detection and location threshold, i.e., their P waves will not be detected by sufficient stations to allow locations to be calculated and m_b values to be assigned. A poorer location capability would be obtained with the one or two most powerful short-period arrays only. Accordingly, near this potential M_s2.6 threshold, the circle will have fully turned and we should be in the paradoxical situation of identifying an explosion on the basis of being able to locate it, and then placing its M_s versus m_b position in the correct region of an established trend. The situation with respect to negative criteria will have turned full circle, and small earthquakes could be identified and ignored in monitoring because of the absence of observable P waves.

The reduction of the M_s threshold significantly below M_s2.6, for example to M_s2.0, by the use of large arrays on the same continent as the events of interest, will require a parallel improvement in the P-wave detection (event location) threshold to below m_b4.0. This will be extremely difficult to achieve. Furthermore, at this limit it could be justifiably argued that it remains to be clearly demonstrated that the principle of identification still works adequately and populations of earthquakes and explosions remain separated.

7. *Conclusions*

(*a*) The threshold of identification of Eurasian underground explosions using standard seismograph stations reported in the returns submitted in accordance with General Assembly resolution 2604 A (XXIV) has been demonstrated to be approximately 20 kilotons in most natural environments (dry alluvium excepted, where the situation is worse). This is the result of an analytical experiment with actual data.

(*b*) The corresponding figure for continental North American underground explosions was previously reported at 10 to 20 kilotons in hard rock using Canadian standard seismograph station data. The derivation of a new, refined surface-wave magnitude scale allows more accurate extrapolation. Accordingly, it is highly probable that an analytical experiment with actual data from stations reported in the returns submitted to the United Nations would reduce this continental North American threshold to between 5 and 10 kilotons in most natural environments (dry alluvium excepted).

(*c*) A corresponding reduction to 5 to 10 kilotons in Eurasia requires the deployment of a limited number of improved single stations only, together with the merging of currently available data to achieve the detection and location ability calculated in the Canadian technical report of December 1970.

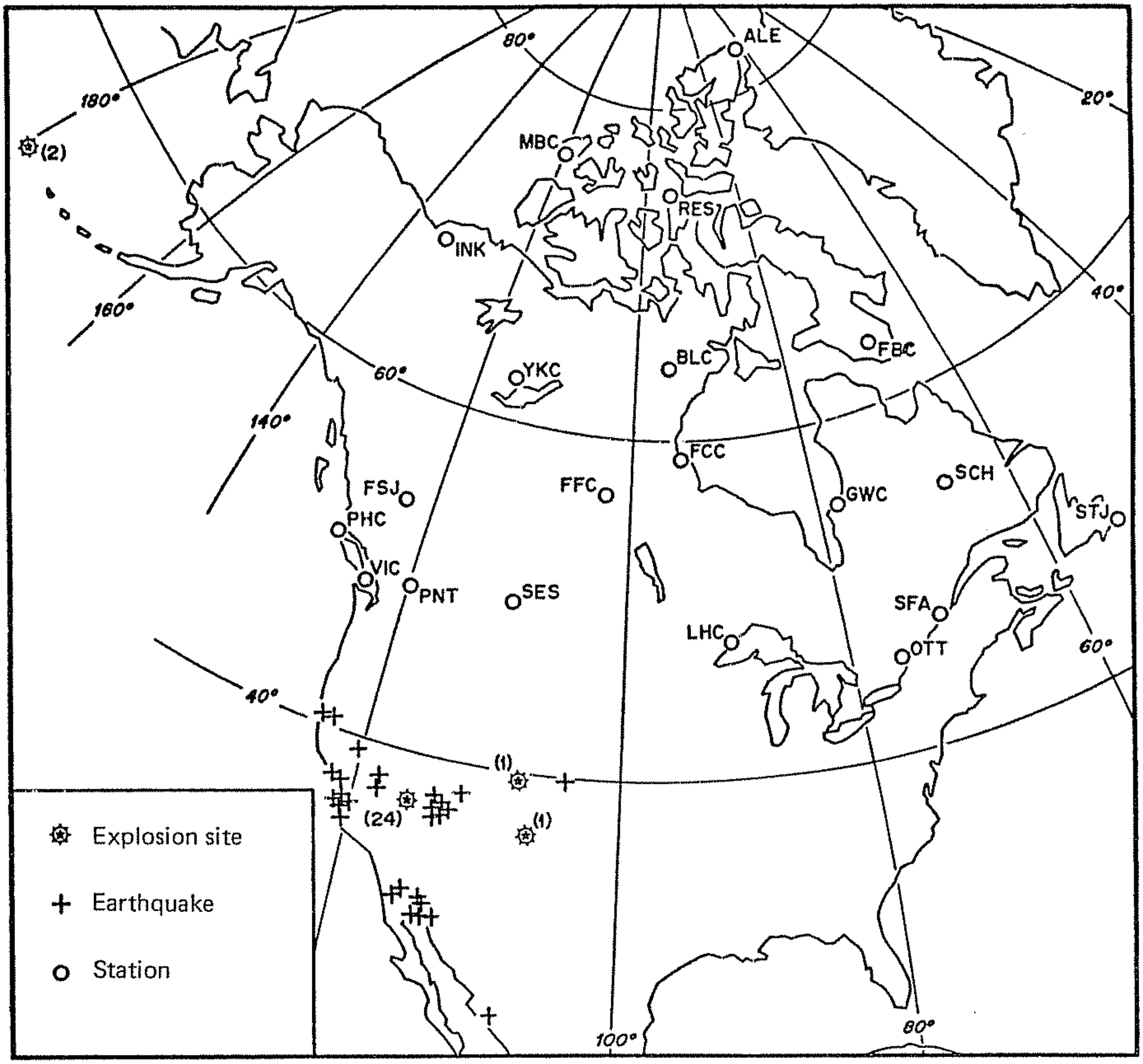
(*d*) To achieve a capability at 1 to 2 kilotons in natural environments other than dry alluvium, massive investment in arrays sited on the same continent as the events is necessary. Re-thinking of the logical processes practised today of detection, location and identification will probably be necessary. Arrays have advantages in addition to their signal enhancement capabilities: they can be used to pick out a signal obscured at an ordinary station by seismic waves generated elsewhere from the event of interest, and they give some approximate location capability independently.

(*e*) Attention to existing test sites simplifies the identification problem: the situation for universal coverage is always more pessimistic than the results which can be achieved for particular developed test sites.

(*f*) The practical potential 5- to 10-kiloton thresholds are possible because of the deployment of such modern standard seismograph networks as the World-Wide Standard Seismograph Network, the Canadian Standard Network and others, the deployment of arrays by the United States, the United Kingdom, Canada, Sweden and other countries, the work of the United States and other countries in the development and deployment of experimental improved single stations, and the ready or potential availability of the data from all these.

(*g*) The lack of information on precise locations and yields of underground explosions, and the deployment of seismograph stations and their capabilities in many Eurasian countries makes the situation in a comparison of North American and Eurasian capabilities somewhat asymmetric.

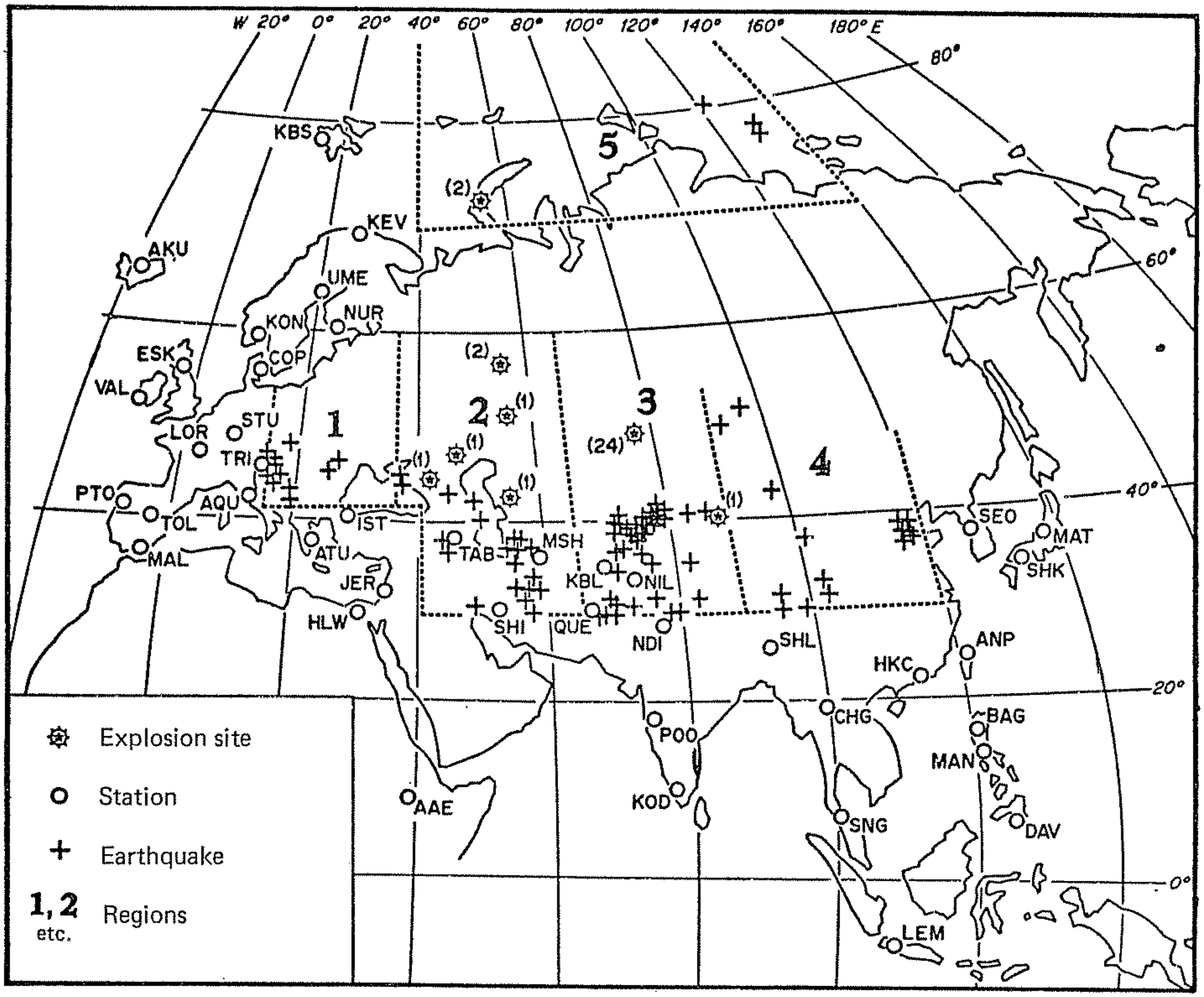
(*h*) Problems with respect to explosions in dry alluvium or in artificially modified environments, or with conceivable measures to confuse the seismic signals from underground nuclear explosions are not considered in this report.



MAP NO. 2290 X

Figure 1

Map of North America showing pertinent Canadian standard seismograph stations and earthquakes and explosions from past Canadian research papers re-evaluated using the refined M_s formula. The bracketed numbers illustrate the number of explosions employed from each test site



MAP NO. 2291 X

Figure 2

Map of Eurasia showing the 42 WWSSN stations, the explosion test sites with bracketed number showing the number of explosions at each site, and the Eurasian earthquakes employed in this analysis. The broken lines illustrate the boundaries of the the regions discussed separately for M_s *versus* m_b discrimination

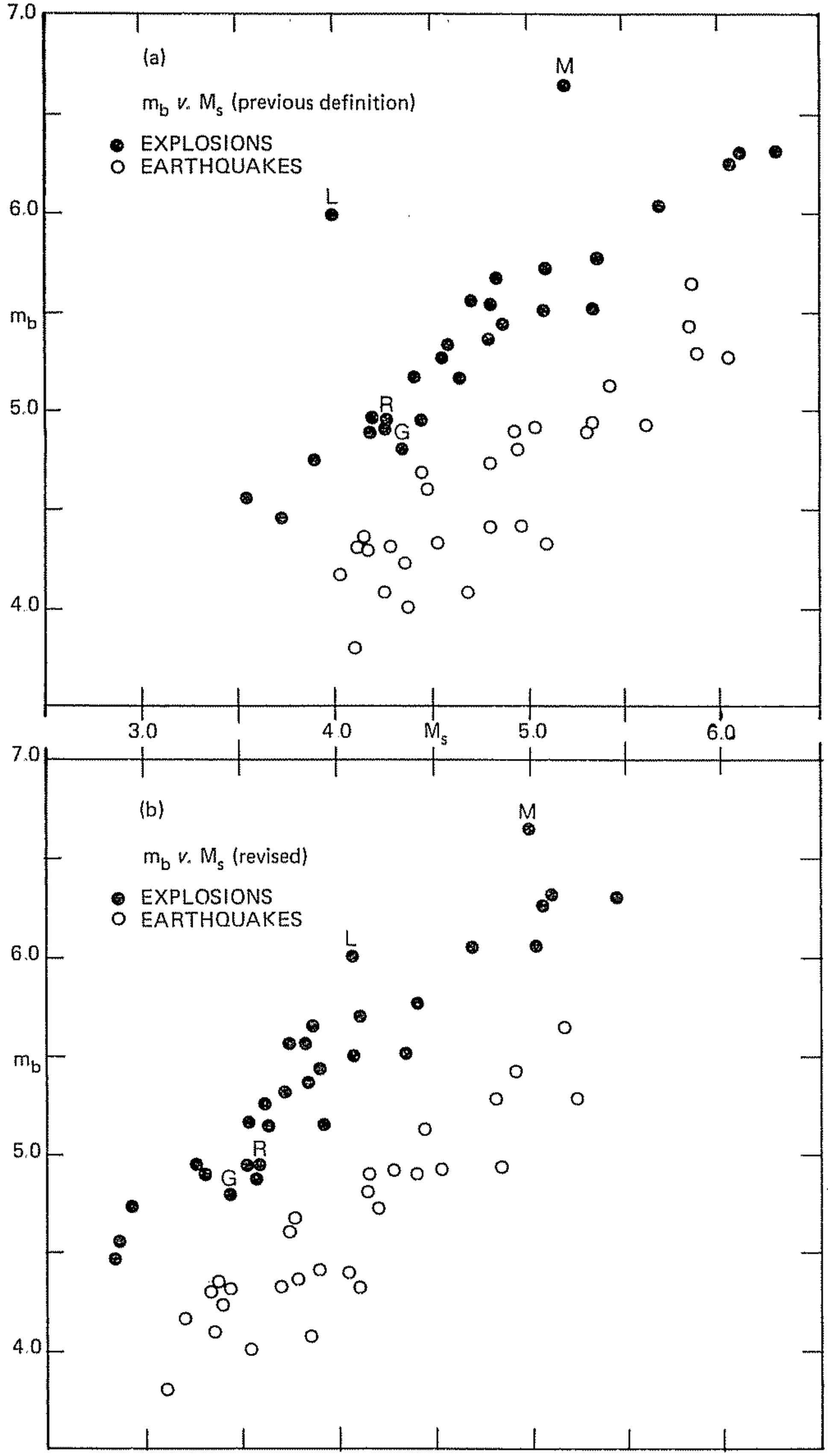


Figure 3

M_s *versus* m_b plot of North American explosions and earthquakes (see figure 1): (*a*) upper diagram using the previous definition of M_s, and (*b*) lower diagram using the revised M_s formula. The letters, L, M, R and G, denote the explosions Longshot and Milrow (Aleutians), Rulison (Colorado) and Gasbuggy (New Mexico), respectively. The unlabelled explosions are at the Nevada test site

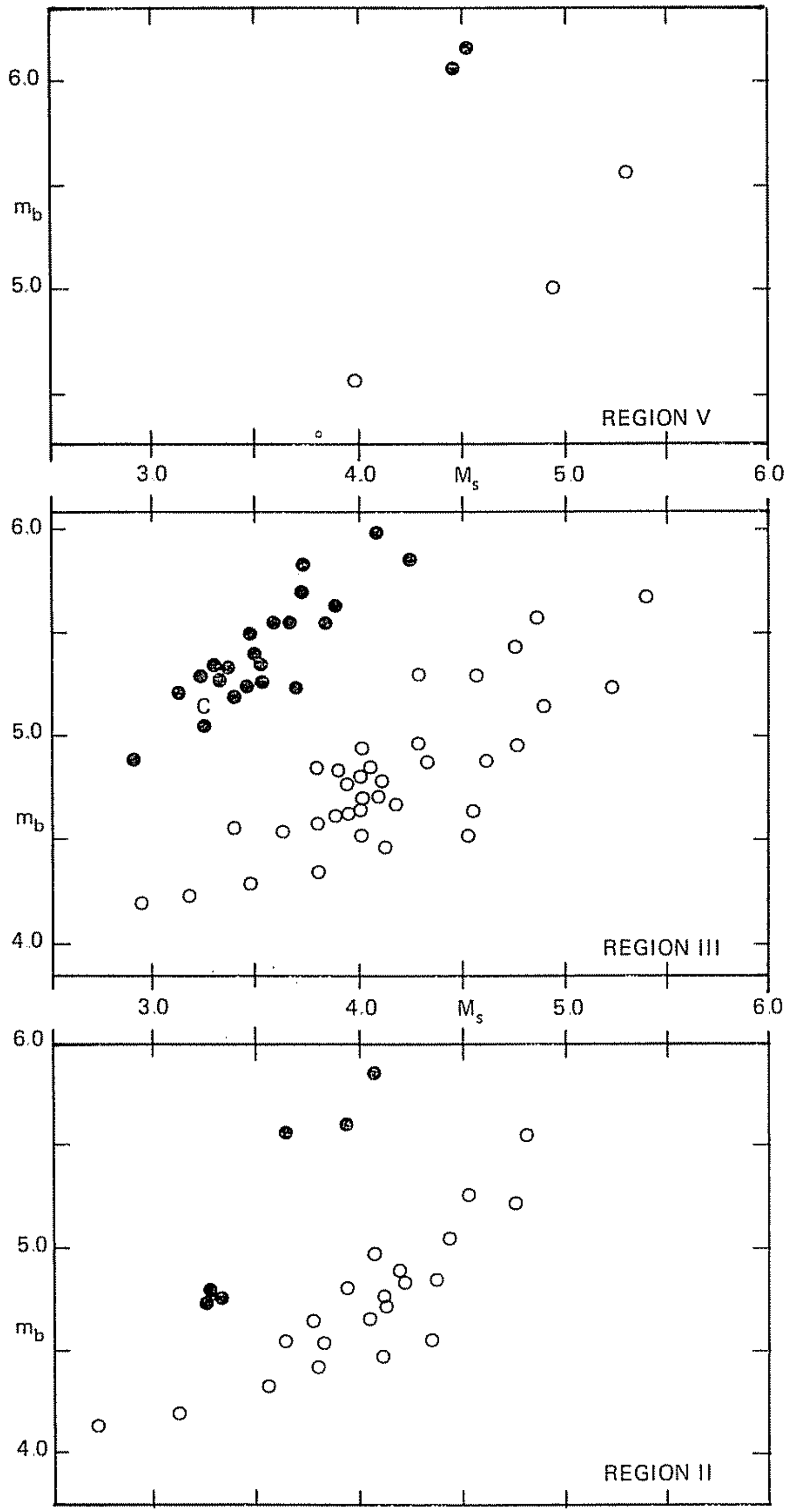


Figure 4

Regionalized plots of M_s *versus* m_b for Eurasian explosions (solid circles) and earthquakes (open circles). Locations of the events are shown in figure 2 and described in the text. The letter "C" denotes the region III Sinkiang explosion

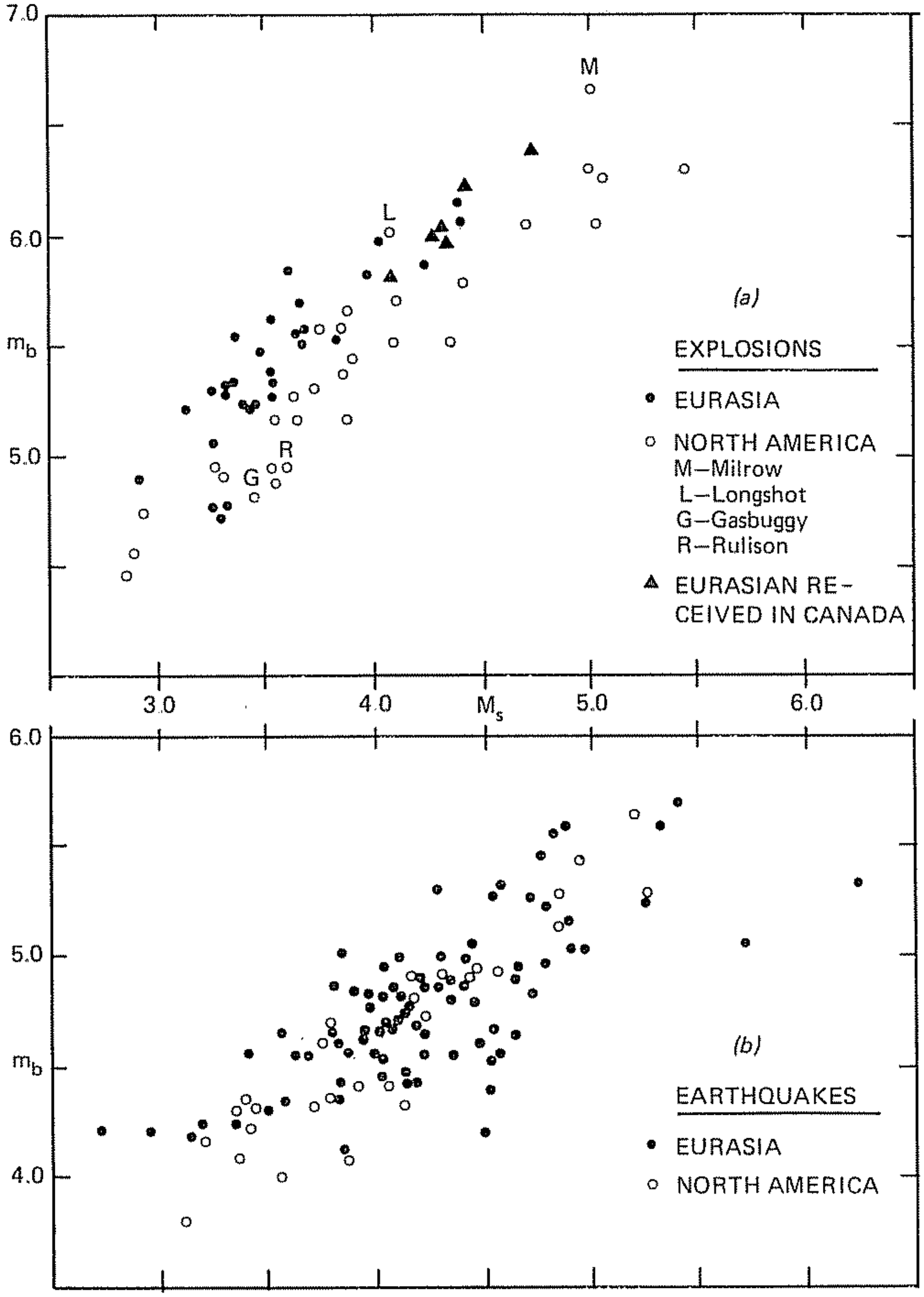


Figure 5

M_s *versus* m_b for all events from figures 1 and 2 plotted separately for (*a*) upper diagram, explosions, and (*b*) lower diagram, earthquakes. Six Eurasian explosions defined using data recorded only in Canada are added to the upper explosion plot for purposes described in the text

Appendix

A GLOSSARY OF TECHNICAL TERMS

Event	An earthquake or an underground nuclear explosion
Station	An establishment which houses seismographs. A standard seismograph station usually operates both long-period and short-period seismographs at a single site. A seismic array station operates an array of long- and/or short-period seismographs distributed in some geometric pattern over an area. A large-aperture array has a total breadth of a few hundred kilometres, a medium-aperture array a few tens of kilometres.
Long-period	Refers to seismic waves, or to recordings of seismic waves, with oscillation periods from about 10 to 50 seconds, the period range of Rayleigh surface waves pertinent to this report.
Short-period	Refers to seismic waves, or to recordings of seismic waves, with oscillation periods from about 0.3 to 2.0 seconds, the period range of P body waves pertinent to this report.
Rayleigh surface waves	A type of seismic wave which propagates along the free surface of the earth. Consideration here is primarily restricted to the vertcial component of these waves.
P body waves	A type of seismic wave which propagates through the body of the earth, and which is the first arriving seismic wave at a station from a distant event. Consideration here is again restricted to the vertical component of these waves.
Detection	Refers to the process of deciding that an event has occurred on the basis of having recorded P and/or Rayleigh waves.
Location	Refers to the process of calculating the location of a seismic event using the observed arrival times of detected P waves at a suitable number of stations.
Identification (discrimination)	Refers to the process of deciding that an event is either an earthquake or an explosion on the basis of an established criterion using the recorded seismic waves.
Threshold	The lowest level in terms of the event magnitude or yield at which each of the above three processes can be achieved with the appropriate statistical reliability. The statistical reliability employed in this papers refers to that magnitude or yield at which there is a 90 per cent probability of detecting the appropriate P or Rayleigh waves at 4 or more stations. The event location threshold is assumed equal to the P-wave detection threshold; the identification threshold is equated with the explosion Rayleigh wave detection threshold.
Focus	The position of an event in three dimensions, i.e., in terms of its geographical co-ordinates and its depth below the earth's surface.
Epicentre	The point of intersection on the earth's surface of a line projected vertically up from the focus, i.e., the geographical coordinates of the focus.
Focal depth	The depth of the focus below the epicentre.
Shallow-focus	Earthquakes can occur at focal depths as great as about 700 km. For purposes of comparison to explosions of surface-focus (or very shallow-focus), we restrict consideration to earthquakes of shallow- (depth less than 50 km) focus.
Surface-focus	In terms of the accuracies of estimating focal depths using distant observations, events shallower than about 10 km (this includes all explosions) can be assumed to be or will be indistinguishable from events at the surface of the earth (i.e., having surface-focus).
M_s (Rayleigh wave magnitude)	A logarithmic scale used to define the size of events on the basis of their Rayleigh wave amplitudes observed at a distance.
M_b (P-wave magnitude)	A logarithmic scale used to define the size of events on the basis of their P-wave amplitudes observed at a distance.
Yield	The nuclear explosion size in terms of the equivalent amount of chemical explosive.
Kiloton	The nuclear explosive equivalent of one thousand tons of chemical explosive.
Seismic zone	Tectonically controlled quasi-linear features along which earthquakes are expected to occur. A system of seismic zones encompassed by a poorly defined geographic boundary can be considered a seismic region.

Earthquake recurrence relationship	An empirical linear relationship between the magnitude of earthquakes and the logarithm of the number of earthquakes that occur per unit time interval. Recurrence relationships for particular seismic regions have shown small variations from the average relationship established for global seismicity.
Continental	In the context of this paper, a situation whereby the seismograph stations and the events of interest are confined to the same broad continental mass.
Intercontinental	In the context of this paper, a situation whereby the seismograph stations and the events considered are on different broad continental masses.
Microseismic noise	Natural, continuous (but with varying intensity) earth vibrations which, in the long-period band, are caused primarily by meteorological disturbances at sea, which propagate to all points of the earth as seismic waves, and by coupling of local meteorological disturbances with the foundation rocks in the vicinity of the seismograph station. The peak in the spectrum of microseismic noise occurs in a band near 6 seconds.
Beam-forming	A process achieved by using seismic array recordings, whereby appropriate time delays are applied to individual array signal elements before their addition in order to improve the signal-to-noise ratio.
Signal enhancement	Any special computational process designed to increase signal amplitude relative to background noise.

* * *

Explanatory comments on working paper CCD/327

Working paper CCD/327 contains the results of a study of 90 Eurasian earthquakes of shallow depth in 1969, and some 33 underground nuclear explosions in Eurasia at eight different sites during the period 1968 to mid-1970. It was designed to fill what we consider to be an important gap in the quickly accumulating knowledge on discrimination capability by defining the situation in Eurasia. The two scientists involved in the case study (and here I might note that one was a Canadian and the other a visiting seismologist from another country—in itself a happy, practical example of the benefits to de derived in these problems from international co-operation) first of all devised a refined scale to measure the size of events using the surface waves which they produce. Technical details will be published elsewhere—for our present purposes, it is sufficient to point out that the work uses those signals most easily measured on standard instruments. Gross corrections for different path types have been derived, which put all observations of surface wave magnitudes or size onto an approximately uniform scale. This intensive study enables data obtained on one continent from events on another to be simply and directly compared with data obtained on the same continental mass as the event of interest (either the American or the Eurasian land masses) for the first time and with considerable clarification.

Using the same scientifically defined conservative threshold of identification that we have adopted in the past and the established criteria for identification involving differences between earthquakes and underground explosions in their relative excitation of two different types of elastic vibrations, namely the body and surface waves, the Eurasian study has an identification threshold best summarized in the refined surface wave scale as surface wave magnitude 3.2, or M_s 3.2. This corresponds, we believe, to explosion yields of about 20 kilotons in most natural environments other than dry alluvium. The improvement obtained in this work over the theoretical conservative study of last year arises from the fact that the case study has now identified and used to best advantage the gross geological path effects in Eurasia and that, working with actual events, the two analysts concerned were able to usefully measure and analyse somewhat smaller signals than those assumed in the theoretical study. The stations used were 42 standard seismograph stations widely distributed in peripheral Asian countries and in Europe and the Middle East: these, in general, were stations reported in the returns submitted to the United Nations in accordance with General Assembly resolution 2604 A (XXIV), and are stations which deposit data in the seismological data centre in the United States. We obtained copies of the data, using exactly the same mechanism freely available to anyone in the international seismological community: this is another illustration of the value of the present level of international data exchange. These stations of the World Wide Standard Seismic Network contribute data routinely to an American centre, as do also the Canadian and other, but not all, national seismic networks.

As a result of this scientific study, it is next appropriate to ask whether our earlier published estimates for North American explosions need revision. To date, the only published network case studies are those we have made with the Canadian Standard Seismic Network alone: these produced the 10- to 20-kiloton figure quoted earlier and take full advantage of geological quirks. Experience with the new refined scale and some simple calculations which follow from our earlier study make it highly probable that, if all the useful data with guaranteed availability were employed, the corresponding North American lower limit for identification could be reduced to between 5 and 10 kilotons in most natural environments, dry alluvium and possibly valley tuff being exceptions.

With the definition of the path effects on the surface waves, we next turned to a consideration of the measures which would be necessary to reduce the lower limit in Eurasia to between 5 and 10 kilotons in the regrettable absence of guaranteed available data in much of the interior of the land mass, and we conclude that this is feasible with two steps. The first requires the deployment of a limited number of improved long-period seismograph stations, rather than more deployment of extensive arrays, and the second requires the merging of currently available data from currently deployed arrays and standard stations to achieve the detection and location ability from seismic body wave readings calculated in our technical report of last December.

Thus, two comparatively simple steps should, in our view at present, produce a 5- to 10-kiloton capability at most current northern hemisphere test sites. From material appearing in the scientific literature, much of it from American sources, we are aware of considerable activity towards the partial implementation of these steps, although again, in our view, some of the activity of general research interest and utility is not necessarily directed in the most effective manner towards the resolution of the identification issue.

Delegates may be curious about our prognosis for a capability at 1 to 2 kilotons in most natural environments. Our technical studies lead us to believe at present that such a hypothetical target would require massive investment in arrays situated on the same continent as the events of interest, and some rethinking of the logical processes practised today, of detection, location and identification. We shall be in a sounder position to examine and comment on the optimum possibilities when the steps outlined earlier to move towards a northern hemisphere 5- to 10-kiloton capability are complete, and have been documented with adequate studies on populations of earthquakes and explosions from key stations, existing arrays and combined groups of stations. Studies on existing arrays and special upgraded long-period stations, therefore, need urgent documentation. We are also aware that some delegations may express doubt about the capability of the usual method of seismic discrimination at such low yields as 1 or 2 kilotons. Although no studies have yet been made, or at least published, at such low-yield values using network observations at considerable distances from test sites, we believe that enough seismological observations of a highly specialized kind have been made to suggest that the usual discrimination tools would still be effective, if only the signals could be measured. Once again, prior examination of data in the 5- to 10-kiloton range and the corresponding weak earthquakes would provide the basis for a more certain extrapolation of the possibilities.

One or two more difficult points should next be made in order to present our argument fully. First, we would urge delegates to start thinking about explosion yields in terms of the refined surface wave scale we have proposed. As we understand it, movements in this direction can be discerned in American, Swedish and British scientific contributions. The relation which we use with the data available to us is given in the technical working paper above: other delegations, particularly those of the nuclear testing powers, with more information can probably improve on it. With a change in viewpoint, some of the East-West arguments of the past regarding the body-wave magnitude and yield relationship become of lesser importance. In any case, we can explain these very largely in terms of the different instrument responses of seismographs tuned to the short-period body waves. More importantly, we believe there are sound semi-theoretical and empirical reasons for advocating the shift of thinking—increased yield precision is obtained because the evidence available to us suggest that, within rather small limits, the refined surface wave magnitude for an explosion is not highly sensitive to the detonation medium. Dry alluvium and possibly valley tuff are exceptions. Our working paper illustrates our belief, for example, that a Kazakh test site explosion of a given yield will have the same refined surface wave magnitude as a Nevada test site explosion of the same yield in hardrock, but that the body wave magnitudes will be somewhat larger for the Soviet event. There are a number of reasons which might account for this difference—the degree of coupling, differences in the structure of the earth at upper mantle depths, and so on, but these are somewhat secondary to the argument that increased clarity and precision in extrapolation may well follow some change in traditional patterns of thought.

Secondly, we should like to note once again that our working paper has used only one of the many tools at the disposal of the seismologist who wishes to discriminate underground explosions from earthquakes. We, with comparatively modest resources, are conducting research with other discriminants, and we know that our contributions are only a small portion of the total effort and literature in this field. In summary, some of these perhaps less perfect and sometimes less powerful criteria, when properly used and often in combination can be extremely powerful down to yields of less than 10 kilotons in hardrock. Some of these were mentioned in our technical report of last December, and since that time additional information and studies have suggested considerable utility for certain specific test site/station combinations.

Thirdly, we should like to explain that it is necessary in the technical papers to discuss events in terms of a defined threshold. Delegates should appreciate that we have adopted what is believed to be a reasonable definition in terms of having a greater than 90 per cent probability of having usable or measurable signals at four stations. As we relax this criterion, the lower limit of yield decreases, and because of the probabilistic nature of the problem we have data, i.e. observations from fewer stations, below this defined threshold. The point of this discussion is to state clearly that discrimination is statistically possible below the threshold figures we have quoted and this is shown clearly in the illustrations —in a sense, therefore, some deterrence exists below our formal thresholds. At this point I might add that we must perforce define scientific discrimination thresholds at defined levels of probability in order to quantify our results: as explained earlier, there is an inherent fuzziness about them. This concept should not be confused with the political concept of a treaty prohibition threshold as a well-defined point, a concept which from time to time has been discussed by different delegations at Geneva. The technical problems with the advocation of such a clear decision point have been well expressed by the Swedish delegate at the 513th meeting of this Conference: we believe these are well known to the professional seismological community.

What lessons can be drawn from the study presented in the working paper?

First, the lack of released information on the precise location and yields of underground nuclear explosions and on the deployment of seismographic stations and their capabilities in much of the Eurasian land mass makes the situation below about 20-kiloton hardrock yields asymetric between Eurasia and North America. The release of such information concerning explosions as advocated on 6 April by the delegation of Canada (see CCD/PV 507), and concerning seismographic stations and their capabilities as called for in General Assembly resolution 2604 A (XXIV) woud undoubtedly assist the process of clarification, and help reduce the lower yield limits.

Secondly, we have conducted an international experiment in co-operation, admittedly on a small scale, using data acquired internationally, and we consider that the results fully justify our insistence on the need for the guaranteed availability of seismic data if countries such as Canada, with only modest resources available, are to be able to identify low-yield and low- to intermediate-yield underground explosions.

Thirdly, we would welcome and encourage continued international co-operation to make further progress.

10.

United Arab Republic: working paper containing suggestions in regard to the draft convention on the prohibition of the development, production and stockpiling of bacteriological (biological) weapons and toxins and on their destruction, contained in document CCD/325/Rev.1

[*CCD/328 of 29 June 1971*]
[*Original: English*]

1. *Article I:* After the word "undertakes", add the following: "never in any circumstances to engage in research on,". The first part of the first sentence will thus read: "Each State Party to this Convention undertakes never in any circumstances to engage in research on, develop, produce, stockpile or otherwise acquire".

2. *Article II:* After the words "accumulated weapons", add the words "and agents".

3. *Article III:* The provisions of this article should also preclude the receipt by the State Party to the Convention of assistance, encouragement, etc. . . . from any other State, particularly a non-party to the proposed Convention.

4. *Article VI:* The provisions of this article should take into account the fact that there are instances when relations between some States are of a nature as not to allow of its normal implementation.

5. *Article IX:* The following elements should be reflected in the provisions of this article:

(i) The principle of the prohibition of research, development, production and stockpiling of chemical weapons and their means of delivery as well as the destruction of both;

(ii) The obligation to implement this principle through negotiations;

(iii) The element of urgency and the importance of achieving a chemical convention.

6. A new article is to be added providing for the procedure of withdrawal from the Convention.

11.

Sweden: working paper on the seismological verification of a ban on underground nuclear weapon tests

[*CCD/329 of 29 June 1971*]
[*Original: English*]

1. The present working paper summarizes six scientific reports recently distributed by the Swedish delegation[35] and also some hitherto unreported results of efforts at the Research Institute of National Defence in Sweden to contribute to the solution of remaining problems with seismological verification of a ban on underground test explosions of nuclear weapons.

2. Paper (1) describes a method of calculating, from the times of arrival of seismic waves at seismographic observatories, the relative positions of particular events in narrow source areas, such as earthquake zones and explosion tests sites. The method provides not only rather precise relative positions but also confidence areas on the ground, as measures of the precision of the calculated positions. The method steadily improves upon acquisition of data from new events in the same source area. Applications to some nuclear explosions on islands in the Pacific Ocean and in Kazakhstan gave 90 per cent confidence areas, mostly between 25 and 100 square kilometres in size. In the present context the method facilitates the understanding of differences between events by relating them to topographic, geologic and tectonic features of the earthquake and explosion source areas. The method facilitates decisions about the "nationality" of events near national borders and the selection of areas to be investigated by other means, such as inspections. In all three applications the usefulness of the method is greatly increased if the real position of some calibration events can be used to fix the relative positions accurately on the map.

3. Paper (2), earlier versions of which have been the basis of several Swedish statements on the test-ban control problem (see ENDC/PV.309, 315, 323, 385, 399, 415 and 487) and of a memorandum on the subject,[36] describes a means of determining, in numerical terms, the usefulness of particular seismic discriminants to the problems of political decisions posed by test-ban control with or without obligatory inspections. The problem involves, on the one hand, the probability of correctly identifying an explosion as such and, on the other hand, the probability of sounding a false earthquake alarm. The political requirements of the verification procedure call for a certain minimum probability for correct identification of explosions, to deter from treaty violations, but also for a not too high rate of false alarms. The latter very much depends on the natural rate of earthquakes and, in the case of control with obligatory on-site inspections, also on the permitted rate of such inspections and on their effectiveness. The solution offered in paper (2) took the statistical properties of earthquakes and explosions into account and compared the politically required combination of deterrence level and false alarm rate with those practically attainable. This method showed that certain identification measures could be considered as sufficiently effective for some test-ban control purposes. However, several problems remained to be solved. Paper (2) did not take weak events into account, nor did the method offer ways to combine simultaneous but often greatly different measurements at several stations in a seismographic network. The statistical properties of earthquake and explosion waves also remained to be established more firmly. Relatively few observations were used in paper (2) and the conclusions drawn from them were approximate, with unknown confidence intervals. Another unsolved problem of great practical importance was therefore how to obtain numerical estimates of the reliability of results obtained according to the method described in paper (2). These problems have been taken up since then and have been at least partly solved in some of the investigations summarized below.

4. In paper (3) the connexion between the yield or energy of an explosion and the body and surface wave magnitudes measured by a network of stations is described by a set of linear equations between the magnitudes and the logarithm of the yield, with super-imposed statistical disturbances. The relation between yield and mean surface wave magnitudes, reproduced last year in document CCD/306[37] and obtained from Canadian observations, was then new and closely coincides with a relation recently published by J. Evernden and J. Filson in the United States.[38] Expressions for the maximum likelihood estimates of yields from network magnitudes and approximate confidence ranges for these were also obtained. Three findings were of particular importance in the present context. One was that the statistical disturbances could be described by normal distributions. The other was that, after an increase of the explosion yield the magnitudes measured at some 20 Canadian stations increased in essentially the same way at all stations. The third finding was that, in spite of this, the relative magnitude levels varied greatly (by nearly two units) between stations. The latter finding demonstrates the importance of avoiding global averages of magnitudes. Instead, one should try to keep apart the situations defined by individual source areas and individual stations. Evernden and Filson have found that differences between stations can be correlated with local seismic noise levels. The bearing of such level differences on the impracticability of global event magnitudes for control of an underground test ban above a certain threshold is discussed in paper (3) in some detail. Individually calibrated stations and restriction of explosions permitted under such a treaty to calibrated test areas seem desirable in the case of such a treaty. Finally, paper (3) also provided a basis for the construction of discriminants which use body and surface wave magnitudes and which are normally distributed and independent of the explosion yield.

5. In paper (4) the yield estimation mĕthod established in paper (3), or subsidiary methods derived from it, are applied to 20 different source-network or source-station situations, with 69 underground nuclear explosions in the USSR and 75 in the United States. Estimates by one surface-wave station are found to be about as precise as joint estimates by four body-wave stations. Yield estimates from surface waves are therefore to be preferred, when available and calibrated. Seismometric networks provide yield estimates which can be as repeatable as the basic radio-chemical yield estimates, but without calibrated test sites and calibrated stations the average correctness of such seismometric estimates is rather low. In uncalibrated situations the seismometric estimates, as given in paper (4), are only equivalent yields, being the yield to be exploded in a reference area (in our case the Pahute Mesa in

[35] The six scientific reports are listed as follows: (1) K. Kogeus, Teleismic relative location of closely spaced epicenters, report C 4370-26, Research Institute of National Defence (Stockholm, 1968); (2) U. Ericsson, Event identification for test ban control, *Bulletin of the Seismological Society of America*, vol 60, p. 1551; (3) U. Ericsson, A linear model for the yield dependence of magnitudes measured by a seismographic network, report C 4455-26, Research Institute of National Defence (Stockholm, 1971); (4) U. Ericsson, Seismometric estimates of underground nuclear explosion yields, report C 4464-26, Research Institute of National Defence (Stockholm, 1971); (5) O. Dahlman, H. Israelson, G. Hornstrom, B. Soderstrom, R. Slunga, H. Wagner, L. Nordgren and I. Nedgard, *Hagfors Observatory annual report*, report A 4501-26, Research Institute of National Defence (Stockholm, 1971); (6) H. Israelson, Identification of earthquakes and explosions with seismic data from Hagfors Observatory, report C 4468-26, Research Institute of National Defence (Stockholm, 1971).

[36] *Official Records of the Disarmament Commission, Supplement for 1967 and 1968*, documents DC/230 and Add.1, annex IV, sect. 5.

[37] *Ibid.*, *Supplement for 1970*, document DC/233, annex C, sect. 35.

[38] J. Evernden and J. Filson, Regional dependence of surface-wave versus body-wave magnitudes, *Journal of Geophysical Research*, vol. 76, p. 3303.

the Nevada test site) in order to reproduce the magnitude from the event under consideration. Of particular interest in the present context is the finding in paper (4) that the way of obtaining one earthquake-explosion discriminant from all the body-wave and surface-wave magnitudes recorded in a network described in paper (3) also combines the measurements in such a way that the sharpness of discrimination is increased as much as possible, thereby maximizing the advantage of using a network of stations instead of single stations.

6. Paper (5) describes the activities during 1970 at the Hagfors Seismological Observatory in Sweden, including its operational performance. Paper (5) also lists nuclear explosions recorded at Hagfors, including the body-wave and surface-wave magnitudes obtained there. The spectral content of body-waves was found to depend very considerably on the position of the source area, with high frequencies dominating in waves from the Aleutians and from Eurasia. The detection capability for Eurasian events was found to be much better than for North American. Of special interest in the present context is a summary given in paper (5) of studies of identification using discriminants constructed from Hagfors measurements of body- and surface-wave magnitudes, of short-period spectral ratios and of complexities.

7. Paper (6) gives a more detailed account of the identification studies on Hagfors data summarized in paper (5). Identification by complexity is found to be somewhat better for USSR explosions and Eurasian earthquakes than for United States explosions and North American earthquakes, but in neither case can the identification be considered as very effective. A yet unreported study of complexity data from other stations shows, however, that identification by complexity can be much improved when data from several stations are combined. Identification by short-period spectral ratio is noticeably better than by complexity and, again, identification at Hagfors of Asian events is better than that of North American events. The events studied so far with this method had equivalent yields down to about five kilotons. Identification by body- and surface-wave magnitudes appear, however, to be by far the most effective method with Hagfors data. Again, Asian events are much better identified than North American events. However, present equipment at Hagfors does not permit the required surface-wave detection for explosions in Central Asia with equivalent yields below 50 kilotons. For North American events the present surface-wave detection level at Hagfors is just below 100 kilotons.

8. Further, still unreported, Swedish studies deal with the optimal use of single station discriminants, the combination of different kinds of discriminants, the use of station networks for identification and the dependence of the power of identification by body- and surface-wave magnitudes on the position of the source area and on the strength of the event. These studies include Canadian data on North American events, which show that identification can be made yield-independent; the available data, however, did not cover yields below five kilotons. Using observations made in Montana, Scotland, Australia and several stations in South Asia, significant regional differences in identification effectiveness have been observed between Eurasian and between North American source areas, as well as some striking homogeneities in the extended arc of earthquake sources made up by the Kuriles, Kamchatka and the Aleutians. Finally, it should be mentioned that a method has been found to determine the reliability of conclusions about identification capabilities. Applications in progress are intended to show how confident one can be, on the basis of present observations, that a discriminant can meet some specific political demand and also how many observations one needs for quite confident conclusions. The purpose of these investigations is to show how much further observations, if any, are needed to consolidate our understanding of identification possibilities.

Conclusions

9. This summary of Swedish research into seismic verification of a ban on underground tests of nuclear weapons has not given full consideration to the most recent contributions from other research groups. At a later stage it will be possible to obtain a more complete picture of the present state of understanding. Many of the results summarized above are also rather technical and bear mostly on how to conduct further research about seismic identification. In a general way, however, it can be said that the results recently obtained support and elaborate the decision-theoretical approach described in paper (2). That approach has been advocated by the Swedish delegation since 1967 as a way of obtaining an adequate test-ban control. The method of identification by body- and surface-waves has been seen to work down to about five kilotons, provided that properly placed and equipped stations provide the necessary data. Identification by this method can be highly efficient but differences in the susceptibility of different source regions to that method make it advisable to consider some source regions separately. Methods have been obtained for the efficient use of integrated data from station networks and they are expected to increase even further the efficiency of identification by body- and surface-wave magnitudes. It also appears that identification by short-period spectral ratio might work at least down to five kilotons. This is of special interest, as it appears much easier to record signals from weak events for the application of this method than for the method using body and surface wave magnitudes. Our data basis is, however, far too narrow for final conclusions about identification by short-period spectral ratio. Finally, work is under way to determine how much experimental data really are needed for confident conclusions about identification capabilities.

12.

United States of America: working paper containing remarks by Dr. Stephan Lukasik, Director of the United States Advanced Research Projects Agency, regarding research on seismic detection and the location and identification of earthquakes and explosions, presented at an informal meeting on 30 June 1971

[*CCD/330 of 30 June 1971*]
[*Original: English*]

Introduction

As is well known, the United States, as its contribution to progress towards a comprehensive test ban, has devoted considerable effort to the study of the seismic detection, location, and identification of earthquakes and explosions. This research has been directed toward improving detection capability and location accuracy, the development of discrimination criteria, and the installation of appropriate instrumentation to provide the necessary seismic data to support the discrimination research. This presentation reviews our work regarding the present state of the art of seismic verification and its concomitant limitations. We shall review the progress to date in pursuing this research from teleseismic distances, for which some major tools, including two new large arrays, are just now coming into full operation. Notwithstanding the success that may be achieved in such research, there are inherent limitations to seismic techniques for the verification of a comprehensive test-ban treaty which we shall also mention.

Discrimination criteria

Clearly there is a relationship between an understanding of source mechanisms and an understanding of seismic signatures arising from those sources. Thus, much emphasis is being placed in our current research programme on earthquake and explosion source mechanisms. The effect of the source time-function, the source dimension, the inherent symmetry of explosive sources and asymmetry of earthquake sources, the focal depth, and realistic earth structures have all to be taken into account in developing theoretical models of seismic sources.

As discussed perhaps most recently at the Woods Hole conference on seismic discrimination, theory supported by experimental data now suggests several methods to distinguish between earthquakes and explosions. Although the technique may or may not prove to be practical in a real world noise environment, we feel this development is extremely important.

As long as progress is totally dependent on empirical correlations to suggest differences between earthquakes and explosions we shall suffer from the severe limitations introduced by the small size of the explosion sample. For a full understanding of the seismic verification aspects relevant to a test ban, explosions at arbitrary locations, in a variety of media, and at low yields, should be considered. The practical management of a nuclear test programme tends to limit the variety of locations, media, and the number of low-yield explosions to the point where the available empirical evidence is inadequate or at least ambiguous. But the combination of theoretical insight coupled with empirical observations may offer the possibility of reasonably definitive scientific extrapolations where data are deficient.

As an example, in the M_s:m_b method, it is believed that the source time-function affects the M_s:m_b ratio for earthquakes in a manner different from explosions and that the source dimension-function results in a more efficient radiation of surface waves for earthquakes than for explosions. In a similar manner, the depth of focus, as well as source time and dimension, affect the spectral content of surface and body waves from earthquakes and explosions. Although the question of why some earthquakes exhibit unusually little surface wave radiation is still not resolved, the theory of the seismic source as it is now understood indicates that in principle the separation of shallow earthquakes and explosions will continue below magnitude 4.5. Indeed, recent data on M_s:m_b indicate that the method which applies at m_b5 extends below 4.5, whether discrimination is based on 10-second, 20-second or 40-second Rayleigh waves. It should be noted, however, that with decreasing magnitude there is increasing overlap of the earthquake and explosion populations in part as a result of the small signal-to-noise ratios involved and in part due to regional variations in tectonic stress, attenuation, and surface wave propagation. The former can be improved by increased signal-to-noise ratio although the problem becomes greater at longer ranges; but the practicality of calibrating all seismic regions of interest is unknown.

Another discrimination approach which previously appeared promising was the shape of the amplitude spectra of Rayleigh waves. Recent theoretical results have demonstrated, however, that this is not the case, and that earthquake source orientation has a drastic influence on the shape of the surface wave spectra. For example, a shallow-focus dip-slip fault has been found to give a spectrum similar to that of an explosion.

Two important points concerning long-period P, S, and Love waves emerged from our research. The ratio of Love to Rayleigh waves appears to be a useful, but not as yet fully developed, discriminant. Also the P wave spectra (0.3 to 3 Hz) of the Aleutian explosions Longshot and Milrow were quite different from the P wave spectra of Aleutian earthquakes of comparable body wave magnitude. Corner frequencies for these earthquakes were approximately one decade lower than for the explosions.

The possibility of tectonic energy release has been studied but the effects so far observed have been minor and have not weakened the M_s:m_b criterion.

We have also examined the utility of the short-period P wave for identification. It would appear that we will rely on the P wave for event detection for a long time to come and in some cases the P wave will be the only signal available for further analysis. The P wave may, at sufficiently high signal-to-noise ratios, show an unambiguous earthquake first motion and it may also show pP and sP phases that are adequate to establish the depth of focus with sufficient precision to exclude an explosive origin. Furthermore, S-P time differences, P arrival time residuals, and the use of master events can provide useful ways to determine source depth.

Short-period spectral ratio techniques have been somewhat less successful and must at best be considered diagnostic aids. We have found that the influence of propagation path and receiver site characteristics are such that the techniques must be carefully "tailored" in order to be useful. For example, techniques useful at LASA to identify presumed explosions in Eastern Kazakhstan fail when applied to NORSAR data on the same events nor are they useful to identify explosions in Nevada recorded at NORSAR.

A general problem with all seismic discriminants, both short period and long period, is that they fail when applied to small events near the detection threshold of the network due to signal-to-noise limitations. The aim of the ARPA large-array programme and the Very-Long-Period Experiment is to explore techniques to enhance signal-to-noise ratios thereby extending the effectiveness of discrimination criteria to events of lower magnitude at teleseismic distances. A further aim is to demonstrate the feasibility of the automatic digital processing of the large number of events which occur at lower magnitudes.

Large-array programme

The mechanism for signal-to-noise enhancement in long and short period arrays is essentially different. Long-period noise for periods of less than 25 seconds, such as that induced by oceanic storms, is generally coherent across the aperture of our large teleseismic arrays. The noise reduction relies on the formation of narrow beams which allow the noise to be subtracted from the signal by beam steering. The short-period noise, on the other hand, is incoherent at sensor spacings of a few kilometres and noise suppression relies on the number of elements in the array, the signal-to-noise ratio increasing as the square root of the number of elements. Two of ARPA's three large teleseismic arrays are a combination of short-period and long-period instruments, while the third is composed entirely of long-period sensors.

The first of these arrays, the Montana LASA, was completed in 1965 and has operated continuously since that time. Its current configuration comprises 345 short-period and 16 three-component, long-period instruments distributed over a 200-km aperture. The teleseismic detection threshold of LASA, at the 90 per cent incremental level for the distance range of 20° to 90° is about m_b 4.2 for short-period signals using automated data processing techniques. As a result of experience gained at LASA, improvements were incorporated in the Norwegian array, NORSAR, particularly in respect to the sensor spacing and distribution, automatic array monitoring systems, and automated data processing. A six-month operational test and evaluation of NORSAR was initiated in February 1971. NORSAR, which is operated by the Royal Norwegian Council for Scientific and Industrial Research, comprises 132 short-period seismometers and 22 three-component long-period instruments. The teleseismic zones from which LASA and NORSAR will record seismic events overlap and this will allow increased corroboration between events, particularly when our aim of multi-array analysis is attained shortly. The recently completed Alaskan array, ALPA, is concerned with the long-period region of the spectrum. This array comprises 19 three-component instruments in 60-foot boreholes. ALPA and NORSAR will allow corroborative data to be obtained for long-period signals from events in many of the world's seismic regions.

Very-Long-Period Experiment

A companion programme to the large arrays is the Very-Long-Period Experiment initiated to obtain seismic data covering the 30- to 60-second spectral band by utilizing recently developed high gain broad band instruments. This instrument will be installed at carefully selected, deeply buried, very quiet sites and is expected to be capable of recording seismic signals much smaller than normally recorded by the World Wide Standard Seismic Network instruments in this frequency band. A prototype system has been operating at Ogdensburg, New Jersey, for the past two years, with encouraging results. Identical systems have been installed at five other locations: Fairbanks, Alaska; Charter Towers, Australia; Chiang Mai, Thailand; Eilat, Israel; and Toledo, Spain. Plans call for improved instrumentation at four other stations in the near future.

Automatic data processing

In discussing the large-array programme, attention is often focused on the distribution of instruments, their siting, response characteristics, and monitoring utility. One of the major research objectives, however, has been to test the feasibility of operating and maintaining such an array and at the same time process the large amount of data in an effective manner. There are over 10 times as many events to process if the array is operating at a m_b 4.0 magnitude threshold rather than at 5.0. Thus the very improvement in signal-to-noise ratio sought from the arrays, which allow the detection of smaller magnitude events, imposes a critical constraint on the data processing; it must be automated in order to handle the greatly increased volume of data. Furthermore, recording systems must necessarily be digital rather than analog.

The focal point for data from the three large arrays is the Seismic Array Analysis Center in Alexandria, Virginia, which also handles data from the Very-Long-Period Experiment. Multi-array analysis can thus be performed to compare signals from different azimuths for the various discrimination criteria previously mentioned. However, the implementation on a routine basis of a new generation of azimuthal and spectral discriminants would require a major transformation and expansion of even this very advanced data acquisition and analysis facility.

Seismic location

An essential element of a seismic verification capability is accurate location of all detected seismic events. The location error is dependent upon the accuracy with which average travel time curves and regional travel time anomalies are known, and to a large extent on the number and azimuthal distribution of recording stations about the source area.

As a result of our research programme improved P-wave world average travel time tables, based on 400 earthquakes and a number of large nuclear explosions (well recorded world-wide), have been developed. Azimuthally-dependent station corrections have been established for our major seismic observatories and source corrections have been calculated for a number of source regions.

We have found that location error has been observed at essentially all sites where known source locations are available for comparison. One important cause of errors in estimates of epicentres is source bias, i.e., variation in velocity with azimuth and incidence angle in a source region. Tectonic regions known to display significant bias (errors of 25 to 45 kilometres) include the volcanic island chains of the Aleutians and Hawaii. Where bias can be effectively removed by use of calibration events to determine regional travel time anomalies, it appears possible to locate large events to within a few kilometres if recorded by a sufficient number of instruments well distributed in azimuth.

However, neither statistical study of large numbers of earthquakes nor the use of master earthquakes provides a solution to the bias problem. Only explosions or shallow earthquakes well recorded by local networks can provide calibrations for estimating source bias from the various source regions. As previously discussed, the practicality of this is unknown.

As an example of the improvement possible with the application of travel time anomaly corrections, consider the locations determined for 19 Nevada explosions recorded at teleseismic distances by a network of 4 to 13 stations. Mean location error was 26 kilometres without corrections for travel time anomalies. The error was reduced to 3 kilometres when pre-determined travel time anomalies derived from other nearby explosions were utilized in the calculations.

Future prospects for seismic verification

Since the thrust of our concern at this meeting is the future as much as the past and present, it is appropriate to comment on our expectations of the amount and the rate of progress that might be expected in the area of identification and detection by seismic means. In the area of discrimination criteria, considerable progress has been achieved during the past decade by a number of research workers in various countries. Judging from the progress made to date and the wealth of ideas currently being discussed for further improvements, it appears that the problem of discriminating earthquakes from explosions by seismic means is a difficult but not totally insoluble problem. However, background seismic noise will almost inevitably constitute a limitation on how far this progress can be pursued, and we anticipate that some uncertainties will persist above the identification threshold. Improved seismic instrumentation is clearly needed to attain further advances below magnitude 4.5 and to assess the limits of teleseismic discrimination.

We have seen that to translate the greater scientific understanding of the identification problem into improvements in the seismic verification capability requires more sophisticated installations than currently exist. One might suggest that it will become important, for instance, to upgrade the capability to detect P waves at lower levels than is currently feasible in order to enhance detection and location. Similarly, it would also seem important to improve identification capabilities preferably down to where tamped nuclear explosions at the few-kiloton level can be readily identified at teleseismic distances. Likewise, expansion of the existing network of seismic arrays and individual stations would seem highly desirable. This expansion would help to provide coverage for seismic events in all land areas, particularly those in the northern hemisphere.

Many of these improvements would undoubtedly require considerable time and they would represent a substantial capital investment. Much effort would have to go into determining where these additional facilities should be located in order to achieve maximum performance.

As the recent Canadian study has shown, of the large number of existing seismic stations it is the sophisticated array stations and the single instrument stations in strategically located quiet sites that provide most of the capability. The array stations have generally required several years for site selection and installation. Quiet single instrument sites similarly require time for site surveys and the installation is certain to involve a remote location in order to minimize man-made noise.

Nevertheless, various combinations of new stations at quiet locations, long-period and short-period arrays, and the latest in broadband long-period instruments could provide much of the data. Decisions will also have to be made on the design of such a network based on the discrimination criteria employed.

The cost of new installations is very difficult to estimate until the number, size, and specific locations of the stations are known. In general, cost estimates become less reliable the further one departs from an existing understood system. Also, it must be kept in mind that optimum system performance requires a good deal of operating experience before it is actually achieved, and it is crucially dependent on the quality of system management. The more one relies, as one will have to, on sophisticated techniques such as automatic real-time digital processing and high-gain long-period instruments, the more important over-all system management will become.

Limitations of the seismic verification method

It should be recognized that seismic means alone are not sufficient to achieve the identification of earthquakes and explosions in all cases, even when the magnitude of the event would seem sufficient. Moreover, it seems unlikely that such a goal will ever be realized because of inherent limitations in the method. In the first place, identification can only take place where detection has preceded it. The practical limit for the teleseismic detection of short-period signals is set by the natural noise field of the earth. Array technology, including the use of sophisticated digitized adaptive filtering, has provided a means for increasing the signal-to-noise ratio. It must be recognized that there may be some minimum practical detection threshold for short-period signals.

At higher magnitudes, it should be remembered that there are now several ambiguities per year above magnitude 4.5 which cannot be resolved. Considering the vagaries of seismic sources and seismic propagation paths, it seems likely that there will continue to be circumstances where natural events cannot be distinguished from explosions by seismic means alone. Also, as teleseismic identification thresholds are progressively lowered, explosions will be identified whose origin is non-nuclear, without the seismic means for drawing the distinction between them and nuclear explosions of the same magnitude.

Detection can also be lacking where the noise field is temporarily high, as in the case of the saturation response of seismometers to large earthquakes anywhere in the world and the interference of their aftershocks. Such high noise fields may be sufficient to blank out explosions of significant yields. It is also possible that there would not be identifiable seismic signals from an underground explosion of a device pre-emplaced in or near a naturally seismic region and detonated a short time after the onset of the signals from a larger magnitude earthquake. This could be the situation if the earthquake were at least 1/2 to 1 magnitude units larger than the explosion magnitude and if epicentre were within a few hundred kilometres of the location of the nuclear explosion. In some seismic regions of the world this would seem to indicate the possibility that a number of explosions of significant yields could take place in a year. Even if signals from such explosions were detected, they might be interpreted as those from a natural earthquake. This would be particularly true of an earthquake with a definite aftershock sequence.

Neither should it be overlooked that the seismic coupling from an explosion would be reduced if it took place in an underground cavity. Cavities already exist that have been washed in salt domes by solution mining techniques in the course of the storage of hydrocarbons. Moreover, with the inherent limitations in detection already noted, partial, as well as complete, decoupling would affect the ability to detect and identify seismic signals.

13.

Italy: working paper on the problem of underground nuclear explosions

[*CCD/331 of 1 July 1971*]
[*Original: English*]

At the informal meeting held on 30 June 1971, with the participation of experts, the delegation of Italy submitted to the Conference some views on the problem of underground nuclear explosions.

These views are summarized in the present working paper for further consideration by the Conference.

In joining the delegations that requested the convening of the informal meeting of 30 June 1971, the delegation of Italy meant to stress once again the extreme urgency of the problem of stopping underground nuclear tests. It also meant to reaffirm the view that initiatives for the institution of an international seismological data exchange system might lead to substantial progress in the detection and identification of seismic phenomena and thereby favour the solution of the problem of underground testing.

From the very outset Italy has always lent its support to such initiatives whether in the Conference of the Committee on Disarmament or in the United Nations General Assembly, where, more recently, Italy was a sponsor of resolution 2663 A (XXV), initiated by the delegation of Canada.

The delegation of Italy is well aware of the complexity of the problems of establishing an effective international seismological data exchange system. Nevertheless, it feels that by joint efforts in studying the technical aspects of this problem positive results can definitely be achieved. The working papers that have been circulated by other delegations provide the Committee with a useful picture of current studies and research in the field of seismology and at the same time hold out prospects of further technical advances.

The delegation of Italy, as a preliminary contribution, therefore, submits to the Committee the following considerations:

1. In the view of the Italian delegation the problem of external monitoring is linked with three fundamental assumptions:

(*a*) Efficient collaboration and organization among the various nations concerned in regard to data processing and to the exchange of scientific reports.

(*b*) An adequate, homogeneous network of monitoring stations with standard seismographs. In this connexion, considering for the time being only the northern hemisphere, Italy thinks that such well-known bodies as LASA, NORSTAR and ALPA should be integrated with other networks, particularly in the Mediterranean area.

(*c*) In the present situation and even allowing for further desirable improvements in national seismic organizations, if a reasonable threshold for external monitoring in terms of magnitude is to be accepted, it should not fall below 4.75 for explosions in hard rock.

2. The threshold value of 4.75, indicated above, may seem somewhat pessimistic, especially in the light of working paper CCD/327, introduced by the Canadian delegation on 29 June 1971 (see sect. 9 above). However, with reference to intercontinental paths which are the most significant for worldwide monitoring purposes, the Italian delegation considers that the value of $M_s = 4.3$, taken as a basis in the Canadian paper, can be attained by national organizations in North America and Northern Europe but not by stations in the Mediterranean basin. This is explained by the fact that in the latter areas the geographical distribution of seismic observatories was designed for different purposes than that of the identification of underground nuclear explosions.

Another fact which must not be disregarded is that amplification of the short-period seismographs of many Mediterranean stations cannot be carried beyond certain limits because of the presence of intense microseismic activity peculiar to the Mediterranean basin. The predominant periods shown up by this microseismic activity are of the same order as those of body waves with the result that the application of appropriate filters produces distortions in the amplitudes of the waves whose periods are to be identified.

This is amply confirmed by measurements carried out at the Central Observatory of the National Institute of Geophysics at Monte Porzio of earthquakes of magnitude 4.5 approximately, and at distances of 3,000 to 4,000 kilometres.

These remarks do not take into account the possibility of "decoupling", which would obviously pose a number of problems, thereby making the definition of the threshold more difficult.

The definition of a threshold, moreover, raises another question, which in the opinion of the Italian delegation should be carefully examined: it seems beyond question that for external monitoring purposes the threshold will have to be expressed in terms of magnitude only, rather than in terms of yield. Hence arises the necessity to determine the magnitude/yield ratio between error limits of the order accepted in the case of earthquakes, that is a quarter of the unit of magnitude. It is a known fact that such correlations are regional in character in so far as they depend on the geology of the station sites. They are also related to the actual paths of the waves reaching the stations.

This problem has already been solved by seismology within satisfactory limits and a similar method can be adopted by the various national organizations for use at their observation stations.

Once an acceptable magnitude/yield ratio has been obtained, a threshold value should be determined, bearing in mind that the distribution of seismic observatories in many countries is not sufficient to guarantee adequate results as far as the problem of nuclear testing is concerned since it was designed for research in other fields such as pure seismology and tectonics.

The above remarks should be taken as a purely technical contribution to the problem of defining a threshold. Of course they leave the door open to other solutions for a gradual reduction of underground nuclear tests such as those envisaged by the distinguished representative of Canada in his constructive proposals of 6 April last (see CCD/PV.507).

3. Concerning possible improvements in international detection and identification techniques, the Italian delegation suggests the adoption of a programme along the following lines:

(*a*) Establishment of an international centre for the co-ordination of research, dissemination of scientific reports on results obtained and data storage.

(*b*) Subdivision of each continent into zones with their own centres responsible for data gathering and processing and execution of study programmes. The Mediterranean area should form a single zone to be organized with its own centre following criteria and methods already adopted in North America and Northern Europe. In this way, an important deficiency in the detection and identification system in the northern hemisphere could be eliminated.

(*c*) Commitment by national authorities to bring their existing observatories into line with agreed standards and, where necessary, remedy any deficiencies.

(*d*) Commitment by Governments to bear operational, equipment and research costs and to lend their assistance in the improvement of a world-wide seismological network along the lines indicated by resolution 2663 A (XXV) of the United Nations General Assembly.

Particular attention, however, should be paid to the problem of explosions in alluvium over which there is a good deal of uncertainty. In this regard, the Italian delegation was particularly interested in the statement of the Netherlands delegation on 29 April last (see CCD/PV.512) concerning the possibility of identifying explosions in alluvium by other means.

4. As regards the most suitable approach in order to find adequate solutions to the problem of nuclear tests, the Italian delegation believes that very careful consideration should be given to proposals which offer a way out of the deadlock brought about by the divergent positions taken in this Committee and a chance of making at least partial progress, pending a complete solution to the problem.

In this connexion the Italian delegation draws the Committee's attention to the suggestions put forward in the Italian working papers ENDC/234 and ENDC/250 of 23 August 1968 and 22 May 1969 respectively[39], according to which the regulation of underground nuclear explosions for peaceful purposes should temporarily be separated from that of underground nuclear explosions for military purposes. Those suggestions, implying a prior notification to the International Atomic Energy Agency of underground nuclear explosions for peaceful purposes, were aimed at reducing the scope of the field not yet covered by the 1963 Treaty[40] and, therefore, at creating a more favourable situation for the solution of the problem of underground nuclear explosions.

Communication of data concerning underground nuclear tests for peaceful purposes would favour, moreover, the improvement of existing seismological verification capabilities.

14.

United States of America: working paper on the verification of chemical warfare agents

[*CCD/332 of 5 July 1971*]
[*Original: English*]

This paper examines three possible areas of verification of chemical warfare agents: first, safety features in plants producing nerve agents, secondly, the sealing and monitoring of plants formerly producing nerve agents, and thirdly, sampling to detect possible nerve agent production.

A. *Safety features of plants manufacturing nerve agents*

1. Safety features are a usual—and often distinctive—attribute of processing facilities which deal with toxic materials. The final stages of organophosphorous nerve agent manufacture, involving some of the most toxic known substances, demand especially stringent controls to safeguard operating personnel and surrounding areas. Many, although not necessarily all, of the following safety features might logically be expected in connexion with nerve agent production:

The building in which processing is conducted is likely to be unique in design. The specifications may call for it to be constructed with solid, airtight walls and roof, with all openings having tightly fitting closures with a minimum possiblity of air leakage. A building designed and constructed in this manner would make it possible to have a continuous pressure differential between the exterior atmosphere, the work areas within the building and the toxic product production areas. The maintenance of lower atmospheric pressure in the production areas would help to prevent any accidental leakage of toxic materials from reaching other sections of the plant or its surroundings.

Intermediate products produced during agent manufacture are highly reactive with oxygen and moisture of the atmosphere. In many instances, the materials are pyrophoric, i.e., spontaneously flammable with the atmosphere or its components. Because of this, the equipment and process operations would be expected to have comprehensive vent control systems. They would be likely to include provisions for inert gas purge of all equipment as well as the maintenance of inert gas blankets over all process and storage vessels to prevent contact with the atmosphere. Vents from all process equipment lines and storage vessels would probably lead to a central vent where the gases can either be "scrubbed", i.e., separated by chemical and mechanical means, from the atmosphere or "flared", i.e., burned under controlled conditions to prevent accidents.

Pumps used in nerve agent plants would probably be of a type which ensures positive control of possible leaks of material to the atmosphere. Because of the problems of keeping pumps leakfree, process flows might be by gravity. Submerged pumps could be used in storage and supply vessels to minimize the likelihood that accidental leakage could spread.

Within the process building, personnel areas would very probably be separated from the process areas by airtight construction. All normal production operations could be conducted by controls located in the personnel areas. For example, valves which might require manual operation for process control could be provided with reach rods which would extend into the operating area through airtight packing glands, i.e., seals made of an impervious material, installed in the walls separating the process area from adjacent corridors. Windows would probably be provided in the walls between the safe corridors and the process area to permit observation of the process and of any personnel that are in the toxic area. There might also be closed-circuit television, with the receiver in the control room using a portable television camera which can be plugged in at various locations in order to permit visual observation of activities within the process area by control operators.

All personnel who worked in the general area would probably be supplied with individual protective masks. There would be a number of gas alarms located throughout the building in order to give automatic warning of malfunctions creating a toxic situation. Test animals, such as rabbits, might also be kept in cages in critical areas to provide indications of leakage of toxic materials. All persons entering the toxic area would normally wear full protective clothing. Portable radio receivers and transmitters might be provided for use inside such protective suits. This would allow standby safety operators in the corridor to communicate with personnel within the toxic area.

Doors into the toxic area might lack handles or other means of opening from within the toxic area, and exits from

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[39] For document ENDC/234, see *Official Records of the Disarmament Commission, Supplement for 1967 and 1968*, document DC/231, annex I, sect. 9; for document ENDC/250, see *Ibid., Supplement for 1969*, document DC/232, annex C, sect. 13.

[40] Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and under Water (United Nations, *Treaty Series*, vol. 480 (1963), No. 6964).

the process area would be through air locks, with self-closing doors. Each air lock would probably be equipped with sprays and with sufficient spray heads to thoroughly drench any person passing through the exit. The first or inner spray would probably be connected to a 5 per cent caustic system and the outer spray connected to a service water system for rinsing. Waste from these showers would drain into the chemical waste system.

The process area might be equipped with overhead spray heads for spraying a caustic solution or water as controlled by valves in the corridor. Caustic spray is useful to detoxify equipment and to neutralize agent spilled within the area. Water sprays may be used to wash down the equipment and to wash away caustic contamination from the process area. These same sprays might be used in the event of fire in the toxic area.

There might be special arrangements in the plant and process design to reduce the hazards of sample taking. Special sample chambers might be provided, discharging a predetermined amount of material which would not overflow sample bottles. An interlock could be provided through the wall between the process area and the laboratory so that samples could be passed directly into a laboratory hood without the sample taker leaving the toxic area. Provisions might be made within the toxic area to decontaminate and dispose of returned samples.

Emergency facilities, to include air for instrument operation and power for lighting, operation of the air "scrubbers", and ventilation, might be provided as a backup in the event of normal power failure. This could include a system for automatic activation of the auxiliary power source in an emergency.

2. Any facility found to be equipped with many or all of these safety features would merit further investigation. The presence of these safety features would, however, not be determinative of nerve agent production. What is considered to be a necessary margin of safety may vary significantly from country to country, between civilian and military-run facilities and from one plant to another. There are also some kinds of commercial chemical production, including that involving organophosphorous compounds, which are potentially very hazardous for plant personnel and, if not adequately controlled, damaging to the environment, Such considerations may justify maximum possible safety controls in commercial plants similar to what might be expected in nerve agent production. However, while safety features and environmental safeguards associated with nerve agent production may be found in some commercial manufacturing, they are nevertheless sufficiently unusual to merit serious attention in the broad study of chemical warfare verification.

B. *Sealing and monitoring of production facilities*

1. One task facing a verifications system for an agreement prohibiting production of chemical weapons is to ensure that facilities which previously manufactured organophosphorous nerve agents refrain from proscribed activity.

2. There are several ways to dispose of former nerve agent plants. For instance, they might be converted for commercial manufacturing. This would raise one type of verification problem, which has been frequently discussed in the Conference of the Committee on Disarmament, based on the need to ensure that commercial manufacturing is not replaced or supplemented by agent production

3. Former nerve agent facilities could also be dismantled and the sites used for activities unrelated to chemical processing. While offering verification advantages, dismantling would be expensive and deny future possible use of the facilities for some non-proscribed purpose.

4. A third approach would be to shut down agent facilities, but to defer the decision on their further disposition. This would preserve the option of converting a plant to other uses at some future date, or of eventually dismantling it.

5. Closing down former nerve agent plants would raise another type of verification question. Assuming the location were known, verification's major role would be assuring that activity was not resumed at the site. One way to gain this assurance would be through sealing the facility. This could involve placing some form of sealing devices on doors, fans associated with ventilation equipment, or on certain key valves in the process equipment. This would have to be done, however, in such a way that an inspector checking such seals would be able to tell whether they had been tampered with. This would depend on techniques involving tamper-resistant unattended safeguards. These have been studied in connexion with safeguarding power reactors and other nuclear facilities. A progress report on a joint Canadian/United States safeguards research and development project sponsored by the Atomic Energy Control Board of Canada and the United States Arms Control and Disarmament Agency was presented at an International Atomic Energy Agency symposium at Karlsruhe, Federal Republic of Germany, in July 1970. The project's purpose was development of a practical system using unattended instruments, the integrity of which would be assured even though all design and operational details were known to participating Governments.

6. While it is doubtful whether any seal or other technical barrier could be made completely inviolable, there may be ways to gave high assurance that an unattended system would show that it had or had not been tampered with. One possibility would be specially sealed containers around key valves or ventilation equipment controls. The containers might be made of heat-resistant Pyrex glass with aluminized inner surfaces. They would need to be the proper shape to fit around the item to be sealed. Once placed around the object, the container might be locked by using a fibre-optic cable threaded through holes in the container. A fibre-optic cable consists of glass fibres, bonded together with epoxy. Random cross sections of such cables show distinctly differing fibre configurations, because of uncontrollable variables in aligning the fibres during manufacture. Each cable thus has its own unique "fingerprint", which cannot be duplicated, but which can be recorded by photographing the optically polished fibre ends. An attempt to pull such a sealing cable free or cut it would distort or destroy the unique "fingerprint". It would not be possible to reproduce an identical "fingerprint". An inspector equipped with a photograph of a cross section of the original sealing cable would be able to compare its configuration with that in the locking device and notice any differences. Efforts to penetrate the glass container without disturbing the sealing cable could be made discernible in a number of ways. For instance, the interior aluminium coating referred to above would help to make even small holes visually obvious.

7. Another way to ensure that a closed plant was not put into production again would be by the use of seismic sensors. Every production facility with mechanical equipment causes a vibration pattern in the structure, building or ground surrounding the plant. In theory a seismic device could be installed in or at a closed facility to determine the presence or absence of vibrations which accompany manufacturing activity.

8. There are a number of practical questions concerning the utility of sensing devices such as seismic detectors in monitoring a closed-down facility. For example:

How would the sensor function? Would it transmit continuously or only if vibrations exceeded a certain level?

To what degree could the sensors be made tamper-proof?

How frequently would a sensor require maintenance servicing or inspection to assure proper functioning?

At what distances and by what means could sensor signals be monitored?

Could seismic detectors distinguish between vibration patterns? Could they be developed to monitor a fully or partially converted plant to assure that it was not engaged in agent production?

9. There are other types of sensors which might be useful in monitoring a closed down plant if installed in or near the facility. For example, closed-circuit television or heat detectors could be of help in determining that a facility was not being used. In addition, there are a number of sampling

techniques—some of which are discussed below—that might be developed for use as remote alarms signalling resumption of activity possibly related to nerve agent production.

C. *Sampling to detect possible nerve agent production*

1. Organophosphorous nerve agent production is characterized by the presence of distinctive chemical compounds in the later manufacturing stages. They are present to some degree in all materials, including wastes, which have come in contact with the final processes.

2. A number of analytical techniques, which are at various stages of development for other purposes, might have applicability in on-site sampling for nerve agent production. The Japanese working paper of 6 August 1970[41] described one such method, gas chromatography. Other techniques of possible interest include infrared spectrophotometry, thin-layer chromatography, nuclear magnetic resonance spectrometry, emission spectography, electron paramagnetic resonance, colorimetry, enzymatic analysis, and mass spectrometry.

3. It is probably necessary to concentrate chemical warfare compounds present in air, water, and soil samples before effective analyses can be carried out by any of these methods. Air and water samples might be concentrated by passing them over absorbent materials like charcoal or ion-exchange resins. Nerve agent compounds present in soil and vegetation samples could be extracted with a solvent. Some analytical procedures require samples with a very high degree of purity. With these procedures, it would be necessary to separate the target compounds from extraneous substances in the samples. For example, only high-quality samples are satisfactory for use with nuclear magnetic resonance techniques. The following analytical techniques, in addition to gas chromatography, might be considered for possible roles in inspection sampling:

Infra-red spectrophotometry detects and identifies small quantities of substances by analysing the structure of molecules. The infra-red absorption spectrum of a compound acts as a sort of "signature" which can be compared with spectra of various possible substances.

Thin-layer chromatography (TLC) is a technique for separating the components of mixtures on a thin layer of finely divided solid absorbant. The resulting chromatogram shows a series of small deposits, each, ideally, containing a single component of the analysed mixture which can be visualized and compared to predeveloped signatures.

Nuclear magnetic resonance (NMR) is the term applied to spectroscopy used to detect and distinguish between the nuclear particles present in a sample.

Emission spectrography is based on the principle of supplying additional energy to the electrons of molecules. Since there are definite energy states and since only certain changes are possible, there are a limited number of wave lengths possible in the emission spectrum, which can be measured.

Electron paramagnetic resonance (EPR) is based on the fact that atoms, ions, molecules, or molecule fragments having an odd number of electrons exhibit characteristic magnetic properties.

Colorimetry is a quantitative method of measuring the amount of a particular substance in solution by determining the intensity of its colour. Most colorimetric methods currently in use are photometric, where the colour intensity is measured by a photo-electric cell. Readings can be made in visible wave lengths as well as in ultra-violet and infra-red.

Enzymatic analysis. Substances which accelerate chemical reactions without being used up in the process are known as "catalysts"; those formed in living cells are called "enzymes". Organophosphorous nerve agents interfere with the action of an enzyme, cholinesterase, essential to the functions of the nervous system. An analytical system utilizing cholinesterase might be used to detect and measure organophosphorous compounds.

Mass spectrometry uses an instrument that sorts out ions according to the ratio of mass to charge. Usually, the ionic species are brought successively to focus on a fine exit slit and collected on a device which can measure the intensity.

4. While all of these techniques are of proven value in analysing organophosphorous compounds under laboratory conditions, their respective usefulness for on-site inspection has not yet been thoroughly examined. There are a number of factors that need to be taken into account, including sensitivity, expense, portability, and speed, as well as simplicity of operation under actual sampling conditions. Further study of the technical aspects of inspection should include attention to the question of what kinds of sampling techniques might be most appropriate.

[41] *Official Records of the Disarmament Commission, Supplement for 1970*, document DC/232, annex C, sect. 30.

15.

Sweden: working paper on some aspects of the definition of toxins

[*CCD/333 of 6 July 1971*]
[*Original: English*]

Introduction

According to the definitions given in the United Nations report entitled *Chemical and Bacteriological (Biological) Weapons and the Effects of Their Possible Use*[42] and the report of the World Health Organization entitled *Health Aspects of Chemical and Biological Weapons*,[43] toxins are to be considered as chemical warfare agents because of their (direct) toxic effects on living organisms and the fact that these effects do not depend on multiplication of the agent, which is a characteristic of bacterial (biological) agents. Nowhere, however, has a comprehensive definition of toxins been given allowing a clear-cut delimitation, although a useful description of toxins is to be found in the United States working paper CCD/286 of 21 April 1970.[44] In a comprehensive treaty covering prohibition of development, production and stockpiling of both bacterial and chemical warfare agents a strict definition would not be necessary. For separate treaties, however, a definition seems indispensable.

The term "toxin" is often used in a vague sense. Some authorities consider any poisonous substance of biological origin or occurrence as a toxin, other authorities regard only macromolecules of microbial origin, lethal to man in microgramme amounts, as toxins. In addition there is the question of synthetic or semisynthetic toxins to be considered.

The toxic effects of toxins extend over a wide range, the weakest being comparable to the less toxic chemical warfare agents and the strongest to the most potent biological warfare agents. This is exemplified in the table annexed to this paper.

The fact that some very toxic compounds of biological origin have important use as medical drugs in small quantities must be recognized and provided for in a treaty.

The following is an attempt to discuss briefly the implications of different ways of defining the concept of toxins for use in a treaty dealing explicitly with toxins.

Possible criteria for the definition of toxins

Criteria that can be used for the definition of "toxins" are of four main types:

(*a*) The natural origin or occurrence of the compounds.

Examples: Biological, microbial or microbiological, bacteriological.

(*b*) Degree of toxicity, type of toxic activity, and mode of action.

[42] United Nations publication, Sales No.: E.69.I.24.
[43] World Health Organization (Geneva, 1970).
[44] *Official Records of the Disarmament Commission, Supplement for 1970*, document DC/233, annex C, sect. 15.

Examples: Highly toxic, toxic in amounts less than one mg, neurotoxic, incapacitating.

(*c*) The chemical nature of the compounds.

Examples: Proteins, macromolecules.

(*d*) Chemical operations producing toxins and poisonous substances related to toxins.

Examples: Synthetic, semi-synthetic, chemically modified.

A definition of "toxins" will very probably have to include criteria of more than one of the above types. In the following, some criteria and possible combinations of criteria will be briefly discussed.

Natural origin of toxins

One of the more or less unspoken understandings with the concepts of toxins presented hitherto is that they are chemical substances resulting from metabolic processes of living organisms. Thus, in paragraph 44 of the United Nations report on chemical and bacteriological (biological) weapons, toxins are defined as "biologically produced chemical substances which are very highly toxic and may act by ingestion or inhalation". This definition will include not only the classical toxins of microbial origin (e.g., botulinum toxin A) but also toxic compounds of plant origin (e.g. convallatoxin) and animal origin (e.g., tetrodotoxin and many snake venoms).

For warfare purposes, highly toxic compounds of microbial origin are presently of higher potential importance than compounds of other biological origins. One could therefore circumscribe the definition to include only compounds of microbial origin, if such a narrow definition is desired. It would still cover most of the natural toxins of potential usefulness in warfare known today.

However, it may turn out that some highly toxic compounds of plant or animal origin are sufficiently stable and easily distributed to have a place in a potent weapon system. In order to anticipate such a situation, it may be advantageous to include toxic compounds of any biological origin in the toxin concept.

An interesting fact is that some toxic compounds arise from non-biological transformations occurring in nature, e.g. hydrolysis and oxidation of substances of biological origin. In a strict sense, these toxic compounds are not "biologically produced", but ought to be covered by a definition of toxins.

Toxicity of toxins

The expression "very highly toxic" used in the United Nations report reference is somewhat imprecise. Some toxins merit special consideration as warfare agents because they are effective in doses smaller—sometimes several orders of magnitude smaller—than one milligramme for a man. This dose is below the dose limits of today's most powerful synthetic agents.

If toxic compounds of any biological origin are considered, this interpretation of "very highly toxic" should include for example, botulinum toxin, staphylococcal enterotoxin, tetrodotoxin (fish, newt), and batrachotoxin (frog) (see the table below). Some of the naturally occurring toxic compounds, excluded by a definition of "very highly toxic", are monofluoroacetic acid (plant: *Dichapetalum cymosum*) and hydrogen cyanide (fungi).

If a minimum effective dose is specified in a prohibition, it would appear natural also to specify the mode of administration, since many compounds will differ considerably in toxicity, depending upon whether they are introduced for example, intravenously, orally, percutaneously or by inhalation. However, it is probably more convenient, if the criterion of toxins is to be employed, to regard all compounds that fulfil the minimum effective dose criterion by any means of administration as toxins, provided that they also meet certain other criteria.

If the aim of a definition of the toxin concept for warfare purposes is to include only the macromolecular microbial toxins, criteria may be chosen from their immunological properties. In contrast to other toxic compounds, the macromolecular microbial toxins act as antigenes and stimulate antibody (antitoxin) production.

Chemical nature of toxins

Most of the highly toxic microbial compounds are proteins of high molecular weight. However, other chemical types of compounds are also represented, e.g. a highly fever-producing, non-protein macromolecule is known from *E.coli* (minimum effective dose for man: 0.0001 mg). Many other types of chemical compounds are found among the highly toxic plant and animal constituents.

The only possible delimitations of the toxin concept by means of purely chemical criteria are by defining toxins as proteins and/or macromolecules. However, in either case, virtually all highly toxic compounds of plant and animal origin, as well as some of microbial origin, would be excluded.

Synthesis and semi-synthesis of toxins and of chemically closely related compounds

The criterion based upon some type of biological occurrence or origin does not cover the possibilities of man-made, chemically wholly-synthetized substances. Neither does it cover by chemical means modified substances of biological origin or occurrence. Thus, in many cases, slight chemical modifications of highly toxic molecules can be made without major alteration of their toxic properties, e.g. if an extra methyl group is introduced in a part of the naturally occurring batrachotoxin, the toxicity is somewhat enhanced (LD_{50} for subcutanenous administration in mice changes from 0.002 to 0.001 mg/kg body weight). This semi-synthetic compound is best prepared from the relatively innocent frog constituent batrachotoxinin A. It will not qualify as a toxin unless a proviso is made to the effect that compounds closely related to naturally occuring, highly toxic compounds will be regarded as toxins if they have similar toxic properties.

LSD (d-lysergic acid diethylamide), which is considered as a potential chemical warfare agent, constitutes another example. It has not been found in nature, but is very closely related to lysergamide (known from plants of the genera *Argyreia*, *Ipomea*, and *Rivea*). Lysergamide exhibits psychotomimetic activity in doses below the milligramme level, and LSD is about 10 times as potent. If only highly toxic compounds of biological origin are considered as toxins, lysergamide—but not its chemically produced derivative LSD—would be covered by the definition.

Judging by the rapid advances of organic synthesis, it seems very likely that within a decade numerous highly toxic compounds can be prepared, modelled upon naturally occurring complex substances. A comprehensive toxin definition ought to include these probable synthetic or semi-synthetic compounds.

It is evident that it might be difficult to cover in definitions all the varieties that may arise in this respect from different chemical operations and an expression such as "compounds chemically closely related to toxins" may be used, although not totally adequate. It should be possible to overcome the imperfection by specifying the nature of the chemical modifications (e.g. substitution, change of an amino-acid residue, homologation).

Summary

The concept of toxins must be clearly and unambiguously defined in a treaty obligation.

A definition for treaty purposes might be adopted by a selection from the different criteria listed hereabove, i.e. natural and synthetic origin, toxicity and chemical nature.

Toxin	*LD_{50}, mouse, mg/kg bodyweight*	*Biological origin*	*Molecular weight*
Botulinum toxin A	0.001-0.00003	bacteria	900,000
Tetanus toxin	0.002-0.0001	bacteria	68,000
Staphylococcal enterotoxin B	0.1 (LD_{50} monkey)	bacteria	35,000
Ricin	0.6 (dog)	plant	80,000
Batrachotoxin	2	frog	399
Tetrodotoxin	8	fish, newt	319
Saxitoxin	9	dinoflagellate	370
Cobratoxin	50	snake	6,800
Convallatoxin	80 (cat)	plant	550
Curare	500	plant	696
Strychnine	500	plant	334
For comparison, two synthetic compounds are included:			
Sarin	100		140
Mustard gas	8,600		159

16.

Canada: working paper on atmospheric sensing and verification of a ban on the development, production and stockpiling of chemical weapons

[*CCD/334 of 8 July 1971*]
[*Original: English*]

Over the past two years many proposals have been put forward for discussion at the meetings of the Conference of the Committee on Disarmament on possible ways of verifying that an international agreement on the prohibition of the development, production and stockpiling of chemical weapons is being honoured by the signatories. These proposals have ranged from the employment of on-site inspection teams to remote sensing by sophisticated technical gadgetry. The most reliable verification scheme is one where international inspection teams are permitted within a country. A discussion of such schemes is given in the report of the Stockholm International Peace Research Institute (SIPRI).[45] However, the degree of intrusion may not be acceptable, and Canada, along with other countries, has been striving to find a method, which is both reliable and acceptable, and during the past six months has examined remote atmospheric sensing of field testing of chemical warfare agents.

First the various possibilities of monitoring the industrial and military activities of a country from a distance were considered. The SIPRI report suggested that economic monitoring of a country might provide a good indication of contravention of a chemical arms agreement, but the United States reported in a paper last year (see CCD/311)[46] that in the case of the nerve agents, economic monitoring in itself is not feasible—and the situation would be even more difficult with other known chemical agents.

We have looked into the possibilities of monitoring a country by means of satellites and, while we have limited expertise in the field of military satellite reconnaissance, we are unable to visualize an agency working under the auspices of the United Nations utilizing such an approach. The United Kingdom working paper last year concluded that satellites would not be likely to prove very effective.[47] Moreover it would be a very expensive and complex approach to verification, which would be available to only a few wealthy nations and under present political structures, not the United Nations.

We concluded in our survey that the only approach which did not involve intrusion and was within the realms of feasibility was remote chemical sampling of chemical test areas. The SIPRI report expressed some confidence in monitoring chemical testing, while the United Kingdom in their paper to the Conference of the Committee on Disarmament last year expressed doubt as to its value.

In our study on chemical sampling we assumed that in order for a nation to have a significant chemical warfare capability it must field-test the weapons that it has developed. The size of such a test could range from the detonation of a single artillery shell to the spraying of terrain by an aircraft. We have chosen the case of a large-scale aircraft spray trial to illustrate the feasibility of detecting agents downwind of a test site; obviously the larger the experiment the easier would be the possibilities of detecting it. But it is not believed that tests would be carried out with live agents on a scale larger than this since much can be done with simulants: i.e., the use of agents relatively non-toxic but which possess physical properties similar to toxic ones and as a result when detonated or sprayed behave in much the same way.

It was assumed that an aircraft could contaminate a strip of terrain of dimensions 1,000 metres cross-wind by 250 metres down-wind to an agent density of between 5 and 20 gm/m^2. Down-wind concentration (mg/m^3) and total dosage ($mg. min/m^3$) profiles for the following agents: mustard, a representative persistent V-agent, and two volatile G-agents, sarin and soman, were calculated. Mustard was assumed to have been laid down to a contamination density of 20 gm/m^2 while the others were assumed to have been laid down to a density of 5 gm/m^2. These agents are representative of those which an industrial country with a chemical warfare capability might be expected to possess, i.e., a persistent vesicant, two volatile nerve agents and a persistent nerve agent.

Calculations of the down-wind concentrations and the total dosages were made with the aid of a diffusion model which Canada has developed to assess down-wind chemical agent hazard. This model is based on classical atmospheric diffusion models; it takes into account the nature of the terrain, the absorptive and evaporative characteristics of the agent, and the meteorological conditions that the programmer wishes to simulate. Since this model is a steady state model, all agent vapour concentrations were peak concentrations.

Two extremes of meteorological stability were assumed, namely slight lapse and moderate inversion, and the criteria of detectability of agent used was the level of sensitivity of the various agent detection devices currently available to the Canadian Armed Forces.

Our studies have amplified the fact that certain agents, especially some persistent nerve agents, are readily absorbed on soil and vegetation over which the agent cloud passes. For example, we do not believe, given the sensitivity of the existing detection equipment, that a persistent V-agent could be detected at distances of more than approximately 10 kilo-

[45] *The Problem of Chemical and Biological Warfare* (Stockholm, Almqvist & Wiksell, 1971 and 1972).
[46] *Official Records of the Disarmament Commission, Supplement for 1970*, document DC/233, annex C, sect. 40.
[47] *Ibid.*, sect. 37.

metres, down-wind of our simulated source. And in our opinion this distance would tend to be optimistic. On the other hand, there is some chance of detecting a large sarin gas source at distances in hundreds of kilometres. And mustard laid down in the contamination density mentioned might be detectable at distances in the tens of kilometres. Again we wish to emphasize that these are theoretical calculations and, if anything, overestimates. Obviously if the test involved the detonation of a single chemical artillery shell, the problem of detection would be much more acute.

No clear statement can be made concerning the feasibility of remote chemical detection of chemical warfare agent field testing, since we would require knowledge of the characteristics of the agents which we are attempting to detect. But from our studies we find that, while it may be possible to detect some chemical warfare agents at considerable distances down-wind of their source, it is virtually impossible to detect others at very short distances. Therefore, it is believed that remote atmospheric sensoring, by chemical sampling techniques, is not a practical approach to verification unless sampling sensitivities are greatly increased and some form of intrusion is allowed.

It is reasonable to assume that chemical sampling capabilities could be increased, say a thousandfold, and used to identify a nerve agent at an air concentration level of approximately 2.5×10^{-5} mg/m^3. Such a level of sensitivity would greatly increase the down-wind distance at which detection and identification of agents could take place. However, it is improbable that chemical samplers, even if they had such a capability, could be used on their own and outside a country to verify adherence to a chemical test ban: some countries are just too large, and there is also the chance of agents being washed out by moisture and dispersed by natural barriers such as mountains. It is unrealistic to suppose that an agent cloud after travelling for thousands of miles could be detected by presently available sampling equipment. Thus, any country with a large land mass could ensure, if it wished to carry out a test, that its activities could not be monitored by a neighbouring country by careful selection of the location of the site and by undertaking testing when prevailing winds were in the appropriate direction.

There is another problem. What countries are willing to have such instrumentation, controlled by foreign nationals, within the confines of their national boundaries? Perhaps one might be restricted to placing them on the borders of a remote country, because the country in question might in turn be surrounded by an adjoining country which was also opposed to the intrusion. Under such circumstances one would be forced either to sample from the nearest country willing to permit the intrusion, or from international waters, which might easily be thousands of miles away.

In most studies on possible approaches to verification the constraining factor has been the problem of getting close enough to the source of possible clandestine activities to verify adherence to the international agreement. We believe that remote chemical sampling of the atmosphere to monitor the testing of chemical weapons with existing or improved equipment is not feasible. It might be applicable to small countries but in the case of countries that stretch thousands of miles in one direction, dilution of the agent cloud over such distances would greatly decrease the possibilities of detection. Then also, as we have pointed out, some agents because of their absorptive characteristics are virtually undetectable a few kilometres down-wind of their source.

So far this has all been rather negative. We can suggest, however, a way of using chemical samplers in a verification scheme, which, while involving a degree of intrusion, might be acceptable to those nations seriously interested in resolving this problem. The effects of industrial pollution on our environment have caused increasing concern within the last few years, as the industrial development of the world has outstripped industry's efforts to dispose of its waste products. In the world today many government agencies have been set up to control pollution and to attempt to make industry operate within strict anti-pollution guide-lines. It is now normal to see in the daily newspapers of large industrial cities on the North American continent the measured atmospheric concentrations of sulphur and nitrogen oxides above these cities. We would suggest that, since trace quantities of nerve agents from field tests could conceivably be considered as other pollutants in the atmosphere, they could be detected by a national pollution monitoring system with facilities for an international exchange of information.

There would be problems, but the war gases of primary concern, the nerve agents, have their own distinctive signature. They are organophosphorous compounds and as such are not easily confused with common industrial pollutants. It might be feasible to develop a "national" monitoring system if nations would agree to collect concentration levels, for example of organophosphorous compounds, within their country. The collection of the data could be carried out by a national network of meteorological stations, while transmission and summary analysis of the data could be carried out within the framework of international exchanges such as now exist through the World Meteorological Organization.

In conclusion we can summarize by stating that in our opinion remote (extraterritorial) chemical sampling for the verification of an adherence to a chemical disarmament agreement does not appear to be feasible. However, in addition to any economic monitoring, considered in other working papers, employed in connexion with the control of pollution, the use of samplers for verification by national means and surveyed by an international organization merits further examination. It may be within this context that techniques can be established that would assist in the development of a verification mechanism for a ban on the development, production and stockpiling of chemical weapons.

17.

Italy: working paper dealing with problems related to the prohibition of chemical weapons

[*CCD/335 of 8 July 1971*]
[*Original: English*]

During the informal meeting held on 7 July 1971 with the presence of experts, the delegation of Italy dealt with three major technical problems which, in its view, should be tackled with a view to solving the question of the prohibition of chemical weapons, namely: the compiling of a complete list of agents to be banned; the control of production of such agents; and the destruction of stockpiles of chemical agents.

For the Committee's further consideration the views of the Italian delegation are set forth in this working paper.

(1) With regard to the first problem—the compilation of a complete list of agents to be banned—our delegation has studied with keen interest the various proposals that have already been submitted by other delegations. We note, however, that the Committee has so far been unable to undertake a thorough comparative analysis of the proposals and to draw, where possible, useful conclusions for our further work. In this connexion we should like to stress once again the desirability of the Committee itself taking steps to establish a group of experts with the task of studying such proposals. It will be recalled that on 30 June 1970 we submitted a working paper (CCD/289)[48] on this procedural matter.

Among the various suggestions for the compilation of a list, those submitted by the delegation of the Netherlands and of Japan deserve particular attention. The Dutch proposal contained in document CCD/320 of 2 March 1971 (see sect. 3 above) has the advantage of covering in a single general formula all the organophosphorous compounds recognized today as chemical agents or as very similar to them; and it includes therefore, by its very comprehensiveness, all those which are or will be synthetically produced, e.g. Sarin, Soman, Tabun, V-agents, Tammelin Esters, insecticides, etc. Even if this general formula leaves out a number of

[48] *Ibid.*, sect. 18.

substances officially defined as warfare agents (e.g. mustard gas, cyanogen chloride, phosgene, etc.), it does cover all the agents that actually constitute the most dangerous and lethal weapons of chemical warfare. It should not be difficult, however, to reach agreement on a complete list of agents not covered by the formula.

(2) Concerning the second problem—control of substances to be prohibited—here again we note that the Committee has no suitable body to study and co-ordinate the various proposals in order that the Committee itself may undertake a proper assessment of this problem.

Some of the working papers and statements of other delegations on the control question have received careful consideration because of the specific data they contain. In his statement of 18 March last (see CCD/PV.502), the distinguished representative of the United States discussed the percentage distribution of raw material flows in respect of their over-all utilization in the economy of a given country. According to this statement, the percentage to be diverted in order to obtain 10,000 tons of phosphorus agents annually was only about 1 per cent of the raw material produced and therefore too insignificant a variation to arouse suspicion and justify a complaint. This conclusion would appear at first glance to rule out any possibility of pursuing this line of inquiry.

If, however, we look more closely into the implications of the United States representative's argument, the question can be seen in less negative terms. It is true that the percentage variation required for the production of 10,000 tons of phosphorus agents is small in the case where the quantity of raw material is quite considerable. But, by taking into account smaller quantities of raw material, we find that the percentage variation assumes significant values. Let us assume, for example, an economically advanced country processing in one year 3 million tons of phosphate rock; its raw material production is assumed to be about one tenth the amount postulated in the United States example but well above that of the great majority of countries in the world. It must be considered that this hypothetical country in case of war (and perhaps particularly in such a case) could not avoid devoting very important quantities of raw material to vital economic sectors (fertilizers, fuels, lubricants, etc.). It is therefore reasonable to estimate that the amount of phosphorus still available, from which the quantities necessary for the production of chemical agents could be drawn, would be about 50,000 tons; which means that in order to produce 10,000 tons of warfare agents the country would have to divert 2,000 tons (4 per cent of the 50,000 tons), which is quite a significant variation.

The objection that to take a smaller parameter for phosphate rock mined or available could imply a smaller production of chemical agents does not seem convincing. The quantity of agents produced or to be produced does not depend on the availability of raw material, but essentially on military requirements. The latter necessitate that production of chemical agents cannot be kept below a certain level without its becoming of no military significance.

From these considerations it seems clear that, if only one parameter is used for our analysis, controls are not feasible for the generality of countries, but it is equally clear that the number of countries for which controls do not seem feasible would be small. On the one hand, there are a very few countries whose production of phosphate rock is so large that the percentage variation in respect of raw material that might be diverted to weapons production would seem insignificant. On the other, if we examine the geographical distribution of sources of phosphate rock, we find that in the great majority of countries the quantity which can be mined is quite small and seldom such as to allow them to be self-sufficient in respect of its uses for solely peaceful purposes. Thus the method of using only one parameter, because it is not universally applicable, could be only envisaged as a first approach.

In our working paper CCD/304 of 6 August 1970[49], concerning indirect controls, we formulated a number of questions for a group of experts to work on. One of the questions was related to the use of percentage variation as a first step towards the identification of signs to be deemed suspicious in the monitoring of economic data on phosphorus production and flows. We further asked whether, in the event of variation in a single parameter not being significant in itself, it might become significant when associated with a variation in one or more other parameters to be found.

In order to clarify better what we had in mind when we posed these questions, the example mentioned above may be further considered with particular reference to the production of phosphorus trichloride and phosphorus oxychloride as intermediates in the production of agents. The annual production of these intermediates, estimated on the basis of the data already used in this example, would come to 5,000 tons, which would be completely absorbed in the production of 10,000 tons of agents and yet would be insufficient. The shifting of a parameter concerning the production of phosphorus trichloride and phosphorus oxychloride would therefore be of very great importance. A further question to be elucidated is whether it will also be sufficiently indicative when applied to those few countries producing large quantities of phosphate rock.

To sum up, it seems to us that on the basis of reliable data for a single parameter a significant number of countries can, even now, be effectively monitored. Additional parameters based on monitoring of percentage variations in respect of phosphorus and organophosphorus substances would enable the range of controls to be extended. For this purpose other parameters could be found and taken into account, and their correlation would progressively enable us to establish a model for use in an appropriate computer and thereby create an effective system of controls applicable to the whole world. We feel justified therefore in urging that researchers make a determined effort to identify one or more parameters which, linked to the first, could close all loopholes.

We are well aware that the problem bristles with difficulties. Its solution will necessitate the collection and processing by powerful computers of large quantities of statistical data for the construction of complex models, which must be tested out and improved until a definitive model is worked out and proved valid for all cases.

We share in this respect the views expressed by the Japanese delegation in its working paper CCD/301 of 6 August 1970[50] concerning the collection of statistical data. We appreciate the ingenious method proposed in the Japanese paper for the selection of substances for statistical monitoring. It would be very useful to compare this method with other methods and procedures which experts from other countries might wish to propose. It should be noted that a proposal similar to the Japanese one is to be found in the Swedish working paper CCD/322 of 16 March 1971 (see sect. 5 above). Moreover, it seems to us that the inspection questionnaire circulated informally by the United States delegation at the 518th meeting on 6 July 1971 contains some useful suggestions.

Working paper CCD/332 (see sect. 14 above), introduced at the same meeting by the United States delegation, highlights factors which can be utilized by means of on-site inspection to determine whether a plant is producing prohibited chemical substances, taking into account the characteristics of the plant and the chemical nature of the waste materials released by the plant. The most refined and up-to-date methods have been indicated for the analysis of these waste products. The United States paper, which assumes that there will be on-site inspection, is a valuable contribution to a solution of the control problem. It is reasonable to suppose, however, that this type of inspection cannot be of a permanent and general character. It seems desirable therefore to seek a method whereby a suspicion can be formulated as a basis for a complaint. This in turn could be followed by on-site inspection, using, among others, the factors and methods suggested by the United States delegation.

[49] *Ibid.*, sect. 33.

[50] *Ibid.*, sect. 30.

In making these remarks of a methodological character we cannot of course foresee whether the search for a solution, such as the one we have outlined, will produce positive or negative results. We are convinced, however, that the problem must be tackled so that we may know with certainty what is the answer concerning the feasibility of controls. If the results are positive the Committee will have a suitable gauge for the detection of a dangerous situation. If they are negative we shall at least be able to draw the logical inference for the final elaboration of a political instrument.

(3) Lastly, in our opinion, very careful consideration should be paid to the question of the destruction of stockpiles of chemical weapons and agents. The Committee has already received a valuable contribution from the Swedish delegation (working paper CCD/324 of March 30, 1971) (see sect. 7 above), drawing attention to this grave problem at an early stage. Since the destruction of large stocks by dumping them into the ocean depths is unthinkable, and combustion is not readily practicable, a more logical course would appear to be that of chemical transformation, which implies a timely study of chemical processes and methods to be applied.

A closely related problem is that of controlling the destruction of chemical weapons. Once again we reiterate the necessity of having available the contribution of a group of experts who should be given a precise mandate and asked to report back to the Committee itself. The problem is much too grave and the risks involved are too great.

In joining the other delegations that requested the convening of the meeting, the Italian delegation shared the hope that a careful study on the technical level would lead to further progress in our consideration of the problems outlined above.

The meeting may open up prospects for fruitful future contacts between experts along the lines we have indicated. The interesting new data and information that the Committee has received will require further detailed analysis whose conclusions should be compared and discussed together in another exercise of this kind in order to trace the guidelines for constructive work before the next United Nations General Assembly.

18.

Canada: working paper on possible progress towards the suspension of nuclear and thermonuclear tests

[*CCD/336 of 22 July 1971*]
[*Original: English*]

Since the Moscow partial test-ban Treaty was negotiated in 1963,[51] Canada has joined other members of the Committee in urging that the obligation to achieve the discontinuance of testing, which was accepted by the parties to that Treaty, should be fulfilled as soon as possible. Taking into consideration the fact that differing views regarding the nature of an adequate verification system for any ban on underground testing apparently represents the major obstacle to early progress, Canada and a number of other delegations have attempted to focus attention on the evident utility of international seismological data exchange as a method for discriminating between underground nuclear explosions and natural earthquakes. This has involved clarifying what resources would be available for the eventual establishment of an effective world-wide exchange of seismological information designed to facilitate the achievement of a comprehensive test ban. Efforts in this direction are continuing.

General Assembly resolution 2663 (XXV) urges Governments to consider and, wherever possible, to implement methods of improving their capability to contribute high-quality seismic data with assured international availability. The same resolution invites the Conference of the Committee on Disarmament "to co-operate in further study of this issue".

[51] Treaty Banning Weapon Tests in the Atmosphere, in Outer Space and under Water (United Nations, *Treaty Series*, vol. 480 (1963), No. 6964).

The extended delay in concluding an underground nuclear test ban and the increase in the rate and size of underground explosions, which have lent additional urgency to the repeated calls by the United Nations General Assembly for the suspension of all testing, also raise the question of how interim restraints might be imposed in the immediate future. Pending the achievement of a total ban, the Canadian delegation recommends that certain transitional or confidence-building measures should be considered which would, without raising verification problems, reduce underground testing and represent progress towards the objective of a comprehensive ban. Such measures, which could be of two general types, might include the following:

(1) Measures to help develop seismological identification techniques and facilities which could contribute to the effective verification of a comprehensive test ban through:

(*a*) Advance notification of details of planned underground nuclear explosions in order to assist in further research on seismological identification methods; and

(*b*) Undertakings to co-operate in the use, development and improvement of facilities for the monitoring of underground tests by seismological means;

(2) Measures to reduce testing and guard against its harmful effects through:

(*a*) An undertaking to reduce testing, beginning with high-yield testing, as an earnest on the part of the nuclear testing powers of their intent to work towards a complete test ban; and

(*b*) Consideration of further measures to guard against environmental risks connected with underground testing.

19.

Bulgaria, Czechoslovakia, Hungary, Mongolia, Poland, Romania and Union of Soviet Socialist Republics: revised draft convention on the prohibition of the development, production and stockpiling of bacteriological (biological) and toxin weapons and on their destruction*

[*CCD/337 of 12 August 1971***]
[*Original: Russian*]

The States Parties to this Convention,

Determined to act with a view to achieving effective progress towards general and complete disarmament, including the prohibition and elimination of all types of weapons of mass destruction, and convinced that the prohibition of the development, production and stockpiling of bacteriological (biological) weapons and toxins intended for use as weapons, and their elimination, will facilitate the achievement of general and complete disarmament under strict and effective international control,

Desiring thereby, for the sake of all mankind, to exclude completely the possibility of bacteriological (biological) agents and toxins being used as weapons,

Convinced of the immense importance and urgent necessity of eliminating from the arsenals of States such dangerous weapons of mass destruction as weapons using bacteriological (biological) agents and toxins,

Desiring to contribute to the strengthening of confidence between peoples and the general improvement of the international atmosphere,

Believing that scientific discoveries in the field of bacteriology (biology) must in the interest of all mankind be used solely for peaceful purposes,

Recognizing nevertheless that in the absence of appropriate prohibitions the development of scientific knowledge throughout the world would increase the risk of the use of bacteriological (biological) methods of warfare,

* The draft convention was also submitted on behalf of the Byelorussian Soviet Socialist Republic and the Ukrainian Soviet Socialist Republic.
** Replaces the text of 5 August 1971.

Convinced that such use would be repugnant to the conscience of mankind and that no effort should be spared to minimize this risk,

Recognizing the important significance of the Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare, signed at Geneva on 17 June 1925,[52] and conscious also of the contribution which the said Protocol has already made, and continues to make, to mitigating the horrors of war,

Reaffirming their adherence to the purposes and principles of that Protocol and calling upon all States to comply strictly with them,

Recalling resolutions of the United Nations General Assembly, which has condemned all actions contrary to the principles and purposes of the Geneva Protocol,

Convinced that an agreement on the prohibition of bacteriological (biological) and toxin weapons will facilitate progress towards the achievement of agreement on effective measures to prohibit the development, production and stockpiling of chemical weapons, on which negotiations will be continued,

Anxious to contribute to the realization of the purposes and principles of the Charter of the United Nations,

Have agreed as follows:

Article I

Each State Party to this Convention undertakes not to develop, produce, stockpile or otherwise acquire or retain:

1. Microbial or other biological agents, or toxins of types and in quantities that have no justification for prophylactic or other peaceful purposes;

2. Weapons, equipment or means of delivery designed to use such agents or toxins for hostile purposes or in armed conflict.

Article II

Each State Party to this Convention undertakes to destroy, or to divert to peaceful purposes, as soon as possible but not later than . . . months after the entry into force of the Convention, all agents, toxins, weapons, equipment and means of delivery specified in article I of the Convention, which are in its possession or under its jurisdiction or control. In implementing the provisions of this article all necessary safety precautions shall be observed to protect the population and the environment.

Article III

Each State Party to this Convention undertakes not to transfer to any recipient whatsoever, directly or indirectly, and not in any way to assist, encourage, or induce any State, group of States or international organizations to manufacture or otherwise acquire any agent, toxin, weapon, equipment or means of delivery specified in article I of the Convention.

Article IV

Each State Party to this Convention shall, in accordance with its constitutional processes, take any necessary measures to prohibit and prevent the development, production, stockpiling, acquisition or retention of the agents, toxins, weapons, equipment and means of delivery specified in article I of the Convention, within the territory of such State, under its jurisdiction or under its control anywhere.

Article V

The States Parties to this Convention undertake to consult one another and to co-operate in solving any problems which may arise in the application of the provisions of the Convention.

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[52] League of Nations, *Treaty Series*, vol. XCIV (1929), No. 2138.

Article VI

(1) Any State Party to this Convention which finds that actions of any other State Party constitute a breach of the obligations assumed under the provisions of the Convention may lodge a complaint with the Security Council of the United Nations. Such a complaint should include all possible evidence confirming its validity, as well as a request for its consideration by the Security Council. The Security Council shall inform the States Parties to the Convention of the result of the investigation.

(2) Each State Party to this Convention undertakes to co-operate in carrying out any investigations which the Security Council may undertake, in accordance with the provisions of the United Nations Charter, on the basis of the complaint received by the Council.

Article VII

Nothing in this Convention shall be interpreted as in any way limiting or detracting from the obligations assumed by any State under the Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare, signed at Geneva on 17 June 1925.

Article VIII

Each State Party to this Convention undertakes to conduct negotiations in good faith on effective measures for prohibiting the development, production and stockpiling of chemical weapons and for their destruction, and on appropriate measures concerning the equipment and means of delivery specifically designed for the production or use of chemical weapons for warfare.

Article IX

(1) The States Parties to this Convention undertake to facilitate, and have the right to participate in, the fullest possible exchange of equipment, materials and scientific and technological information for the use of bacteriological (biological) agents and toxins for peaceful purposes.

(2) This Convention shall be implemented in a manner designed to avoid hampering the economic or technological development of States Parties to the Convention or international co-operation in the field of peaceful bacteriological (biological) activities, including the international exchange of bacteriological (biological) agents and toxins and equipment for the processing, use or production of bacteriological (biological) agents and toxins for peaceful purposes in accordance with the provisions of the Convention.

Article X

Any State Party may propose amendments to this Convention. Amendments shall enter into force for each State Party accepting the amendments upon their acceptance by a majority of the States Parties to the Convention and thereafter for each remaining State Party on the date of acceptance by it.

Article XI

Five years after the entry into force of this Convention, or earlier if it is requested by a majority of Parties to the Convention by submitting a proposal to this effect to the Depositary Governments, a conference of States Parties to the Convention shall be held at Geneva, Switzerland, to review the operation of the Convention, with a view to assuring that the purposes of the preamble and the provisions of the Convention, including the provisions concerning negotiations on chemical weapons, are being realized. Such review shall take into account any new scientific and technological developments relevant to the Convention.

Article XII

(1) This Convention shall be of unlimited duration.

(2) Each State Party to this Convention shall in exercising its national sovereignty have the right to withdraw from the Convention if it decides that extraordinary events, related

to the subject matter of the Convention, have jeopardized the supreme interests of its country. It shall give notice of such withdrawal to all other States Parties to the Convention and to the United Nations Security Council three months in advance. Such notice shall include a statement of the extraordinary events its regards as having jeopardized its supreme interests.

Article XIII

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

(2) This Convention shall be subject to ratification by signatory States. Instruments of ratification and instruments of accession shall de deposited with the Governments of . . . which are hereby designated the Depositary Governments.

(3) This Convention shall enter into force after the deposit of instruments of ratification by . . . Governments, including the Governments designated as Depositaries of the Convention.

(4) For States whose instruments of ratification or accession are deposited subsequent to the entry into force of this Convention, it shall enter into force on the date of the deposit of their instruments of ratification or accession.

(5) The Depositary Governments shall promptly inform all signatory and acceding States of the date of each signature, the date of deposit of each instrument of ratification or of accession and the date of the entry into force of this Convention, and of other notices.

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

Article XIV

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

IN WITNESS WHEREOF the undersigned, duly authorized, have signed this Convention.

DONE IN . . . at . . . , this . . . day of . . . , . . .

20.

United States of America: draft convention on the prohibition of the development, production and stockpiling of bacteriological (biological) and toxin weapons and on their destruction

[*CCD/338 of 12 August 1971**]
[*Original: English*]

[*Text identical with that of section 19 above.*]

21.

Hungary, Mongolia and Poland: draft Security Council resolution relating to the draft convention on the prohibition of the development, production and stockpiling of bacteriological (biological) and toxin weapons and on their destruction

[*CCD/339 of 10 August 1971*]
[*Original: Russian*]

The Security Council,

Highly appreciating the desire of a large number of States to subscribe to the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction,

Bearing in mind that under article . . . . of the Convention the States Parties shall have the right to lodge complaints with the Security Council, with the request that they be considered by the Council,

Recognizing the need for the adoption of appropriate measures with a view to ensuring the observance of the obligations contained in the Convention,

Taking into consideration the desire of the States Parties to co-operate with the Security Council for the purpose of ensuring the strict observance of the obligations contained in the Convention,

1. *Declares its readiness:*

(*a*) To consider immediately any complaints lodged under article . . . . of the Convention;

(*b*) To take all necessary measures for the investigation of a complaint; and

(*c*) To inform the States Parties to the Convention of the result of the investigation;

2. *Calls upon* all States Parties to the Convention to co-operate for the purpose of implementing the provisions of this resolution.

22.

Pakistan: working paper suggesting some provisions of a treaty banning underground nuclear weapon tests

[*CCD/340 of 12 August 1971*]
[*Original: English*]

1. The relationship between an underground test ban and peaceful nuclear explosions has been recognized and often emphasized. In this context two considerations have to be borne in mind: first, an underground test ban should not deprive the signatories of the benefits that may be derived from peaceful nuclear explosions. Secondly, and more important, an exception for peaceful nuclear explosions must not serve as a loophole either permitting the proliferation of nuclear weapons or as a means of conducting explosions for military purposes. This need arises from the fact that there is no difference between nuclear weapons and the so-called peaceful nuclear explosive devices. Hence a clause permitting peaceful nuclear explosions should be so worded that it cannot be misconstrued to mean that it permits the conducting of peaceful nuclear explosions by the non-nuclear-weapon States themselves. Accordingly, it is proposed that an underground test-ban treaty should include, as in the Treaty on the Non-Proliferation of Nuclear Weapons,[53] two kinds of provisions: one for nuclear-weapon States and the other for non-nuclear-weapon States.

2. As regards the nuclear-weapon States, the treaty should prohibit them from conducting any underground nuclear weapon test explosions. They may, however, be permitted to conduct explosions which are carried out for construction or peaceful purposes only and which take place in conformity with an international agreement to be negotiated separately, either as an independent agreement or as a protocol to a comprehensive test ban.

3. As regards non-nuclear-weapon States, the treaty should include a separate provision which would prohibit all underground explosions whether they are in the category of "weapon tests" or not. In other words, non-nuclear-weapon States must not conduct any kind of nuclear explosions whatsoever—not even peaceful nuclear explosions. Non-nuclear-weapon States may benefit from peaceful explosions conducted for them or on their behalf in accordance with the provisions of the international agreement referred to in paragraph 2 above.

4. Lastly, since it has been suggested that separate provisions should be included for nuclear-weapon and non-nuclear-weapon States, the category of such States has to be defined. It is, therefore, proposed that the following provision, contained in the second sentence of paragraph 3 of article IX, of the nuclear non-proliferation Treaty, should be included in the proposed treaty: "For the purpose of this Treaty, a nuclear-weapon State is one which has manufactured and exploded a nuclear weapon or other nuclear explosive device prior to 1 January 1967".

* Replaces the text of 5 August 1971.

[53] General Assembly resolution 2373 (XXII), annex.

23.

Brazil, Burma, Ethiopia, India, Mexico, Morocco, Nigeria, Pakistan, Sweden, United Arab Republic and Yugoslavia: working paper containing suggestions on desirable changes in the draft convention on the prohibition of the development, production and stockpiling of bacteriological (biological) and toxin weapons and on their destruction (CCD/337 and 338)

[*CCD/341 of 17 August 1971*]
[*Original: English*]

Pursuant to General Assembly resolution 2603 A (XXIV) regarding the use of chemical and bacteriological (biological) weapons and to the joint memorandum of the group of 12 members of the Conference of the Committee on Disarmament on the basic approach to the question of the prohibition of the development, production and stockpiling of chemical and bacteriological (biological) weapons, (CCD/310)[54] which was commended by the General Assembly of the United Nations in its resolution 2662 (XXV), and in view of the present stage of negotiations in the Conference of the Committee on Disarmament, whereby the prohibition of bacteriological (biological) and toxin weapons alone, and their destruction, now seem to be possible, the above 11 countries submit the following suggestions for consideration and acceptance by the Conference of the Committee on Disarmament. However, they take no stand at the present stage of negotiations on the need and desirability for any further suggestions that might be submitted by its members, individually or jointly.

A. *Preamble*

1. In the first paragraph:

(i) Add the words "chemical and" before the word "bacteriological";

(ii) Delete the words "and toxins intended for use as weapons".

2. In the second paragraph:

(i) Add the words "chemical and" before the word "bacteriological";

(ii) Delete the words "and toxins".

3. In the third paragraph:

(i) Add the words "chemical and" before the word "bacteriological";

(ii) Delete the words "immense", "urgent" and "and toxins".

4. In the fifth paragraph: add the words "chemistry and" before the word "bacteriology".

5. Redraft the sixth paragraph so that it reads as follows:

"*Recognizing* that the application of scientific knowledge in the field of chemistry and bacteriology (biology) for weapons purposes would increase the risk of the use of chemical and bacteriological (biological) weapons".

6. Move the eighth, ninth and tenth paragraphs to the beginning of the preamble, so that they become the first, second and third paragraphs respectively.

7. Redraft the eleventh paragraph so that it reads as follows:

"*Recognizing* that an agreement on the elimination of bacteriological (biological) and toxin weapons represents a first possible step towards the achievement of agreement on effective measures for complete prohibition of the development, production and stockpiling of chemical and bacteriological (biological) weapons, and determined to continue negotiations to that end".

8. Insert a new twelfth paragraph, which would read as follows:

"*Affirming* the principle that a substantial portion of the savings derived from measures in the field of disarmament should be devoted to promoting economic and social development, particularly in the developing countries".

[54] *Official Records of the Disarmament Commission, Supplement for 1970*, annex C, sect. 39.

B. *Operative part*

9. At the end of article V add the following paragraph:

"Consultation and co-operation pursuant to this article may also be undertaken through appropriate international procedures within the framework of the United Nations and in accordance with its Charter".

10. Redraft article VIII so that it reads as follows:

"Each State Party to this Convention accepts the principle of complete prohibition of chemical weapons and undertakes to continue negotiations in good faith with a view to reaching early agreement on prohibition of their development, production and stockpiling and on their destruction, and on appropriate measures concerning equipment and means of delivery specifically designed for the production or use of chemical agents for weapons purposes".

11. At the end of paragraph (1) of article IX add the following sentence:

"Parties to the Convention shall also co-operate in contributing individually or together with other States or international organizations to the further development and application of scientific discoveries in the field of bacteriology (biology) for the prevention of disease, or for other peaceful purposes".

24.

Mexico: working paper dealing with certain basic facts regarding the Treaty for the Prohibition of Nuclear Weapons in Latin America (Treaty of Tlatelolco) and its Additional Protocol II

[*CCD/342 of 19 August 1971*]
[*Original: Spanish*]

1. On 6 July 1971, document A/8336/Rev.1,[55] containing the text of the reply from the Supreme Soviet of the USSR to the Senate of the United Mexican States, dated 4 January 1971, "regarding the signature and ratification of Additional Protocol II of the Treaty for the Prohibition of Nuclear Weapons in Latin America", was circulated at United Nations Headquarters at the request of the Permanent Representative of the Union of Soviet Socialist Republics to the United Nations.

2. The document in question was circulated under the agenda item of the twenty-sixth session of the General Assembly entitled "Status of the implementation of General Assembly resolution 2666 (XXV) concerning the signature and ratification of Additional Protocol II of the Treaty for the Prohibition of Nuclear Weapons in Latin America (Treaty of Tlatelolco)". It would appear from an analysis of its contents that the Soviet Government is still reluctant to comply with the repeated appeals of the General Assembly to the nuclear Powers to sign and ratify without further delay Additional Protocol II of the Treaty for the Prohibition of Nuclear Weapons in Latin America (Treaty of Tlatelolco).[56]

3. Since this is a question which the Conference of the Committee on Disarmament may well have to deal with in the not too distant future, the item on nuclear-weapon-free zones still being on its agenda, it is fitting to draw the Committee's attention to some basic facts which must be taken into consideration if the question is to appear in its proper perspective. The purpose of this working paper is to sum up the most important of these facts.

1. *Position of the Mexican Senate*

4. The reasons which led the Mexican Senate to address an appeal to the legislative bodies of all States for whose signature and ratification the Treaty of Tlatelolco or one of the Additional Protocols thereof are open[57] are set out in the last paragraph of the appeal in the following words:

[55] *Official Records of the General Assembly, Twenty-sixth Session, Annexes*, agenda items 27, 28, 29, 30, 31, 32 and 98.
[56] United Nations, *Treaty Series*, vol. 634 (1968), No. 9068.
[57] For the status of the Treaty and its two Protocols on 1 August 1971, see annex I.

"From the foregoing it may be seen that the lofty purposes inspiring the Treaty of Tlatelolco have the fervent and total support of the countries of the world and that its provisions have become the expression not of mere aspirations but of a will which is asserting itself at an accelerating pace and with which, we are convinced, no country on earth can fail to associate itself. The ratification and implementation of this instrument by all the countries of Latin America, and of its additional protocols by all nuclear-weapon States or States having territories for which, *de jure* or *de facto,* they are internationally responsible—whether or not they are Members of the United Nations—constitute at this time in the world's history, we firmly believe, a moral imperative which mankind insists must be fulfilled in the interests of a creative peace which will be conducive to further achievements on the path of progress and happiness for all peoples".

2. *Extent of obligations assumed under the Treaty of Tlatelolco*

5. The extent of the obligations assumed under the Treaty of Tlatelolco with a view to implementing the régime of total absence of nuclear weapons established in the Treaty is exactly the same for Mexico as for all other States Parties to the instrument.

6. Article 1 of the Treaty, in which these obligations are specified, reads as follows:

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

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

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

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

3. *Extent of obligations assumed under Additional Protocol II*

7. Nuclear-weapon States which, by signing and ratifying Additional Protocol II of the Treaty of Tlatelolco, become parties to it, assume the following obligations:

(*a*) To respect, "in all its express aims and provisions" the "statute of denuclearization of Latin America in respect of warlike purposes, as defined, delimited and set forth in" the Treaty of Tlatelolco;

(*b*) ". . . not to contribute in any way to the performance of acts involving a violation of the obligations of article 1 of the Treaty in the territories to which the Treaty applies"; and

(*c*) ". . . not to use or threaten to use nuclear weapons against the Contracting Parties of the Treaty".

8. After expressly mentioning these obligations, the General Assembly, in its resolution 2666 (XXV), adopted on 7 December 1970 by 104 votes to none, affirmed its conviction that they "are entirely in conformity with the general obligations assumed under the Charter of the United Nations, which every Member of the Organization has solemnly undertaken to fulfil in good faith, as set forth in Article 2 of the Charter".

4. *Some responsible opinions on the Treaty of Tlatelolco*

9. (*a*) In its resolution 2286 (XXII) of 5 December 1967, the United Nations General Assembly stated that it:

"*Welcomes with special satisfaction* the Treaty for the Prohibition of Nuclear Weapons in Latin America, which constitutes an event of historic significance in the efforts to prevent the proliferation of nuclear weapons and to promote international peace and security and which at the same time establishes the right of Latin American countries to use nuclear energy for demonstrated peaceful purposes in order to accelerate the economic and social development of their peoples".

(*b*) In its resolution B of 27 September 1968, the Conference of Non-Nuclear-Weapon States observed that: "the Treaty for the Prohibition of Nuclear Weapons in Latin America, also known as the Treaty of Tlatelolco, has already established a nuclear-weapon-free zone comprising territories densely populated by man".[58]

(*c*) In his address delivered at the opening meeting of the first session of the General Conference of the Agency for the Prohibition of Nuclear Weapons in Latin America (OPANAL), on 2 September 1969, the Secretary-General of the United Nations said, *inter alia,* the following:

". . .

"In a world that all too often seems dark and foreboding, the Treaty of Tlatelolco will shine as a beacon light. It is a practical demonstration to all mankind of what can be achieved if sufficient dedication and the requisite political will exist.

"The Treaty of Tlatelolco is unique in several respects. . . . The Treaty of Tlatelolco is unique in that it applies to an important inhabited area of the earth. It is also unique in that the Agency which is being established at this session will have the advantage of a permanent and effective system of control with a number of novel features. In addition to applying the safeguards system of the International Atomic Energy Agency, the régime under the Treaty also makes provision for special reports and inquiries and, in cases of suspicion, for special inspections. There is embodied in the Treaty a number of aspects of the system known as 'verification by challenge', which is one of the more hopeful new concepts introduced into the complicated question of verification and control.

"The Treaty of Tlatelolco preceded the Treaty for the Non-Proliferation of Nuclear Weapons by more than a year and exceeds it in the scope of its prohibitions and its control features. Both Treaties have a similar goal, but the former Treaty goes beyond the latter in also prohibiting the use or threat of use of nuclear weapons in the area of the nuclear-free zone . . . .

". . .

"Under the safeguards and guarantees provided by the Treaty of Tlatelolco and by the operations of the Agency, nuclear energy will be used for exclusively peaceful purposes in the countries within the zone and its benefits will be devoted solely towards the economic development and social progress of your people. Thus, the States members of OPANAL will take the lead in demonstrating to the world that nuclear energy will be, as it should be, a great boon to mankind and not the instrument of its doom.

"The States of Latin America, which also include the States of the Caribbean Sea, have laboured hard and built well in erecting the edifice of the Agency for the Prohibition of Nuclear Weapons in Latin America. Perhaps history will record that they, too, 'builded better than they knew'. And now OPANAL has come to life. I am confident that it has the good wishes of the Members of the United Nations. As the Agency proceeds with its work for security, for peace and for progress, I feel sure it will continue to have the encouragement and support of the United Nations. Under the Agency's charter—the Treaty of Tlatelolco—you have provided for close links with the United Nations. It is my hope that in the years to come these links will be forged ever stronger for the mutual benefit of both organizations in their common cause".[59]

[58] See *Official Records of the General Assembly, Twenty-third Session,* agenda item 96, document A/7277 and corr. 1 and 2, para. 17.

[59] See *Official Records of the Disarmament Commission, Supplement for 1969,* document DC/232, annex C, sect. 33.

(*d*) On the same occasion, the Director-General of the International Atomic Energy Agency said, *inter alia*, the following:

"I am honoured to be invited to be present on this important occasion, when for the first time an international body has been created specifically to ensure compliance with a treaty under which parties to the treaty solemnly pledge to use nuclear energy exclusively for peaceful purposes, and to keep an entire subcontinent free from nuclear weapons. It is also the first meeting of a regional grouping that has accepted the application of safeguards by another organization on their nuclear activities.

"Although the concept of establishing a nuclear-weapon-free zone is not new, the creation of the Agency for the Prohibition of Nuclear Weapons in Latin America is the first tangible realization of such an ideal. With it the aspirations of the people of Latin America for security and the prospect of wider and more productive applications of atomic energy for peaceful purposes has come nearer to fulfilment.

"...

"... The Tlatelolco Treaty might thus be regarded as the first multilateral treaty in the field of nuclear disarmament which provides for the application of an institutionalized and international control system and as such represents a decisive step forward in the recognition and acceptance of international safeguards ...".[50]

5. *Attitude of the United Nations and the Conference of Non-Nuclear-Weapon States to the signature and ratification of Additional Protocol II*

10. The General Assembly of the United Nations has adopted three consecutive resolutions, and the Conference of Non-Nuclear-Weapon States one, urging the nuclear Powers to sign and ratify Additional Protocol II of the Treaty of Tlatelolco.

11. The relevant provisions of these resolutions, which were adopted without a single opposing vote, are:

(*a*) Operative paragraph 4 of General Assembly resolution 2286 (XXII) of 5 December 1967, in which the Assembly:

"*Invites* Powers possessing nuclear weapons to sign and ratify Additional Protocol II of the Treaty as soon as possible";

(*b*) Section II of resolution B of the Conference of Non-Nuclear-Weapon States, dated 27 September 1968, in which the Conference:

"1. *Regrets* the fact that not all the nuclear-weapon States have yet signed Additional Protocol II of the Treaty of Tlatelolco;

"2. *Urges* the nuclear-weapon Powers to comply fully with paragraph 4 of resolution 2286 (XXII), adopted by the United Nations General Assembly on 5 December 1967";

(*c*) The operative paragraph of General Assembly resolution 2456 B (XXIII) of 20 December 1968, in which the Assembly:

"*Reiterates* the recommendation contained in resolution B of the Conference of Non-Nuclear-Weapon States, concerning the establishment of nuclear-weapon-free zones, and especially the urgent appeal for full compliance by the nuclear-weapon Powers with paragraph 4 of General Assembly resolution 2286 (XXII) of 5 December 1967, in which the Assembly invited Powers possessing nuclear weapons to sign and ratify as soon as possible Additional Protocol II of the Treaty for the prohibition of Nuclear Weapons in Latin America";

(*d*) Operative paragraphs 1, 2 and 3 of General Assembly resolution 2666 (XXV) of 7 December 1970, in which the Assembly:

"1. *Reaffirms* the appeals it has addressed to the nuclear-weapon States, in its resolutions 2286 (XXII) and 2456 B (XXIII), to sign and ratify Additional Protocol II of the Treaty for the Prohibition of Nuclear Weapons in Latin America (Treaty of Tlatelolco) as soon as possible and urges them to avoid further delay in the fulfilment of such appeals;

"2. *Notes with satisfaction* that one of those States has already signed and ratified the Protocol and that another has signed it and is now actively engaged in the ratification process;

"3. *Deplores* that not all nuclear-weapon States have as yet signed the Protocol".

6. *Need for Additional Protocol II*

12. With reference to the question whether the co-operation of the nuclear-weapon Powers in respect of the Treaty of Tlatelolco should take the form of formal acceptance of the commitments specified in Additional Protocol II or merely of unilateral declarations, the General Assembly's appeals mentioned in the previous section of this memorandum show clearly that the Assembly is categorically in favour of the first alternative.

13. To this should be added the fact that, as the General Assembly noted in its resolution 2666 (XXV) of 7 December 1970, the Conference of Non-Nuclear-Weapon States, in 1968, after expressing the conviction in its resolution B that "for the maximum effectiveness of any treaty establishing a nuclear-weapon-free zone, the co-operation of the nuclear-weapon States is necessary", emphasized that "such co-operation should take the form of commitments likewise undertaken in a formal international instrument which is legally binding, such as a treaty, convention or protocol".

14. It is also pertinent in connexion with this point to quote the very recent statement of 6 May 1971, made at the Conference of the Committee on Disarmament by the representative of the Soviet Union who, referring to the draft treaties which the Committee is considering in connexion with the item on the prohibition of chemical and biological weapons, said at the Committe's 514th meeting:

"... On numerous occasions the Soviet delegation has stated that unilateral declarations cannot achieve the same purpose as international agreements. In this respect we fully support the statement made by the representatives of Sweden, Mrs. Myrdal, to the effect that 'unilateral decisions can be no substitute for internationally-binding agreements.... And it is, of course, preferable to arrive at a state of affairs in which we shall have an international treaty so that all renunciations will have the same and, we hold, maximum coverage'."

7. *Importance of the signature and ratification of Additional Protocol II*

15. The importance which the United Nations attaches to compliance with the repeated appeals by the General Assembly that the nuclear Powers should sign and ratify Additional Protocol II "as soon as possible" is demonstrated both by the fact that in its latest resolution—resolution 2666 (XXV)—the Assembly, in words used in exceptional cases only, urged them "to avoid further delay in the fulfilment of such appeals" and, in particular, by the fact that the resolution itself contains two decisions, those in operative paragraphs 4 and 5, the texts of which read as follows:

"4. *Decides* to include in the provisional agenda of its twenty-sixth session an item entitled 'Status of the implementation of General Assembly resolution 2666 (XXV) concerning the signature and ratification of Additional Protocol II of the Treaty for the Prohibition of Nuclear Weapons in Latin America (Treaty of Tlatelolco)';

"5. *Requests* the Secretary-General to arrange for transmittal of the present resolution to the nuclear-weapon States and to inform the General Assembly at its twenty-sixth session of any measure adopted by them in order to implement it."

Annex I

STATUS OF THE TREATY FOR THE PROHIBITION OF NUCLEAR WEAPONS IN LATIN AMERICA (TREATY OF TLATELOLCO) AND ITS TWO ADDITIONAL PROTOCOLS, AS AT 1 AUGUST 1971

A. TREATY

1. *Signatures*

Bolivia	14 February 1967
Chile	14 February 1967
Colombia	14 February 1967
Costa Rica	14 February 1967
Ecuador	14 February 1967
El Salvador	14 February 1967
Guatemala	14 February 1967
Haiti	14 February 1967
Honduras	14 February 1967
Mexico	14 February 1967
Panama	14 February 1967
Peru	14 February 1967
Uruguay	14 February 1967
Venezuela	14 February 1967
Nicaragua	15 February 1967
Paraguay	26 April 1967
Brazil	9 May 1967
Trinidad and Tobago	27 June 1967
Dominican Republic	28 July 1967
Argentina	27 September 1967
Jamaica	26 October 1967
Barbados	18 October 1968

2. *Ratifications*

Mexico	20 September 1967
Brazil	29 January 1968
El Salvador	22 April 1968
Dominican Republica	14 June 1968
Uruguay	20 August 1968
Honduras	23 September 1968
Nicaragua	24 October 1968
Ecuador	11 February 1969
Bolivia	18 February 1969
Peru	4 March 1969
Paraguay	19 March 1969
Barbados	25 April 1969
Haiti	23 May 1969
Jamaica	26 June 1969
Costa Rica	25 August 1969
Guatemala	6 February 1970
Venezuela	23 March 1970
Trinidad and Tobago	3 December 1970
Panama	11 June 1971

NOTE: With the exception of Brazil and Trinidad and Tobago, all the above States deposited, together with their respective instruments of ratification, declarations by which, in exercise of the right accorded by article 28, paragraph 2, of the Treaty, they waived all the requirements laid down in paragraph 1 of that article, so that the Treaty is already in force for them.

B. ADDITIONAL PROTOCOL I

States to which the Protocol is open	*Signatures*	*Ratifications*
United Kingdom of Great Britain and Northern Ireland	20 December 1967	11 December 1969
Netherlands	15 March 1968	26 July 1971
United States of America		
France		

C. ADDITIONAL PROTOCOL II

States to which the Protocol is open	*Signatures*	*Ratifications*
United Kingdom of Great Britain and Northern Ireland	20 December 1967	11 December 1969
United States of America	1 April 1968	12 May 1971
France		
People's Republic of China		
Union of Soviet Socialist Republics		

Annex II

GENERAL ASSEMBLY RESOLUTION 2666 (XXV) ENTITLED "STATUS OF THE IMPLEMENTATION OF GENERAL ASSEMBLY RESOLUTION 2456 B (XXIII) CONCERNING THE SIGNATURE AND RATIFICATION OF ADDITIONAL PROTOCOL II OF THE TREATY FOR THE PROHIBITION OF NUCLEAR WEAPONS IN LATIN AMERICA (TREATY OF TLATELOLCO)"

[*For the text, see* Official Records of the General Assembly, Twenty-fifth Session, Supplement No. 28.]

NOTE. In connexion with the seventh preambular paragraph of the resolution, which indicated that only two States had signed Additional Protocol II and only one had ratified it, the United States of America ratified the Protocol on 12 May 1971, thereby increasing to two the number of nuclear Powers for which the Protocol is in force. In connexion with the eighth preambular paragraph, which noted that the Treaty was in force for 16 Latin American States, Panama ratified the Treaty on 11 June 1971, waiving all requirements, so that the States Parties now number seventeen.

25.

Japan: working paper on a biological approach to the question of verification in connexion with the prohibition of chemical weapons (organophosphorus chemical agents)

[*CCD/343 of 24 August 1971*]
[*Original: English*]

As the report of the Stockholm International Peace Research Institute (SIPRI) entitled *The Problem of Chemical and Biological Warfare*[60] notes in the section dealing with the subject of verification, nerve agent plants are usually kept airtight and operated at negative pressure. Furthermore, critical chemical reaction equipment is handled by remote control devices and so forth and the plants are designed so as to avoid exposing the workers to the chemical agent. The safety facilities are thus presumably fully organized. Doubtless under ideal labour management conditions, continuous and periodical health examination are provided.

Here, we should like to attempt a biological approach to the question of verification on the prohibition of chemical weapons from the viewpoint of workers' health control.

The biological effects of organophosphorus compounds depend mainly on their inhibitory effect on the activity of cholinesterase in man, and the inhibition rate is said to run parallel to the dose. It is also a known fact that a change in the activity of cholinesterase in the body takes place with the presence of an organophosphorus compound in a quantity which is too small to produce any clinical symptom, either subjective or objective, in man. Consequently, the measurement of the change is regarded as a useful indicator for checking whether or not the body has been exposed to an organophosphorus compound.

It is to be noted further that the measurement of the activity of cholinesterase in the blood requires relatively simple techniques, since the cholinesterase in the plasma, which is the amorphous part of blood, is more easily affected than that in the other organs or tissues; and moreover the activity

[60] Stockholm, Almqvist & Wiksell, 1971 and 1972.

level of the cholinesterase in the red cells, which are the solid part of the blood, undergoes an irreversible change. Therefore, the measurements of the change in the activity of the cholinesterase in both plasma and red cells could be used as an effective and practicable method in protecting those who are engaged in activities where there is a possibility of exposure to chemical compounds of the organophosphorus family.

It might be worthwhile to mention in this context the governmental guidelines adopted in Japan for the purpose of maintaining the health of workers in factories producing or using organophosphorus compounds. Under this policy, the diagnosis of such symptoms as a decline in the level of activity of the cholinesterase in the blood, sudoresis or excessive perspiration, myosis or the contraction of the pupil and muscular fibrillation of the eyelids and the face are suggested as criteria for the periodical medical examinations. As mentioned above, among the four criteria of the examinations, a decline in the level of activity of the cholinesterase is the most sensitive criterion. Therefore it becomes the best parameter for biological change though the effect of organophosphorus compounds. Based on the above guidelines, in a case where the activity level of the cholinesterase in the plasma of a worker is found to have dropped by 30 percent or more, he should be transferred to another post or given a certain period of rest for the purpose of natural physical recovery.

In accordance with the above guidelines, plants producing organophosphorus compounds in our country have made great efforts for the maintenance of workers' health. For example, in the case of workers in plants producing organophosphorus pesticide, the level of activity of the cholinesterase in workers' plasma is measured three or five times before workers start to work in the plant, and therefore the mean value of the level calculated as mentioned before is recorded as the individual normal level of activity. The workers' level of cholinesterase activity is examined regularly, varying from every two weeks to every two months according to the toxicity of the pesticide which is being produced. We have not had any significant incidents for over 10 years, even during the period in which parathion, which has a highly toxic effect on mammals, was being produced. As a general observation, however, under similar conditions of labour management the decline in the level of cholinesterase activity among workers engaged in the production of organophosphorus compounds compared with that among workers engaged in the production of other chemical compounds is remarkable.

Of course, even when a change is detected in the level of activity of the cholinesterase in the blood, it would be almost impossible to draw from that fact an inference as to the type or the amount of production of the chemical compound. On the other hand, considering the fact that some of the organophosphorus compounds now used for peaceful purposes could be employed as chemical weapons and the plants now producing such compounds could change the nature of production as the need arose, a means of verification which covered a wide range of organophosphorus compounds might be useful.

It should be natural that the facilities of a factory would vary according to the degree of the workers' exposure to organophosphorus compounds. However, even in the case of a plant with ideal equipment, where the possibility of exposure to organophosphorus compounds might be completely eliminated, it would still be necessary from the medical point of view, as long as there are workers engaged in their production, to conduct a medical examination to ensure complete safety. In the case of a factory where precautionary measures are being taken to such an extent as to completely eliminate the possibility of exposure, no biological change is detected in man. Such special precautionary measures themselves would provide useful data for verification purposes.

In accordance with the above considerations, we should like to suggest that this Committee explore the possibility of establishing a method of verification based on the examination of the level of activity of the cholinesterase in the blood of people working in chemical plants engaged in the production of organophosphorus compounds and on whether extraordinary safety measures are being taken in such plants.

26.

Japan: working paper containing remarks by Professor Shunichi Yamada, of the University of Tokyo, on the verification of compliance with the prohibition of chemical weapons, presented at the informal meeting held on 7 July 1971

[*CCD/344 of 24 August 1971*]
[*Original: English*]

The question of verification of compliance with the prohibition of chemical weapons is considered to be extremely difficult because of the close interrelationship between the production of such weapons and industry for peaceful purposes and also because such production requires only comparatively simple techniques. We have made a careful study with a view to finding technical methods which would enable us to conduct more or less effective verification, which, as we have just mentioned, will involve many complexities, and our past study has made it possible for us to come up with some suggestions in this regard. We believe that a suitable combination of these suggestions, though it may be far from perfect as a method of verification of chemical weapons, will provide us with some clue in our present efforts. This paper tries to examine our past suggestions in more detail and attempts to present them in a somewhat more precise manner.

Since the question of verification of chemical weapons in general is much too wide a subject, we have concentrated on the question of verification specifically relating to the production of nerve agents, which are, of course, organophosphorus compounds. Organophosphorus compounds are widely used in industry for peaceful purposes in the production of pesticides and it was from the research in pesticides that the discovery of nerve agents originated. However, unlike the field of pesticides, where efforts have been made to lower the toxic effects on mammals, development efforts in the field of nerve agents have been directed towards increasing their toxic effect. At the present time the toxic level of nerve agents is reported to be between 1,000 and 10,000 times greater than that of pesticides. It is to be noted that the difference in chemical structure between nerve agents and pesticides lies in the fact that, while sarin, soman, V-agents and all other new types of nerve agents, with a few exceptions, contain methyl-phosphorus bonds, no chemical compounds with such bonds are used as pesticides. Therefore, should we be able to establish a highly sensitive method of microanalysing a methyl-phosphorus bond, it would greatly facilitate the detection of nerve agents.

Last summer we submitted to this Committee a working paper (CCD/301)[61] in which we stated: "If an emission electrode for a flame thermionic detector is attached to the nozzle of a flame ionization detector in gaschromatography, a high sensitivity will be shown by phosphorus compounds and the minimum amount detectable will be 1 x 10^{-12} g/sec." We noted further that, by using this method, it would be possible to detect and identify such known nerve agents as sarin, soman and V-agents or their decomposed products, which might exist in very small quantities in liquid wastes from the chemical plant concerned, the soil and dust in and around the producing plant, or on the production equipment or the workers' clothes, by checking their retention times.

Generally speaking, nerve agents are methylphosphonic ester halogenides and they are converted to methylphosphonic acid by hydrolysis, with their methyl-phosphorus bond remaining unsevered. If, therefore, we apply the method of gaschromatography mentioned above to such methylphosphonic acid itself or to its methyl or ethyl ester, which has a low boiling point, we might be able to analyse them both qualitatively and quantitatively. Since this method would enable us to verify the presence or absence of known nerve agents as well as those derivatives which have methyl-phosphorus bonds and which cannot be used for purposes other than the production of

[61] *Official Records of the Disarmament Commission, Supplement for 1970*, document DC/233, annex C, sect. 30.

nerve agents, it would be a useful means of verification of nerve agents, irrespective of whether or not they are already known.

It will hardly be necessary to add that further detailed study of various factors affecting hydrolysis or conditions in applying gaschromatography such as the type of columns to be used, temperature, sensitivity of the instruments, etc, would be required.

If we could establish the method of microanalysis of chemical compounds with a methyl-prosphorus bond, it would be possible to verify whether or not nerve agents are being produced by checking liquid wastes from the suspected plant or even from the atmosphere or river water at a considerable distance from the plant. It goes without saying that the same method, if applied in the case of an investigation with direct access to the suspected plant, would be even more effective. Although we have at present no such data based on actual experiments, we believe that the method we have suggested can be a possible means of verification, and if we could visit, together with representatives from other countries, facilities where nerve agents are actually handled, and investigate them, it would provide us with valuable information to prove the effectiveness of our concept.

We put forward another suggestion in the same working paper dealing with necessary data which would contribute indirectly, if not directly, to the detection of production of nerve agents. To that end, we suggested the establishment of a system under which countries would report on the statistics for certain phosphorus compounds, giving the amounts produced, exported and imported and figures for consumption for different purposes. If such a system worked properly, it would contribute to the prevention of the use of those substances for the production of nerve agents. We should now like to attempt to explain this approach in rather more detail.

Nerve agents are organophosphorus compounds and their manufacture requires phosphorus compounds as the principal raw material as well as many kinds of auxiliary materials or solvents, and the lack of any of them would make production impossible. However, since the auxiliary materials or solvents used in the production of phosphorus compounds are also widely used in the production of many other industrial goods and it would be extremely difficult to trace the flow of these materials, it would be practical to leave them aside for the moment and focus our attention on the flow of the principal raw material, that is, phosphorus compounds. Thus, if we check statistically the amount of production and consumption of yellow phosphorus, which is the starting material, and other various important intermediates in the production of nerve agents, we should be able to ascertain whether or not chemical compounds of the organophosphorus family are being used for the production of nerve agents. Although there are various methods for the production of such agents, which are already known or could conceivably be developed, it would suffice for us to concentrate on some of them from the viewpoint of the possibility of industrial mass production. Important intermediates which are common in those several practicable methods are yellow phosphorus, phosphorus trichloride, phosphorus oxychloride, phosphorus pentachloride and phosphorus pentasulfide, which are all inorganic phosphorus compounds, as well as such organophosphorus compounds as dimethyl or diethyl phosphite, trimethyl or triethyl phosphite and methylphosphonic dichloride or difluoride. With the exceptions of methylphosphonic dihalogenides, those compounds are all used in great quantities as materials or solvents in the manufacturing of agricultural chemicals, pharmaceuticals, perfumes, dyestuffs, vinyl chloride stabilizer or plasticizer. Methylphosphonic acid dichloride or difluoride contains a methyl-phosphorus bond, and belongs to a special group of chemical compounds. It is also considered to be an important final intermediate in the production process of nerve agents and is reported as possessing itself a high toxic effect. Although it is reported that it can be used as a material for the production of polymers containing phosphorus, we do not have any detailed information on it.

In Japan, the statistics on the amounts of the production and consumption of the inorganic phosphorus compounds mentioned above are systematized and made public. Recently a survey has been conducted on the flow of those intermediate materials in Japan. For the information of each delegation, the tables on the amount of consumption of phosphorus trichloride and phosphorus oxychloride in Japan are attached to this working paper. However, there are not sufficient statistics on organophosphorus compounds other than agricultural chemicals. Furthermore, methylphosphonic dihalogenides, which have no peaceful uses, are, of course, not industrially produced or used in Japan. Accordingly, we believe that, if countries do their best to gather reliable statistics in a more systematic way on the phosphorus compounds and to clarify the flow of such compounds, it will make it possible to some extent to check the possibility of their being diverted to the production of nerve agents. Considering the possibility of other methods of manufacturing nerve agents and of the isolation of intermediates, those chemical compounds which we have dealt with might not be the best ones to use as check points. Also, the question of the relationship between the extent of statistical errors and the amounts of intermediates required for the production of nerve agents might throw some doubts on the usefulness of preparing such statistics. However, if we try to minimize the weaknesses in the system of preparing statistics, and if countries concerned are persuaded to make their statistics public, it will result in a situation favouring the prevention of the production of nerve agents and will help to build up mutual confidence among States.

We should like now to deal with a matter which is not necessarily related to any concrete means of verification but is designed to prevent the secret development of or research on new types of highly toxic chemical weapons in the future. Last summer, in this Committee, we proposed that the existing chemical compounds with toxic effects above a certain level should be listed as items to be reported upon and that a system should be established so that, when new chemical substances whose toxic effects equalled or exceeded that level were discovered, they might be tested by an appropriate international research institute and, if they were found to have toxic effects equal to or above that level, that fact would be announced. We further suggested as the toxic level to be used as the criterion for this purpose a lethal dose (LD_{50}) of 0.5 milligramme per kilogramme of body weight by hypodermic injection. The basis for that suggestion was that we could safely assume that no chemical substance with a toxic effect equal to or above that level could be used for peaceful purposes.

There are more than 10 kinds of chemical compounds with toxic effects equal to or exceeding the suggested level namely: tabun, soman, sarin, VX, a few organophosphorus compounds which were mentioned in the working paper we submitted last summer and in the Netherlands working paper submitted this spring in document CCD/320 (see sect. 3 above), such toxins as botulinum toxin and tetrodotoxin, alkaloids such as aconitine and heart poisons derived from plants such as scillaren. If these substances needed to be manufactured as pharmaceuticals or for other peaceful purposes, we would be able to agree to report on the purpose, amount and place of the production.

The criterion lethal dose (LD_{50}) of 0.5 milligramme per kilogramme of body weight would be based on hypodermic injection, the method by which most or our available data have been obtained. However, there still exist such questions as whether the criterion should be based on the same route of absorption as in the case of use as a chemical weapon, that is, inhalation or percutaneous absorption, and whether we should use a uniform method of testing on animals, specifying the kind of animals to be used, their weight and number. On these problems we should like to hear the opinion of pharmacology experts. It would also be desirable to hold further discusions on the question of choosing an appropriate international body which would carry out authoritative tests in this regard.

TABLE 1. CONSUMPTION OF PHOSPHORUS TRICHLORIDE (PCl_3) IN JAPAN

Purpose	1965	1966	1967	1968	1969	1970 (estimated)
			(tons)*			
Agricultural Chemicals	785 (32.4)	1 182 (40.3)	1 761 (46.0)	2 343 (51.2)	2 714 (53.9)	3 120 (55.7)
Vinyl Chloride Stabilizer	689 (38.4)	877 (29.9)	1 112 (29.0)	1 063 (23.1)	1 229 (24.4)	1 280 (22.9)
Dyestuffs	622 (25.7)	507 (17.3)	677 (17.7)	801 (17.5)	642 (12.7)	493 (8.8)
Pharmaceuticals	77 (3.2)	115 (4.0)	80 (3.1)	122 (2.7)	99 (2.0)	175 (3.1)
Others	249 (10.3)	250 (8.5)	200 (5.2)	250 (5.5)	353 (7.0)	532 (9.5)
TOTAL	2 422 (100)	2 931 (100)	3 830 (100)	4 579 (100)	5 037 (100)	5 600 (100)

* Percentage values are given in parentheses.

TABLE 2. CONSUMPTION OF PHOSPHORUS OXYCHLORIDE ($POCl_3$) IN JAPAN

Purpose	1965	1966	1967	1968	1969	1970 (estimated)
			(tons)*			
Plasticizers	1 263 (41.6)	1 460 (42.2)	1 963 (47.6)	2 376 (48.1)	2 498 (48.5)	2 882 (53.9)
Pharmaceuticals	1 037 (34.2)	800 (23.1)	790 (19.2)	1 017 (20.6)	1 288 (25.0)	1 164 (21.8)
Perfumes	49 (1.6)	45 (1.3)	97 (2.4)	141 (2.9)	134 (2.6)	107 (2.0)
Others	684 (22.6)	1 157 (33.4)	1 270 (30.8)	1 405 (28.4)	1 233 (23.9)	1 199 (22.4)
TOTAL	3 033 (100)	3 462 (100)	4 120 (100)	4 939 (100)	5 153 (100)	5 351 (100)

* Percentage values are given in parentheses.

27.

Japan: working paper containing remarks by Dr. Shigeji Suyehiro, of the Japanese Meteorological Agency, on the usefulness of employing ocean-bottom seismographs and a universally acceptable means of determining the magnitude of seismic events, presented at the informal meeting held on 30 June 1971

[*CCD/345 of 24 August 1971*]
[*Original: English*]

Introduction

Two topics will be discussed in connexion with the seismological approach to the detection and identification of underground nuclear explosions. The first topic is the employment of ocean-bottom seismographs to improve our present detection capability for seismic events and possibly to increase the capability of identifying explosions and distinguishing them from natural events as well. The second concerns a possible and universally acceptable means of determining the magnitude of seismic events.

Detection and identification of seismic events

Great efforts have been made to evaluate the present detection capability for seismic events at teleseismic distances and also to ascertain the extent to which one can apply the identification criteria. In the report of the SIPRI Seismic Study Group it was reported that the identification criterion, using the ratio of surface wave magnitude to body wave magnitude, was valid to a figure of 4.75 in body wave magnitude. Subsequent studies revealed that the criterion remained valid for events down to about 4.0. An encouraging paper has been produced by American scientists, reporting that events of even smaller magnitude, about 3.5, may still be identified by the same criterion. This means that a hardrock nuclear explosion of less than 1 kiloton could be identified if we were able to detect it and obtain sufficient data from it for the criterion to be applied.

In addition to the identification criterion of surface wave to body wave, other criteria which depend solely on body waves are now being developed. In Japan, we are pursuing a study of the energy ratio of high frequency to low frequency in P waves to see if this can be used as a positive discriminant, and the results are promising at teleseismic distances. If results attained so far are borne out by further studies, it will certainly lower the present identification threshold at teleseismic distances, since detecting surface waves, necessary for the application of the criterion of Ms : mb, is at the moment more difficult than detecting body waves. It is also reported that similar studies using P waves alone at short distances are in progress in the United States.

All these recent studies indicate that we have already acquired, or are about to acquire, techniques for discriminating between natural earthquakes and explosions valid to a considerably smaller magnitude range, if sufficient data is made available. And once our data acquisition system is sufficiently improved to make the identification capability for such small events practical, seismological verification will contribute much more than is possible at present to the conclusion of a treaty to limit or ban underground nuclear weapons tests. To achieve this, our detection techniques must be improved to match the level of identification techniques.

A recent study by our American colleagues using an improved high-gain, long-period seismograph system is encouraging. According to the report, a considerable enhancement is expected in the detection of Rayleigh waves. Yet our detection capability and azimuthal coverage have definite limits if we depend on teleseismic observation and confine ourselves to the land and a small number of islands. These limits will be substantially lowered if we can extend our systems by placing stations on the ocean floor, which accounts for 70 per cent of the earth's surface.

Our recent observations off the Pacific coast of Japan using ocean-bottom seismographs showed that the background noise level at the site is only 1.0 to 1.5 millimicrons in a frequency range 2 to 10 cps, which is less than half that of the quietest land sites. This quietness is neither affected by weather nor is subject to seasonal changes. We fired 1 kilogram of dynamite in the water, and Pn wave from the explosion was clearly recorded at a distance of 100 kilometres. If we apply the empirical law that the recordable distance is proportional to the square root of the amount of explosive, a 1-ton explosion in water should be recordable at a distance of 3,000 kilometres. Background noise at the ocean bottom is naturally higher in the lower frequency range because of microseisms. The extremely low level of background noise in a range 2 to 10 cps, however, should not be overlooked, bearing in mind the fact that the P wave energy from underground explosions inclines toward a higher frequency range as compared with the energy from natural earthquakes.

The instrumentation of our present ocean-bottom seismographs is such that we can send them down to the sea floor to depths of several thousand metres and operate them for a period of 2 to 5 months without maintenance, if we so wish. And the information stored on magnetic tape can be processed in a very short time. We will require more sophisticated instrumentation to handle a long-period pendulum. But even such an experiment is not technically impossible.

Taking the above points into consideration, it is believed that as far as signal-to-noise ratio is concerned even a single ocean-bottom station would serve to detect seismic events equivalent to a fairly large array station on land. If one could further set up a tripartite array at the ocean-bottom, it would have a certain independent location capability. With the development of identification criteria which use only P waves it will also provide data useful for identification.

We can obtain seismological access to areas exposed to the sea from under the high seas and without intruding into sovereign territory. It is, of course, difficult to obtain data from ocean-bottom seismographs on a real time basis. However, we can use them in such a way that we can bring them to the surface and examine the records only when necessary. Since ocean-bottom stations have such definite merits, it is suggested that we should not exclude the ocean-bottom seismograph from consideration when we contemplate improving or making changes in the global seismological network in the future.

Determination of magnitude

Let us suppose that a threshold has been agreed upon, above which underground nuclear explosions are banned, and that the verification of compliance with such an agreement is to be undertaken by seismological methods. As all of us are aware, such a threshold must be defined in terms of the size of seismic events, and we shall have to say whether an event is above or below the threshold. And this decision would have to be acceptable to all parties as being scientifically valid or, if there is no sufficiently convincing scientific basis, would have to be a matter for international political agreement. Even if we do not establish a threshold, we have to be concerned about the means of determining magnitude, as long as we employ magnitude as a scale by which to estimate underground explosions.

Determining the magnitude of an earthquake is not like measuring a length or a weight. We have learned from painful experience that the magnitude determined at station A can differ by as much as 1.0 from that determined at station B and that such a deviation from the mean value is not only a function of station but varies depending on each source-station combination. How can we cope with the task using what is, in a sense, an ambiguous quantity? One way to do it is to employ the mean magnitude of many stations and the other is to designate a certain number of stations as key stations and to accept the magnitude at these stations *a priori*.

As to the first scheme, there is the question of how many stations are needed if the mean magnitude is to be statistically significant. It is generally accepted that the magnitude determined by a single station has a standard deviation of about 0.5. The standard deviation of the mean magnitude decreases in proportion to the inverse square root of the number of stations. If we take the mean of 25 stations, the standard deviation will be 0.1. Magnitudes of this accuracy should be accepted without serious objection.

The following table shows how many stations of the 44 World-Wide Standard Seismograph Network (WWSSN) stations in appendix 7 of the SIPRI report and the 46-station SPZ network in the Canadian report of 1970 are found within 90° from the existing nuclear test sites. Stations operated by the nuclear Powers using a particular test site are not included in the number for that site.

Test site	*Number of stations in WWSSN (SIPRI)*	*Number of stations in the 46-station network*
Nevada	19	15
Sahara	28	17
Aleutians	26	28
Novaya Zemlya	28	24
Kazakh	26	26
Sinkiang	28	23
Mururoa	11	27

There are sufficient numbers of stations to give statistically significant magnitudes for seismic events in these regions if the event is recorded at all stations. Consequently, the next question is what the magnitude threshold is for earthquakes which can be detected at a distance of 90°. We assume that the minimum readable trace amplitude is 1 mm (peak to zero), that the magnification at one-second period is 75 K, that the amplitude attenuation follows Gutenberg's B (Δ) curve, and that stations could register magnitudes as much as 0.5 below the mean value; should an event be 5¼ in magnitude, it could thus be detected at all sensitive stations within 90°. Because the sensitivity of many stations is actually higher than assumed here and a safety factor of dm = 0.5 is given, this threshold magnitude of 5¼ is a conservative estimate.

A similar value was given in the Canadian report as the identification threshold depending on the existing SPZ and LPZ networks. To obtain Rayleigh wave data for the discriminant of Ms : mb, the identification threshold must be set about 0.8 higher in magnitude than the detection threshold for seismic events. As a consequence, we can obtain sufficient data of P wave for magnitude determination of statistical significance.

On the other hand we have high hopes of lowering the detection threshold for Rayleigh waves to that of P waves owing to recent developments in long-period instrumentation. In this case, the identification threshold will also be lowered. At the same time, however, the number of stations required for detection, location and identification must be reduced. Accordingly the two sets, each consisting of a relatively small number of stations used for minor events, will be completely different in the case of an event in Nevada and an event in Kazakh, for instance, since most Asian and Middle East stations near Kazakh are more than 90° from Nevada. What can we do when we have magnitudes with comparatively low statistical value derived from two such different sets of stations?

We can of course decide to accept them as a first approximation. But if we wish to have higher accuracy, we must try to find the coefficient of station correction as a function of the station-source combination so as to compensate for the geophysical peculiarities of the earth. Such a task undertaken on a global basis would be tremendous. If, however, we limit the study to combinations of stations of the highest sensitivity and possible source regions of underground nuclear explosions, it should not be too difficult.

It may be most practical to agree to start with the first approximation and then to revise the method of magnitude determination as the study progresses. In any case, there is no doubt that such a comprehensive study achieved through international co-operation would also provide our academic community with valuable fundamental geophysical information.

28.

Mexico: working paper containing a proposal for the inclusion of an additional article in the draft convention on the prohibition of the development, production and stockpiling of bacteriological (biological) and toxin weapons and on their destruction (CCD/337 and 338)

[*CCD/346 of 24 August 1971*]
[*Original: Spanish*]

1. Insert a new article IX which would read as follows:

"Pending the agreement referred to in article VIII, the States Parties to this Convention undertake to refrain from any further development, production or stockpiling of those chemical agents for weapons purposes which because of their degree of toxicity have the highest lethal effects. The agents in question are listed in the Protocol annexed to this Convention".

2. Renumber the subsequent articles accordingly.

29.

Morocco: working paper on the draft convention on the prohibition of the development, production and stockpiling of bacteriological (biological) and toxin weapons and on their destruction (CCD/337 and 338)

[*CCD/347 of 24 August 1971*]
[*Original: French*]

1. Amend the text of the tenth preambular paragraph to read as follows:

"*Recalling* that the General Assembly of the United Nations has repeatedly condemned all actions contrary to the principles and purposes of the Geneva Protocol of 17 June 1925,"

2. (*a*) The international community should be notified of the execution of the provisions of article II by States Parties possessing bacteriological or toxin weapons as soon as they destroy them or divert them to peaceful purposes. The notice of that operation could be addressed to the Secretary-General of the United Nations and, through him, to all States Parties;

(*b*) The term "population" in the last sentence of article II should be replaced by the plural "populations".

3. Insert a new article reading as follows:

"Each State Party to this Convention declares its intention to supply, within the limits of its ability, appropriate humanitarian assistance to another State Party which so requests and is exposed by another State, in violation of the provisions of the Convention, to danger resulting from deliberate use or accidental or chance dissemination of biological agents or toxins intended for military purposes."

4. There can be no doubt that the preparation of a viable convention completely and finally prohibiting bacteriological and toxin weapons requires that all States Parties shall be absolutely certain in law that the reservations formulated by many States to the Geneva Protocol of 17 June 1925[62] have been declared null and void with regard to the prohibition of the use of bacteriological and toxin weapons. Failure to cancel those reservations would be likely to limit the very scope of the Convention and also to give rise to erroneous interpretations of article VII. A legal solution should therefore be found for this problem.

5. It would be highly desirable to reach agreement, immediately after the entry into force of the Convention on the prohibition of bacteriological and toxin weapons, on actual cessation of the production of chemical weapons.

30.

Sweden: working paper suggesting possible provisions of a treaty banning underground nuclear weapon tests*

[*CCD/348 of 2 September 1971*]
[*Original: English*]

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

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

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

Recalling the determination expressed by the Parties to the 1963 Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and under Water[63] in its preamble to seek to achieve the discontinuance of all test explosions of nuclear weapons for all time and to continue negotiations to this end,

Convinced that a continued testing of nuclear explosives brings about unforeseeable consequences in regard to imbalance and mistrust between States,

Heeding the appeals of the General Assembly of the United Nations for the suspension of nuclear weapon tests in all environments,

Affirming the principle that the benefits of peaceful applications of nuclear technology, including any technological by-products which may be derived by nuclear-weapon States from the development of nuclear explosive devices, should be available for peaceful purposes to all Parties to the Treaty, whether nuclear-weapon or non-nuclear-weapon States,

Affirming also the principle that a substantial portion of the savings derived from measures in the field of disarmament should be devoted to promoting economic and social development, particularly in the developing countries,

Have agreed as follows:

Article I

1. Each State Party to this Treaty undertakes to prohibit, to prevent and not to carry out any underground nuclear weapon test explosion, or any other underground nuclear explosion, at any place under its jurisdiction or control. This obligation is subject to the provisions contained in paragraph 2 of this article and in article II.

2. For each nuclear weapon state this Treaty shall be fully operative after a period of . . . months from the entry into force of the Treaty, during which period any nuclear weapon test explosions shall be phased out in accordance with the provisions laid down in Protocol I annexed to this Treaty.

* Revised version of working paper ENDC/242 of 1 April 1969 (*Official Records of the Disarmament Commission, Supplement for 1969*, document DC/232, annex C, sect. 6).

[62] Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare (League of Nations, *Treaty Series*, vol. XCIV (1929), No. 2138).

[63] United Nations, *Treaty Series*, vol. 480 (1963), No. 6964.

3. Each State Party to this Treaty undertakes, furthermore, to refrain from causing, encouraging or in any way participating in the carrying out of any nuclear weapon test explosion, or any other nuclear explosion prohibited under this Treaty.

Article II

The provisions of article I of this Treaty do not apply to nuclear explosions which are carried out for construction or other peaceful purposes and which take place in conformity with the separate Protocol II annexed to this Treaty.

Article III

1. Each State Party to this Treaty undertakes to co-operate in good faith to ensure the full observance and implementation of this Treaty.

2. Each State Party to this Treaty undertakes to co-operate in good faith in an effective international exchange of seismological data in order to facilitate the detection, identification and location of underground events.

3. Each State Party to this Treaty undertakes to co-operate in good faith for the clarification of all events pertaining to the subject matter of this Treaty. In accordance with this provision, each State Party to the Treaty is entitled:

(*a*) To make inquiries and to receive information as a result of such inquiries;

(*b*) To invite inspection on its territory or territory under its jurisdiction, such inspection to be carried out in the manner prescribed by the inviting Party;

(*c*) To make proposals, if it deems the information available or made available to it under all or any of the preceding provisions inadequate, as to suitable methods of clarification.

4 Each State Party to this Treaty may bring to the attention of the Security Council of the United Nations and of the other Parties to the Treaty that it deems another Party to have failed to co-operate to the fullest extent for the clarification of a particular event.

5. Provisions for the seismological data exchange referred to in paragraph 2 of this article are laid down in the separate Protocol III, annexed to this Treaty. Special provisions for the seismological data exchange during the phasing-out period and for the explosions for peaceful purposes referred to in articles I and II are laid down in the Protocols I and II respectively.

Article IV

Any State Party may propose amendments to this Treaty. Amendments shall enter into force for each State Party accepting the amendments upon their acceptance by a majority of the States Parties to the Treaty and thereafter for each remaining State Party on the date of acceptance by it.

Article V

. . . years after the entry into force of this Treaty, a conference of Parties to the Treaty shall be held at Geneva, Switzerland, in order to review the operation of the Treaty with a view to assuring that the purposes of the preamble and the provisions of the Treaty are being realized. The review conference shall determine in accordance with the views of a majority of those Parties attending whether and when an additional review conference shall be convened.

Article VI

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

2. This Treaty shall be subject to ratification by signatory States. Instruments of ratification and of accession shall be deposited with the Governments of . . . which are hereby designated the Depositary Governments.

3. This Treaty shall enter into force after the deposit of instruments of ratification by . . . Governments, including the Governments designated as Depositary Governments of this Treaty.

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

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

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

Article VII

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

Article VIII

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

IN WITNESS WHEREOF the undersigned, being duly authorized thereto, have signed this Treaty.

DONE in . . . at . . . this . . . day of . . . , . . .

31.

Netherlands: working paper on the seismicity of the United States of America, the Union of Soviet Socialist Republics and China

[*CCD/349 of 7 September 1971*]
[*Original: English*]

In this working paper an estimate is given of the number of seismic events occurring in certain parts of the world, especially in those parts where unidentified events could give rise to concern in the framework of a comprehensive test ban.

The study is based on a computer analysis of the epicentres of events in the years 1961-1970 inclusive, as given by the United States Coast and Geodetic Survey (USCGS) (now the National Oceanic and Atmospheric Administration). At present, these data seem to represent the most up-to-date and comprehensive set of earthquake data for the whole world. Only earthquakes with a focal depth of 33 kilometres or less were included in the analysis. Separate countings were made for:

1. Mainland China, exclusive of Tibet
2. The U.S.S.R., exclusive of the Kuriles but inclusive of Kamchatka, Novaya Zemlya and Severnya Zemlya
3. The region of the Kurile Islands
4. The region of the Aleutian Islands
5. Alaska
6. The continental United States, exclusive of Alaska
7. The region of the Hawaiian Islands

A more detailed indication of the delineation of the different regions is given below in the appendix. Where possible, border regions of a width of about a hundred kilometres with neighbouring countries were excluded in the countings for the mainland countries, as were the earthquakes with epicentres in the neighbouring seas for these areas. Tibet was not included in China. Separate countings of available data for the territory of Tibet in the years 1968-1970 inclusive show that, for these years, the seismicity of Tibet alone was about 0.3 times that of the rest of China. A magnitude/frequency-relation was determined for the complete material and also for the above-mentioned regions 1 to 7 separately.

An excerpt of the accumulated numbers of earthquakes of certain magnitudes for the particular regions is given in table 1 for the years 1963-1970 inclusive. Magnitudes are of the m_B-type.[64] The years 1961 and 1962 have not been used since at that time magnitudes were not reported on a routine basis.

In graphs it can be shown that above m_B 5 a homogeneous relationship exists between the logarithm of the number of earthquakes above a certain magnitude and that magnitude. It is supposed that this character of the magnitude/frequency relation indicates that all or nearly all events above magnitude 5 are included in the USCGS material, although slight differences exist for the different regions. Under m_B 5, however, not all of the events occurring are included, so corrections have to be made by extrapolating the magnitude/frequency-curve.

The numbers of explosions or suspected explosions in the course of the same eight years are given in table 2. It seems that for both the USSR and the continental United States the numbers of earthquakes and explosions of $m_B \geqslant 5$ in the last 8 years are about equal.

The percentages of earthquakes with $m_B \geqslant 5$ for the separate regions with respect to the total number of the world of these magnitudes are given in table 3. They are of the order of 1 to 7 per cent. For the continental territories of China, the USSR and the United States together, this value is 4.1 per cent only.

In table 4 the mean annual numbers of earthquakes are given for the individual regions for magnitudes $m_B \geqslant 5$, $m_B \geqslant 4\frac{3}{4}$ and $m_B \geqslant 4\frac{1}{2}$. This would be equivalent to magnitudes caused by explosions in hard rock of respectively $\geqslant$ 10 to 25 kilotons, $\geqslant$ 6 to 15 kilotons and $\geqslant$ 3 to 8 kilotons. The first column gives only the observed numbers of earthquakes since, as already stated above, all or nearly all events above m_B 5 are registered. The second and third columns give both the observed numbers and the numbers that have been found by extrapolation of the magnitude/frequency distribution for magnitudes $m_B \geqslant 5$ (in parentheses), which can be considered as estimates of the actual number of events occurring. Also indicated are the four-station identification probabilities for the different entries, taken from figure 8 of the Canadian paper of P. W. Basham and K. Whitham.[65]

Finally, in table 5 the mean annual number of events that may pass unidentified with the current seismograph network is given for the regions of China, the USSR and the United States. This table was obtained by combining the estimated numbers of earthquakes and the identification probabilities as given in table 4. Annually, there will be about three earthquakes in the USSR, with a magnitude equivalent to a hard rock yield of ±10 kilotons or more that could not be discriminated from an explosion. For the United States this number is 1 and for China 7.

Of course, these numbers would be considerably lower if the seismic monitoring system were improved. For example, an achievable four-station 90 per cent identification level in the 5- to 10-kiloton range, as indicated in the Canadian document CCD/327 (see sect. 9 above) would mean that annually only one earthquake in the USSR could not be discriminated from an explosion greater than 5 to 10 kilotons.

From the point of view of seismicity alone, it may be concluded that the regions of the Kuriles, the Aleutians and Alaska offer the best opportunities for evasion of an underground test ban. It must be remembered, however, that in the Kurile and Aleutian regions the great majority of the earthquakes have their epicentres at sea, so the numbers given for these regions are on the conservative side. The proximity of territories of other countries, the exposed location with respect to sea-going detection systems and the long and exposed lines of communication would also seem to make it rather difficult to perform underground nuclear tests here in a clandestine way.

[64] No magnitude was assigned to about one in three of the events in the USCGS lists. Most of these are from the lower magnitude classes, but according to the number of recording stations, about 15 earthquakes and 4 explosions for the regions in question must be at least of m_B 5. These changes in the data from the original USCGS lists have been incorporated in tables 1 and 2.

[65] P. W. Basham and K. Whitham, Seismological detection and identification of underground nuclear explosions, *Publications of the Earth Physics Branch* (Canadian Government publication), vol. 41, No. 9.

TABLE 1. CUMULATIVE NUMBERS OF USCGS EPICENTRES IN THE YEARS 1963-1970 INCLUSIVE

m_B	*1. China*	*2. USSR*	*3. Kuriles*	*4. Aleutians*	*5. Alaska*	*6. United States*	*7. Hawaii*
$\geqslant 7$			2	1	1		
$\geqslant 6\frac{1}{2}$			2	1	1		
$\geqslant 6$	5	2	6	10	10	1	
$\geqslant 5\frac{1}{2}$	18	10	45	66	55	7	
$\geqslant 5$	83	52	178	296	187	43	3
$\geqslant 4\frac{1}{2}$	184	138	498	806	457	225	12
$\geqslant 4$	197	163	769	1 561	869	617	24
all	205	188	805	1 724	1 469	2 009	33

TABLE 2. NUMBERS OF EXPLOSIONS OR SUSPECTED EXPLOSIONS IN THE YEARS 1963-1970 INCLUSIVE

m_B	*1. China*	*2. USSR*	*3. East Kazakh*	*4. Novaya Zemlya*	*5. Urals*	*6. Continental United States*	*7. Aleutians*	*Equivalent yields in hard rock*
$\geqslant 6$		12	6	4	2	5	1	$\geqslant$ 100-200 k'tons
$\geqslant 5$	1	63	54	5	4	44	2	$\geqslant$ 10-25 k'tons
$\geqslant 4$	3	77	63	7	7	93	2	$\geqslant$ 2 k'tons

TABLE 3. NUMBERS AND PERCENTAGES OF EARTHQUAKES OF $m_B \geq 5$ FOR THE YEARS 1963-1970 INCLUSIVE

	Numbers	Per cent		
1. China	83	1.9	19.1% (rows 1-7)	4.1% (rows 1, 2, 6)
2. USSR	52	1.2		
3. Kuriles	178	4.0		
4. Aleutians	296	6.7		
5. Alaska	187	4.2		
6. United States	43	1.0		
7. Hawaii	3	0.1		
TOTAL WORLD	±4 440	100		

TABLE 4. ANNUAL NUMBERS OF EARTHQUAKES EQUIVALENT TO CERTAIN YIELDS IN HARD ROCK
(Extrapolated numbers in parentheses; approximate identification levels indicated)

	$m_B \geq 5$ $\geq$ 10-25 k'ton	$m_B \geq 4\frac{3}{4}$ $\geq$ 6-15 k'ton	$m_B \geq 4\frac{1}{2}$ $\geq$ 3-8 k'ton
1. China	10 4R90	17 (20) 4R65	23 (38) 4R40
2. USSR	6 4R95	12 (13) 4R75	17 (25) 4R50
3. Kuriles	22	38 (65)	62 (125)
4. Aleutians	37	63 (85)	101 (150)
5. Alaska	23	40 (50)	57 (88)
6. United States	5	12 (12) 4R90	28 (28) 4R70
7. Hawaii	0.5	0.8 (1)	1.5 (2)

TABLE 5. MEAN ANNUAL NUMBERS OF EARTHQUAKES THAT MAY PASS UNIDENTIFIED WITH THE CURRENT SEISMOGRAPH NETWORK

	$m_B \geq 5$ $\geq$ 10-25 k'ton	$m_B \geq 4\frac{3}{4}$ $\geq$ 6-15 k'ton	$m_B \geq 4\frac{1}{2}$ $\geq$ 3-8 k'ton
1. China	1	7	23
2. USSR	1/3	3	12
6. United States	—	1	8

Appendix

For the delineation of the different regions the geographical code numbers of FLINN/ENGDAHL have been used. The regions considered are composites of the following FLINN/ENGDAHL blocks:

1. China : 307, 318, 321, 322, 323, 325, 332, 658, 664
2. USSR : 217, 326, 327, 328, 329, 330, 335, 336, 337, 339, 340, 357, 361, 362, 645, 648, 652, 656, 662, 668, 671, 713, 714, 715, 716, 724, 725, 726
3. Kuriles : 221
4. Aleutians : 4 - 10 inclusive
5. Alaska : 1, 2, 12, 13, 14, 19, 676
6. United States : 28, 29, 32, 33, 36, 37, 39, 40, 41, 42, 43, 44, 456-512 incl., 514, 519, 520
7. Hawaii : 613

32.

United Kingdom: working paper containing comments on the Canadian study of the seismological detection and identification of underground nuclear explosions (CCD/327) and on its implication for the expanded seismic array system outlined in the United Kingdom working paper CCD/296*

[*CCD/351 of 23 September 1971*]
[*Original: English*]

1. The Canadian working paper CCD/327 (see sect. 9 above) represents the culmination of one of the most careful and comprehensive studies made on the seismological aspects of the comprehensive test-ban treaty. This study also has the virtue that it needed no expensive processing aids; it is an experiment which can both be verified and extended by any competent seismologist with access to a microfilm reader and with existing international co-operation. One of its most useful features is that it provides new and better defined limits to the capacity of the existing network of seismograph stations to discriminate between earthquakes and explosions, superseding the conclusions of the conference held by the Stockholm International Peace Research Institute (SIPRI) in 1968.

2. The Canadian study has experimentally verified (4,000 seismograms measured) that the threshold of identification for underground explosions fired in the northern hemisphere is approximately 20 kilotons when fired in rocks other than dry

* *Official Records of the Disarmament Commission, Supplement for 1970*, document DC/233, annex C, sect. 25.

alluvium. This figure is in line with the lower limit of the 1968 SIPRI conclusions, and is a measure of the degree to which the uncertainties of the SIPRI data have been reduced. The principal reasons for this improvement are:

(*a*) Peaceful uses of nuclear explosions (PNE) in several different regions have provided a better sample of explosion data than was available for the SIPRI conference. (This underlines the importance of the resolution of the PNE Working Group of the International Atomic Energy Agency of January 1971 urging the release of PNE source data.)

(*b*) A practical method of correcting for major transmission path (source-to-receiver) differences has resulted in more precise estimates of the surface wave magnitude M_s.

(*c*) Records from additional standard stations, Kabul and Spitzbergen for example, were available for analysis.

3. In contrast with the results which were presented at SIPRI, however, the Canadian study deliberately omitted data from the Kamchatka-Kurile regions. The practical reason was that much more time would have been needed to study the large number of earthquakes which take place in this area.

4. There are however scientific reasons why special studies of this and similar areas should be completed on the lines of the Canadian project, namely:

(*a*) The distribution of recording stations relative to the Kamchatka-Kurile area is much less uniform than for events elsewhere in Eurasia because of the physical difficulty of siting a suitable number of recording stations in the Pacific Ocean hemisphere.

(*b*) Independent geophysical evidence indicates that the complication of transmission paths for seismic waves are likely to be extreme near such regions compared with wholly continental paths.

(*c*) The theory of oceanic transmission path effects predicts that in the useful band of frequencies the surface wave amplitudes from nuclear explosions may be 2 or 3 times less for similar distance than over wholly continental paths.

5. Other matters which require further thought and study in the context of using national means to monitor a nuclear test ban are:

(*a*) The degree to which signals may be mixed when events take place almost simultaneously. The Canadian study found 8, or 5 per cent of such events.

(*b*) There are problems with the organization and discipline of national seismic systems, which in this particular study resulted in a gross total of 25 per cent of the data being lost. The continuity and reliability of a few stations covered this loss, but in the context of a comprehensive test ban greater reliability of the network as a whole may be required. Anyone who commonly uses the data of standard stations is aware that those from some stations may not be received for a year or more after the date of the event. This is a field in which improvements in the quality and accessibility of the seismic data could result from appropriate political decisions.

(*c*) The Canadian study was completed by two seismologists who between them have nearly 20 man-years of experience in reading seismograms with a special reference to the discrimination problem; small signals, which less experienced analysts would have missed, were observed and measured. The need for creating an experienced cadre of analysts for monitoring systems is again one which could be stimulated by the various countries concerned.

6. There is no doubt that, as the Canadian working paper suggests, for a moderate expenditure significant improvements could be made in the existing network. Indeed those improvements, designed to give greater reliability, precision and recording quality, would give better value for the present-day level of expenditure. The use of magnetic tape, in place of the standard station photographic recording, would provide opportunities for the application of well-established processes to enhance explosion and earthquake signals at the expense of the background noise.

7. What remains in doubt is the degree to which the identification threshold of the standard network can be lowered by these methods. The Canadian figure of 5 to 10 kilotons should be compared with that of 3 to 6 kilotons estimated for the identification threshold of the specially deployed network simulated in the United Kingdom working paper CCD/296. The base-line for this simulation was the SIPRI conference figure of 20 to 60 kilotons. If the results of the Canadian study were to be used instead, the difficulties experienced in detecting the smaller R waves would be reduced, so smaller long-period seismometer arrays might suffice; this requires further thought and a detailed study of the scientific paper on which the working paper is based. However, it is difficult, at the moment, to believe that long-period arrays could be dispensed with altogether. There are two principal difficulties:

(*a*) If the magnification of the standard long-period seismometers is increased, both the signal and the background noise, including noise induced by minute atmospheric pressure and temperature changes, is enhanced. The better standard stations would experience no improvement in the ratio of signal-to-noise amplitudes. In the expanded array system described in the United Kingdom working paper advantage would be taken of new seismometers, which are sealed against environmental effects (other than ground motion), and of array processing methods to reduce earth-induced noise relative to signals from seismic events.

(*b*) As the sensitivity (and therefore the number of events recorded) at a receiving station are increased, so will the chance of signals interfering (overlapping in time) with one another be greater. An array provides the possibility of reducing this chance by tuning in the signal of interest at the expense of the second.

8. Since the informal meeting of last August the United Kingdom Atomic Energy Authority, with the co-operation of the Bhabha Atomic Research Centre, has assisted in establishing a long-period array in southern India; through the good offices of the Defence Research Institute of Sweden, the Authority now receives recordings from the Institute's long-period array; and with the help of Canadian authorities recordings are received from the Canadian long-period array. Long-period data from the Warramunga array in Australia are also expected. With these, as well as data recorded in the United Kingdom for experimental background, the United Kingdom delegation may be in a position to comment in due course on these two problems, as well as on the physical basis and reliability of the method for calculating surface wave magnitudes, which have been such a feature of the improvements presented in the Canadian paper.

9. The Canadian study has demonstrated that, for a given technical threshold, defined as the magnitude of a seismic event which gives the minimum number of recordings required to locate and identify the event, the measurements required to apply the identification criteria are relatively simple to make at each standard station.

10. If these stations were to be improved by installing tape recording, the analysis procedure would not be so straightforward; some degree of electronic processing would be necessary before the seismogram could be made visible for measurement. With array stations, the complexities involved in handling data and optimum processing would multiply. The United Kingdom paper suggested that by employing a small computer each station should be able to provide for itself the "best" seismogram for every event recorded and subsequently to make the simple measurements required for the criteria.

11. A research group in the United Kingdom has been studying practical ways of realizing a system of this kind. During the past year the group has received material assistance from colleagues in Canada and Australia who have built similar systems for laboratory use. The principal problems seem to have been solved and an idea has emerged of the kind of computer which would be required. Furthermore it appears that this computer would cost approximately half that estimated in the United Kingdom paper. If the less conservative Canadian estimates on the detection of R waves are also confirmed, the monitoring network described in the working paper might well be established for significantly less than the estimate of $15 million made last year.

12. With regard to the "decoupling" of seismic signals by dry alluvium relative to other common rock materials, the Canadian study has confirmed that for these and other reasons concerned with the handling of enormous numbers of small events and the increasing number of cases in which smaller events are obscured by larger events, the conclusion in paragraph 27 of the United Kingdom working paper remains valid; namely, because discrimination criteria for low magnitude events ($m_b 4 - m_b 4\frac{1}{2}$) are not yet proven, and because in the larger countries signals from explosions of about 10 kilotons and less, fired in dry alluvium, may not be detected by the external portion of the network, there would be little point in defining a more elaborate and costly seismic data system than that described in the United Kingdom working paper.

33.

Argentina, Brazil, Burma, Egypt, Ethiopia, India, Mexico, Morocco, Nigeria, Pakistan, Sweden and Yugoslavia: joint memorandum on the prohibition of the development, production and stockpiling of chemical weapons and on their destruction

[*CCD/352 of 28 September 1971*]
[*Original: English*]

In the joint memorandum of the group of 12 members of the Conference of the Committee on Disarmament on the question of chemical and bacteriological (biological) methods of warfare (CCD/310)[66], the group expressed the following views:

(i) It is urgent and important to reach agreement on the problem of chemical and bacteriological (biological) methods of warfare;

(ii) Both chemical and bacteriological (biological) weapons should continue to be dealt with together in taking steps towards the prohibition of their development, production and stockpiling and their effective elimination from the arsenals of all States;

(iii) The issue of verification is important in the field of chemical and bacteriological (biological) weapons, as indeed adequate verification is also essential in regard to the success of any measures in the field of disarmament. Reasonable guarantees and safeguards should, therefore, be devised to inspire confidence in the implementation of any agreement in the field of chemical and bacteriological (biological) weapons. Verification should be based on a combination of appropriate national and international measures, which would complement and supplement each other, thereby providing an acceptable system which would ensure effective implementation of the prohibition.

This basic approach was commended by the General Assembly of the United Nations in its resolution 2662 (XXV).

The group of 12 members of the Conference of the Committee on Disarmament has taken note of subsequent developments in the negotiations, as a result of which it would only seem possible, at the present stage, to elaborate a convention on the prohibition of bacteriological (biological) and toxin weapons and on their destruction. However, the group wishes to emphasize the immense importance and urgency of reaching agreement on the elimination of chemical weapons as well.

Bearing in mind the recognized principle of the elimination of chemical weapons, as well as the firmly expressed commitment to continue negotiations in good faith until early agreement is reached on effective measures for the prohibition of the development, production and stockpiling of chemical weapons and on their destruction, the group offers the following elements on which such negotiations should be based:

1. An obligation to prohibit the development, production, stockpiling, acquisition and retention of chemical agents of types and in quantities that will be defined in future agreed provisions, and weapons using such chemical agents as well as equipment or means of delivery designed to facilitate the use of such agents or weapons;

2. An undertaking not to assist, receive, encourage or induce any State, group of States or international organizations in the above mentioned prohibited activities;

3. An undertaking to destroy or convert to peaceful uses, taking all necessary safety precautions, all chemical agents, weapons, equipment or means of delivery and facilities specially meant for the development, production and stockpiling or for using such agents or weapons;

4. An undertaking to disband and not to establish anew special military or other forces employed to use chemical agents or weapons;

5. The problem of verification should be treated in accordance with the suggestions contained in the joint memorandum of the group of 12 members of the Conference of the Committee on Disarmament;

6. A clear understanding whereby future agreed provisions for the prohibition of the development, production and stockpiling of chemical weapons are not to be interpreted as in any way limiting or detracting from the obligations assumed by the Parties under the Geneva Protocol of 1925;[67]

7. Future agreed provisions should be implemented in a manner designed to avoid hampering the research, development, production, possession and application of chemical agents for peaceful purposes or hindering the economic or technological development of States Parties;

8. An undertaking to facilitate the fullest possible exchange of chemical agents, equipment, material and scientific and technological information for the use of such chemical agents for peaceful purposes;

9. A recognition of the principle that a substantial portion of the savings derived from measures in the field of disarmament should be devoted to promoting economic and social development, particularly in the developing countries.

The group is firmly convinced that the Conference of the Committee on Disarmament should proceed with the task of elaborating, as a high priority item, agreed provisions for the prohibition of the development, production and stockpiling of chemical weapons.

The group finally expresses the hope that the elements suggested in the preceding paragraphs will receive general acceptance so that early agreement can be reached on the complete prohibition of the development, production and stockpiling of chemical weapons and on their effective elimination from the arsenals of States.

34.

Burma, Egypt, Ethiopia, Mexico, Morocco, Nigeria, Pakistan, Sweden and Yugoslavia: joint memorandum on a comprehensive test-ban treaty

[*CCD/354 of 30 September 1971*]
[*Original: English*]

The delegations of Burma, Egypt, Ethiopia, Mexico, Morocco, Nigeria, Pakistan, Sweden and Yugoslavia are deeply concerned at the fact that it has still not been possible to reach agreement on a comprehensive ban of nuclear weapon tests.

This matter has been the object of many years' work. As early as 1959 the question of the suspension of nuclear and thermonuclear tests was included in the agenda of the United Nations General Assembly. Since then resolutions on the urgent need of such suspension have been adopted by the Assembly each year.

In 1962 the General Assembly condemned all nuclear weapon tests and asked that they cease immediately and not later than 1 January 1963.[68] The eight-nation joint memorandum of 16 April 1962[69] was endorsed as a basis for negotia-

[66] *Ibid.*, sect. 39.

[67] Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare (League of Nations, *Treaty Series*, vol. XCIV (1929), No. 2138).

[68] Resolution 1762 A (XVII).

[69] *Official Records of the Disarmament Commission, Supplement for January 1961 to December 1962*, document DC/203, annex 1, sect. J.

tions. The eight non-aligned members of the Conference of the Eighteen-Nation Committee on Disarmament presented several such joint memoranda outlining their views on this matter between 1962 and 1968.

In the Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and under Water,[70] the three nuclear-weapon Powers parties to the Treaty committed themselves to seek to achieve the discontinuance of all test explosions of nuclear weapons for all time and to continue negotiations to that end.

In its latest resolution on the subject, resolution 2663 B (XXV) of 7 December 1970, the General Assembly urged all States that had not yet done so to adhere without further delay to the partial test-ban Treaty of 1963 and again called upon all nuclear-weapon States to suspend nuclear weapon tests in all environments.

The General Assembly in the same resolution requested the Conference of the Committee on Disarmament to continue, as a matter of urgency, its deliberations on a treaty banning underground nuclear weapon tests and to submit to the Assembly at its twenty-sixth session a special report on the results of these deliberations. The Secretary-General of the United Nations, in his letter to the Co-Chairman of the Conference of the Committee on Disarmament, dated 16 February 1971 (see sect. 1 above), wished to draw attention, in particular, to this mandate.

The nine delegations again want to call to serious attention the fact that not all the nuclear-weapon States have adhered to the partial test-ban Treaty yet and that nuclear weapon tests are still carried out in the atmosphere. They are also gravely concerned that nuclear weapon tests—some of great magnitude—are continued underground by parties to the partial test-ban Treaty, an activity contrary to the expectation of world opinion and inconsistent with the aim of that Treaty. It must be recalled that the prospects of an early banning of nuclear weapon tests in all environments was held out by the nuclear-weapon States as their contribution to the halting of the nuclear arms race, complementing the commitment of non-nuclear-weapon States in the Treaty on the Non-Proliferation of Nuclear Weapons[71] not to acquire nuclear weapons.

Attention has been drawn earlier to the fact that underground tests have led to leakages of radioactive debris outside the territorial limits of testing States. The nine delegations wish to underline that even an occurrence of such radioactivity, which does not generate health hazards, still constitutes an infringement of the partial test-ban Treaty. They understand that such releases have continued to occur, thus resulting in an undesirable weakening of the integrity of the partial test-ban Treaty.

[70] United Nations, *Treaty Series*, vol. 480 (1963), No. 6964.
[71] General Assembly resolution 2373 (XXII), annex.

The nine delegations express the hope that the bilateral negotiations between the United States and the USSR on the limitation of strategic arms will very soon bring about a first positive result and thereby pave the way for immediate further efforts in the field of nuclear disarmament. An agreement on a comprehensive test ban could in its turn have a positive influence upon the continued bilateral negotiations between the United States and the USSR on the limitation of strategic arms. Such an agreement is in fact indispensable for halting the politically devastating and economically wasteful qualitative arms race in the nuclear sphere and for creating the necessary climate for further measures of disarmament.

The nine delegations note with satisfaction the scientific progress taking place in the field of seismology. Considerable attention has been devoted in the Conference of the Committee on Disarmament to the technical aspects of the verification of a ban on underground nuclear weapon tests. The nine delegations are convinced that the verification problem could be resolved on the basis of national means, i.e., remote control supplemented and improved upon by international co-operation and procedures. The two methods complement each other. An adequate international exchange of seismological data from national stations should be promoted by concrete measures in order to facilitate such a solution of the verification problem. Such measures, coupled with a withdrawal clause and provisions for relatively frequent review conferences, should ensure that the required deterrence level is obtained.

The nine delegations affirm the benefits of the applicatio[n] of nuclear technology for peaceful purposes to all countries and are of the opinion that the peaceful application of nuclear explosives needs to be regulated. The International Atomic Energy Agency should play an important role in this context.

The nine delegations ardently desire to see an immediate and comprehensive prohibition of all nuclear weapon tests. Such tests endanger the existence of all treaties concluded so far in the nuclear disarmament field, as well as the continued disarmament negotiations. Renewed and urgent efforts must thus be made to conclude a treaty banning underground nuclear weapon tests, whereby the partial test-ban Treaty will be completed. Both treaties should be adhered to by all nuclear-weapon States.

The nine delegations particularly expect the testing nuclear-weapon States to give priority to this question and to take an active and constructive part in working out a treaty banning underground nuclear weapon tests. They note that concrete proposals and suggestions relating to such a treaty have been made by several members of the Conference of the Committee on Disarmament, including some members of th[e] group of twelve. They request that the nuclear-weapon State[s] submit their own proposals as a matter of urgency, so that purposeful negotiations can be undertaken immediately.

ANNEX D

List of verbatim records of the meetings of the Conference of the Committee on Disarmament

CCD/PV.495-516 (23 February-13 May 1971): records of the 495th to 516th meetings.

CCD/PV.517-544 (29 June-30 September 1971): records of the 517th to 544th meetings

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26693—January 1973—1,750