REPORT

OF THE

CONFERENCE OF THE

COMMITTEE ON DISARMAMENT

VOLUME II

GENERAL ASSEMBLY

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NOTE

Symbols of the United Nations documents are composed of capital letters combined with figures. Mention of such a symbol indicates a reference to a United Nations document.

The present volume contains annex II to the report of the Conference. The report and annexes I, III and IV appear in volume I.

/Original: English/Russian/
Spanish/

/10 October 1977/

ANNEX II

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

CCD/511/Rev.1
8 August 1977

Original: Russian

UNION OF SOVIET SOCIALIST REPUBLICS

Revised draft agreement on the prohibition of the development and manufacture of new types of weapons of mass destruction and new systems of such weapons

The States Parties to this Agreement,

Guided by the interests of strengthening international peace and security,

Desiring to contribute to the cause of saving mankind from the danger of the use of new means of warfare, limiting the arms race and bringing about disarmament,

Recognizing that modern science and technology have reached a level where a serious danger arises of the development of new, still more destructive types of weapons of mass destruction and of new systems of such weapons,

Conscious that the development and manufacture of such weapons are fraught with the most serious consequences for the peace and security of nations,

Bearing in mind that recent years have seen the conclusion of a number of important agreements concerning limitation of the arms race and disarmament, including those relating to the prohibition of weapons of mass destruction,

Expressing the profound interest of States and peoples in the adoption of measures to prevent the use of the achievements of modern science and technology for the development and manufacture of the above-mentioned weapons of mass destruction,

Desiring to promote the strengthening of confidence among nations and the further improvement of the international situation,

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

Having agreed as follows:

Article I

1. Each State Party to this Agreement undertakes not to develop or manufacture new types of weapons of mass destruction or new systems of such weapons.

For the purposes of this Agreement, the expression "new types and new systems of weapons of mass destruction" includes weapons which may be developed in the future, either on the basis of scientific and technological principles that are known now but that have not yet been applied severally or jointly to the development of weapons of mass destruction or on the basis of scientific and technological principles that may be discovered in the future, and which will have properties similar to or more powerful than those of known types of weapons of mass destruction in destructive and/or injuring effect.

The list of types and systems of weapons of mass destruction to be prohibited by this Agreement is contained in the Annex to the Agreement.

2. In the event that new areas of development and manufacture of weapons of mass destruction and systems of such weapons not covered by this Agreement emerge after the entry into force of the Agreement, the Parties shall conduct negotiations with a view to extending the prohibition provided for by this Agreement to cover such potential new types and systems of weapons.

3. States Parties to the Agreement may, in cases where they deem it necessary, conclude special agreements on the prohibition of particular new types and systems of weapons of mass destruction.

4. Each State Party to this Agreement undertakes not to assist, encourage or induce any other State, group of States or international organization to engage in activities contrary to the provisions of paragraph 1 of this article.

Article II

Each State Party to this Agreement undertakes, in accordance with its constitutional procedures, to take the necessary measures to prohibit and prevent any activity contrary to the provisions of this Agreement within the territory of such State, under its jurisdiction or under its control anywhere.

Article III

1. In the event that any State Party to this Agreement has any suspicions that another State Party has violated the provisions of this Agreement, the parties concerned undertake to consult one another and to co-operate in solving the problems which arise.

2. If the consultations referred to in paragraph 1 of this article fail to produce results mutually acceptable to the parties concerned, the State which has such suspicions may lodge a complaint with the Security Council of the United Nations. Such complaint shall include evidence confirming its validity and a request for its consideration by the Security Council.

3. Each State Party to this Agreement 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 Agreement of the results of the investigation.

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

Article IV

1. Nothing in this Agreement shall be interpreted as affecting the inalienable right of all the States Parties to the Agreement to develop and use scientific research and discoveries exclusively for peaceful purposes without any discrimination.

2. The States Parties to this Agreement undertake to facilitate scientific and technological co-operation in the use of the latest achievements and discoveries of science and technology for peaceful purposes.

Article V

Each State Party to this Agreement undertakes to pursue in a spirit of good will negotiations on effective measures to limit the arms race in all its forms and put an end to it, and also on a treaty on general and complete disarmament under strict and effective international control.

Article VI

1. Any State Party may propose amendments to this Agreement. Each proposed amendment shall be submitted to the depositary Governments and circulated by them to all Parties to the Agreement, which shall inform the depositary Governments of the acceptance or rejection of the amendment as soon as possible after its receipt.

2. The amendment shall enter into force for each State Party accepting the amendment upon its acceptance by a majority of the States Parties to the Agreement, including the depositary Governments, and thereafter for each remaining State Party on the date of its acceptance of the amendment.

Article VII

1. This Agreement shall be of unlimited duration.

2. Each State Party to this Agreement shall, in the exercise of its State sovereignty, have the right to withdraw from the Agreement if it decides that extraordinary circumstances related to the subject-matter of the Agreement have

jeopardized its supreme interests. It shall give notice of such withdrawal to all other States Parties to the Agreement and to the Security Council of the United Nations three months in advance. Such notice shall include a statement of the extraordinary circumstances which it regards as having jeopardized its supreme interests.

Article VIII

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

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

3. This Agreement shall enter into force after the deposit of instruments of ratification by ..... Governments, including the Governments designated the Governments depositaries of the Agreement.

4. For States whose instruments of ratification or accession are deposited subsequent to the entry into force of this Agreement, 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 accession and the date of the entry into force of this Agreement, and of the receipt of other notices.

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

Article IX

This Agreement, 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 Agreement 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 Agreement.

DONE in ..... copies, at ..... on the ..... day of ....., ...

ANNEX TO THE AGREEMENT

An approximate list of types and systems of weapons of mass destruction covered by the Agreement on the prohibition of the development and manufacture of new types of weapons of mass destruction and new systems of such weapons

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The following types and systems of weapons shall be prohibited by the Agreement on the prohibition of the development and manufacture of new types of weapons of mass destruction and new systems of such weapons:

(1) Radiological means of the non-explosive type acting with the aid of radioactive materials.

(2) Technical means of inflicting radiation injury based on the use of charged or neutral particles to affect biological targets.

(3) Infrasonic means using acoustic radiation to affect biological targets.

(4) Means using electromagnetic radiation to affect biological targets.

This list of types and systems of weapons to be prohibited may be supplemented as necessary.

LETTER DATED 28 JANUARY 1977 FROM THE SECRETARY-GENERAL OF THE UNITED NATIONS TO THE CO-CHAIRMAN OF THE CONFERENCE OF THE COMMITTEE ON DISARMAMENT TRANSMITTING THE RESOLUTIONS ON DISARMAMENT ADOPTED BY THE GENERAL ASSEMBLY AT ITS THIRTY-FIRST SESSION

I have the honour to transmit herewith the following resolutions adopted by the General Assembly at its thirty-first session, which entrust specific responsibilities to the Conference of the Committee on Disarmament: resolution 31/65, "Chemical and bacteriological (biological) weapons"; resolution 31/66, "Urgent need for cessation of nuclear and thermo-nuclear tests and conclusion of a treaty designed to achieve a comprehensive test ban"; resolution 31/68, "Effective measures to implement the purposes and objectives of the Disarmament Decade"; resolution 31/72, "Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques"; and resolution 31/74, "Prohibition of the development and manufacture of new types of weapons of mass destruction and new systems of such weapons".

I would like to draw your attention, in particular, to the following specific provisions contained in these resolutions:

(a) In resolution 31/65, operative paragraph 3 requests the Conference of the Committee on Disarmament to continue negotiations as a matter of high priority, taking into account the existing proposals, with a view to reaching early agreement on effective measures for the prohibition of the development, production and stockpiling of all chemical weapons and for their destruction; and operative paragraph 6 requests the Conference of the Committee on Disarmament to report on the results of its negotiations to the General Assembly at its thirty-second session.

(b) In resolution 31/66, operative paragraph 6 urges the Conference of the Committee on Disarmament to continue to give the highest priority to the conclusion of a comprehensive test ban agreement and to report to the General Assembly at its thirty-second session on the progress achieved.

(c) In resolution 31/68, operative paragraph 7 urges the Conference of the Committee on Disarmament to adopt, during its 1977 session, a comprehensive programme dealing with all aspects of the problem of the cessation of the arms race

and general and complete disarmament under strict and effective international control, in accordance with General Assembly resolution 2602 E (XXIV) proclaiming the Disarmament Decade.

(d) In resolution 31/72, operative paragraph 4 calls upon the Conference of the Committee on Disarmament, without prejudice to the priorities established in its programme of work, to keep under review the problem of effectively averting the dangers of military or any other hostile use of environmental modification techniques.

(e) In resolution 31/74, operative paragraph 1 requests the Conference of the Committee on Disarmament to continue the negotiations, with the assistance of qualified governmental experts, aimed at working out the text of an agreement on the prohibition of the development and manufacture of new types of weapons of mass destruction and new systems of such weapons and to submit a report on the results achieved to the General Assembly for consideration at its thirty-second session.

Furthermore, the General Assembly, in operative paragraph 6 of resoltuion 31/70, entitled "Comprehensive study of the question of nuclear-weapon-free zones in all its aspects", decided to convey the comprehensive study and the report of the Secretary-General related thereto, inter alia, to the Conference of the Committee on Disarmament for the further consideration and measures that it may deem appropriate within its field of competence.

The General Assembly, in the above-mentioned resolutions 31/65, 72 and 74, also requested the Secretary-General to transmit to the Conference of the Committee on Disarmament all the relevant documents and records. They are the following:

Resolution 31/65: A/31/27, A/C.1/31/PV.20-40, 42, A/C.1/31/L.13, A/31/373, A/31/PV.96.

Resolution 31/72: A/31/27, A/C.1/31/L.4, L.4/Rev.1, A/C.1/31/8, A/C.1/31/L.5, L.5/Rev.1, L.5/Rev.2 and Corr.1, L.5/Rev.3, A/C.1/31/PV.20-44, 50-51, A/31/382, A/31/PV.96.

Resolution 31/74: A/31/27, A/C.1/31/L.10, L.10/Rev.1, L.10/Rev.2, A/C.1/31/PV.20-39, 41, 46-47, A/31/385, A/31/PV.96.

The relevant documents and records in connexion with the other resolutions are the following:

Resolution 31/66: A/31/27, A/C.1/31/L.15, A/C.1/31/PV.20-39, 42, 44, A/31/374, A/31/PV.96.

Resolution 31/68: A/31/27, A/C.1/31/L.14, A/C.1/31/PV.20-39, 41, 44, A/31/378, A/31/PV.96.

Resolution 31/70: A/10027/Add.1, A/31/189 and Add.1 and 2, A/C.1/31/L.8, A/C.1/31/PV.20-39, 44, 47, A/31/380, A/31/PV.96.

All these documents and records were distributed during the thirty-first 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 Conference of the Committee on Disarmament, the following resolutions adopted by the General Assembly at its thirty-first session which deal with disarmament matters: resolution 31/64, "Incendiary and other specific conventional weapons which may be the subject of prohibitions or restrictions of use for humanitarian reasons"; resolution 31/67, "Implementation of General Assembly resolution 3467 (XXX) concerning the signature and ratification of Additional Protocol II of the Treaty for the Prohibition of Nuclear Weapons in Latin America (Treaty of Tlatelolco)"; resolution 31/69, "Implementation of the Declaration on the Denuclearization of Africa"; resolution 31/71, "Establishment of a nuclear-weapon-free zone in the region of the Middle East"; resolution 31/73, "Establishment of a nuclear-weapon-free zone in South Asia"; resolution 31/75, "Implementation of the conclusions of the first Review Conference of the Parties to the Treaty on the Non-Proliferation of Nuclear Weapons"; resolution 31/87, "Reduction of military budgets"; resolution 31/88, "Implementation of the Declaration of the Indian Ocean as a Zone of Peace"; resolution 31/89, "Conclusion of a treaty on the complete and general prohibition of nuclear-weapon tests"; resolution.31/90, "Strengthening of the role of the United Nations in the field of disarmament"; resolution 31/189, "General and complete disarmament"; and resolution 31/190, "World Disarmament Conference".

I also wish to call attention to the following resolutions which are related to disarmament matters: resolution 31/9, "Conclusion of a world treaty on the non-use of force in international relations"; resolution 31/11, "Report of the International Atomic Energy Agency"; resolution 31/19, "Respect for human rights in armed conflicts"; and resolution 31/92, "Implementation of the Declaration on the Strengthening of International Security".

Copies of these resolutions are attached.

Accept, Sir, the assurances of my highest consideration.

(Signed) Kurt Waldheim
Secretary-General

/For the text of the above-mentioned resolutions, see Official Records of the General Assembly, Thirty-first Session, Supplement No. 39./

CCD/522
15 February 1977
Original: Russian

UNION OF SOVIET SOCIALIST REPUBLICS

Memorandum of the Soviet Union on questions of ending the arms race and disarmament

Under the new historic conditions in which international détente is making itself felt to an ever-greater degree and people everywhere entertain increasing hopes for the establishment of lasting peace, the Soviet Union, guided by the foreign policy programme of the 25th Congress of the CPSU, renews its appeal to all States Members of the United Nations, to all the States of the world, to redouble their efforts towards solving the problem which is greatest in scope and significance in contemporary relations among States -- the problem of ending the arms race and disarmament.

No task confronting mankind today is more urgent. "Today, this objective is more vital than ever", declared L.I. Brezhnev, General Secretary of the Central Committee of the CPSU. "Mankind is tired of sitting upon mountains of arms, yet the arms race, spurred on by aggressive imperialist circles, is becoming more intensive."

An arms race in the nuclear age is fraught with a far more serious threat to the life of the peoples than at any time in the past. Modern weapons are thousands of times more powerful than any of those used in wars of earlier periods. The destruction of Hiroshima -- the first victims of the use of nuclear weapons - lives in the memory of the peoples as a horrible tragedy. But nowadays States possess such types of these weapons and possess them in such quantities that hundreds, and even thousands, of cities like Hiroshima could be destroyed. One modern nuclear warhead has a destructive power exceeding that of all explosives used by States in the Second World War. Yet weapons of mass destruction continue to develop, absorbing the latest achievements of the scientific and technological revolution, and they are ever growing in quantity.

It is an utterly false concept which justifies the arms race by alleging that the "balance of fear" is indeed a safeguard for peace. An official report by United Nations experts, world famous scholars, admits with full justice that each new step in the development of weapons of mass destruction entails a new and still more ominous degree of uncertainty and increased danger. The arms race provides security for no one.

Another thing is also obvious. If the arms race is not stopped, it will inevitably set up a barrier to the strengthening of political détente in relations between States. This is why an increasing number of States recognize the need for supplementing political détente with efforts towards reducing military confrontation and facilitating disarmament. The States that participated in the Conference on Security and Co-operation in Europe unanimously came out in favour of such a policy.

The arms race is inconsistent with the interests and the will of the peoples. Only the militarists and the military-industrial complex stand to gain from it. The arms race consumes the vital resources of countries and deprives the peoples of a considerable and ever-growing proportion of the wealth created by their labour. According to United Nations data, the world as a whole now spends about $300 billion a year on armaments, i.e., $1 million every two minutes. This considerably exceeds the entire national income of the developing countries of Asia and Africa. In the modern world, it costs on the average 60 times less to educate a child for creative endeavour than to teach a soldier the ABC's of destruction. And more and more States are being drawn into the arms race.

The continuance of the arms race hampers the solution of such urgent problems common to all mankind as the development of essentially new sources of energy, extensive exploration and use of the oceans and outer space, prevention of disastrous changes in the environment, and the eradication of disease, hunger and cultural backwardness. For all this to be done, enormous investments are needed, and it is impossible to mobilize sufficient resources without putting an end to the competition in armaments.

Thus, the problem confronting mankind today is as follows: either the arms race will be stopped and States will embark on disarmament, reducing step by step the threat of military conflict and releasing more and more material and intellectual resources for the purposes of economic and social development, or the gigantic war-preparations machine will consume an ever-greater amount of resources vitally needed by people, while the shadow of the catastrophe of war will loom larger and larger over all nations.

For any State desirous of safeguarding the security of its people and of creating the most favourable opportunities for their advancement along the road of progress, for any politician conscious of his responsibility for world developments, and for any sensible person, there can only be one alternative: to do everything that can be done to bring about disarmament and the cessation of the arms race. This is not a simple task, for in working out any measure in the field of disarmament, States have to take decisions on matters having a direct bearing on their national security and must carefully weigh the various political, strategic, technological and military factors. However, it is well known that the failure to put an end to the arms race is not due to these difficulties.

The main obstacle is the resistance of the forces of imperialism. This obstacle finds its principle support in monopolistic quarters for which the arms race brings in thousands of millions of dollars in profits. Another obstacle is the cold-war policy of political parties and groups which will not abandon their foolhardy designs to resolve the historical confrontation of the two social systems by force. Also desirous of impeding the resolution of disarmament problems are those who cynically assert that mankind's future can most easily be built on radioactive ruins, who, in pursuit of the narrow objectives of their great-Power policy, which are alien to the interests of the peoples, are ready to doom even their own people to mass annihilation in another world war.

These forces would not stop at any means of deception in the attempt to complicate the question of the cessation of the arms race and to hamper the struggle of the peoples for disarmament. These include shameless slander directed at the policies of States advocating disarmament, and specious reasoning about the lust for power inherent in man and about human rights and fundamental freedoms, with the aim of covering up the most inhuman and brutal activity of all -- the manufacture of weapons for the annihilation of people.

However, there is not, nor can there be, any doubt about the real possibility of overcoming the opposition of the opponents of disarmament. In these, our times, the alignment of forces in international politics is not at all in their favour. The socialist States, whose social and political character rules out any kind of interest in war and armaments, are resolutely and persistently striving to bring about the cessation of the arms race. The non-aligned movement is also in favour of disarmament. Statesmen and politicians of widely differing countries throughout the world are becoming more keenly aware of the fact that in the nuclear age a military conflict is fraught with exceedingly grave consequences and that the interests of security demand the curbing of the arms race and not its further intensification. The voice of public opinion is becoming louder and more confident in demanding the early adoption of effective measures to this end.

The possibility of solving the disarmament problem has been convincingly demonstrated by the fact that in recent years certain steps of this kind have indeed been taken. Although these are but first steps and are limited in scope, they are of great importance.

These are the Soviet-United States agreements for preventing nuclear war and reducing the risk of its accidental outbreak and for the limitation of strategic arms, as well as the agreement between the Soviet Union and France on the prevention of accidental or unauthorized use of nuclear weapons.

These are the measures for limiting the nuclear arms race, including the treaties on the prohibition of nuclear weapon tests in the atmosphere, in outer space and under water; on the limitation of underground nuclear weapon tests; on the non-proliferation of nuclear weapons; and on the prohibition of the emplacement of nuclear weapons in outer space, on celestial bodies, on the sea-bed and the ocean floor. Talks are now in progress on a long-term Soviet-United States agreement on the limitation of strategic offensive arms, and the successful completion of these talks would be a major new contribution to the consolidation of international peace and security.

These are also the international convention on the prohibition of the development and production and the destruction of stockpiles of bacteriological (biological) and toxin weapons, which is already in force, and the convention on the prohibition of military and any other hostile use of environmental modification techniques, the discussions on which are nearing completion.

And, finally, these are the efforts being made to ease military confrontation in different parts of the world. Of special importance in this connexion are, unquestionably, the negotiations now going on regarding the reduction of armed forces and armaments in Central Europe, the area where the most powerful groups of NATO and Warsaw Treaty armed forces are concentrated. Having recently advanced new proposals aimed at moving these negotiations forward, the participating socialist countries are now expecting reciprocal steps from their counterparts.

The Soviet Union's proposal for the conclusion of a world treaty on the non-use of force in international relations is now getting broad support. The purpose of this initiative is, through the joint effort of States, to make the principle of the non-use of force embodied in the United Nations Charter an integral part of the practical policies of States and an effective rule of international life. The use of both nuclear and conventional weapons should be completely excluded from relations between States.

Thus, at the present time new prerequisites, both political and material, for more resolute progress towards ending the arms race and towards disarmament are now taking shape. In the past, including the years preceding the Second World War and the first post-war decades, such prerequisites did not exist. They do exist now. It is the duty of all States to make the utmost use of them in the interests of international peace and security and in the interest of the peoples.

The Soviet Union is prepared, as it has been in the past, to conduct negotiations on the most radical disarmament measures, going even so far as general and complete disarmament. It is prepared, in concert with its Warsaw Treaty allies, to take steps for the reciprocal dismantling of counterbalancing military-political groupings of States or, to begin with, of their military organizations. If not all parties are prepared to set about realizing these objectives at once, they should do so gradually, step by step. What is most important is to move on from discussions on ending the arms race to practical action.

An analysis of the present world political and strategic situation, of the trends and prospects for the future and of the material and technological factors determining the nature and form of the arms race leads to the conclusion that under present conditions the main areas for co-ordinated action by States in the field of disarmament are the following.

1. Cessation of the nuclear arms race, reduction and subsequent elimination of nuclear weapons

In a situation in which nuclear weapons pose the greatest danger to mankind, complete nuclear disarmament becomes the most important measure.

The Soviet Union has always favoured the banning of nuclear weapons and their exclusion from the arsenals of States. It worked for this when nuclear weapons had just appeared. At that time the stockpiles of such weapons were not large and it was relatively easier to agree on their prohibition and elimination. Now that nuclear weapons have grown into a huge complex of types and systems of means of destruction, diverse in purpose, capacity and ways of delivering nuclear charges to the target, the problem of eliminating them has become much more difficult. But it can be solved in the present situation as well.

The first thing necessary for this purpose is to stop the arms race, that is, to stop manufacturing nuclear weapons, equipping the armed forces of States with them, developing and constructing new models and types of such weapons. At the same time, or immediately after that, reductions in the stockpiles of nuclear weapons should commence, with the transfer of nuclear materials thus released to peaceful sectors of the economy. The ultimate goal of the reduction should be the complete elimination of all types of nuclear weapons — strategic and tactical, offensive and defensive. Along with the reduction of stockpiles of nuclear charges, warheads and bombs, there should be a reduction of their means of delivery.

Naturally, simultaneously with nuclear disarmament, measures should be taken for the limitation and reduction of the armed forces of States and armaments of conventional types, which also pose a considerable threat to the world's peoples.

It is evident that nuclear disarmament can be achieved only if all States possessing nuclear weapons take part in it. It is inconceivable that some nuclear Powers should be moving ahead towards eliminating their nuclear weapons while others are stockpiling and perfecting them. Therefore all nuclear Powers should participate in nuclear disarmament negotiations. As for the Soviet Union, it is prepared, as has been already stated by the Soviet side, to sit down at any time at the negotiating table together with all the other nuclear Powers for a comprehensive discussion of the nuclear disarmament problem in its full scope and for a joint elaboration of concrete ways of its practical solution. The Soviet Union has no objection to non-nuclear Powers also taking part in such negotiations, since all countries and all the peoples of the world are interested in nuclear disarmament.

2. Prohibition of nuclear-weapon tests

An important issue, on the solution of which the cessation of the arms race largely depends, is the prohibition of all nuclear-weapon tests. This problem should be tackled without waiting for the outcome of negotiations on complete nuclear disarmament.

The prohibition of all tests of nuclear weapons will put an end to their qualitative improvement and prevent the emergence of new types of such weapons. The Moscow Treaty banning nuclear-weapon tests in the atmosphere, in outer space and under water and the treaty between the USSR and the United States on the limitation of underground tests have only partially solved this problem. Furthermore, two nuclear Powers out of five have not acceded to the Moscow Treaty, and one of them China, still continues to carry out nuclear test explosions in the atmosphere.

The time has now come to bring the task of stopping nuclear-weapon tests to a conclusion. Conditions are quite ripe for that, in particular as a result of the signing between the USSR and the United States of a treaty on underground nuclear explosions for peaceful purposes, establishing such a procedure for carrying out peaceful explosions as will preclude their use for perfecting nuclear weapons.

As is known, in 1975 the Soviet Union proposed the conclusion of a treaty on the complete and general prohibition of nuclear-weapon tests, that is, a treaty prohibiting the conduct of nuclear test explosions in all environments and by all States. The draft of such a treaty was submitted by the Soviet Union to the United Nations at that time, and a year has already passed since the General Assembly declared itself in favour of holding concrete negotiations to reach agreement on the complete and general prohibition of nuclear-weapon tests. However, owing to the negative stand taken by some nuclear Powers, such negotiations have not started. It is necessary to begin them promptly.

It is a known fact that the question of stopping underground nuclear tests was complicated by certain States which artificially exaggerated the problem of supervision. It was persistently alleged, in particular, that it was impossible without on-site inspections to tell natural seismic phenomena (earthquakes) from similar phenomena caused by underground nuclear explosions, and that therefore, it was impossible to verify whether States were complying with their obligations with regard to the prohibition of underground nuclear-weapon tests. Most experts never accepted that view, believing that national technical means and the international exchange of seismic data were sufficient to verify compliance with a treaty banning underground nuclear-weapon tests. With the development of technology for detecting and identifying seismic phenomena, this view now enjoys practically unanimous support among scientists. However, even now some States suggest providing for the possibility of on-site inspection of actual circumstances if there is doubt as to compliance with obligations to stop underground nuclear tests.

The Soviet Union is convinced that no particular difficulties should arise in elaborating such a compromise basis for an agreement as would ensure a voluntary framework for taking decisions relating to on-site ascertaining of relevant circumstances and, at the same time, impart confidence to all parties to the treaty that the obligations are complied with. The Soviet Union stands ready to participate in a search for a universally acceptable understanding on this basis.

3. Consolidation of the régime of non-proliferation of nuclear weapons

It is quite clear that the threat of nuclear war would immeasurably increase if other States which at present do not possess nuclear weapons were to become involved in the process of developing and stockpiling such weapons. It is not difficult to imagine the consequences that would be brought about by the development of a situation in which the arsenals of parties in conflict in one region or another included nuclear weapons as well.

Hence the effective prevention of a further spread of nuclear weapons is essential. The Treaty on the Non-Proliferation of Nuclear Weapons, to which about 100 States have become parties, has achieved a great deal in this regard. The obligation to renounce the proliferation of nuclear weapons is now a rule of international law.

It must, however, be taken into account that not all nuclear Powers have yet become parties to the Treaty on the Non-Proliferation of Nuclear Weapons. Some non-nuclear States which are capable, in view of their industrial and technological level, of developing nuclear weapons of their own are also refusing to become parties to it. It is important, therefore, to make the Treaty on the Non-Proliferation of Nuclear Weapons genuinely universal. The Soviet Union supports all the decisions adopted in this respect by the United Nations.

In the interests of consolidating the régime of non-proliferation of nuclear weapons it is also necessary to take actions of another kind. It is well known that in the process of their operation nuclear power plants produce and accumulate as a "by-product" a fissionable material -- plutonium -- which can be used for manufacturing nuclear weapons. With the development of international trade in nuclear materials, equipment and technology, possibilities of this kind will increase, including those of the States which have not assumed obligations under the Treaty on the Non-Proliferation of Nuclear Weapons. It is obvious that the States which supply nuclear materials, equipment and technology bear special responsibility in this connexion. Strict safeguards are needed to prevent international co-operation in the field of peaceful uses of nuclear energy from becoming a channel for spreading nuclear weapons. This is not a question of commerce but a question of policy, a question of international security.

The Soviet Union is also firmly in favour of perfecting in every possible way the system of supervision over nuclear installations and materials that is exercised by the International Atomic Energy Agency. It is ready to co-operate with all interested States to this end.

4. Prohibition and destruction of chemical weapons

Following the conclusion of the convention banning bacteriological weapons, the task of completely prohibiting and eliminating another dangerous category of weapons of mass destruction -- chemical weapons -- has become especially pressing. The use of such weapons as far back as the years of the First World War caused grave suffering and mass deaths. Since that time, however, chemical warfare technology has made great strides. New types of chemical weapons threatening people with still more agonizing death have been developed. Radical improvements have also been made in the means of delivery of chemical weapons, which can now be used not only in combat areas, that is, against the armed forces of the other side, but also against the civilian population in vital centres of States.

The Soviet Union, together with many other countries, has long proposed that agreement should be reached on the prohibition and elimination of all chemical means of warfare. This problem should be solved radically and by a single action, as was the case with bacteriological weapons. However, the negotiations on this subject, which have already been going on for several years, still fail to offer prospects of such a comprehensive solution. A question that arises in this connexion concerns the possibility of starting with agreement on the prohibition and elimination of the most dangerous, lethal types of chemical weapons. The Soviet Union is ready to seek such a solution as well. A substantial contribution to this end could be the implementation of the Soviet-United States accord on a joint initiative to conclude a convention on the most dangerous, lethal chemical means of warfare.

Supervision of compliance with the prohibition of chemical weapons should be based on national means. In this respect there exists a positive precedent in the convention banning bacteriological weapons. At the same time, the Soviet Union is ready to examine the possibility of using additional supervision procedures and, in particular, to discuss methods of verifying the destruction of stockpiles of chemical weapons which are to be excluded from the arsenals of States.

There is not, and there cannot be, any reason for delay on the question of banning chemical weapons. What is needed is a demonstration of the political will and desire to reach generally acceptable agreement.

5. Prohibition of the development of new types and new systems of weapons of mass destruction

Scientific and technological progress poses the pressing problem of preventing the emergence of new types and systems of weapons of mass destruction. New types of weapons may appear even in the foreseeable future and may become commensurate in destructive capability with nuclear, chemical or bacteriological weapons, or even surpass them.

At present there are no limitations whatsoever on the use of science for such purposes. This means that the most unexpected developments, whose consequences cannot be foreseen, may occur at any time. The danger is great, and it is necessary to find means to avert it.

It was precisely these considerations that guided the Soviet Union when it proposed in 1975 the conclusion of an international agreement which would prevent the development and manufacture of new types and systems of weapons of mass destruction. As is known, negotiations in this matter are already under way, which is a positive factor. In the course of the negotiations it has become desirable to specify the object of the prohibition, that is, define new types and new systems of weapons of mass destruction.

The Soviet Union is ready to propose an approach which would include among new types of weapons of mass destruction any types of weapons based on qualitatively new principles of action -- according to the method of use and the targets to be attacked or the nature of their impact. Some examples are ray weapons capable of affecting blood and intracellular plasma, infrasound weapons designed to damage internal organs and affect human behaviour, or genetic weapons whose use would affect the mechanism of heredity. If we take into account the fact that the forward march of science never stops, it is not difficult to realize that possibilities for the development of even more dangerous types of weapons may emerge in the future.

New systems of weapons of mass destruction should not be developed either for new types of such weapons or for those types of weapons which are based on scientific principles already in use but whose characteristics can be made even more dangerous by introducing new technical elements of combat or support means. In this context, aero-space systems of nuclear weapons using transport space ships as a basis may serve as an example.

The question of the prohibition of the development of new types and new systems of weapons of mass destruction is an important and timely one; it embraces an essential aspect of the whole problem of disarmament and prevention of war. Negotiations on this question should be given top priority.

6. Reduction of armed forces and conventional armaments

Nuclear and other types of weapons of mass destruction unquestionably pose the greatest threat to mankind. But can anyone forget how many millions of human lives have been lost as a result of the use of so-called conventional armaments? Even in the period since the Second World War the destructive power of these weapons has increased manyfold. A modern tank is a weapon many times more deadly than a tank of the 1940s. The same is true of artillery, small arms and, of course, aircraft.

The military conflicts which have taken place in various parts of the world in recent years have shown the tragic consequences for people of the use of new models of conventional weapons and the vast destruction of material values which they cause.

Thus, past experience confronts States with the task of taking practical measures to reduce the number of aircraft, artillery, tanks and other modern types of conventional armaments as well as armed forces equipped with those weapons. Since the Second World War, the Soviet Union has repeatedly made concrete proposals in this regard. It has cited specific figures for ceilings on the strength of the armed forces of major States and has expressed willingness to conduct negotiations on the matter both within the framework of a programme of general complete disarmament and as a separate measure covering major States. These proposals have not been accepted. Even now, however, the Soviet Union is prepared to conduct negotiations on the reduction of armed forces and armaments. Given a desire for this on the part of all States possessing powerful armed forces, such negotiations could lead to positive results and to constructive agreements.

Similarly, the Soviet Union considers it desirable that new efforts should be made at the international level to bring about the elimination of all military bases in foreign territory and the withdrawal of foreign troops from such territory. The United Nations has, in many of its forums, expressed itself in very definite terms in favour of a solution to this problem both on a global scale and in relation to individual continents. However, no progress has been made in this regard -- a fact which cannot but cause concern. The Soviet Union is, as before, prepared to co-operate actively and constructively in solving this problem.

7. Zones of peace in the Indian Ocean and other regions

In recent years, States in various parts of the world have been ever more insistent in raising the question of carrying out regional measures of military détente and have particularly stressed that Powers which do not belong to a given region should not build up their armed forces or establish military bases there.

Thus, the coastal States of the Indian Ocean are expressing concern at the fact that some States which are geographically very remote from the region are expanding their military bases there and increasing their military presence. Regarding such actions as a threat to their independence and security, these countries are putting forward the idea of transforming the Indian Ocean into a zone of peace. The Soviet Union regards this proposal with understanding.

Obviously, the key question here is to ensure that there are no foreign military bases in the Indian Ocean, that bases which have been established there are dismantled and that no new bases are established. As far as the Soviet Union is concerned, it never has and does not now intend to build military bases in the Indian Ocean.

In resolving the question of foreign military bases along these lines, the Soviet Union would be prepared to join with other Powers in seeking ways to reduce on a reciprocal basis the military activities of non-coastal States in the Indian Ocean and in the regions directly adjacent to it. Naturally, measures of this kind must take fully into account the generally recognized rules of international law regarding freedom of navigation on the high seas and the need for commercial stops at the ports of coastal States as well as for research. This question is of great importance to the Soviet Union, since virtually the only sea route navigable all the year round which links the European part of the USSR with the Soviet Far East passes through the Indian Ocean.

The coastal States of the Indian Ocean are in favour of holding an international conference to discuss practical measures for transforming the region into a zone of peace. The Soviet Union would be prepared to consider the question of its attitude towards the convening of such a conference in the light of the considerations set out above.

The Mediterranean is another region where military tensions, particularly in connexion with the Middle East conflict, have at times reached dangerous proportions. With a view to reducing these tensions, the Soviet Union proposed to the United States some time ago that an agreement should be reached on the withdrawal from the Mediterranean of Soviet and United States ships and submarines carrying nuclear weapons. This proposal still holds good, and it is in the interests of all States whose security in one way or another depends on the situation in the Mediterranean to work for its implementation.

The problem of military détente has great immediacy for the Middle East. The Soviet Union has repeatedly expressed itself in favour of halting the arms race in the Middle East within the framework of a comprehensive political settlement of the Middle East conflict.

In various parts of the world, interested States are putting forward proposals for the establishment of denuclearized zones. That reflects their desire for effective limitation of the proliferation of nuclear weapons and for a lessening of the threat of

nuclear war. The Soviet Union supports such proposals. It is prepared to co-operate in their implementation, having regard, of course, to what is possible in any given region where it is proposed to establish a denuclearized zone. It is important that such zones should actually be free of nuclear weapons and that the relevant agreements should contain no loop-holes and should be fully consistent with the generally recognized rules of international law.

C. Reduction of military budgets

One promising approach to halting the arms race and to disarmament is the reduction of the military budgets of States. The resources thus released could be utilized for the economic and social progress of peoples and for accelerating the rate of economic growth, ensuring employment, developing new sources of energy, solving the food problem, combating disease and building new schools and universities.

The Soviet Union has repeatedly put forward proposals for reducing military budgets and has, by its actions, set an example in that regard. Several years ago, it proposed that agreement should be reached on the reduction of the military budgets of States permanent members of the United Nations Security Council by 10 per cent and utilization of part of the funds thus saved to provide assistance to developing countries. This proposal was approved by the United Nations General Assembly, but so far it has not been implemented because of opposition by those States which are stubbornly pursuing a policy of increasing military expenditure.

The Soviet Union is prepared to take a flexible position regarding the specific figure with which a reduction of military budgets would begin. A figure greater or smaller than 10 per cent could be agreed upon as a first step for 1977. What is important, however, is that this question should as soon as possible become the subject of businesslike negotiations between the States concerned. The present steady growth of military expenditure by many States can and must give way to the practice of systematically reducing that expenditure.

9. Negotiations on halting the arms race and on disarmament are being conducted in various forms: on a bilateral basis, particularly where States with the greatest military and war industry potential are concerned; within particular groups of States directly concerned, including negotiations at the regional level; in special bodies set up to discuss the disarmament problem as a whole or individual aspects of it and composed of States representing the major political groupings and geographical areas of the present-day world. Each year, questions relating to disarmament are given a prominent place in the work of the United Nations General Assembly.

On the whole, these various types of negotiations and discussions have proved their usefulness. They will unquestionably be used in the future as well. At the same time, the achievement of radical changes in dealing with the problem of disarmament, which affects the interests of all States without exception, requires consideration of it in the broadest and most authoritative possible international forum.

Such a forum must, first of all, be truly universal, and all States must be represented in it; secondly, it must provide an opportunity for examining the whole range of disarmament questions with the necessary expertise, with due regard for all circumstances and in the necessary detail; thirdly, it must be given the power to take effective decisions.

These prerequisites would be met by convening a World Disarmament Conference, and the Soviet Union continues to believe that such a conference should be held.

A special session of the United Nations General Assembly could also be an appropriate forum for discussing disarmament questions in all their scope, for deciding through joint efforts on the ways and means of resolving them and for working out a long-term programme of practical measures. In order to ensure that its results amount to something more than decisions containing general provisions in favour of disarmament of the kind with which the archives of the United Nations are already overflowing, such a special session of the General Assembly and the manner in which it is organized must not be routine in nature. It should be a very particular kind of session. It should be prepared, organized and held in such a way as to ensure a break-through in solving the problems of disarmament. All its work should fully reflect the high responsibility of all States in the world and, in particular, of the major Powers which possess the most powerful armaments and armed forces.

The holding of a special session of the General Assembly should not, of course, push aside the question of a World Disarmament Conference.

The Soviet Union conceives of the convening of such a session as an interim stage which should, by its decisions, prepare the way for a broad and far-reaching review of the problem of disarmament at the World Conference. The session should not be burdened with strict time limitations or with the procedure normally followed at General Assembly sessions, including special sessions.

* * *

Those are the views which the Soviet Union deems it necessary to bring to the attention of all States Members of the United Nations and of all States in the world. The Soviet Union hopes that these views, which are inspired by concern for peace and the security of peoples, by a desire to further mankind's advance along the path towards halting the arms race and towards disarmament, will be carefully considered by all States and will be helpful in achieving practical results in dealing with this historic task that faces mankind.

CCD/523
22 February 1977

Original: Russian

UNION OF SOVIET SOCIALIST REPUBLICS

Draft treaty on the complete and general prohibition of nuclear weapon tests

The States Parties to this Treaty,

Proclaiming their intention to bring about, as speedily as possible, the cessation of the nuclear arms race, the adoption of effective measures towards nuclear disarmament and the conclusion of an agreement on general and complete disarmament under strict and effective international control,

Taking into account the appeals by the General Assembly of the United Nations to put an end to nuclear weapon tests in all environments,

Noting that the prohibition of all nuclear weapon tests would be in the interests of strengthening peace and slowing the arms race and would be a contribution to the process of international détente,

Reaffirming that the potential benefits of any peaceful application of nuclear explosions should be available to nuclear as well as non-nuclear States in conformity with the provisions of the Treaty on the Non-Proliferation of Nuclear Weapons and of the present Treaty,

Noting the great positive significance of the Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and under Water, signed in Moscow on 5 August 1963,

Stressing the importance of strict compliance with the above-mentioned Treaty up to the time of the entry into force of this Treaty,

Seeking to achieve the permanent cessation of all test explosions of nuclear weapons by all States,

Having agreed on the following:

Article I

1. Each State Party to this Treaty undertakes to prohibit, to prevent and to refrain from carrying out any test explosions of nuclear weapons anywhere under its jurisdiction or control in all environments - in the atmosphere, in outer space, under water and underground.

2. Each State Party to this Treaty undertakes to refrain from encouraging, inciting, or in any way participating in the carrying out of nuclear explosions prohibited by paragraph 1 of this article.

Article II

1. Control over compliance with this Treaty shall be conducted by the States Parties, through their own national technical means of control, in accordance with the generally recognized rules of international law.

2. In order to promote the objectives of and ensure compliance with the provisions of this Treaty, the Parties to the Treaty shall co-operate in an international exchange of seismic data.

3. In case a State Party to this Treaty has doubts regarding the nature of a seismic event that occurred in the territory of another State Party to this Treaty, it has the right to raise the question of carrying out an on-site inspection in order to ascertain the true nature of that event. The State Party to the Treaty that raised this question must cite appropriate grounds in support of the necessity of carrying out the inspection. The State Party to the Treaty which is the object of doubts regarding its compliance with the Treaty, recognizing the importance of this question, may take a favourable position regarding the carrying out of an inspection in its territory, provided it finds the grounds convincing, or it may take another decision. Such an inspection shall be carried out according to rules established by the inviting State Party.

4. In order to promote the objectives of and to ensure compliance with the provisions of this Treaty, the Parties shall, when necessary, consult one another, make inquiries and receive appropriate information in connexion with such inquiries.

5. Any State Party to this Treaty which ascertains that any other State Party is acting in violation of obligations deriving from the provisions of the Treaty may lodge a complaint with the Security Council of the United Nations. Such a complaint must contain all possible evidence confirming its validity and a request for its consideration by the Security Council. The Council shall inform the States Parties to the Treaty of the results of its consideration.

Article III

1. The provisions of article I shall not apply to any underground nuclear explosions conducted by nuclear-weapon States for peaceful purposes on the territory under their jurisdiction and in compliance with the agreements under which, in accordance with article V of the Treaty of the Non-Proliferation of Nuclear Weapons, non-nuclear-weapon States are to benefit from any peaceful applications of nuclear explosions.

2. The explosions referred to in paragraph 1 of this article shall be conducted as follows:

(a) In the case of non-nuclear-weapon States, in conformity with the provisions of article V of the Treaty on the Non-Proliferation of Nuclear Weapons;

(b) In the case of nuclear-weapon States, in conformity with a procedure to be established under a special agreement concerning which the nuclear-weapon States will conduct negotiations with due regard for the recommendations of the International Atomic Energy Agency on the subject and which will be concluded as speedily as possible.

Article IV

The provisions of this Treaty shall not affect obligations assumed by the States Parties to the Treaty under other international agreements.

Article V

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

2. Any amendment to this Treaty must be approved by a majority of the votes of all the Parties to the Treaty, including the votes of all nuclear-weapon States Parties to the Treaty. The amendment shall enter into force for each Party depositing its instrument of ratification of the amendment upon the deposit of such instruments of ratification by a majority of all the Parties, including the nuclear-weapon States Parties to the Treaty. Thereafter, it shall enter into force for any other Party upon the deposit of its instrument of ratification of the amendment.

Article VI

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

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

3. This Treaty shall enter into force upon the deposit of the instruments of ratification by ... Governments, including the Governments of all nuclear-weapon States.

4. For States whose instruments of ratification or accession are deposited subsequent to the entry into force of this Treaty, the Treaty 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 accession, the date of the entry into force of this Treaty, and the date of receipt of any requests for convening a conference of Parties to the Treaty or of other notifications.

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

Article VII

1. This Treaty shall be of unlimited duration.

2. Each State Party shall, in the exercise of its national sovereignty, have the right to withdraw from the Treaty if it decides that extraordinary circumstances, connected with the subject-matter of this Treaty, have jeopardized its supreme interests. It shall give three months' notice of such withdrawal to all other Parties to the Treaty and to the Security Council of the United Nations. Such notice shall include a statement of the extraordinary circumstances which 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 signatory and acceding States.

IN WITNESS WHEREOF the undersigned, duly authorized for the purpose, have signed this Treaty.

DONE in ... copies, at ... on the ... day of ..., ...

CCD/524
24 February 1977
Original: English

JAPAN

Working paper on location capability of a multi-array stations system

1. Introduction

Since the early 1960s, hardware and software for the seismological means of verifying underground nuclear explosions have been improved so the threshold of seismic events, which can be detected, located and identified have thus been lowered. One of the most outstanding examples is the development of seismic array stations, for there is a limit to the threshold mainly due to environmental conditions as far as the data for verification depends on seismic stations of a conventional type. Many studies have also been made as to the relation between an assumed seismic network and the location accuracy by statistical or simulation methods. For example, Basham et al reported that if a seismic network of 39 ordinary stations and 7 array stations is properly selected, seismic events of mb over 4.5 in the northern hemisphere can be detected at more than 4 stations of the proposed network.

To find out the actual threshold of the existing network of about 1,500 stations in the world, the magnitude and number of reporting stations were investigated with regard to the explosions from January 1971 to June 1974, the location and magnitude of which were determined by the International Seismological Centre. As shown in Fig. 1, there exists a clear relationship between them, and several (ten to one hundred) observations are available for locating explosions of mb 4 3/4, and more than 300, for events of mb over 6. It must be noted, however, that many data are obtained from stations in the USA and Canada, irrespective of explosion yields, so far as explosions at the Nevada test site are concerned.

The statistics suggest that the existing world-wide seismological network is capable of locating events of mb over 4 3/4, providing explosions are made at the existing test sites or in their vicinity.

As to the processing time, however, it takes about one year at least to collect data from stations, in which, instruments and data handlings are not yet standardized. This delay in data collection would be a serious problem for verifying underground explosions.

Even in USGS, to which the seismic data from many stations are reported more quickly, event location with only a very short delay, for instance, a few days, is difficult, for the incoming data are not necessarily computer-compatible. Even though this difficulty could be overcome, the lowest magnitude of events, whose source parameters can be determined, would be 4 3/4.

On the other hand, at array stations, the detection capability is considerably higher, and the output data are all computer-compatible. In this paper, a study is made of the location capability of networks consisting of the existing and possible future array stations.

2. Simulation of the location capability of an array station network

First, the calibration function Q for determining event magnitude, noise levels at array stations, accuracy of station-epicenter azimuth and epicentral distance determined by array stations, must be mentioned.

(a) Calibration function Q

As already pointed out by several seismologists, Gutenberg's calibration function for determining body wave magnitude as short distances is problematic. It is necessary, therefore, to confirm whether the Q values for shallow depths are applicable to magnitude estimation for underground explosions, which are exploded at very shallow depths. In view of this problem a new calibration function is proposed here. Data used in this study are obtained from log (A/T) at various stations for various explosions which are given in the ISC bulletins from January 1971 to June 1974.

Fig. 2 shows the relation between (mb - log(A/T)) and distance Δ, and X in the figure indicates Q value for the focal depth of 0 km taken from Gutenberg's Q chart. It is evident that Q values derived from the explosion data for distances shorter than 20 degrees shift systematically from Gutenberg's Qs. It is also notable that the observed Q values are widely scattered, and the standard deviation for the observations is 0.3 mb. The standard deviation will be used in evaluating detection capability at various stations in the present simulation.

(b) Station noise level and detection threshold

Since the detection capability at a station is closely related to the noise level at the station, an unreasonable assumption must be avoided not to give any serious influence to the location capability obtained from the simulation. Noise levels at various stations are assumed to be those referred to in papers by Basham et al (1971), Evernden (1976) and Bungum et al (1974). Furthermore, it is assumed that the onset of the initial P wave can be identified when the amplitude is one and a half times as large as the noise level assumed, and the corresponding maximum amplitude in the wave train is twice as large as the initial motion.

The magnitude determination requires the period corresponding to the maximum amplitude. As seen in Fig. 3 which shows the frequency distribution of periods of maximum amplitudes at various stations for the explosions used in the Q value study, the predominant period is approximately one second, regardless of magnitude and epicentral distance. Therefore, the period corresponding to the maximum amplitude is assumed to be one second in the present simulation.

Under the assumptions above-mentioned, $\log(\bar{A}/T)$ for each station is calculated, and is given in Table 1, where $\bar{A}$ is the maximum amplitude corresponding to the threshold amplitude of P in mμ and T, corresponding period in second.

The threshold magnitude to be detected at a station as a function of epicentral distance is calculated from the $\log(\bar{A}/T)$ and Q values given by broken lines in Fig. 2. When the threshold magnitude thus calculated for a station is smaller than an assumed magnitude m_T, the signal corresponding to the event of m_b is undetectable at the station.

(c) Accuracy of observations

Weichert et al (1972) and Basham et al (1970) compared positions of explosions and epicenters of aftershocks produced by explosions in the USA with azimuths and distances obtained by the array station data at Yellow Knife and by USGS. The standard deviations for discrepancies between them are about 1/2 degree in aximuth and 1 degree in distance, respectively. The median for distances between USGS's epicenters and those determined by the NORSAR seismic array station (NAO) (Bungum et al, 1974) is 145 km. However, recent data issued by NAO indicate that the accuracy of epicenter determination has been considerably improved, and the standard deviations of error in azimuth and sitance were reduced to 0.5 degrees and 1 degree, respectively.

Accumulation of data will give more effective corrections to epicenter determination by a single array station, and this makes it possible to locate epicenters more accurately.

(d) Algorithm for epicenter determination

P arrival times at various stations are mainly used to locate epicenters by the method of least squares. Standard errors for epicenter determination by the least squares using P times from the world-wide network is 2-3 km when data are supplied from stations close to epicenter, and more than 30 km without data close to epicenter.

Comparisons between known positions of underground explosions and those determined as epicenters on the basis of the least squares suggest that the standard errors do not necessarily represent absolute accuracy. According to USGS, the absolute accuracy for epicenter determination of USGS is a few tenths of a degree. In our experience, the accuracy will be nearly 1 degree when there are no data near epicenters.

In case of explosions of smaller yields, it is difficult to obtain many data at short distances. This suggests that the accuracy of location for underground explosions will be less than the above-mentioned values.

In view of the fact that accuracy of epicenter determination by an array station is less than 1 degree, more reliable epicenters will be determined by processing data obtained from multi-array stations. Based on the following algorithm, a computer programme for locating epicenters by use of station-epicenter azimuths and epicentral distances determined by array stations has been developed, and the programme is applied to estimate detection and location capabilities of the existing and possible future array stations networks.

The relation among azimuthal angle, distance from a station to an epicenter, and co-ordinates of station and epicenter is represented by the following equation:

$$\mathrm{Sin}\,\Delta \cos\phi = aA + bB + cC$$

where $a = -\sin\varphi_S \cos\lambda_S$, $b = -\sin\varphi_S \sin\lambda_S$, $c = \cos\varphi_S$,
$A = \cos\varphi_E \cos\lambda_E$, $B = \cos\varphi_E \sin\lambda_E$, $C = \sin\varphi_E$,
(φ_E, λ_E); epicenter co-ordinates, and
(φ_S, λ_S); station co-ordinates.

Δ, ϕ, a, b and c in the above equations are known parameters and A, B and C are parameters to be determined.

When more than four observations on ϕ and Δ are available, the unknown parameters A, B and C can be solved by the method of least squares. Furthermore, the data used in the computation can be checked by the epicenter given by the above processing, and a higher order of epicenter determination can be reached using the accepted data. The iteration technique will give more reliable epicenters.

The following is the procedure of the present simulation.

(1) Various parameters such as station co-ordinates, station noise levels, standard deviations for distance and azimuth observations, etc. are given.

(2) An epicenter and threshold magnitude m_T are assumed.

(3) Distances and azimuths to the epicenter from each station are calculated and normal random errors for those theoretical Δ and ϕ values are generated. Δ and ϕ comprising the random errors are considered to be observation data in the simulation.

(4) From $\log(\bar{A}/T)$ in Table 1 and broken lines in Fig. 2, the magnitude for each station is evaluated. When the magnitude comprising normal random error whose

standard deviation is δm is less than m_T, the station data will be rejected because the amplitude of initial motion is too small to read. If the number of stations accepted is less than 4, the event is unlocatable.

(5) By using the simulation data generated by the procedures from (1) to (4), the epicenter is once again determined according to the above-mentioned programme.

(6) The epicenter determination is made for each mesh point of 10 degrees for longitude and latitude.

The simulation is performed for the cases shown in Table 2. In the table, $\delta\phi$, $\delta\Delta$ and δm are the standard deviations in the determination of azimuth, distance, and magnitude respectively by each array station and N is the number of stations.

Fig. 4 exhibits one of the computer outputs obtained and the numerals in the figure represent distance discrepancies between assigned and determined epicenters (unit; 0.1 degrees). Global contours of location threshold for various cases are shown in Fig. 5.

The simulation seems to suggest that more than 13 array stations are necessary to determine reliably epicenters of events of mb over 4 1/4 occurring in the major part of the world. If a network of 15 array stations can be used, it would be possible to locate epicenters of events of mb over 4 occurring in the northern hemisphere.

3. Conclusion

From the standpoint of verifying underground nuclear explosions, the observational data must be processed as quickly as possible. In many seismic stations of a conventional type, the recording system has not yet been made computer-compatible. On the other hand, in array stations the data are all processed by computer, which makes the data processing time very short. As has been made clear in the present investigation, if the seismic events of mb over 4 1/4 throughout the world can be located with an accuracy of $\pm$ 30 km by a network of 15 array stations, this system is preferable also from the viewpoint of quick data processing. For the number of stations, fifteen, which is not very large, will assure quick data exchange. The seismological means of verification must include discrimination in addition to location. However, it must be emphasized that a large number of events can be screened out by location alone. For example, seismic events under the ocean, near populated regions or of large depths cannot be explosions.

Therefore, it is practical to detect and locate of seismic events by a multi-array system, and to examine a limited number of doubtful events by data obtained by broad-band observations from very short periods to very long periods.

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Table 1. Detection threshold in terms of log ($\bar{A}$/T) for various situations. $\bar{A}$ = noise level x 3 in mμ, T = period of maximum amplitude in second

station	λ	φ	log($\bar{A}$/T)
ALP	-147°44.60'	65°14.00'	0.6
BAO	- 47 59.49	-15 38.09	0.8
EKA	- 3 09.55	55 19.98	1.2
GBA	77 26.17	13 36.25	0.9
ILPA	50 44.00	35 25.00	0.5
LAO	-106 13.33	46 41.32	0.3
MAT	138 12.53	36 06.25	1.2
NAO	10 49.94	60 49.42	0.3
WRA	134 21.05	-19 56.87	0.8
YKA	-114 36.28	62 29.57	0.6
IM1	90 00.0	55 00.0	0.5
IM2	-70 00.0	5 00.0	0.5
IM3	20 00.0	10 00.0	0.5
IM4	65 00.0	35 00.0	0.6
IM5	105 00.0	35 00.0	0.6

Table 2. Parameters used in the simulation

δφ	0.5°	0.5°	0.75°	0.75°	1.0°	1.0°
δΔ	0.5°	1.0°	0.75°	1.25°	1.0°	1.5°
δm	0.1/0.3	0.1/0.3	0.1/0.3	0.1/0.3	0.1/0.3	0.1/0.3
N	9/13/15	9/13/15	9/13/15	9/13/15	9/13/15	9/13/15

FIGURE CAPTIONS

Figure 1 Relations between explosion magnitude mb and number of reporting stations.

Figure 2 $\bar{m}b - \log(A/T)$ vs epicentral distance Δ.

$\bar{m}b$; mean magnitude, A; maximum amplitude in mμ, T: period of maximum amplitude in second, X : Q value for h at 0km on the Gutenberg's Q chart.

Figure 3 Frequency distribution of period of maximum amplitude for various magnitude ranges.

O : $mb \leqslant 5.0$, o : $5.1 \leqslant mb \leqslant 5.5$, : $mb > 5.6$

Figure 4 An example of outputs produced by the simulation.

Figure 5 Global contours of location threshold for various cases.

Solid circles show location of stations.

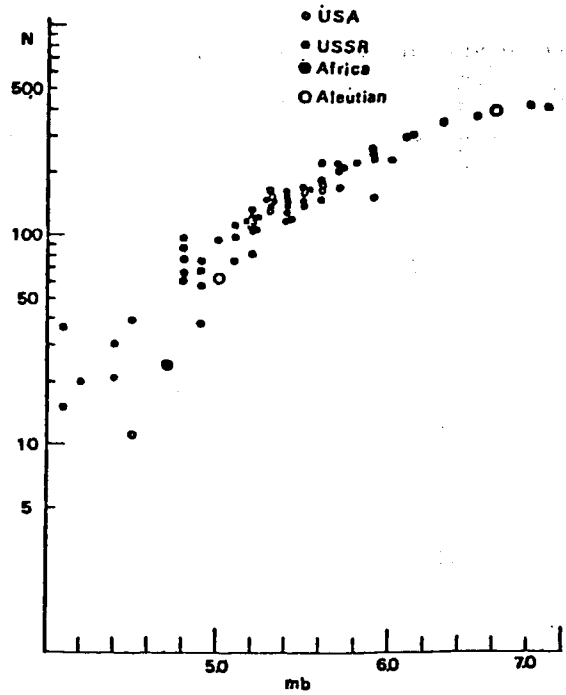
$\delta\phi$ = standard deviation for station-epicenter azimuth.

$\delta\Delta$ = standard deviation for epicentral distance.

δm = standard deviation for magnitude

N = number of stations

Figure 1



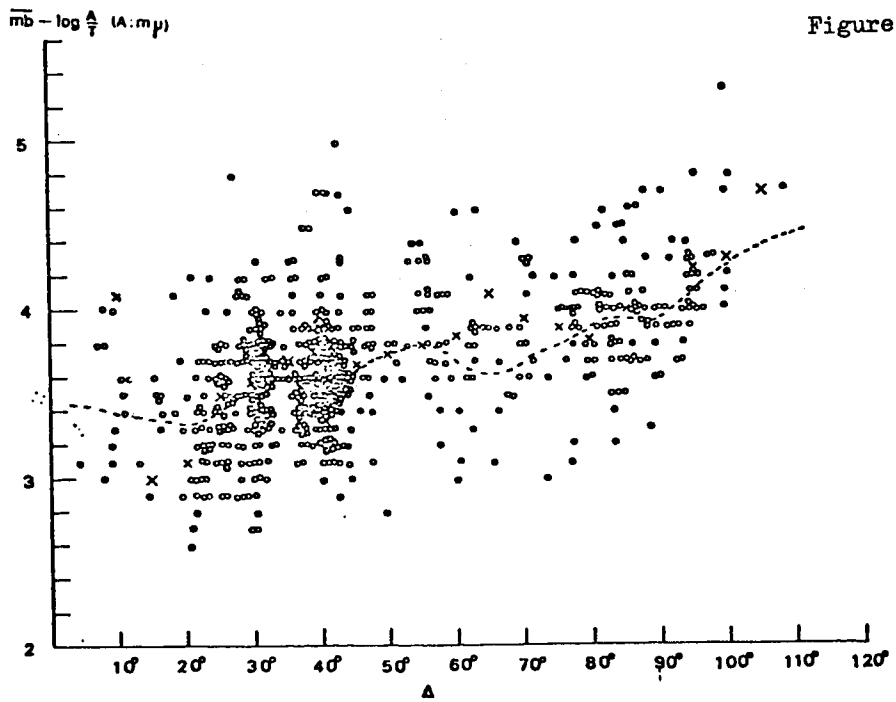
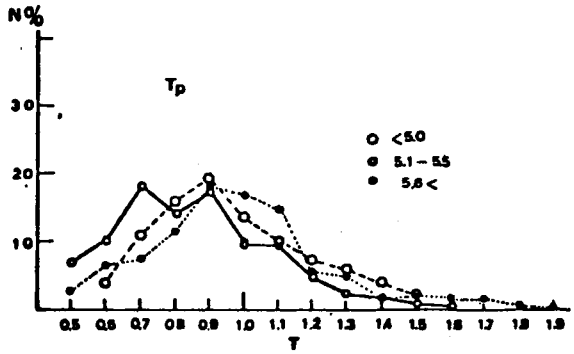


Figure 2

Figure 3



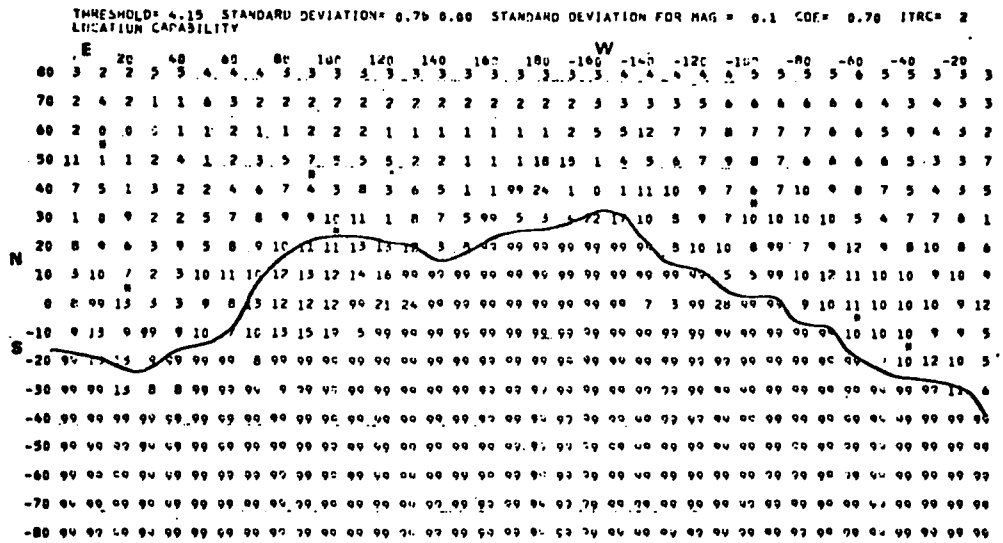
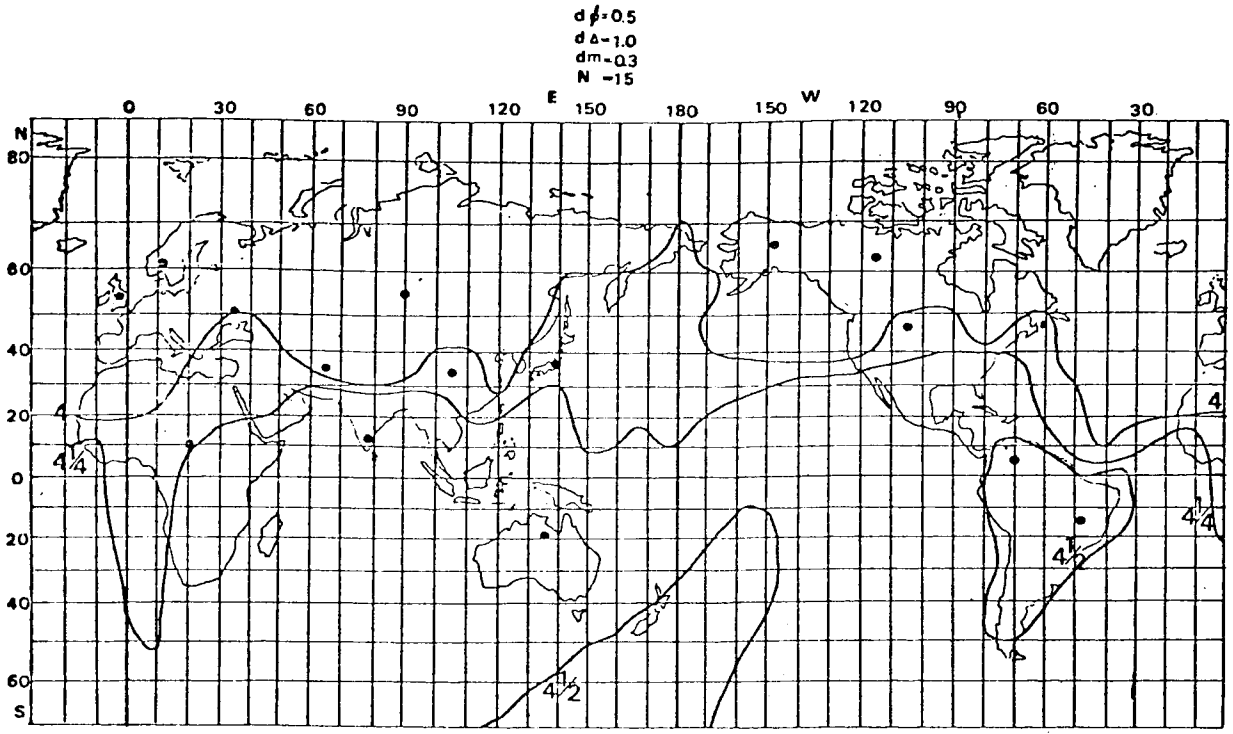


Figure 4


dϕ=0.5
dΔ=1.0
dm=0.3
N =15
0
30
60
90
120
E
150
180
150
W
120
90
60
30
N
80
60
40
20
0
20
40
60
S
4
4¼
4½

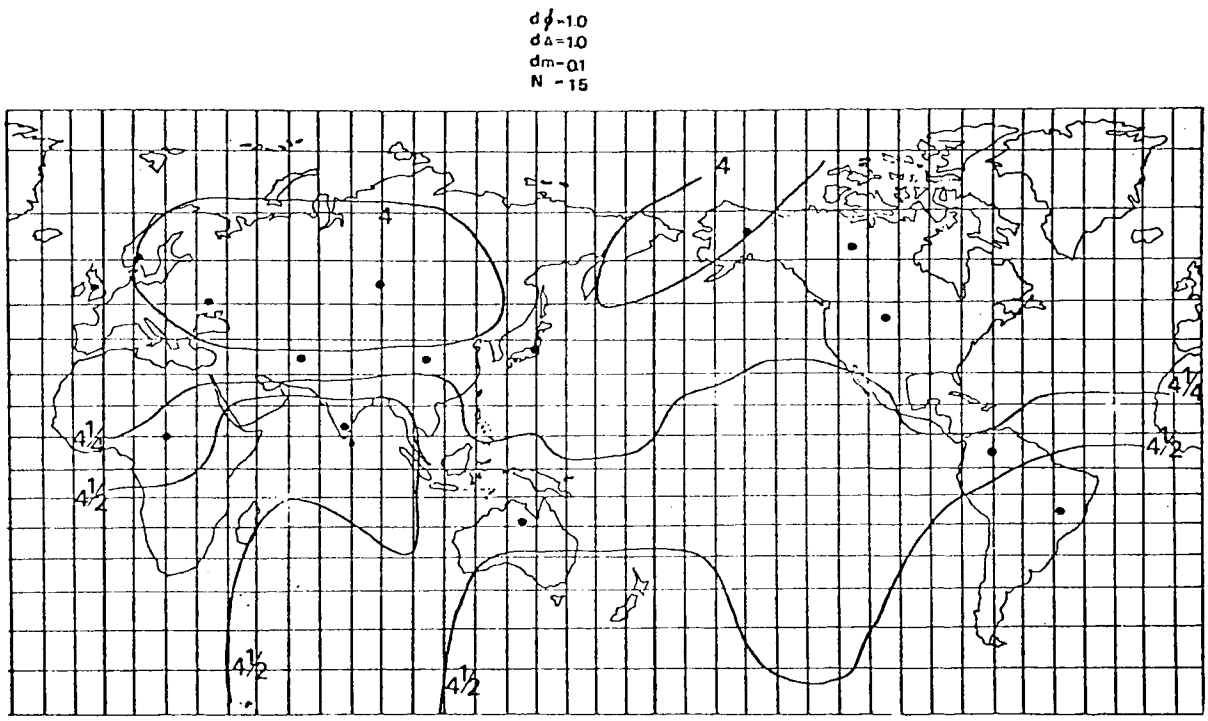
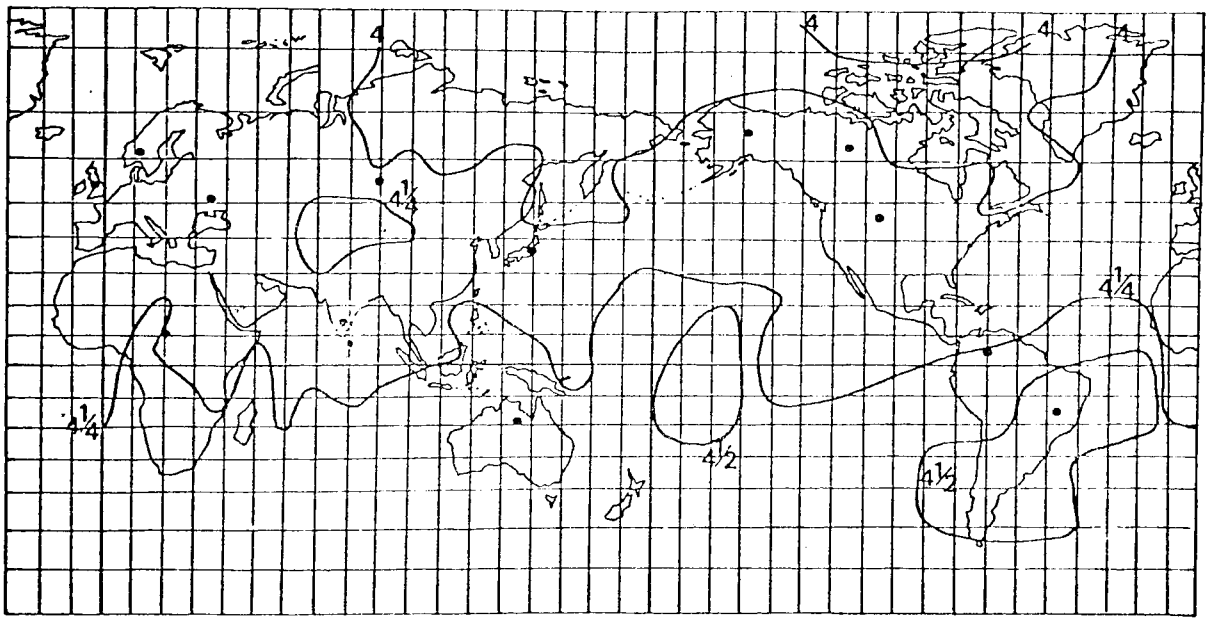

dϕ=1.0
dΔ=1.0
dm=0.1
N =15
4
4¼
4½

Figure 5-1

dϕ = 0.5
dΔ = 1.0
dm = 0.3
N = 13



dϕ = 1.0
dΔ = 1.0
dm = 0.1
N = 13

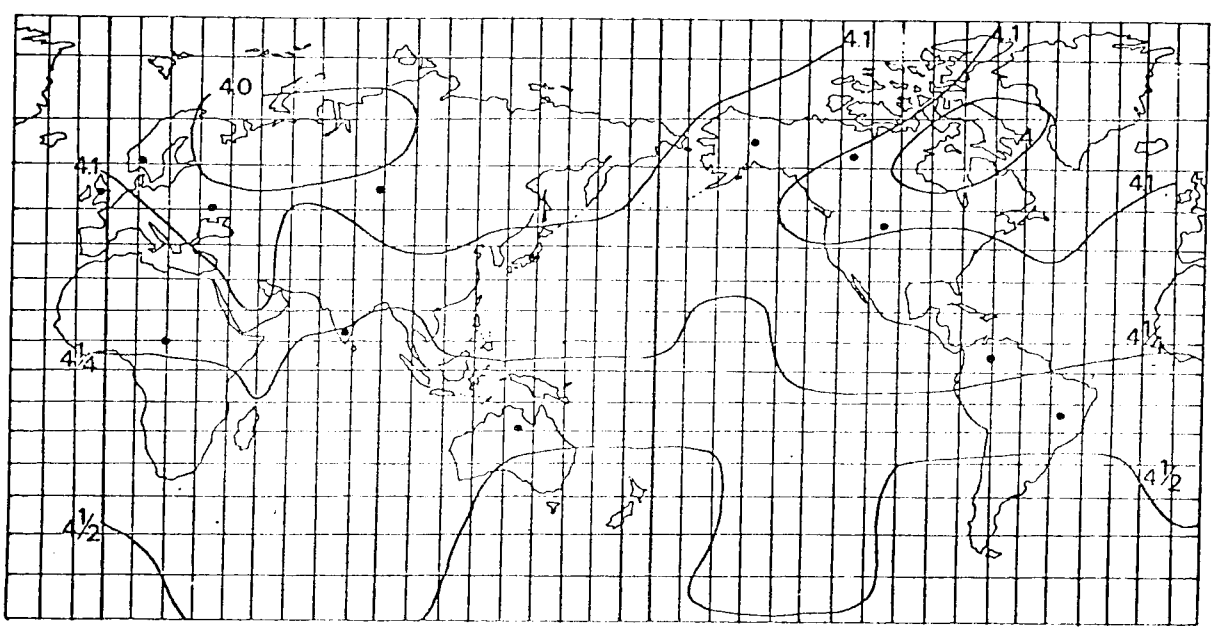
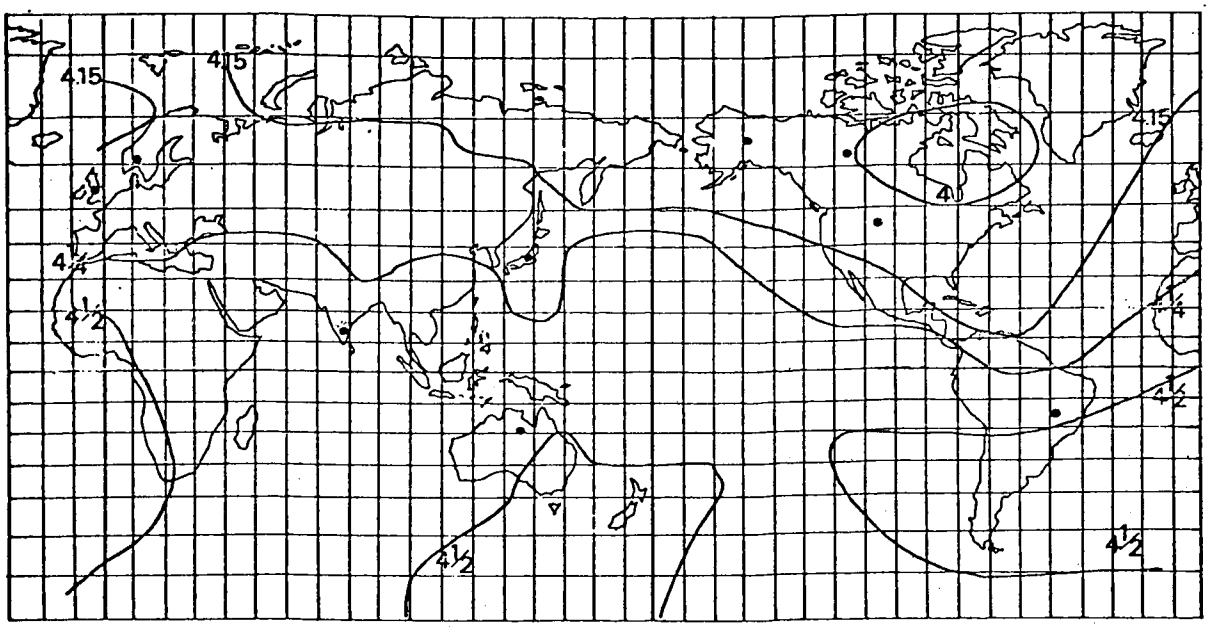


Figure 5-2

dφ=0.5
dλ=0.5
dm=0.1
N = 9



dφ=1.0
dλ=1.0
dm=0.1
N = 9

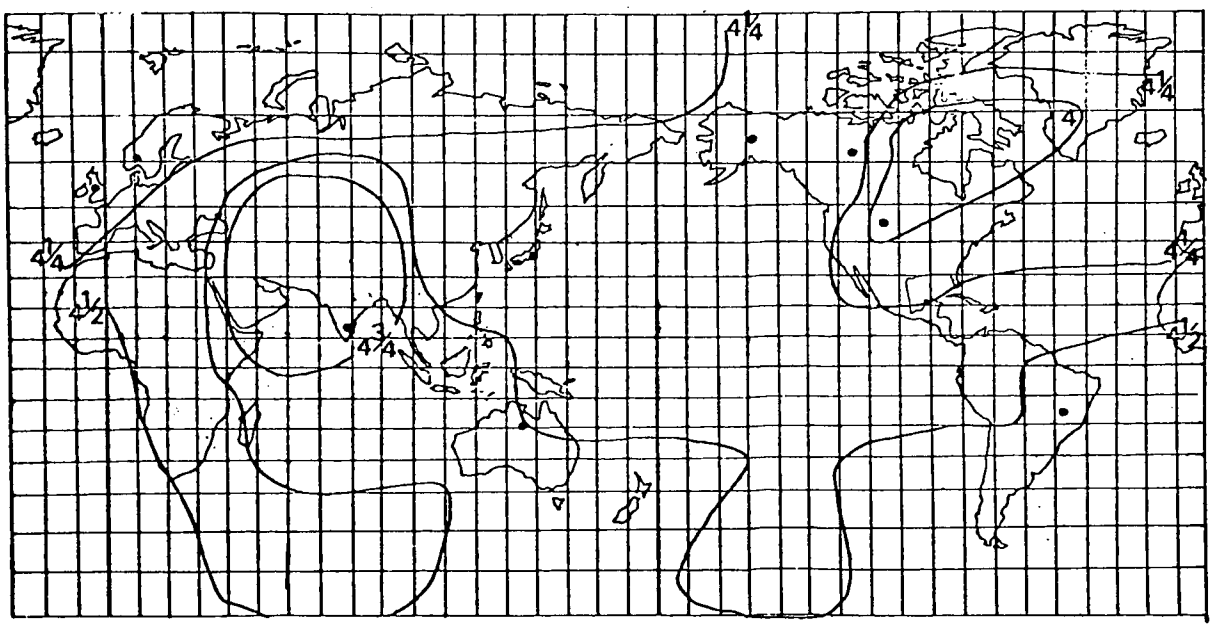


Figure 5-3

CCD/525
25 February 1977

Original: **Spanish**

MEXICO

Letter dated 25 February 1977 from the Leader of the Permanent Delegation of Mexico to the Conference of the Committee on Disarmament addressed to the Special Representative of the Secretary-General to the Conference of the Committee on Disarmament submitting two declarations relating to the commemorative meeting on the occasion of the tenth anniversary of the Treaty of Tlatelolco held in Mexico City on 14 February 1977

I have pleasure in sending you, annexed hereto, the following documents of the General Conference of the Agency for the Prohibition of Nuclear Weapons in Latin America (OPANAL):

1. Statement made by Dr. Hector Gros Espiell, the General Secretary of the Agency for the Prohibition of Nuclear Weapons in Latin America (OPANAL), at the commemorative meeting on the tenth anniversary of the opening for signature of the Treaty of Tlatelolco, held in Mexico City on 14 February 1977;

2. Declaration adopted unanimously by the General Conference of the Agency for the Prohibition of Nuclear Weapons in Latin America (OPANAL) at the commemorative meeting on the tenth anniversary of the opening for signature of the Treaty of Tlatelolco, held in Mexico City on 14 February 1977.

In view of the contents of these documents, which are both connected with the recent celebration of the tenth anniversary of the opening for signature of the Treaty for the Prohibition of Nuclear Weapons in Latin America, or Treaty of Tlatelolco, and the fact that the establishment of nuclear-weapon-free zones has been on the provisional agenda of the Conference of the Committee on Disarmament since 1968, I would ask you kindly to have them reproduced and circulated in a CCD document.

Accept, Sir, the assurances of my highest consideration.

(Signed) Alfonso García Robles
Ambassador
Leader of the Permanent Delegation of Mexico to the Conference of the Committee on Disarmament

1. Statement[1/] made by Dr. Hector Gros Espiell, the General Secretary of the Agency for the Prohibition of Nuclear Weapons in Latin America (OPANAL), at the commemorative meeting on the tenth anniversary of the opening for signature of the Treaty of Tlatelolco, held in Mexico City on 14 February 1977

On this solemn occasion on which the General Conference commemorates the tenth anniversary of the opening for signature of the Treaty for the Prohibition of Nuclear Weapons in Latin America, my remarks will be brief.

Highly qualified speakers have already explained at this meeting what the Treaty of Tlatelolco meant and still means as a contribution by Latin America to international peace and security, and what contribution it has made and continues to make to mankind's efforts for disarmament.

Amid the disappointments and frustrations we have witnessed in matters of disarmament — for international rhetoric never could, and still cannot, hide the tragic truth of a universal arms race on a monstrous and incredible scale -- the Treaty of Tlatelolco showed that it was feasible to establish militarily denuclearized zones as a means of obviating, in certain regions of the world, any possibility of a warlike conflict with atomic weapons. In this respect Latin America has served as a teacher, and the Treaty of Tlatelolco had and still has an influence by example which makes it conceivable that in the future, if various other nuclear-weapon-free zones were created and the possible areas of atomic confrontation reduced to the minimum -- for atomic zones would be limited to the territories of nuclear Powers -- the dangers of an atomic conflagration would be considerably reduced.

There is no need for me to repeat now the advantages of this formula, which also means that the resources freed from a stupid competition in armaments can be used for economic and social development. It was not originally an idea conceived by or for Latin America. So far, however, the spirit of our continent is the only one that has been capable of making the idea a living reality. This is reason enough for us to take pride in Latin America's contribution to peace, security, progress and international law.

1/ English translation from the Spanish text by the United Nations Secretariat.

I wish now to refer only to two questions:

Firstly, the process of binding the Latin American States to the Treaty of Tlatelolco, and of binding to Protocols I and II the States referred to therein, is still open. It has been shown that, over the 10 years that have passed, the reasons which led to the first signatures, ratifications and waivers have not been exhausted and that, on the contrary, the inescapable process whereby all the States involved tend to become Parties to these three multilateral instruments is continuing. In fact not a year has passed without developments in this connexion, and today, when new signatures have been received from new States, novel and universally known international factors are having a positive effect by speeding up the process and providing grounds for optimism about its completion.

I pledge my entire efforts --the fruit of a deep conviction which has grown during the negotiations completed and those in progress -- to continue to do all in my modest powers to achieve this result and to speed up this process, which has never been slow but which can now go forward with renewed impetus.

No one can be unaware that the Treaty of Tlatelolco was adopted unanimously at the last session of the Preparatory Commission for the Denuclearization of Latin America, after a process of negotiation and drafting that had taken several years. All the States that took part in the process signed the Treaty and, although one has not yet ratified it and two more have not yet made the waiver referred to in article 28 of the Treaty, there is no doubt that all those countries agree with the purposes and principles of the Treaty and that, as I pointed out in the statement I made at the opening meeting of the fourth regular session of the General Conference in 1975, these countries are bound not to defeat the object and purpose of the Treaty: that is to say, not to carry on activities which are essentially contrary to the Tlatelolco system and which are likely to interfere seriously with the attainment of its objectives and purposes. That is a general principle of international law which has been laid down in article 18 of the Vienna Convention on the Law of Treaties, and which had already been applied by the Permanent Court of International Justice in 1924 in the case concerning certain German interests in Polish Upper Silesia.

Thanks to the Treaty of Tlatelolco -- and this cannot be denied -- there are presumably no nuclear weapons anywhere in Latin America today. The senseless extravagance of a nuclear arms race has been avoided and there will be no need for atomic arsenals in the future.

Secondly I wish to refer to the peaceful use of nuclear energy.

As is logical, the Treaty of Tlatelolco makes a positive approach to this question, for there is nothing in it to impede or inhibit the exercise of the right to full utilization of this form of energy.

The present world situation, the existing energy crisis and the future depletion of non-renewable sources of energy make it necessary to face the question of peaceful use of atomic energy with renewed attention. The use of this energy will be unavoidable in the future; it must be used in such a way that it does not affect or endanger the safety of the human environment, for the ecological question must be considered in its entirety and any possible diversion from peaceful to military uses must be avoided.

Safeguard agreements are the legal instrument for ensuring that atomic energy for peaceful uses cannot be diverted to military uses. The Treaty of Tlatelolco provides for such agreements and requires the Contracting Parties to negotiate and conclude them with IAEA. Experience over the years has shown that merely being a Party to the Treaty of Tlatelolco enables a State to conclude such agreements in virtue of the Treaty's provisions alone, without having to be a Party to any other multilateral international instrument designed to prohibit nuclear weapons or prevent their proliferation. Hence, the agreements of the Latin American States Parties to the Treaty of Tlatelolco are sufficient to secure for them the scientific, technological, financial, economic and industrial support, assistance and co-operation, both multilateral and bilateral, which they need in order to consider and carry out plans for the use of atomic energy and to obtain, extract, work and process the materials needed to produce such energy.

In the present situation -- and, given the examples we all have in mind, there is no need to emphasize the importance of the question -- a State need only be a Party to the Treaty of Tlatelolco and have concluded the corresponding safeguard agreement in accordance with its provisions, and it will be able to use atomic energy for peaceful purposes and thus to maintain in the years to come the rate of growth and economic

development which is essential if we are to plan and build a better future for the peoples of our countries. Thus the difficulties which some Latin American States not Parties to the Treaty of Tlatelolco are meeting in their endeavours to use nuclear energy for peaceful purposes should come to an end automatically if those States decide to become Contracting Parties to this Latin American instrument.

The peaceful use of nuclear energy in Latin America calls for a regional planning body, a Latin American information centre to co-ordinate, advise and assist the countries of the continent, whenever necessary, in planning and carrying out their energy projects. OPANAL, with the experience it has already gained and its valid co-operation agreement with IAEA, should be that body in the future. Its function should not be solely that of monitoring strict compliance with the prohibition of nuclear weapons laid down in the Treaty of Tlatelolco; it should also include the positive element resulting from its position as the agency responsible for regional programming and co-ordination, in accordance with the wishes of the Latin American States, of the peaceful use of nuclear energy on the continent.

This arrangement will entail the practical exercise of initiative and new institutional formulas, and I am sure the Latin American States will prepare them for consideration in the competent international forums in the near future.

Lastly, a few words of recognition and thanks.

I thank all the States Parties to the Treaty for their constant support and for their full solidarity with the principles of Tlatelolco, which has made it possible to apply the Treaty without problems and has enabled the countries of Latin America to take joint and common action in OPANAL and other international forums in order to uphold the ideals stated in the Treaty and to ensure that they are disseminated and respected.

I thank the Government of the Headquarters country, the Depositary of the Treaty of Tlateloloo: that is to say, the Government of the United Mexican States, which has always lent its unconditional co-operation, not only in settling questions concerned with the operation of OPANAL, but also in the international political process and in negotiations designed to achieve full and complete acceptance of the Treaty for the Prohibition of Nuclear Weapons in Latin America and its two Additional Protocols.

I also thank the States Parties to Protocols I and II for understanding what these instruments mean for international peace and security, and for the attitude they show as a gesture of friendship and co-operation with Latin America. I am also mindful of the tribute due to my predecessors as General Secretary ad interim or General Secretary, Carlos Peón del Valle, Antonio González de León and Leopoldo Benites Vinueza, who took the first difficult steps to give effect to the Treaty of Tlatelolco.

I cannot conclude these remarks without a mention— which I make with particular satisfaction-- of the man who, over these 10 years, as Chairman of COPREDAL, as President of the first regular session of OPANAL, as representative of Mexico to the United Nations Conference of the Committee on Disarmament and as his country's Secretary for Foreign Affairs, was the most enthusiastic promoter of the idea of denuclearization of Latin America, the most tireless negotiator in the process of drafting the Treaty and the strongest fighter for the attainment of its full validity and that of its two Additional Protocols. I refer to Ambassador Alfonso García Robles, to whom, on concluding this statement, I pay a tribute of recognition and gratitude.

2. Declaration[1/] adopted unanimously by the General Conference of the Agency for the Prohibition of Nuclear Weapons in Latin America (OPANAL) at the commemorative meeting on the tenth anniversary of the opening for signature of the Treaty of Tlatelolco, held in Mexico City on 14 February 1977

The General Conference,

Recalling that today, 14 February 1977, 10 years have elapsed since the opening for signature in Mexico City of the Treaty for the Prohibition of Nuclear Weapons in Latin America,

Aware of the historic importance of this anniversary, which marks the legal culmination of the establishment of the first militarily denuclearized zone in an inhabited region of the earth,

Considering that this has made, is making and will make a vital contribution to disarmament and consequently to international peace and security and that Latin America, by this example, has furnished mankind with an effective, practical and realistic formula for lessening and restricting the dangers of a nuclear conflagration, which makes it possible for the opportunities resulting from scientific and technological progress to be used, in peace and co-operation, for economic and social progress,

---

1/ English translation from the Spanish text by the United Nations Secretariat.

Resolved to spare no efforts to secure the complete and realistic fulfilment of the purposes of the Treaty of Tlatelolco and the attainment of the essential objective that all Latin American States should become Parties to it, that the statute of military denuclearization governed by the Treaty should be applied to all the territories situated in the zone prescribed by it, and that all nuclear Powers should guarantee and respect by treaty the integrity of the Latin American nuclear-weapon-free zone,

HEREBY DECLARES:

1. The firm decision of the States Parties to the Treaty for the Prohibition of Nuclear Weapons in Latin America to continue unceasingly their efforts to ensure that all Latin American countries become Parties to the Treaty, that all non-Latin American States which have de jure or de facto international responsibility for territories situated in the geographical zone established by the Treaty sign and ratify Additional Protocol I, and that the nuclear Power which has not yet signed and ratified Additional Protocol II soon becomes a Party to it;

2. Its conviction that the strict application of the control system established by the Treaty of Tlatelolco, in co-ordination with the International Atomic Energy Agency, ensures the effectiveness of nuclear disarmament in Latin America;

3. Its determination to promote the use of nuclear energy in Latin America, co-ordinating the efforts of member countries to that end and setting about regional planning for the peaceful use of such energy;

4. Its will that the Agency for the Prohibition of Nuclear Weapons in Latin America should be the instrument responsible for this activity, thus combining with the competence it possesses in matters of disarmament the functions and powers needed to transform it into the international agency which, at the regional level, plans, systematizes, regulates and co-ordinates Latin American efforts for full and effective peaceful use of this form of energy;

5. Its certainty that the Treaty of Tlatelolco, whose provisions concerning nuclear disarmament, the control system and verification are more comprehensive and stricter than those laid down in any other international instrument at present in force, is sufficient in itself to ensure that the countries Parties to it devote all their efforts to development based on the peaceful use of atomic energy and that the States Parties to the Treaty of Tlatelolco may accordingly be supplied by international agencies, States and the competent public or private organizations with all the scientific, technological, economic and industrial assistance and co-operation required for the implementation and application of the scientific and industrial programmes needed for the utilization of the energy released by nuclear fission;

Consequently

Reiterates the inherent right of the countries Parties to the Treaty of Tlatelolco, in their capacity as sovereign States, to the use of atomic energy for peaceful purposes. The exercise of this right prevents their resources from being diverted into a futile and senseless armaments race and instead allows them to be directed towards harnessing a source of energy which, properly used in such a way that it does not endanger the environment, health or safety, will contribute decisively to the economic and social development and general advancement of the peoples of the Latin American countries.

In reaffirming the objectives and purposes of the Treaty of Tlatelolco, in confirming their will to comply with the obligations imposed by that instrument and in solemnly declaring their decision to fight for peace, justice and development, the States Parties to the Treaty of Tlatelolco call upon all States which have not yet joined in this Latin American undertaking to do so shortly, and upon States situated in other regions which are in a position to establish militarily denuclearized zones to persist in their efforts towards that end. The multiplication of nuclear-weapon-free zones will necessarily have the effect of reducing the danger of a nuclear holocaust and, by preventing a purposeless and senseless competition in armaments, will ensure full utilization of the available resources in the economic and social development of peoples.

The General Conference,

Convinced of the need to promote a wider and better knowledge of the Treaty of Tlatelolco,

Invites the States Parties to disseminate as widely as possible the Treaty for the Prohibition of Nuclear Weapons in Latin America, explaining its objectives and principles.

CCD/526
1 March 1977
Original: **English**

SWEDEN

Draft treaty banning nuclear weapon test explosions in all environments

The States Parties to this Treaty,

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

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

Have agreed as follows:

ARTICLE I

1. Each Party to this Treaty undertakes not to carry out any nuclear weapon test explosion, or any explosion of other nuclear devices, in any environment.

2. Each Party to this Treaty undertakes, furthermore, to refrain from causing, encouraging, assisting or in any way participating in the carrying out of any nuclear weapon test explosion or of any explosion of other nuclear devices.

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

- -

(Optional provision for a transitional arrangement - if needed - another alternative is found in Article VII para. 4).

4. As regards the period ending on .... the provisions of Protocol I annexed to this Treaty shall be applicable to the Governments of the United States of America and the Union of Soviet Socialist Republics.

- -

ARTICLE II

The provisions of Article I of this Treaty do not apply to those nuclear explosions for peaceful purposes which might be carried out under international supervision and control and which take place in conformity with Protocol II annexed to this Treaty.

ARTICLE III

1. Each Party to this Treaty undertakes to co-operate in good faith to ensure the full observance and implementation of this Treaty.

2. Each Party to this Treaty undertakes to co-operate in good faith in an effective international exchange of seismological data in order to facilitate the detection, identification and location of underground events. The arrangements for technical supervision of the compliance with this Treaty are laid down in Protocol III annexed to this Treaty.

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

(a) to 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. For the purpose set forth in this Article, the Parties to the Treaty shall engage the services of a Consultative Committee. The Depositary shall within one month of the receipt of a request from any Party convene the Committee. Any

Party may appoint a representative to this Committee whose functions and rules of procedures are set out in Protocol IV annexed to this Treaty.

5. If after consultation and co-operation pursuant to this Article there remains a serious question concerning the fulfilment of the obligations assumed under this Treaty, a Party may, in accordance with the provisions of the Charter of the United Nations, bring the matter to the attention of the Security Council and to other Parties to the Treaty.

ARTICLE IV

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

ARTICLE V

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

ARTICLE VI

Five years after the entry into force of this Treaty, a conference of Parties to the Treaty shall be held in Geneva, Switzerland, in order to review the operation of this Treaty with a view to assuring that the purposes 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 additional review conferences shall be convened.

ARTICLE VII

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

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

3. This Treaty shall enter into force upon the deposit with the Depositary of instruments of ratification by x Governments including the Governments of the United States of America and the Union of Soviet Socialist Republics.

- -

(Optional provision for a transitional arrangement -- if needed - another alternative is found in Article I para. 4).

4. Pending the entry into force of this Treaty the Governments of the United States of America and the Union of Soviet Socialist Republics undertake to apply the provisions of Protocol I as from the date on which this Treaty has been signed by these two Governments.

(following subparagraphs would be renumbered accordingly if the above provision were to be inserted)

- -

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

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

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

ARTICLE VIII

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

ARTICLE IX

If this Treat has not been adhered to by all nuclear-weapon States x years after its entry into force, each Party shall by giving notice to the Depositary have the right to withdraw from the Treaty with immediate effect.

ARTICLE X

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

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

Done at .....on.....

CCD/526/Rev.1
5 July 1977
Original: **English**

SWEDEN

Revised draft treaty banning nuclear weapon test explosions in all environments

The States Parties to this Treaty,

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

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

Have agreed as follows:

ARTICLE I

1. Each Party to this Treaty undertakes not to carry out any nuclear weapon test explosion, or any explosion of other nuclear devices, in any environment.

2. Each Party to this Treaty undertakes, furthermore, to refrain from causing, encouraging, assisting or in any way participating in the carrying out of any nuclear weapon test explosion or of any explosion of other nuclear devices.

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

- -

(Optional provision for a transitional arrangement - if needed - another alternative is found in Article VII, para.4.)

4. As regards the period ending on ..... the provisions of Protocol I annexed to this Treaty shall be applicable to the Governments of the United States of America and the Union of Soviet Socialist Republics.

- -

ARTICLE II

The provisions of Article I of this Treaty do not apply to those nuclear explosions for peaceful purposes which might be carried out under international supervision and control and which take place in conformity with Protocol II annexed to this Treaty.

ARTICLE III

1. Each Party to this Treaty undertakes to co-operate in good faith to ensure the full observance and implementation of this Treaty.

2. For the purpose set forth in this Article, the Parties to the Treaty shall engage the services of a consultative committee. The depositary shall either on his own initiative or within one month of the receipt of a request from any Party convene the committee. Any Party may appoint a representative to this committee whose functions and rules of procedures are set out in Protocol III annexed to this Treaty.

ARTICLE IV

1. Each Party to this Treaty undertakes to co-operate in good faith in an effective international exchange of seismological data in order to facilitate the detection, identification and location of underground events. The arrangements for technical supervision of the compliance with this Treaty are laid down in Protocol IV annexed to this Treaty.

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

(a) to 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.

3. If after consultation and co-operation pursuant to this Article there remains a serious question concerning the fulfilment of the obligations assumed under this Treaty, a Party may, in accordance with the provisions of the Charter of the United Nations, bring the matter to the attention of the Security Council and to other Parties to the Treaty.

ARTICLE V

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

ARTICLE VI

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

ARTICLE VII

Five years after the entry into force of this Treaty, a conference of Parties to the Treaty shall be held in Geneva, Switzerland, in order to review the operation of this Treaty with a view to assuring that the purposes 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 additional review conferences shall be convened.

ARTICLE VIII

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

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

3. This Treaty shall enter into force upon the deposit with the Depositary of instruments of ratification by x Governments including the Governments of the United States of America and the Union of Soviet Socialist Republics.

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(Optional provision for a transitional arrangement - if needed - another alternative is found in Article I, para.4.)

4. Pending the entry into force of this Treaty the Governments of the United States of America and the Union of Soviet Socialist Republics undertake to apply the provisions of Protocol I as from the date on which this Treaty has been signed by these two Governments.
(following subparagraphs would be renumbered accordingly if the above provision were to be inserted)

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

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

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

ARTICLE IX

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

ARTICLE X

If this Treaty has not been adhered to by all nuclear-weapon States x years after its entry into force, each Party shall by giving notice to the Depositary have the right to withdraw from the Treaty with immediate effect.

ARTICLE XI

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

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

Done at ..... on .....

SCHEDULE OF MEETINGS OF THE CONFERENCE OF THE COMMITTEE ON DISARMAMENT FOR THE SPRING SESSION

(Adopted at the 732nd Plenary Meeting on 1 March 1977)

Plenary meetings

Plenary meetings will continue to be held on Tuesday and Thursday at 10.30 a.m., unless decided otherwise. The agenda for the plenary meetings, adopted on 15 August 1968, reads as follows:

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

"Under this heading members may wish to discuss measures dealing with the cessation of testing, the non-use of nuclear weapons, the cessation of production of fissionable materials for weapons use, the cessation of manufacture of weapons and reduction and subsequent elimination of nuclear stockpiles, nuclear-free zones, etc.

"2. Non-nuclear measures.

"Under this heading, members may wish to discuss chemical and bacteriological warfare, regional arms limitations, etc.

"3. Other collateral measures.

"Under this heading, members may wish to discuss prevention of an arms race on the sea-bed, etc.

"4. General and complete disarmament under strict and effective international control.

"The co-Chairmen note the recognized right of any delegation to raise and discuss any disarmament subject in any meeting of the Committee,"

Informal meetings

1 - 4 March	Informal meetings of CCD on CCD procedures.
7 - 11 March	Informal meetings of CCD on comprehensive negotiating programme. (Further meetings on the subject may be arranged later)

14 - 18 March	Informal meetings of CCD, with participation of experts, on new types and systems of weapons of mass destruction
21 - 25 March	Open
28 March - 1 April	Informal meetings of CCD, with the participation of experts, on chemical weapons.
4 - 7 April	Continuation of informal meetings on chemical weapons, with the participation of experts, as necessary.
11 - 15 April	Open
18 - 22 April	Informal meetings of CCD on a comprehensive nuclear test ban.
25 - 29 April*/	Open

Recess

The CCD will go into recess on 29 April 1977. The Committee will reconvene for its summer session at a date to be determined at a later stage.

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*/ During this period, the Group of Scientific Experts to Consider International Co-operative Measures to Detect and Identify Seismic Events will hold its third session.

CCD/528*
1 March 1977
Original: English

SECOND PROGRESS REPORT TO THE CONFERENCE OF THE COMMITTEE ON DISARMAMENT BY THE AD HOC GROUP OF SCIENTIFIC EXPERTS TO CONSIDER INTERNATIONAL CO-OPERATIVE MEASURES TO DETECT AND IDENTIFY SEISMIC EVENTS

1. In pursuance of the decision of the CCD of 22 July 1976, the Ad Hoc Group of Scientific Experts to Consider International Co-operative Measures to Detect and to Identify Seismic Events held its second session from 21 to 25 February 1977 in Geneva, under the Chairmanship of Dr. Ulf Ericsson of Sweden.

2. Scientific experts and representatives of Socialist Member States of the CCD joined the experts and representatives who participated in the first session's discussions. Thus scientific experts and representatives of the following Member States attended the session: Bulgaria, Czechoslovakia, Canada, Egypt, German Democratic Republic, Federal Republic of Germany, Hungary, India, Italy, Japan, Mongolia, Netherlands, Poland, Romania, Sweden, Union of Soviet Socialist Republics, United Kingdom, United States of America.

3. Scientific experts from Australia, Belgium, Denmark, Finland and Norway, who have been invited in accordance with the above-mentioned decision of the CCD continued to participate in the work of the Ad Hoc Group.

4. According to its time-table, adopted at the first session, the Ad Hoc Group reviewed drafts towards its final Reports related to the following subjects:

2(d) Review of earlier relevant studies.

3(a) Data and procedures for detection and location of seismic events by a network of seismological array and single stations.

3(b) Data and procedures for obtaining identification parameters of seismic events at individual stations.

3(c) Data and procedures for obtaining identification parameters of seismic events from networks of stations.

4(a) Technical description of existing stations of potential interest for the network.

4(b) Data produced at these stations and present station capabilities.

5(a) Description of existing data exchange facilities.

6(a) Description of existing data centres.

* Incorporating document CCD/528/Corr.1 of 4 March 1977.

After thorough discussion the Ad Hoc Group gave instructions and guidelines for the Scientific Secretary for the redrafting of these texts, which will be considered at its final session.

5. In view of the delay that had occurred in the proceedings and anxious to complete its work approximately in the same period of time it had planned, the Ad Hoc Group revised its schedule for the remaining work.

6. The Ad Hoc Group adopted a draft Agenda for the next session and designated groups of experts from its members to prepare drafts to be considered at the next session.

7. The Ad Hoc Group noted with satisfaction the interest of the Member States of the CCD in its work, manifested by the increased number of scientific experts and representatives who attended the second session. In order to facilitate the proper assessment of present and planned seismographic installations and data handling facilities, the desire was expressed that all Member States of the CCD should consider the submission of relevant information on their existing and planned seismographic establishments, since, at present, such information, particularly on stations of the Southern Hemisphere, is limited.

8. The Ad Hoc Group envisages holding its next session from 25 to 29 April 1977 at the Palais des Nations, Geneva, subject to confirmation by the CCD.

List of Scientific Experts and Representatives participating in the Second Session of the Ad Hoc Group of Scientific Experts to Consider International Co-operative Measures to Detect and Identify Seismic Events

AUSTRALIA

Mr. P. M. McGregor	Supervising Geophysicist, Bureau of Mineral Resources, Geology and Geophysics

BELGIUM

Mr. J-M van Gils	Chief, Seismological Service to the Royal Belgian Observatory

BULGARIA

Dr. L. V. Hristoskov	Seismologist, Geophysical Institute, Bulgarian Academy of Sciences

CANADA

Mr. P. W. Basham	Government Research Scientist, Earth Physics Branch, Department of Energy, Mines and Resources

CZECHOSLOVAKIA

Mr. V. Rohal-Ilkiv	Attaché, Permanent Mission of the Czechoslovak Socialist Republic to the United Nations Office at Geneva

DENMARK

Mr. J. Hjelme	Stategeodesist, Department of Seismology Geodaetisk Institute

EGYPT

Mr. A. Aboul Kheir	Counsellor, Permanent Mission of Egypt to the United Nations Office at Geneva

FINLAND

Dr. I. Noponen	Institute of Seismology, University of Helsinki

GERMAN DEMOCRATIC REPUBLIC

Dr. M. M. Schneider	Deputy Director, Academy of Sciences GDR, Central Earth Physics Institute

GERMANY, FEDERAL REPUBLIC OF

Dr. H. P. Harjes	Director, Central Seismological Observatory, Erlangen

HUNGARY	
Mr. E. Bisztricsany	Head, Hungarian Seismological Observatory
INDIA	
Dr. T. G. Varghese	Head, Seismology Section, Bhabha Atomic Research Centre
ITALY	
Professor M. Caputo	Professor of Seismology, University of Rome
Dr. R. Console	Geophysicist, National Institute of Geophysics, Rome
JAPAN	
Dr. S. Suyehiro	Head, Seismological Division, Japan Meteoroligical Agency
Dr. M. Ichikawa	Research Official, Japan Meteorological Agency
MONGOLIA	
Mr. P. Khalioune	Ministry of Foreign Affairs, Permanent Mission of the Mongolian People's Republic to the United Nations Office at Geneva
NETHERLANDS	
Dr. A. R. Ritsema	Head, Seismological Department of the Royal Netherlands Meteorological Institute
NORWAY	
Dr. E. S. Husebye	Chief Seismologist, Royal Norwegian Council for Scientific and Industrial Research
Dr. F. Ringdal (Scientific Secretary)	Royal Norwegian Council for Scientific and Industrial Research
POLAND	
Mr. R. Teisseyre	Deputy Director, Institute of Geophysics, Polish Academy of Sciences
Mr. A. Czerkawski	Adviser, Ministry of Defence, Warsaw

ROMANIA

Dr. V. Tudor	Counsellor, Permanent Mission of the Socialist Republic of Romania to the United Nations Office at Geneva
Mr. C. Ivascu	Second Secretary, Permanent Mission of the Socialist Republic of Romania to the United Nations Office at Geneva

SWEDEN

Dr. U. Ericsson (Chairman)	Scientific Adviser, Ministry of Foreign Affairs
Dr. O. Dahlman	Research Institute of National Defence
Dr. H. Israelson	" " " " "
Mrs. B. M. Tygaard	" " " " "

USSR

Professor I. Passetchnik	Institute of Physics of the Earth, Moscow
Dr. O. Kedrov	" " " " " " "
Dr. I. Botcharov	Adviser, Ministry of Defence

UNITED KINGDOM

Dr. H. I. S. Thirlaway	Superintendent, Seismological Research Centre, Berkshire
Mr. I. R. Kenyon	First Secretary, Permanent Delegation of the United Kingdom to the CCD

UNITED STATES OF AMERICA

Dr. J. R. Filson	Programme Manager, Defence Advanced Research Project Agency
Mr. A. R. Turrentine	United States Arms Control and Disarmament Agency

CCD/529
22 March 1977
Original: English

JAPAN

Some thoughts on the international control of chemical weapons

Introduction

The purpose of this working paper is to make some suggestions on the problem of chemical warfare agents to be prohibited. A number of suggestions have been made on the subject but so far have not gone beyond general remarks and have been somewhat lacking in specific substance.

1. Recent trends in the deliberations on the question of banning chemical weapons

Reflecting the positive efforts made up to that time, a communiqué issued at the summit talks between the USSR and the United States of America in July 1974 stated that "the United States and the Soviet Union will take a joint initiative on banning the most dangerous, lethal means of chemical warfare". This gave us hope for the early completion of a treaty banning chemical warfare, but that hope has not yet come to fruition. As more and more people came to deplore the delay in the deliberations on the subject, the United States expressed its views at the spring session of 1976 (CCD/PV.702); an informal expert meeting suggested by the Federal Republic of Germany was held in the summer session; and the British draft convention was submitted in the last stage of that session. During the Committee's deliberations over this period, the problems of "chemical warfare agents to be prohibited" and "control of chemical weapons" were treated as follows.

(1) Chemical warfare agents to be prohibited

A number of suggestions were made on the definition, category and scope of chemical warfare agents to be prohibited. The prevailing view which emerges from these suggestions is that we should prohibit all lethal chemical agents by adopting criteria of purpose; that we should adopt a criterion of toxicity as one of the criteria for determining the individual agents to be prohibited; and that chemical warfare agents should be divided into two categories, namely, single-purpose agents to be used only for warfare, and dual-purpose agents to be used for both peaceful and warlike purposes.

(2) Control of chemical weapons

The problem of verification is at the core of the deliberations. Among the Western and non-aligned countries, the prevailing view is that international verification is necessary; among the Eastern countries, the prevailing view is that national means are in principle enough. In spite of a number of suggestions, a clue to agreement has not yet been found.

However, the following views have been recognized: it is necessary that we should conduct on-site inspections in order to ensure that specific acts such as the destruction of stockpiled agents are carried out; and it is possible that national means should be supplemented without unjustifiable interference, by on-site inspections under international control, including some form of seal, the use of the camera and so on, in order to control production. These views do not go beyond the conceptual stage; they need to be further explored and made more concrete.

2. Our thoughts and suggestions on international control of chemical weapons

With the aim of contributing to the solution of the problems described above we investigated to see whether or not there was some effective treaty now in force which could serve our purpose. We have found that the system of agents to be regulated in a treaty on the control of narcotic drugs and psychotropic drugs has many similarities to a chemical-warfare ban treaty -- which is also concerned with controlling chemical substances -- and can be useful for our purpose. This is the Single Convention on Narcotic Drugs, 1961, as amended (hereinafter referred to as the Narcotic Drugs Convention), to which, as of 1 March 1977, 109 countries, including most members of the CCD, are Parties. Referring to this Convention, we would like to suggest the following:

(1) Chemical warfare agents

There are a variety of chemical warfare agents to be prohibited, and hence it is virtually impossible, in the brief wording of a treaty, to provide specifically for their definition, category and scope. Therefore, in addition to criteria of purpose, which have received almost unanimous support, we suggest the compilation of some tables of the chemical warfare agents to be prohibited. We should throw the net of a comprehensive ban over (i) chemical warfare agents and chemical weapons or munitions, equipment and means of delivery, and (ii) activities connected with their development, production, stockpiling, acquisition, etc. We should list in the tables those chemical warfare agents over which control by treaty is at present considered desirable.

Chemical warfare agents as a whole would be divided into categories in the following three tables:

Table I: single-purpose agents and their highly toxic derivatives;

Table II: dual-purpose agents and their highly toxic derivatives;

Table III: chemical substances with a high potential for use as chemical warfare agents, other than those listed in tables I and II.

First of all, we should list in table I chemical agents used only for warlike purposes and their highly toxic derivatives, and we should place them under a total prohibition (for example, nerve agents VX including their derivatives VE, VM, VG and so on; mustards including their derivatives HN-1, HN-3 and so on). We should list in table II dual-purpose agents for warlike and peaceful purposes and their highly toxic derivatives; we should place them under separate control. We are then left with those chemical agents which are listed neither in table I nor in table II. We should list them in table III in view of their high potentiality for use as chemical warfare agents. Though the chemical substances to be listed in table III cannot be used directly for warlike purposes, we should prevent any State party to the treaty from transforming those substances into chemical weapons by imposing an obligation of notification on any State which is about to perform such activities as production, stockpiling, development, etc. In doing so, we can modify article I, sub-paragraphs (a) and (b), of the British draft to read as follows:

"(a) chemical agents listed in the annexed tables I-III, of types and in quantities that have no justification for protective or other peaceful purposes;

"(b) munitions, equipment or systems designed to fill up, instal[1] or deliver agents specified in the preceding sub-paragraph (a) or chemical substances[2] which are intended to produce the same effect as agents specified in sub-paragraph (a) when fired munitions reach the target."

Thus we can define the subject-matter simply and concretely, make the scope of the treaty clear, and classify chemical warfare agents in tables I, II and III.

1/ The word "instal" is inserted because some munitions, such as chemical mines, do not require to be delivered.

2/ The words "chemical substances" are inserted because binary chemical weapons should be prohibited.

From the standpoint of control over these chemical weapons, we believe it quite effective to classify chemical warfare agents in tables I, II and III. This line of thought stems from the formula employed in the Narcotic Drugs Convention, from the draft treaty, and from our previous thoughts as embodied in the working papers submitted by the Japanese delegation in the past (CCD/430, 466, 483 and 515).

(2) Working procedure for completion of the tables

The following procedure is suggested for the work:

(i) All toxic chemical agents whose toxicity is above the agreed level should be listed using the LD50 spectrum. A method of drawing up the lists has already been suggested by Japan in its "Working Paper: Draft of one form of LD50 spectrum" (CCD/515). The preparation of lists of toxic chemical agents is already under way as an IRPTC project of UNEP and may be very useful to us.

(ii) Chemical agents which are clearly not used at present and chemical substances which, to judge from their characteristics as chemical weapons (for example shelf-life, perceptibility, volatility, explosion stability and so on; see the working paper of the Federal Republic of Germany, CCD/458), are of low potential for use as chemical warfare agents should be deleted from the list referred to in paragraph (i).

(iii) Chemical agents whose toxicity is below the agreed level but which are clearly used as chemical weapons should be added.

(iv) From the above list, single-purpose agents should be listed in table I, dual-purpose agents in table II and the remaining agents in table III. An important point in this process is that the listing work can be done objectively by experts on the basis of a criterion of toxicity and other criteria. The tasks of deleting, adding, and classifying chemical agents should be undertaken by an informal expert meeting or an informal working group composed of qualified experts from CCD member and non-member countries, in accordance with a procedure to be agreed upon by the State parties to the treaty. The various criteria other than purpose criteria are all supplementary means of carrying out this work.

(3) Contribution to the control of chemical weapons

This method, by which we can determine concretely the chemical agents to be controlled by the treaty, will be useful, as explained below, from the standpoint of controlling chemical weapons in order to ensure compliance with the treaty.

(a) In the event that the chemical agents listed in table I are to be destroyed on a phased basis, the method makes it easier to work out a programme for their destruction; to establish procedures for destruction according to the characteristics of individual chemical agents, and for on-site inspections; and to ascertain the amount of destruction accomplished.

(b) If the agents listed in table II are to be brought under control, the method will be useful in preparing annual reports on the actual quantities of production, imports, stocks and so on needed for peaceful purposes, and in submitting estimates of requirements (the reader is referred to the procedure described in article 19 of the Narcotic Drugs Convention).

(c) The method will facilitate periodic review of the tables. In particular, if it becomes clear that chemical substances of recognized potential for use as chemical warfare agents are in use for weapons, the method will make it easier to transfer those substances to table I or II.

To sum up, the purpose of this working paper has been to present some suggestions concerning a number of proposals already submitted, as mentioned in the introduction, and also a suggestion on item (ii) of the scheme suggested by the distinguished delegate of the United Kingdom at the 737th plenary meeting on 17 March 1977, entitled "Means of defining agents to be banned". We have also referred to item (iii) of that scheme, entitled "Verification problems (... destruction of stockpiles, data to be collected and exchanged by national verification systems)".

CCD/530/Add.1
24 March 1977

Original: English

ARGENTINA, BRAZIL, BURMA, EGYPT, IRAN, MEXICO, NIGERIA, PERU, SWEDEN, YUGOSLAVIA AND ZAIRE

Working Paper on Procedures of the Conference of the Committee on Disarmament

Addendum

Add MOROCCO to the list of co-sponsors.

CCD/530 and Add.1
23 March 1977

Original: English

ARGENTINA, BRAZIL, BURMA, EGYPT, IRAN, MEXICO, MOROCCO,
NIGERIA, PERU, SWEDEN, YUGOSLAVIA AND ZAIRE

Working Paper on Procedures of the Conference of the Committee on Disarmament

I. Standing Sub-Committee of the CCD

A standing sub-committee should be set up to negotiate specific texts of draft conventions, treaties, agreements and other documents on those questions in the agenda of the CCD which the Committee may refer for that purpose to the sub-committee.

The organization of work and its procedures should be determined by the CCD and should not impair in any manner the right of the Committee to adopt any other procedural measures it may deem advisable. The chairmanship should be by monthly rotation according to the alphabetical order in English of member States.

The sub-committee should have its records, as appropriate, and should submit its report(s) to the CCD.

The level of representation in the sub-committee should be determined by each delegation.

Its meetings should be held without hampering the regular or informal meetings of the CCD.

II. Preparation of the Report

1. The draft report should be prepared by the Secretariat.

2. The draft should be made available to all members of the CCD at least two weeks before the scheduled date for the closure of the summer session. (It should be up-dated at the end of the succeeding week.)

3. The draft should contain:

(a) The Provisional Agenda as adopted on 15 August 1968;

(b) Summary of specific requests addressed to the CCD by the United Nations General Assembly at its preceding regular session;

(c) Sectional headings in accordance with items comprised in (a) and (b) above and other matters raised in the Committee during the year;

(d) Significant views expressed by delegations under each item including their analysis, if any, of the issues discussed. (If more than one delegation has made the same point the fact should be clearly stated);

(e) Conclusions and decisions, if any, adopted by consensus;

(f) The same kind of index as appeared in the 1975 report as well as a subject index. (The subject headings may need to be changed from time to time.);

(g) Working papers and proposals submitted during the year;

(h) PV's of the meetings held during the year as well as working papers should be distributed in New York to delegations of member States of the United Nations as they are ready in Geneva and should also be distributed as a separate annex of the report.

4. The Committee should consider the draft report during the final week of its summer session. Delegations wishing to make statements on matters of substance during that week, and wishing reference to the statements to be included in the report, should provide very brief summaries for this purpose.

5. The report should be circulated in New York to all delegations of member States of the United Nations by 1 October.

III. Communiqué of the meeting

The communiqué should be made in such a way as to reflect more substantially the proceedings of the CCD plenary meetings.

It should contain information in respect to the consecutive number of the plenary meeting held, and the chairmanship of the day.

The communiqué should enumerate the names of the representatives of the countries who made statements, the topics covered by them as also proposals or working papers submitted to the Committee.

It should also contain information in respect to the Committee's decisions concerning its schedule of work, convening of formal, informal or other meetings.

CCD/531
28 March 1977
Original: English

UNITED STATES OF AMERICA

Working paper concerning incapacitating chemical warfare agents

Introduction

In addition to chemicals that kill or permanently disable, chemicals which have temporary, incapacitating effects are potential chemical warfare agents. For this reason, it is appropriate to consider their inclusion in a future CW arms control measure. The draft Conventions presented by the Socialist countries (CCD/361), Japan (CCD/420), and the United Kingdom (CCD/512), all appear to place restrictions upon incapacitants, as well as on other agents. In addition, the 10-nation memorandum on CW (CCD/400) would seem to advocate prohibition of incapacitants.

While the view that incapacitating agents should be subject to constraints appears to be widely held, little information has been presented at the CCD on this category of agent. The only working paper dealing explicitly with incapacitating agents was presented by Canada in 1974 (CCD/433). That paper examined the problem of defining compounds having significance as irritating or incapacitating agents. The purpose of this paper is to present additional background material.

What are incapacitating agents?

As pointed out in Canadian working paper CCD/433, "incapaciting means having physiological or mental effects which will render individuals incapable of normal concerted physical or mental effort or both for a significant period of time after exposure". The effects are intended to be temporary, resulting in no permanent damage. Such effects may last for hours (or for days in extreme situations) after removal from exposure.

In order to be effective militarily, incapacitating agents must fill the basic requirements common to all chemical agents: reasonable cost of manufacture from readily available materials; a high degree of stability in storage as well as during and after dissemination; capability of being disseminated efficiently and a relatively short time interval between exposure to the agent and the onset of desired effects. In addition, the difference between the effective and lethal doses of an agent must be wide enough to permit the spontaneous recovery of most victims with no permanent after effects.

The most important types of incapacitating agents are found in the following categories:

(1) Psychochemicals. These compounds (usually indole, tryptamine, or piperidine derivatives) may be described as psychotropic, psychotogenic, psychotomimetic, or hallucinogenic. The effects produced may include visual and aural hallucinations; a sense of unreality; and changes in mood, behaviour, performance, memory, attitude, concentration, perception, and thought processes. Representative agents of this group are 3-Quinuclidinyl Benzilate and Lysergic Acid Diethylamide.

(2) Paralysants. Agents that interrupt nerve impulse transmission at the skeletal neuromuscular junction (for example, curare) and those that block transmission in autonomic ganglia (for example, hexamethonium) are found in this group.

(3) Pain producers. Physical irritants which have a persistent effect can be considered incapacitating agents. Representative of this group are urushiol (one of the active principles of poison ivy) and bufotenine (a compound which is secreted by the common toad and causes intensive itching).

Effective dose and other definitional criteria

Toxicity thresholds based on median lethal dose are generally agreed to be a useful supplement to the general purpose criterion for defining which chemicals are potential lethal CW agents. In the Canadian paper CCD/414 this general approach was extended to potential incapacitating CW agents. It was suggested that: "A chemical compound or element can be considered as a potential agent of war if it has a median incapacitating or irritating dosage of less than 500 mg. min/M^3".

While determination of median lethal dosage is relatively straightforward, measurement of median effective dosage is much more complex. The experimental procedure used will depend on the type of effect expected. Separate methods would be needed to determine effective dosage for each class of agents. One method for measuring human mental performance, called the Number Facility Test (NF), employs a series of addition problems, each consisting of three randomly selected 1- or 2-digit numbers. The score is the number correctly added within a 3-minute period. Other tests have been developed to measure eye-hand co-ordination and dexterity. The types of tests used for animal testing are often based on conditioned reflex responses, physical endurance and visual discrimination.

Criteria based on chemical structure or physical properties, analogous to those suggested for lethal agents, would appear to have little utility. Potential incapacitating agents are so diverse that it does not appear possible to find any simple definitional formula. In view of the lack of suitable technical criteria, consideration might be given to relying solely on the general purpose criterion.

Verification considerations

Generally speaking, the findings reached on verification of restrictions on lethal agents will also apply to incapacitating agents. In other words, the ability to verify restrictions on development, production or stockpiling will be no better or worse for incapacitating agents than for lethal agents.

Military role of incapacitating agents

While the potential military role for incapacitating agents has been discussed for decades, such agents do not appear to have become a major component of CW stockpiles. A key factor has undoubtedly been the unsuitability of currently known agents for military purposes. If incapacitating agents were not eventually covered in a CW agreement, however, increased effort might well be devoted to overcoming these shortcomings.

Conclusions

1. The view that limitations should be placed on incapacitating agents, as well as on lethal agents is widely shared.

2. In view of the lack of suitable technical criteria for defining potential incapacitating agents, consideration might be given to relying solely on the general purpose criterion.

3. Limitations on incapacitating agents do not appear to pose any novel verification problems.

4. At present incapacitating agents do not appear to have become a major component of CW stockpiles. Their role could increase, however, if they were not covered in a CW agreement.

CCD/532
21 April 1977
Original: English

DECISION ON CERTAIN PROCEDURAL ASPECTS OF THE CONFERENCE OF THE COMMITTEE ON DISARMAMENT

(Adopted at the 746th Meeting of the Conference on 21 April 1977)

I. Organization of Work of the CCD

The work of the Committee will continue to be conducted in plenary meetings and through any additional arrangements agreed by the Committee, such as special plenary meetings, informal meetings, or informal meetings with experts.

The Committee agrees to the following provisional guidelines for the establishment of ad hoc working groups to facilitate the negotiations of texts of agreements (or any other document).

1. When it appears that there is a basis to negotiate a draft treaty or other draft texts, the CCD should establish an ad hoc working group for this purpose open to all members of the CCD.

2. The CCD should define the mandate for each working group including a target date for submitting its final report to the CCD and should provide the group with such working documents as may form an appropriate starting point for the group's work.

3. In connexion with the establishment of a Working Group, the CCD may take a decision to send through the United Nations Secretary-General's Representative to all States Members of the United Nations, but not members of the CCD, appropriate working documents which have not previously been made available to them.

4. In accordance with the CCD's established procedure, the working groups shall work on the basis of consensus. The chairmanship of the working groups should rotate in the same manner as in the CCD. The meetings of the working groups should be on an informal basis and should be so scheduled as to avoid conflicting or otherwise interfering with the regular or informal meetings of the CCD. The level of representation in the working groups should be determined by each delegation. The working groups, on a periodic basis, should issue whatever reports to the CCD are deemed necessary. The Committee requests that the Secretariat provide assistance to the working groups as necessary, including the preparation of unofficial summaries of the working groups' proceedings.

5. The CCD will take any other decisions that may be necessary regarding the organization and procedures of the working groups.

II. Preparation of the CCD's Annual Report to the United Nations General Assembly

1. The draft report should be prepared by the Secretariat.

2. The draft should be made available to all members of the CCD at least two weeks before the scheduled date for the closure of the summer session. (It should be updated at the end of the succeeding week.)

3. The draft should contain:

(a) The Provisional Agenda as adopted on 15 August 1968;

(b) Summary of specific requests addressed to the CCD by the United Nations General Assembly at its preceding regular session;

(c) Sectional headings in accordance with items comprised in (a) and (b) above and other matters raised in the Committee during the year;

(d) Significant views expressed by delegations under each item including their analysis, if any, of the issues discussed. (If more than one delegation has made the same point the fact should be clearly stated.);

(e) Conclusions and decisions, if any, adopted by consensus;

(f) A table of contents and an index, along the lines of the index which was included in the 1976 report, as well as a subject index of both the basic report and annexes. (The subject headings may need to be changed from time to time.);

(g) Working papers and proposals submitted during the year;

(h) Verbatim records of the meetings held during the year should also be distributed as a separate annex of the report.

4. The Committee will consider the draft report during the final week of its summer session. Delegations wishing to make statements on matters of substance during that week, and wishing reference to the statements to be included in the report, should provide brief summaries for this purpose.

7 5. The report should be circulated in New York to all delegations of member States of the United Nations by 1 October.

III. Distribution of Verbatim Records of CCD Plenary Meetings and CCD Working Documents

Verbatim records of the CCD plenary meetings held during the year and the working documents should be distributed in New York to delegations of members States of the United Nations as soon as received from Geneva.

IV. Communique of CCD Plenary Meetings

The communique should be made in such a way as to reflect adequately the substance of the proceedings of the CCD plenary meetings.

It should contain information in respect to the consecutive number of the plenary meeting held, and the chairmanship of the day.

The communique should enumerate the names of the representatives of the countries who made statements, the topics covered by them as well as proposals or working papers submitted to the Committee.

It should also contain information in respect to the Committee's decisions concerning its schedule of work, convening of formal, informal, or other meetings.

THE NETHERLANDS

Working paper concerning the verification of the presence of nerve agents, their decomposition products or starting materials downstream of chemical production plants

1.1. A NON-INTRUSIVE METHOD TO VERIFY A BAN ON THE PRODUCTION OF NERVE AGENTS

One of the functions of an effective verification system with respect to a ban on the development, production and stockpiling of chemical weapons is to deter the production of chemical weapons, in particular the very dangerous nerve agents. To achieve adequate deterrence, procedures are necessary to ensure that a sufficient chance exists that clandestine production of nerve agents will be detected. On the other hand, one always strives for verification methods which are as non-intrusive as possible.

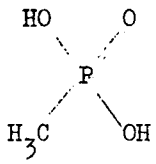
As a contribution to solve part of the problems involved, a highly sensitive method will be described to analyse waste water downstream of chemical production plants and to compare this with an upstream sample with the purpose of detecting the presence therein of nerve agents, their decomposition products or starting materials. The analytical procedure may be carried out in every laboratory equipped with a gas chromotograph and the method is sufficiently sensitive to give a positive indication even after extensive water purification.

From the results it may be concluded that the reported procedure gives a practically unambiguous and simple yes or no answer to the question whether nerve agents, their decomposition products or starting materials are present or not. After a positive detection -- which would only make the plant suspected -- a visit to the plant could be made to reveal the identity of the product manufactured.

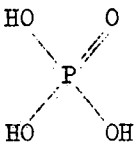
1.2. BASIS OF THE METHOD

The nerve agents are organophosphorus compounds and structurally related to pesticides. Generally both types of compounds may be prepared in similar production plants. However, an important structural difference between both types of compounds exists. The majority of the nerve agents is related to methylphosphonic acid (I),

whereas most of the commercially available organophosphorus pesticides have phosphoric acid (II) as their basic structure apart from a few pesticides based on I which generally have an experimental status[3-5].



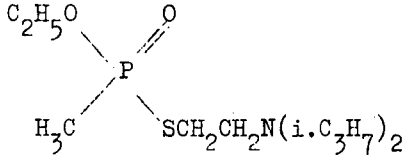
I



II

The Japanese delegation to the Conference of the Committee on Disarmament drew attention to the fact that the phosphurus-carbon bond is not cleaved under mild decomposing conditions. Besides gas chromatography in combination with a specific detection was mentioned as a suitable method to detect organophosphorus compounds at very low concentrations.[6]

A verification procedure, based on the above-mentioned considerations, is presented in this report. Samples from the Rhine and Meuse, both considered as heavily polluted rivers, were used as models for substantially diluted waste water downstream of chemical production plants. As such the procedure provides a rather non-intrusive inspection method. Ethyl S-2-di-isopropylaminoethyl methylphosphonotioate (VX).



was used as a representative of the nerve agents.

After a discussion of the investigations concerning the different aspects of the procedure in part 2 the ultimate procedure is described in part 3. Part 4 comprises some results obtained on application of the ultimate verification procedure on Rhine and Meuse river water samples. Some directions for future work conclude the report as part 5.

2. EVALUATION OF THE VERIFICATION PROCEDURE

2.1. Materials

Rhine river water samples were collected from the Lek at Bergambacht and analysed by the Dune Water Works of the Hague. The Meuse river was sampled at Keizerzveer and analysed by the Drinking Water Works of Rotterdam. The samples were stored in a refrigerating room. The chemical analyses of the water samples are listed in Table 1.

Table 1

Chemical analyses of Rhine and Meuse river samples

component		Rhine						Meuse
		12-12-'73	12-8-'74	20-11-'74	8-1-'75	25-8-'75	3-3-'76	23-2-'76
chloride	(mg/l)	230	175	168	83	140	196	37
sulphate	"	89	86	85	59	70	94	54
bicarbonate	"	140	146	156	146	149	193	134
nitrate	"	11.5	10.8	12.2	14.0	12.7	17.6	17.0
Kjeldahl nitrogen	"	4.4	1.7	2.2	1.5	1.0	2.6	1.9
orthophosphate		0.62	0.55	0.75	0.41	0.98	0.97	0.73
unfiltered	"	1.95	1.27	1.70	1.10	1.61	1.92	1.4
total organic carbon	"	6.2	7.8	5.9	8.0	5.5	8.2	6.9
silt	"	64	10	19	46	33	23	26
cholinesterase inhibition in parathion eq.	(µg/l)	0.17	0.25	0.24	0.04	0.08	0.13	-
pH		7.55	7.60	7.50	7.65	7.70	7.50	7.6
flow	(m^3/sec)	2572*	1648*	2870*	3497*	1964*	1329*	350**

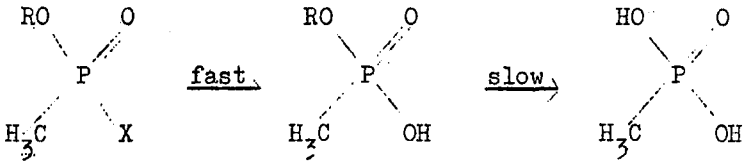
* Lobith.
** Lith.

For each experiment new glassware was used to preclude cross-contamination. ^{32}P-labelled methylphosphonic acid (specific activity 1 mCi/g) and ^{32}P-labelled VX (specific activity 20 mCi/g) as well as the corresponding unlabelled compounds were synthesized in this laboratory. Diazomethane was prepared and used in diethyl ether solution[7].

2.2. Hydrolysis

As stated in Chapter 1 gas chromatography in combination with a specific phosphorus detection is a suitable technique for the tracing of nerve agents in water at very low concentrations. To make the gas chromatographic picture as simple as possible (section 2.6) a complete hydrolysis should be carried out after which most

phosphorus-containing nerve agents will present themselves as methylphosphonic acid (equation 1), whereas organophosphorus pesticides will give rise to phosphoric acid (equation 2).

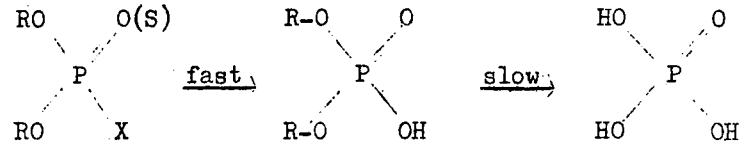


(1)

III IV I

Example of III: VX, in which R = C_2H_5 and X = $SCH_2CH_2N(i.C_3H_7)_2$

Sarin, in which R = $i.C_3H_7$ and X = F.



(2)

V VI II

Example of V: Parathion, in which R = C_2H_5, and X = $OC_6H_4NO_2$-p and

O(S) O

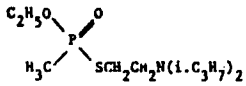
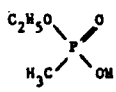
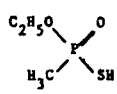
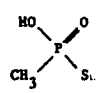
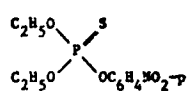
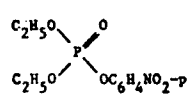
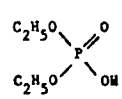
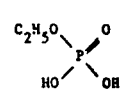
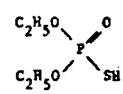
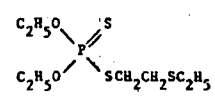
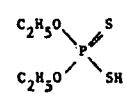
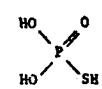
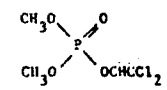
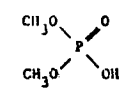
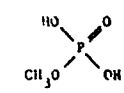
P = P

A strong acidic medium is a prerequisite to ensure a complete hydrolysis of both chemical warfare agents and pesticides with chemical formulae represented in equations 1 and 2 respectively. Moreover the process of hydrolysis should take place in a reasonable period of time. In order to establish optimum conditions, hydrolytic data of a number of organophosphorus compounds were collected.

In addition to some hydrolytic half-life values derived from literature a number of model compounds has been selected to determine their rates of hydrolysis. Experiments were carried out in 1 ml sealed glass ampoules containing 0.5 ml of 0.05 M sodium citrate/citric acid buffer at pH 3. The concentration of the different model compounds was 0.02 M. The ampoules were heated in an oil-bath at 130°C. From the quantitative analysis of the reaction mixture using high-voltage paper electrophoresis, paper chromatography, gas chromatography and ultraviolet spectroscopy the respective hydrolytic half-life values were determined[8]. Table 2 comprises hydrolytic data of a representative of the nerve agents (VX), of some pesticides (Parathion, Disyston and DDVP) and of intermediates that might appear during hydrolysis. To motivate the presence of some of these intermediates it is to be remarked that in the acid hydrolysis of nerve agents (equation 1) and pesticides (equation 2) to I and II respectively, the

Table 2

Hydrolytic half-life values of some compounds related to phosphorus-containing nerve agents and pesticides at pH 3

	compound	systematic or trivial name	hydrolysis temp. (°C)	$t_{\frac{1}{2}}$ (h)	ref.
1		VX	130	0.24	-
2		ethyl hydrogen methylphosphonate	130	10	-
3		ethyl hydrogen methylthiophosphonate	130	9.8	-
4		methylphosphonothioic acid	130	0.36	-
5		Parathion	70	21	13
6		Paraoxon	70	23*	13
7		diethyl hydrogen phosphate	130	82	-
8		ethyl dihydrogen phosphate	130	1.42	-
9		diethyl hydrogen phosphorothioate	130	61	-
10		Disyston	70	62*	13
11		diethyl S-hydrogen phosphorodithioate	130	0.97	-
12		monothiophosphoric acid	52.8	1.2	14
13		DDVP	70	3.4*	13
14		dimethyl hydrogen phosphate	100	110	15
15		methyl dihydrogen phosphate	100	0.25	9

*Value refers to the first leaving group.

hydrolysis of the intermediately formed alkyl hydrogen methylphosphonate (IV) and dialkyl hydrogen phosphate (VI) is the rate determining step. Therefore hydrolytic data on these compounds are included.

The rates of hydrolysis of phosphates and phosphonates are known to be pH-dependent. The hydrolysis of alkyl dihydrogen phosphates[9] generally shows a maximum rate at pH 4; the hydrolysis rates of dialkyl hydrogen phosphates[10] and phosphonates[11] rise progressively when lowering the pH-value. Thiophosphates[12] show a maximum rate at pH 3. As a compromise and for practical reasons a pH 3 was selected for all hydrolysis experiments: acidic solutions below pH 3 may affect the performances (e.g. the capacity) of the anion-exchange column in the second step of the procedure (section 2.3).

A temperature of 130°C was selected to obtain measurable rates of hydrolysis in a four-days period.

From Table 2 it may be concluded that nerve agents, pesticides and their decomposition products hydrolyse to I and II respectively in a reasonable period of time at pH 3 and 130°C. In the ultimate procedure the temperature was increased to 160°C to obtain a complete hydrolysis of organophosphorus esters in 24 hours.

2.3. Isolation and concentration

After the hydrolysis the water samples of the Rhine and the Meuse river are passed through glass-fibre papers to remove solid particles (silt) preceding the use of the anion-exchange column. In this way the resin could be reused by means of a regeneration process*/ and a possible disturbance of the sample flow through the column was excluded. The adsorption of I onto the solid particles in the river samples is negligible as was determined by means of ^{32}P-labelled I. After filtration through the filter paper ng quantities of I were recovered quantitatively in the eluate.

A strong anion-exchange resin [type $\emptyset$-$N(CH_3)_3^{(+)}$] is used to adsorb the methylphosphonate anion from the hydrolysed water samples. A simultaneous adsorption of other anions occurs e.g. chloride, sulphate and phosphate, which are generally present in excess when compared with the amount of compound I. The bicarbonate ion and other anions or weak acids are not adsorbed. A 2-3 fold excess in adsorption capacity of the anion-exchange column is used which is based on the average amount (3.5 meq.) of anions present in 0.5 litre of Rhine water in addition to the methylphosphonate ion and the added amount (about 3 meq.) of hydrochloric acid used to adjust the pH to 3. The first experiments were carried out with the commercially available anion-exchange resin

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*/ According to BIO-RAD: (step 1) resin-$Cl^{(-)}$ + NaOH → resin-$OH^{(-)}$; (step 2) resin-$OH^{(-)}$ + formic acid → resin-formate$^{(-)}$.

Amberlite IRA-400 in the chloride (Cl^-) form. On a column packed with this resin a quantity of 0.1 meq. of the methylphosphonate anion proved to be adsorbed incompletely from one litre of the water sample. 50-60 per cent of the added amount of I was not retained on the column. A quantitative adsorption of I was obtained when the resin was converted into the formate ($HCOO^-$) form. Afterwards a commercially available resin, type BIO-RAD AG 1-X8 $HCOO^-$ was used. By means of a breakthrough chromatogram using a 0.5 litre sample containing 815 mg of chloride or 1200 mg of sulphate and 225 µg of ^{32}P-labelled I it was found that during the isolation I moved as a narrow band on the column in front of the chloride and the sulphate ions. Compound I eluted from the column only when the anion-content in the water sample surpassed the anion-exchange capacity of the column.

After the passage of the water sample the resin is washed with methanol to remove the interstitial water together with some neutral and basic compounds present in the original water sample. It is important that the hydrochloric acid-methanol solution, which is then used to elute the methylphosphonate anion, is dry because the subsequent evaporation of this solution in the presence of water gives rise to considerable losses of compound I.

A recovery of compound I amounting to 75-100 per cent was found after evaporation as was checked by experiments with ^{32}P-labelled I.

2.4. Derivatization

Compound I itself cannot be gas chromatographed but has to be converted into a volatile derivative to achieve a sensitive gas chromatographic detection and separation. The compound was transformed into dimethyl methylphosphonate using diazomethane in diethyl ether solution[7]. The yield of the esterification was nearly quantitative (95 per cent) as determined by gas chromatography (Chapter 3). Other acids such as phosphoric acid and sulphuric acid are methylated simultaneously. These acids may be present in the ion-exchange column eluate coming from the original water sample and trapped on the resin together with compound I.

2.5. Clean-up

This part of the complete verification procedure was introduced to obtain a proper gas chromatographic analysis of dimethyl methylphosphonate as outlined in section 2.6.

Ether as well as methanol are removed from the esterified sample (section 2.4) by means of boiling under reflux in a Vigreux column until a residual volume of 3-4 ml persists. This concentration step was checked by means of a number of experiments with mixtures containing 10 ml of benzene, 10 ml of ether, 1 ml of methanol and 3 µg of dimethyl methylphosphonate. A recovery of 90-100 per cent of the phosphonate was found as determined by gas chromatographic analysis.

The procedure according to reference 16 using a small silica gel column removes the majority of trimethyl phosphate and dimethyl sulphate from the methylated sample solution. Details of the gas chromatographic interferences of dimethyl sulphate are given in section 4. The silica gel column is successively eluted with benzene, ethyl acetate, and methanol. It was found that the benzene fraction contains mainly dimethyl sulphate, the ethyl acetate fraction trimethyl phosphate and the first ml of the methanol fraction about 80 per cent of the added amount of dimethyl methylphosphonate.

2.6. Gas chromatographic analysis

For the separation of dimethyl methylphosphonate and trimethyl phosphate the performances (e.g. resolution and peak symmetry) of a number of different stationary phases such as SE-30, QF-1, FFAP, OV-225, DEGS and Triton X-305 were evaluated. Triton X-305 turned out to be the best.

The optimum column temperature was found to be 140-150°C. Due to an increased column bleeding at higher temperatures the column-life decreased considerably whereas an increase in detector noise and detector contamination occurred.

Besides the use of diazomethane for the esterification of methylphosphonic acid and phosphoric acid it is possible to use other diazoalkanes. The resolution of the resulting trialkyl phosphates and dialkyl methylphosphonates may be expressed by:

$$R_s = 2\,\frac{t_r(\text{trialkyl phosphate}) - t_r(\text{dialkyl methylphosphonate})}{y\,(\text{trialkyl phosphate}) + y(\text{dialkyl methylphosphonate})} \qquad (3)$$

where R_s stands for the resolution, t_r for the retention time and y for the peak width at the base. The results together with the retention time relative to dimethyl methylphosphonate are given in Table 3.

Table 3
Resolution and retention times relative to dimethyl methylphosphonate*/ of a number of methylphosphonates and phosphates

$(RO)_2P(O)CH_3$ R =	relative retention	$(RO)_3P(O)$ R =	relative retention	resolution
CH_3	1.00	CH_3	1.33	2.1
C_2H_5	1.29	C_2H_5	2.07	4.0
$n.C_3H_7$	2.57	$n.C_3H_7$	5.53	4.1
$i.C_3H_7$	1.09**/	$i.C_3H_7$	1.58	2.8

*/ Retention time is 200 sec, column temperature 140°C, for further gas chromatographic conditions see Chapter 3.

**/ Tailing peak.

From the results given in Table 3 it might be concluded that it is advisable to prepare either the ethyl or the n.propyl esters instead of the methyl esters. Nevertheless the use of the methyl esters is to be preferred for the following reasons:

(a) Dimethyl methylphosphonate is detected at least two times more sensitive than diethyl methylphosphonate and dipropyl methylphosphonate.

(b) When using the ethyl esters or n. propyl esters the analysis time will be increased two or four times respectively in comparison with that needed for the methyl esters.

(c) Methanol is used as a main component of the eluent system to desorb methylphosphonic acid from the anion-exchange column. In that case the use of diazomethane[17] is recommended.

Owing to its specificity for organophosphorus compounds the thermionic detector was the detector of choice. The mean lowest detectable amount of dimethyl methylphosphonate proved to be 0.23 ng (range 0.15-0.30 ng). The maximum injection volume was found to be 5 µl. More solvent volume caused an extinction of the detector flame.

Dimethyl methylphosphonate can be identified by means of its retention index according to Kovàts[18]. The index amounts to 1427 when determined at 170°C on Triton X-305 as a stationary phase. Under these conditions trimethyl phosphate, which will be detected as well, has a retention index of 1483.

To prove unambiguously that the peak ascribed to dimethyl methylphosphonate is not due to the presence of a non-phosphorus compound in relatively high concentration, the thermionic detector was used in combination with a flame ionization detector. In case of a non-phosphorus compound the last mentioned detector will give a relatively high pressure

3. DESCRIPTION OF THE VERIFICATION PROCEDURE

From the results outlined in the preceding Chapter the following method was selected to verify the presence of nerve agents or their decomposition products in waste water.

Hydrolysis: The hydrolysis is carried out in sealed 750 ml Carius tubes containing 500 ml water samples adjusted to pH 3 using 0.5 N hydrochloric acid. The tubes are heated in an oil-bath at 160°C during 24 hours.

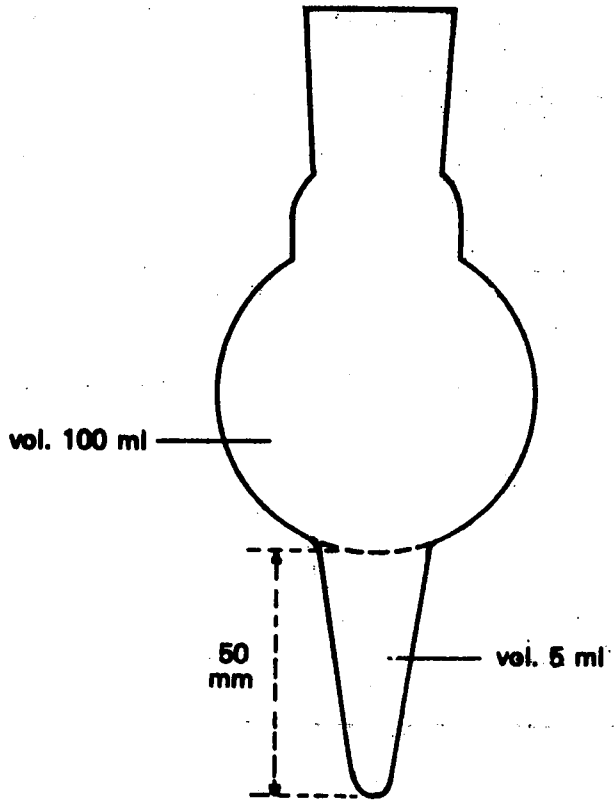

Figure 1. Pear-shaped flask to concentrate the column eluate.

Isolation and concentration: After filtration through glass-fibre paper (Whatman, GF/A) the hydrolyzed sample is passed through an anion-exchange column (length 20 cm, i.d. 11 mm) packed with AG 1-X8 (formate form, BIO-RAD) at a flow rate of 1-2 ml/min. After the passage of the sample the exchange column is washed with 30 ml of methanol. Methylphosphonic acid and other acids adsorbed on the resin are eluted at a flow rate of 0.5-1 ml/min with 20 ml of acidified (with gaseous hydrochloric acid up to 3N) methanol. The eluate, collected in a pear-shaped flask (Fig. 1), is concentrated to a volume of less than 1 ml by evaporation in a water-bath maintained at 50°C, using a gentle stream of air.

Derivatization: A solution of diazomethane, generated from N-methyl-N-nitroso-p-toluenesulphonamide and potassium hydroxide[7], in ether is added to the residue of the eluate until a yellow colour persists. The mixture is allowed to stand for 15-20 minutes. The excess of diazomethane is removed by means of a few droplets of acetic acid.

Clean-up procedure: After the addition of 10 ml of benzene the methylated solution is concentrated by boiling under reflux using a Vigreux column (length 19 cm, i.d. 11 mm) until a residual volume of 3-4 ml. To prevent bumping of the boiling liquid use is made of a device consisting of a glass bar bent in a U-form[7]. During boiling the pear-shaped part of the reaction flask (Fig. 1) is immersed in an oil-bath, which is gently heated from room temperature up to 160°C in the course of 45 minutes.

Silica gel, after pretreatment by heating for 48 hours at 135°C, is partially deactivated by shaking with 3 per cent (w/w) distilled water. After four hours the gel is ready for use. To a column (length 19 cm, i.d. 8 mm) plugged with glass wool 1 g of the silica gel is added, followed by 2 g of anhydrous sodium sulphate[16]. The column is prewashed with 10 ml of hexane. The sample solution is transferred to the silica gel column which is successively rinsed with 16 ml of benzene, 24 ml of ethyl acetate and 8 ml of methanol at a flow rate of 0.2-0.4 ml/min. The eluates of benzene, ethyl acetate and the initial 1 ml of methanol are collected separately. The methanol fraction is set aside for further use.

Gas chromatography: The gas chromatographic analyses are carried out on a Becker gas chromatograph, type 409, equipped with a thermionic detector (TID), type 712. The coiled glass column (length 2 m, i.d. 1.5 mm) is packed with Chromosorb W-AW/DMCS 80-100 mesh coated with Triton X-305 (25 per cent w/w) after sieving in the particle range from 149-177 µm. The column, injector and detector are maintained at 150, 200 and 200°C respectively. Gas flow rates are 40 ml/min for nitrogen, 65 ml/min for hydrogen and 250 ml/min for air. Because of the use of a splitter at the end of the column [ratio (3:1)] only 20 ml of nitrogen pro minute reached the TID detector. The remaining part is led to a flame ionization detector. Maximum sample volumes of 5 µl can be injected. Reference samples of comparable concentration are used for quantitative measurements.

4. APPLICATION AND DISCUSSION

Once developed the complete verification procedure was checked by adding varying quantities (0.1 µg - 1 mg) of VX to 1 litre of demineralized water and Rhine river water.

Based on dimethyl methylphosphonate a mean recovery of 73 $\pm$ 11 per cent was obtained in demineralized water. The clean-up part of the procedure was omitted in this case. Considerable concentrations of phosphoric acid (approximately 0.2 mg/litre) were found which were detected as trimethyl phosphate by gas chromatography. Phosphoric acid is probably released from the wall of the glassware during hydrolysis.

Samples obtained after the addition of a relatively high quantity (1 mg) of VX to 1 litre of Rhine river water were analysed similarly. A clean-up of the sample before the gas chromatographic analysis proved to be unnecessary because no interfering substances were present at that concentration level and the comparable amounts of dimethyl methylphosphonate and trimethyl phosphate could be sufficiently separated by gas chromatography. Based on dimethyl methylphosphonate a recovery of 78 $\pm$ 10% (n=6) was obtained.

In the analytical procedure carried out with small quantities of VX (0.1-1 µg) added to 1 litre of Rhine river water the clean-up method had to be introduced because of interferences in the gas chromatographic analysis. First of all separation of small amounts of dimethyl methylphosphonate from a 1000 fold excess of trimethyl phosphate proved to be insufficient because of overlapping of the peaks. Moreover dimethyl sulphate interfered seriously in the detection of dimethyl methylphosphonate. Depending on the hydrogen flow the thermionic detector gave negative or positive peaks for dimethyl sulphate which influenced the response of dimethyl methylphosphonate, because of peak overlap. Dimethyl sulphate was identified by the combination of gas chromatography and mass spectrometry (type JEOL JMS-01-SG). It is most probably formed by methylation of sulphuric acid present in the Rhine river samples (concentration level of sulphate $\simeq$ 80 mg/litre). The interferences of excess trimethyl phosphate and dimethyl sulphate could be overcome when using a clean-up of the methylated sample before the gas chromatographic analysis. In this way it proved to be possible to analyse concentrations of VX added to Rhine river water samples down to 250 ng/litre. Based on dimethyl methylphosphonate a recovery of 80-90 per cent was found in Rhine river samples taken 25 August 1975.

These recoveries were corrected for an amount of dimethyl methylphosphonate (0.7-0.8 µg/litre) detected in the same Rhine river samples to which no VX was added. The identity of this compound was approved by mass fragmentography on a Finnigan quadrupole gas chromatograph-mass spectrometer, type 3100-003D. The peak was scanned at three characteristic m/e values: 79, 94 and 109 which correspond with $(CH_3O)P(O)H^{\oplus}$, $(CH_3O)P(O)H(CH_3)^{\oplus}$ and $(CH_3)_2P(O)^{\oplus}$. The peak intensity ratio was 6:4.4:1 which

equals the result obtained with a reference sample of dimethyl methylphosphonate. Owing to the small amount the intensity of the molecular ion was too small for scanning

Later on the same compound was detected in the Rhine river samples of 3 March 1976 (conc. 760 ng/litre) and in the Meuse river sample of 23 February 1976 (180 ng/litre). Obviously one or more emission sources in or at both rivers give rise to the presence of a compound containing a PCH_3 group in the molecule. Literature gives no indication that such compounds occur in nature. It is known that a number of insecticides containing a P-C bond are commercially available e.g. Dyfonate (ethyl S-phenyl ethylphosphonodithioate). As a result of the described analytical procedure dimethyl ethylphosphonate will result. According to its retention index (1468) this compound will not interfere in the gas chromatographic analysis of dimethyl methylphosphonate (retention index 1427, see section 2.6). However, Mecarphon[5] to our knowledge the only commercially available pesticide containing a PCH_3 group will give rise to dimethyl methylphosphonate on application of the analytical procedure and will thus interfere in the verification process.

As stated in section 2.6 the mean lowest amount of dimethyl methylphosphonate detectable by gas chromatography (section 2.6) is 0.23 ng of dimethyl methylphosphonate or 250 ng of VX per litre of water, being corrected for a mean recovery of 80 per cent and an original water sample volume of 0.5 litre, which was concentrated to a volume of 1 ml. This means that if a plant carries off at least 5 kg of VX or an equivalent quantity of its decomposition products or starting materials in 24 hours into a river with a flow of 250 m^3/sec it will be detected. A survey of advanced waste treatment technology has revealed that carbon adsorption processes would be capable of reducing a concentration of 1 mg/litre of phosphorus containing insecticides in a waste stream to less than 1 ug/litre[4]. This concentration lies well above the detection limit of the procedure described.

As to the possible presence of PCH_3-containing compounds may also be due to a natural or industrial background a reference sample upstream of the chemical production plant has to be analysed in addition to a downstream sample.

5. FUTURE WORK

Further research is needed to get acquainted with the natural or industrial occurrence of compounds which will deliver dimethyl methylphosphonate after application of the described procedure.

Experiments will be carried out to investigate the applicability of the procedure in case of binary nerve agent systems in which the nerve agent is formed by mixing two compounds during the delivery of the projectile to its target.

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CCD/534
28 April 1977

Original: **English**

THIRD PROGRESS REPORT TO THE CONFERENCE OF THE COMMITTEE ON DISARMAMENT BY THE AD HOC GROUP OF SCIENTIFIC EXPERTS TO CONSIDER INTERNATIONAL CO-OPERATIVE MEASURES TO DETECT AND TO IDENTIFY SEISMIC EVENTS

1. In pursuance of the decision of the CCD of 22 July 1976, the Ad Hoc Group of Scientific Experts to Consider International Co-operative Measures to Detect and to Identify Seismic Events held its third session from 25 to 29 April 1977 in Geneva, under the Chairmanship of Dr. Ulf Ericsson of Sweden.

2. Scientific experts and representatives of the following Member States of the CCD attended the session: Bulgaria, Canada, Czechoslovakia, Egypt, German Democratic Republic, Federal Republic of Germany, Hungary, India, Italy, Japan, Mongolia, Netherlands, Pakistan, Poland, Romania, Sweden, Union of Soviet Socialist Republics, United Kingdom, United States of America.

3. By its decision of 7 April, the CCD had invited New Zealand to participate in the work of the Ad Hoc Group of Scientific Experts to Consider International Co-operative Measures to Detect and to Identify Seismic Events. Thus, scientific experts of the following States, in addition to scientific experts of Member States of the CCD, took part in the discussions of the third session: Australia, Belgium, Denmark, Finland, New Zealand and Norway.

4. According to its timetable, revised at the second session, the Ad Hoc Group reviewed drafts towards its final report relating to the following subjects:

Chapter 4: Selection of seismographic stations for a global network.

Chapter 5: Data exchange between selected stations and data centres.

Chapter 6: Data centres for detection and location of seismic events and for reduction of identification parameters.

Chapter 8: Estimated capability of a specified system of international co-operative measures.

Appendix (to the final report): Problems with the estimation of yields from seismic signals.

After thorough discussion, the Ad Hoc Group decided to reconsider some questions related to Chapters 4, 6 and 8 as well as to the Appendix, at its next session. Accordingly, instructions and guidelines were given to the Scientific Secretary and to the conveners of groups of experts on the chapters mentioned for the re-drafting of the texts.

5. In order to assure the completion of its work in time, the Ad Hoc Group reviewed its schedule and agreed to the necessary adjustments.

6. The Ad Hoc Group adopted a draft Agenda for the next session and designated groups of experts from its members to prepare the remaining drafts of the report to be considered at the next session.

7. In the course of the Ad Hoc Group's deliberations on various aspects of the specification of an international system for the detection and identification of seismic events, including the composition of a network of stations, the view was expressed that, for reasons of efficiency and scientific precision, the inclusion into this network of seismological stations situated also in Central and South America and Africa was extremely important. It was therefore felt that increased co-operation of all CCD Member States with the Ad Hoc Group would greatly facilitate the successful completion of its work.

8. The Ad Hoc Group envisages holding its next session from 25 July to 5 August 1977, at the Palais des Nations, Geneva, subject to confirmation by the CCD. The first week of this session, the period between 25 and 29 July, is intended to be devoted to discussions of working parties dealing with Chapter 6 and the Appendix.

CCD/535
21 July 1977
Original: English

SCHEDULE OF MEETINGS OF THE CONFERENCE OF THE COMMITTEE ON DISARMAMENT FOR THE SUMMER SESSION

(Adopted at the 755th Plenary Meeting on 21 July 1977)

Plenary Meetings

Plenary meetings will continue to be held on Tuesday and Thursday at 10.30 a.m., unless decided otherwise. The agenda for the plenary meetings, adopted on 15 August 1968, reads as follows:

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

"Under this heading members may wish to discuss measures dealing with the cessation of testing, the non-use of nuclear weapons, the cessation of production of fissionable materials for weapons use, the cessation of manufacture of weapons and reduction and subsequent elimination of nuclear stockpiles, nuclear-free zones, etc.

"2. Non-nuclear measures.

"Under this heading, members may wish to discuss chemical and bacteriological warfare, regional arms limitations, etc.

"3. Other collateral measures.

"Under this heading, members may wish to discuss prevention of an arms race on the seabed, etc.

"4. General and complete disarmament under strict and effective international control.

"The Co-Chairmen note the recognized right of any delegation to raise and discuss any disarmament subject in any meeting of the Committee."

Further, pursuant to the decision of 29 April 1977, as well as the relevant discussions of this decision in the Committee, the Co-Chairmen note that the Committee can establish an ad hoc working group whenever it deems it appropriate to do so under the procedural decision of 21 April. The Committee can consider the question of setting up such a group later in the summer session.

Informal Meetings

5 - 15 July	-	Informal meetings of CCD as required to discuss the CCD Summer Session programme.
18 - 22 July	-	Informal meetings of CCD on a comprehensive nuclear test ban.
25 - 29 July*	-	Open.
1 - 5 August*	-	Open.
8 - 12 August	-	Informal meetings of CCD, with the participation of experts, on new types and systems of weapons of mass destruction.
15 - 19 August	-	Informal meetings of CCD on comprehensive negotiating programme.
22 - 26 August	-	Informal meetings of CCD, with participation of experts on chemical weapons (may include consideration of the organization and scheduling of the Committee's further work toward the formulation of a ban on chemical weapons).**

* During this period, the Group of Scientific Experts to Consider International Co-operative Measures to Detect and Identify Seismic Events will hold its Fourth Session.

** Proposal for holding informal meetings on chemical weapons, from 22 August to 26 August, is based on the assumption that the Summer Session will not end prior to 30 August and that 27 August to 30 August will be spent on the report.

CCD/536
22 July 1977
Original: English

LETTER DATED 20 JULY 1977 FROM THE CHARGE D'AFFAIRES A.I. OF THE PERMANENT MISSION OF NEW ZEALAND TO THE UNITED NATIONS OFFICE AT GENEVA ADDRESSED TO THE SPECIAL REPRESENTATIVE OF THE SECRETARY-GENERAL TO THE CONFERENCE OF THE COMMITTEE ON DISARMAMENT TRANSMITTING THE VIEWS OF THE GOVERNMENT OF NEW ZEALAND ON A COMPREHENSIVE TEST BAN TREATY

The New Zealand Government has for some time stressed the urgent need to foster progress towards nuclear disarmament and has taken the view that the next logical step in this direction is the conclusion of a comprehensive test ban treaty.

New Zealand is therefore greatly encouraged by the fact that the subject of a comprehensive test ban has been taken up once more by the CCD and that the three member nuclear weapon States concerned are entering negotiations over a treaty.

At this promising juncture, New Zealand wishes to make known to the member States of the CCD its views on the issues of central importance to the conclusion of such a treaty. My Foreign Minister has accordingly asked me to send you the attached paper and to request you to circulate it together with this letter as an official document of the CCD.

(Signed) C.J.M. Ross
Charge d'Affaires a.i.

NEW ZEALAND VIEWS ON A COMPREHENSIVE TEST BAN TREATY

The Need for a Treaty

The aim of disarmament is to increase the security of each State and thereby to strengthen international security. New Zealand has argued for some time that the highest priority in pursuit of this objective is nuclear disarmament — to replace the balance of terror by a balance of confidence. Some limited steps have been taken along this path: the next logical step is a comprehensive test ban treaty. Within the general aim of improving security such a treaty would have two purposes: to help curb the arms race by encouraging less reliance on nuclear weapons and increasing the level of confidence between States; and to discourage the proliferation of nuclear weapons through the treaty itself and through fulfilment of the Article VI obligations of the NPT.

There is nothing new in this: it was for these reasons that the parties to the Partial Test Ban Treaty of 1963 and the Non-Proliferation Treaty of 1968 pledged themselves to strive for the conclusion of a complete ban on nuclear weapon tests. It is the lack of progress over these many years towards fulfilment of that pledge that leads New Zealand to appeal once again to the member States of the CCD to address themselves urgently and seriously to the task of preparing a comprehensive test ban treaty.

Negotiations have been delayed in the past by fears of some States that a level of perfection could not be achieved in the treaty's provisions and that any imperfections therein would pose an unacceptable threat to the national security of the States parties. As negotiations commence, it is New Zealand's hope that the States most directly involved will accept that perfection of this nature in disarmament is rarely possible. There are risks in any new disarmament agreement but an agreement that falls short of the best of all possible objectives may nevertheless be in the broader interests of each State's national security, and of international security in general. The process and the results of genuine negotiations in this Committee can make a major contribution to the development of greater mutual confidence and security.

The main areas of difficulty would appear to be the problem of universal participation by all nuclear weapon States, the problem of adequate verification of a complete ban, and the question whether or not to permit peaceful nuclear explosions under a test ban treaty.

The Problem of Universal Adherence

The considerable lead in nuclear weapons possessed by the major nuclear powers would seem to provide adequate scope for their adherence to a test ban in advance of China and France. Their continued security can be safeguarded by the various provisions in the drafts before the CCD permitting them to withdraw should their supreme interests be jeopardized.

The conclusion of a treaty should be a more constructive step towards the improvement of international security than a continued insistence on moving at the pace of the most reluctant. Moreover, a decision by the more sophisticated nuclear powers to cease even underground testing should weaken the arguments of those who have so far refused to accept any limitations on their testing programmes and enable international opinion to exert more effective pressure for universal adherence to a complete ban. The recent commencement of negotiations by the three CCD nuclear weapon States is a hopeful sign that this view is gaining wider acceptance.

The Problem of Verification

The extent to which observance of a ban on testing can be verified is a matter of considerable importance. The work of the Expert Seismic Group is therefore valuable in pooling existing knowledge and creating the foundation on which an effective international teleseismic network can be constructed. We hope that the Group will also help to stimulate the development of more accurate detection techniques and that within a short time a network can be relied on to detect explosions down to a very low yield. New Zealand will co-operate fully in the establishment of such a network. It would appear however that there is a threshold to any teleseismic detection capability likely to be developed in the foreseeable future below which clandestine tests might be conducted.

Other methods of verification will strengthen the verification capability of an international seismic network. Further consideration of the nature and siting of unmanned first-zone seismic stations would be required before this method could be usefully integrated into an international verification system. Other national technical means (such as satellite photography) will also be of prime importance for some States in raising the level of confidence in the verification of a treaty. Provision for an agreed form of on-site inspection will also be a useful supplement to the verification of the treaty. But the essential consideration, in New Zealand's view, is a recognition that for each State the level of confidence in the verification of the treaty's provisions is already adequate for a treaty to be concluded: even though this may not entirely exclude the possibility of very low

yield tests being carried out. It seems that there will always remain an ultimate limit to the overall verification capability of a comprehensive test ban as with any disarmament agreement. To forego a CTB on the grounds that the existing possible verification capability is inadequate might therefore be to defer a CTB indefinitely. This is essentially a political judgement, and the decision must accordingly be made on a broader basis than the purely technical constraints of the time.

The Problem of Peaceful Nuclear Explosions

The inseparable relationship between peaceful nuclear explosions (PNEs) and nuclear weapons technology has been one of the problems delaying the conclusion of a CTB. Arms control objectives as they relate to PNEs are two-fold:

(a) to ensure no proliferation of weapon technology to non-nuclear weapon States through PNEs conducted on their territory; and

(b) to ensure no military advantage to nuclear weapon States through PNEs conducted on either their own territory or on the territory of other States.

It appears to be possible to meet the first objective by means of appropriate international observation procedures under agreements provided for by Article V of the NPT and in accordance with guidelines already established by the IAEA. Attainment of the second objective, however, is handicapped by the fact that no existing or foreseeable technology or verification procedure can distinguish between peaceful and weapon test explosions. The choice lies, therefore, between concluding a CTB that has this loophole, or closing the gap through permanent or temporary constraints on PNEs.

One major nuclear power claims it has developed proven economic uses for PNEs, and other countries have expressed interest in using this technology for major development projects. Although their usefulness is not yet universally recognized, there would seem at least to be a potential in this field of technology which demands recognition, and which must be taken into account in a CTB. At the same time, given the incipient state of the technology, the PNE interest must be subordinated to the overriding need to cease weapon testing in the interests of strengthening international security. PNEs should therefore be proscribed until it is established that the objectives of peaceful nuclear technology are not pursued at the cost of the two principal arms control objectives.

Since none of the announced projects appears ready to proceed in the near future, the way seems open to provide for a moratorium on PNEs until satisfactory arrangements for arms control objectives are agreed. Consideration may need to be

given to including an exception for emergency PNEs for such purposes as the sealing of oil and gas leaks which by their nature seem unlikely to provide significant weapons-related benefits. A treaty should contain explicit provision, however, that "non-emergency" PNEs will not be conducted in the territories of both nuclear and non-nuclear weapon States until clear agreement has been reached that no military advantage will be derived from them. A CTB should not await the conclusion of such agreement lest this necessitate further unacceptable delays. The speed with which agreement is reached will prove in part to be a measure of the real importance of PNE technology. Failing the development of any theoretical or technological distinction between PNEs and nuclear weapons tests, it may be that the only way of ensuring that no military advantage is gained from a PNE is by agreement to pool the information, including internal design and all other descriptive information, with all other nuclear weapons States parties to the treaty, through strict international verification procedures. Whether such agreement is ultimately reached, and in what form, should be regarded as secondary to the primary aim of concluding a CTB.

Conclusion

In reiterating its view that there is an urgent need to conclude a comprehensive test ban treaty in the interests of all States, New Zealand recognizes the necessity to resolve without delay the conflicting arguments that have held up a treaty so far.

In our view the advantages of stopping nuclear weapons tests and taking this major step towards general disarmament and improving international security heavily outweigh the risks involved in each of the three problem areas. We believe it is in the interests of national security of nuclear weapons States as well as non-nuclear weapons States, to stop nuclear weapons tests. To wait for technology to solve the problems would not only display a lack of political courage, it would be to wait indefinitely and perhaps for ever. New Zealand greatly hopes that all States, and particularly those nuclear weapon States directly involved in the negotiations, will find it possible to display the political courage needed and to reach agreement on a comprehensive test ban treaty in time for signature at the Special Session on Disarmament next year. The Session will provide the best occasion in which to secure early and general ratification of the treaty. There could be no greater guarantee of a successful Session.

CCD/537/Rev.1
4 August 1977

Original: English

HUNGARY

A possible method of defining toxic chemical agents

Numerous working papers have been submitted to the Conference of the Committee on Disarmament, which are based primarily on the "step by step" approach, and in addition to the "general purpose criterion" use some other specific criteria in their attempts at defining the chemical agents to be covered by the prohibition.

A number of definitions have been offered for "chemical agents .... which .... have the highest lethal effects" (CCD/346), "supertoxic chemical warfare agents" (CCD/PV.631) or "most dangerous lethal means of chemical warfare" (CCD/PV.642 and 643). However, such definitions are in practice subject to various interpretations.

Several suggestions have been made to list the chemical agents to be included in the prohibition, and some of the working papers already contain such lists in annexes (CCD/335, 365, 414, 430, 515, 529). Such lists, however, can be valid or can serve as examples only at a given moment.

Suggestions have also been made to define the chemical agents to be prohibited by reference to chemical structures or formulae (CCD/320, 365, 374, 383). However, this approach is possible only with identical groups of agents, but toxic chemical warfare agents do not all belong to the same group.

Besides the "general purpose criterion", a great number of working papers have proposed the use of the toxicity level. Most of them have proposed using the LD_{50} and LCt_{50} levels, and have also suggested certain thresholds.

The following thresholds, for example, have been suggested for LD_{50}:

- 0.5 mg/kilogram (CCD/320, 335 and 374)
- 1 mg/kilogram (CCD/322 and 373)
- 30 mg/kilogram (CCD/515).

For LCt_{50} the following thresholds have been suggested:

- 35,000 mg.min/$_m$3 (CCD/430)
- 3,000 mg.min/$_m$3 (CCD/473)
- 2,350 mg.min/$_m$3 (CCD/372)
- 500 mg.min/$_m$3 (CCD/414).

We believe that in the case of a "step by step" approach it is sufficient and may be unequivocal to use a joint definition of the "general purpose criterion" together with the toxicity value.

Thus the scope of the prohibition should be worded as follows:

"(1) Chemical agents of a toxicity value under LD_{50} = = x mg/kilogram or LCt_{50} = y mg.min/$_m$3, and in quantities that have no justification for peaceful purposes."

This definition, where the values of "x" and "y" are properly chosen, would provide the following possibilities:

(a) Taking LD_{50} = 200 mg/kilogram or LCt_{50} = = 200,000 mg.min/m^3, the ban would cover all toxic chemical warfare agents, including a significant part of irritants and psychotoxic agents. (See agents below line (a) in Annex I)

(b) Taking LD_{50} = 10 mg/kilogram or LCt_{50} = = 50,000 mg.min/$_m$3, the ban would cover practically all lethal chemical warfare agents but would exclude irritants, psychotoxic agents and defoliants. (See agents below line (b) in A nex I)

(c) Taking LD_{50} = 3 mg/kilogram or LCt_{50} = = 3,000 mg.min/$_m$3, the ban would cover supertoxic agents, first of all nerve gases and supertoxic solids. (See agents below line (c) in Annex I)

A further possibility of simplification lies in the fact that, when the value of LCt_{50} is measured and when the body-weight of the test animal and the amount of air the animal breathes per minute are known, the value of LCt_{50} can be converted to LD_{50} by the following formula:

$$LD_{50}\ (\text{inhaled}) = \frac{(LCt_{50}\ \text{value}) \ .\ (\text{inhaled air})}{\text{body-weight}}$$

The LCt_{50} value should be given in mg.min/$_m$3, the amount of inhaled air in m^3/min and the body-weight in kg.

In this case the prohibition may be worded as follows:

"(1) Chemical agents of a toxicity value under LD_{50} = = x mg/kilogram (inhaled or subcutaneous), and in quantities that have no justification for peaceful purposes."

This definition, when the value of "x" is properly chosen, would provide the following possibilities:

(a) Taking LD_{50} = 200 mg/kilogram, the ban would cover all toxic chemical warfare agents, including irritants and psychotoxic agents. (See agents below line (a) in Annex II)

(b) Taking LD_{50} = 30 mg/kilogram, the ban would cover all lethal chemical warfare agents. (See agents below line (b) in Annex II)

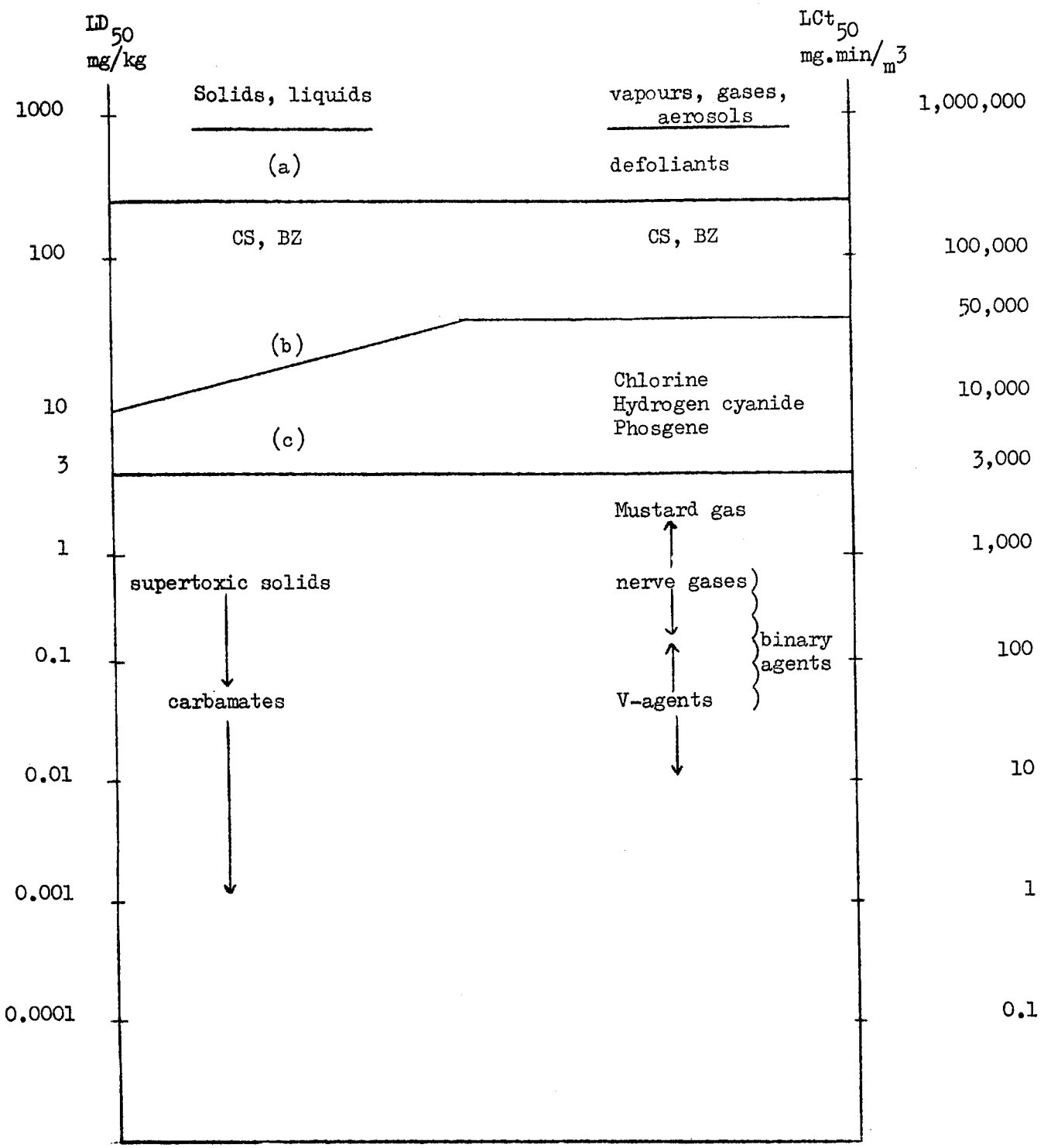
(c) Taking LD_{50} = 3 mg/kilogram, the ban would cover supertoxic agents. (See agents below line (c) in Annex II)

Conclusion

Though we continue to advocate a total ban on all chemical warfare agents, like the other co-sponsors of draft convention CCD/361 and most other countries, we believe that in drafting a possible partial ban the use of the LD_{50} value is feasible, and it would make much more concrete the scope of the prohibition, covering also binary and multicomponent weapons.

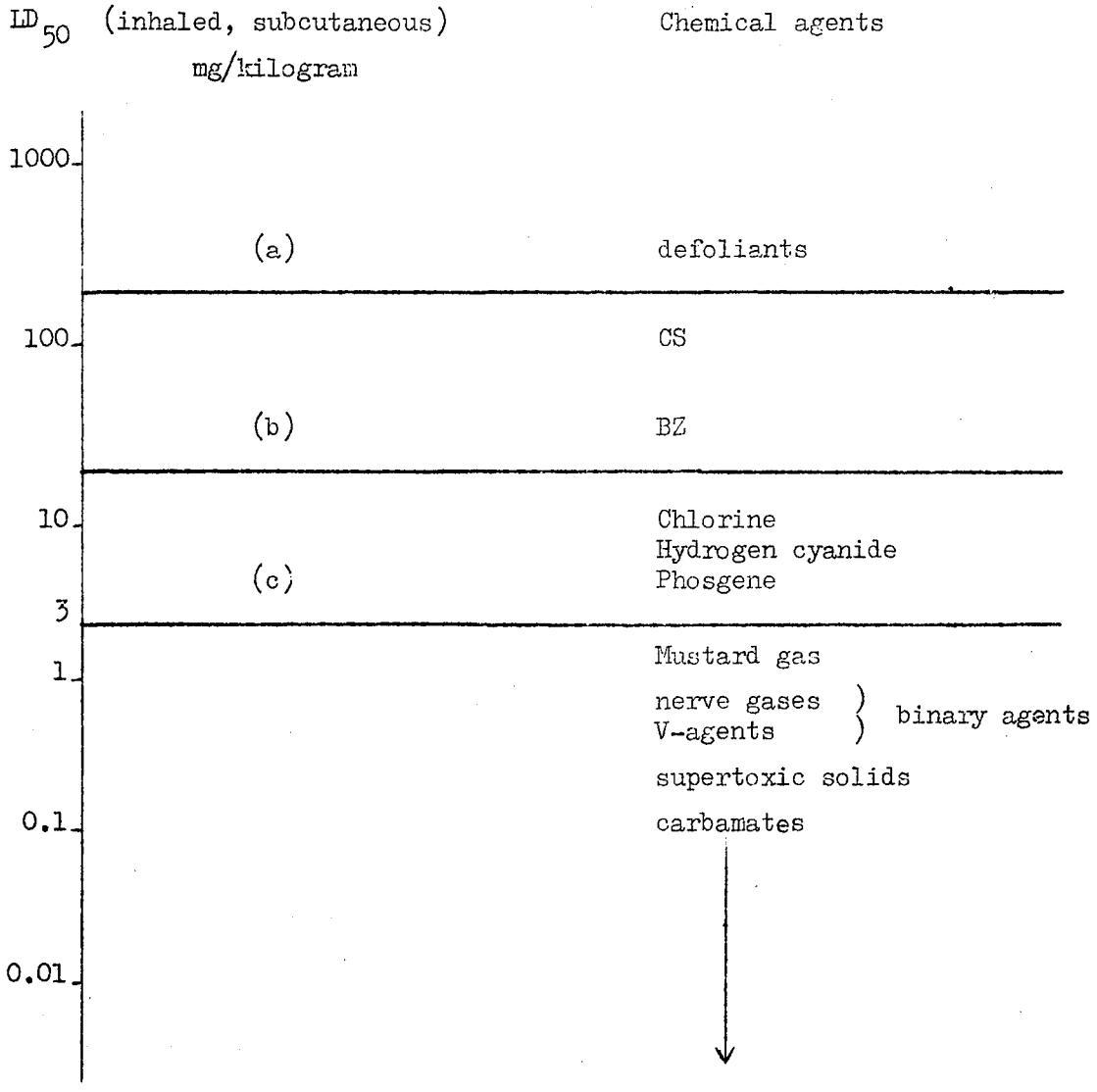
ANNEX I

The LD_{50} and LCt_{50} values of some chemical agents and their possible thresholds



ANNEX II

The LD_{50} values of some chemical agents and possible thresholds



CCD/538
3 August 1977
ENGLISH
Original: **Russian**

UNION OF SOVIET SOCIALIST REPUBLICS

Some methods of monitoring compliance with an agreement on the prohibition of chemical weapons

From the technical standpoint there are two possible methods of verifying compliance with an agreement on the prohibition of chemical weapons: intraterritorial monitoring and extraterritorial monitoring. Intraterritorial monitoring is performed in the territory of the State in which the installation to be monitored is situated or the activity to be monitored is carried on. Intraterritorial monitoring can be subdivided into international and national monitoring. The means of extraterritorial monitoring are situated outside the territory, air space and territorial waters of the monitored State.

In this connexion the question arises of the possible use of various methods of monitoring for each of the above purposes: laboratory (after sampling); remote; indirect (analysis of statistics and other information); and conservative (sealing up installations, telemetric or radiometric surveillance).

All these methods are fully applicable for purposes of intraterritorial national monitoring. Some of the organizational forms of national monitoring were examined, in particular, in the socialist countries' working paper CCD/403. However, the use of those methods in international monitoring is, as we know, inevitably associated with the disclosure of military, industrial and commercial secrets, and consequently cannot be justified from the standpoint of assuring the security and economic interests of the States parties to a future agreement. The present paper therefore takes as its starting point the need to assess the applicability of the above methods to extraterritorial monitoring.

Since any agreement on the prohibition and destruction of chemical weapons will contain provisions banning the development, production and stockpiling of chemical weapons and providing for the elimination of stockpiles of such weapons, it is also desirable to analyse the possibilities of extraterritorial monitoring with due attention to certain special features of monitoring compliance with each of those provisions.

Development (including testing) of chemical weapons

The development of new chemical weapon systems includes the discovery of new chemical agents and/or devising new techniques for using chemical agents for military purposes. The most characteristic signs that chemical weapons are being developed are the following:

(1) The presence of research centres (or systems of such centres) where interrelated solutions are found to chemical, biological and medical problems;

(2) The presence of testing centres in active operation;

(3) The presence of specific systems of scientific and technical planning and financing.

If it is known with sufficient certainty that any of the above signs exist, there are serious grounds for assuming that one or other State is developing chemical weapons. A judgement on the facts concerning the development of chemical weapons can also be formed from published patents and scientific and technical materials which indirectly reflect the interests of specialized chemists taking part in the development work.

Such analysis will form the basis of indirect extraterritorial monitoring. Undeclared tests of chemical weapons can be monitored only by applying remote techniques and modern instrumentation.

Production of chemical weapons

The volume of production of chemical weapons is limited mainly by the production of chemical agents, which in turn is determined by the level of technological development and the availability of well-developed production facilities. The characteristic feature of the production of chemical agents is, above all, its close connexion with the production of initial, intermediate, assimilable and similar substances, of which the vast majority are not agents used for military purposes. For this reason, plants and shops which produce chemical agents may be located at a large number of industrial works belonging to various firms, departments and ministries throughout the territory of the State and even in other countries. In cases where chemical agents are being produced in secrecy, monitoring can be carried on by recording and analysing the various emissions into the atmosphere and hydrosphere by remote techniques and with the aid of the latest instrumentation. Great prospects for extraterritorial monitoring of the production of chemical agents are held out by indirect methods and, in particular, statistical analysis based on estimates of the consumption of initial and intermediate substances used in the production of chemical agents.

Stockpiling of chemical weapons

The stockpiling of chemical weapons, irrespective of the method used— be it production or acquisition from other States— consists of stockpiling chemical agents proper and stockpiling the means of delivery or other equipment designed to use chemical agents for military purposes. Stockpiles of chemical weapons may be located in a large number of storage places in different geographical parts of a particular State and even in the territory of other States. In cases where chemical weapons are stockpiled secretly, the stockpiles are virtually impossible to detect by extraterritorial methods. Detection by remote methods of secret transport operations may be the only indirect indication that chemical weapons are being stockpiled.

Indirect methods may be of some importance: in particular, statistical analysis of inter-State monetary and financial transactions.

Destruction of stockpiles of chemical weapons

The destruction of chemical weapons inevitably entails the destruction of chemical agents proper and sometimes disarming the means of delivery or other equipment designed to use chemical agents for military purposes.

Extraterritorial monitoring of the destruction of stockpiles of chemical weapons can be performed by a remote and an indirect method. The basis of the remote method is the recording with sensitive instruments of specific gaseous substances which may be discharged into the atmosphere when certain methods of destruction are used. Indirect monitoring, which in this case can play only a minor role, is feasible only where destruction entails making material preparations (building up stocks of degassing substances, transporting chemical agents and degassers, etc.). In this case it should also be borne in mind that the destruction of combat chemical agents entails substantial expenditure which may be reflected in the budgets of the appropriate departments.

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Our examination of the question of the applicability of various methods for monitoring compliance with the provisions of a future agreement leads to the following conclusions:

1. The basis of a monitoring system which will furnish a comprehensive and effective solution to the problem must be national means used for the purpose of intraterritorial national and extraterritorial monitoring.

2. Laboratory, remote, indirect and conservative methods can be used in intraterritorial national monitoring in all cases.

3. Extraterritorial monitoring can be performed chiefly by remote and indirect methods.

Remote methods of monitoring

Remote methods for use in both intraterritorial and extraterritorial monitoring must be based mainly on instrumentation. In principle it is possible to develop remote methods for use in the following two cases:

(1) Where a sample for monitoring is delivered "naturally" in a current of air or water (by the wind or a watercourse), thus making it possible to use any laboratory methods thereafter;

(2) Where the analysis is based on remote appraisal of some optical (spectral) characteristics of the monitored sample, which may now be performed with the aid of artificial earth satellites.

In the first case, the feasibility of monitoring depends to a great degree on natural conditions and phenomena. In the second case -- that of remote appraisal by artificial earth satellite -- the results of monitoring will be more reliable. Hence this method is of special interest in organizing remote extraterritorial monitoring. It has already been discussed in the Committee on Disarmament; in particular, working paper CCD/371 submitted by the United Kingdom on 27 June 1972 examined the feasibility of remote detection of field tests of chemical weapons.

The working paper comes to the conclusion that by using satellite-mounted sensors it is technically possible to detect field tests with a sensitivity of 10^{-1} mg/m^2 and a probability of 0.3 and 0.75 in winter and summer respectively; when the analysed layer is 100 metres thick, detection sensitivity is 10^{-3} mg/m^3.

At the present stage of development of science and technology, a photoconductive detector such as the cadmium-mercury-tellurium (CdHgTe) described in working paper CCD/371 is not the most sensitive. Considerably greater sensitivity is attainable with monolithic detectors based on impure crystals at ultra-low temperatures (a condition easily attainable in outer space) coupled with an advanced system of primary processing.

Other ways to achieve a high detection sensitivity involve the use of the induced and resonance combination scattering (Shorygin) effect. Here the best results are obtained with modulated lasers, which make it possible to operate in "windows" of atmospheric transparency. This will give access to a very high limit of sensitivity (five or more orders higher than that of ordinary combination scattering).

Cybernetic methods of identifying chemical structures and statistical methods of data analysis which are not covered in working paper CCD/371 make it possible to expand considerably the potentialities of extraterritorial monitoring methods in terms of increasing sensitivity and effectiveness in the identification of structures. Characteristics of the structures of chemical agents can be identified by mathematical methods.

Substances can be identified from infrared spectra and spectra of the combination scattering of light. In this case the spectral characteristics of the substances analysed should be fed into computer memories at the centres processing the results.

Special interest attaches to the use of satellites in geostationary orbit because in this case noise can be averaged over time, thus providing an effective means of eliminating noise disturbances generated by atmospheric fluctuations. By this method, the sensitivity of the system can be increased proportionally to the square root of the number of scans.

The technical solutions described above can be applied through the use of a combined system in which one satellite is positioned in geostationary orbit while others revolve in low circular orbits at an altitude of about 250 km.

It follows from the foregoing that, by improving technical means for the remote detection of chemical agents and using a system of certified earth satellites, it will be possible to increase the effectiveness of the method considerably, to record with a high degree of reliability the presence in the atmosphere of very low concentrations of chemical agents, and consequently to detect the production of chemical weapons and field tests of such weapons. Therefore the application of remote method making use of artificial earth satellites is quite sufficient for effective monitoring of compliance with many of the provisions of a future convention on the prohibition of chemical weapons.

Indirect methods of monitoring

Indirect methods can be particularly effective for purposes of extraterritorial monitoring when based on analytical processing of a wide range of information accessible to the general public and covering the development, production and stockpiling of chemical agents. In addition, use may be made of the national information centres already in existence in various countries which analyse for commercial purposes the activities of various foreign research centres, factories, firms and departments and the progress made by individual scientists and specialists

employed there. Since such national systems for selecting and evaluating information in all fields of science and technology exist in the majority of large and technically developed States, it is virtually impossible that any of them should be able to outstrip the others for a long period and on a large scale in any branch of fundamental military technology, including chemical weapons.

Individual questions connected with the use of statistical analysis in production have already been discussed in, for instance, the working papers submitted by the United States of America (CCD/283) and Japan (CCD/344 and to some extent CCD/430).

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Thus the sum total of remote and indirect methods of monitoring afford adequate scope for extraterritorial monitoring by national means. By combining those methods with the specific methods of intraterritorial national monitoring (laboratory, conservative and other methods), a comprehensive and effective solution can be found for the entire problem of monitoring compliance with an agreement on the prohibition of chemical weapons.

CCD/539
3 August 1977

ENGLISH
Original: Russian

UNION OF SOVIET SOCIALIST REPUBLICS

Verification of the destruction of declared stocks of chemical weapons

Working paper CCD/497 of 29 June 1976, submitted by the United States, considered problems of monitoring the destruction of declared stocks of chemical weapons. The paper notes, in particular, that "the basic purpose of on-site monitoring would be to confirm information provided as to the type and quantity of agent destroyed".

The main purpose of monitoring the destruction of declared stocks of chemical weapons should be to establish (a) the fact of the destruction of an agent of a certain type, (b) the quantity of the agent destroyed and (c) the quality of this agent, and to produce appropriately documented results of the verification.

The present paper describes one of the methods of attaining this objective.

Taking as a basis the principle of national control over the destruction of chemical agents, it is necessary to bear in mind that:

(a) chemical agents are destroyed by incineration or detoxification;

(b) the planning of the destruction of chemical agents, as well as their removal from containers or warheads and collection in special receptacles, are regarded as preparatory operations which are undertaken without the participation of controllers;

(c) chemical agents are transported to the place of destruction in special receptacles.

* * *

The quantity of chemical agents brought for destruction is determined by weighing them or by measuring their volume. Where the volume is measured, the weight of liquid substance is calculated by the following formula:

$Q = V \cdot \rho$

where V = the volume, in m^3,

ρ = the density of the substance, in g/cm^3 or t/m^3, and

Q = the quantity of the substance brought for destruction.

The density of the chemical agent is determined in the laboratory. For measuring the density, use may be made of known densitometers (float-type, pycnometric, piezometric and radioactive) which are likely to prove most suitable for work with these substances.

The quantity of solid chemical agent can be measured in a similar manner, with minor differences only in the measurement of density or bulk weight.

On completion of the process of the destruction of the chemical agent, the quantity of the agent remaining in the receptacle -- Q_{rem} -- is measured.

The quality of the chemical agent brought for destruction is determined by the content, in per cent, of the basic substance in the agent - q(%). The method of measuring this can be illustrated by the examples of quality testing for sarin and yperite.

For quality testing for sarin, for example, it is possible to use the technique based on its ability to hydrolyze in an alkaline medium. The control is effected by monitoring the consumption of alkali, and the sarin content is calculated by the following formula:

$$q\% = \frac{7.005(a.K_{NaOH} - b.K_{HCl}) \cdot 100}{A}$$

where a = the quantity 0,1 N of NaOH solution consumed for titration, in ml,

b = the quantity 0,1 N of HCl solution consumed for reverse titration, in ml, and

A = dose by weight, in mg.

Another possible technique is based on the reaction of sarin with hydrogen peroxide in an alkaline medium, with iodometric monitoring of the consumption of hydrogen peroxide.

The sarin content is calculated by the following formula:

$$q\% = \frac{3.502(a-b).K_{Na_2S_2O_3} \cdot 5.100}{A}$$

where a = the quantity 0,1 N of $Na_2S_2O_3$ solution consumed for titration of the control sample, in ml,

b = the quantity 0,1 N of $Na_2S_2O_3$ solution consumed for titration of the substance tested, in ml.

In quality testing for yperite, it is possible to make use of its reaction with an aqueous solution of chloramine T. The control is effected by monitoring the consumption of chloramine by the iodometric method. The yperite content is determined by calibration curves, obtained by titration of standard yperite solutions.

In terms of the main substance, the true quantity of the agent destroyed in one cycle is as follows:

$$Q_{tr} = (Q - Q_{rem}) \frac{q}{100} ; \quad (m) .$$

It is impossible to rule out the possibility that the chemical agent brought for destruction may be non-homogeneous in quality. In this case, when the substance is removed from the receptacle for destruction, it is necessary to analyse at least three samples -- one at the beginning of the destruction process, one in the middle and one at the end.

The samples can be taken either directly from the receptacle with a sampler from different layers of the chemical agent, or from the flow by "the flow method" technique when the substance is being fed to the destruction facility.

Each sample is used for determining the content of the basic substance and the density. From the values for the content of the basic substance and for the density, it is possible to calculate their mean values $\bar{q}$ and $\bar{\rho}$ as follows:

$$\bar{q} = \frac{q_1 + q_2 + q_n}{n}$$

where q_1, q_2, and q_n are the content, in per cent, of the basic substance in the first, second and n-th samples; and n is the number of samples taken.

In this case the quantity of the chemical agent destroyed, in terms of the basic substance, would be:

$$Q_{tr} = (Q - Q_{rem}) \frac{q}{100} ; \quad (m).$$

Quantitative data on the destruction of declared stocks of chemical weapons should be recorded in a ledger. The ledger might have, for example, the following entries:

Date	Type of chemical agent to be destroyed	Quantity of chemical agent on arrival (tons) Q	Quantity of chemical agent remaining (tons) Q_{rem}	Mean value of the content of the basic substance $\bar{q}$ (%)	Quantity of basic substance destroyed (tons) Q_{tr}	Remarks
1	2	3	4	5	6	7
Total (tons)	-			-		-

The final stage of laboratory chemical analysis should be the analysis of the extent of decomposition of the chemical agents destroyed.

From the ledgers recording the quantities of substances destroyed at each facility, it is possible to determine whether the quantity of the stocks of chemical weapons actually destroyed corresponds to the declared stocks.

It would seem that stocks of chemical weapons declared for destruction should be expressed in terms of the quantity by weight of the basic substance. This will make it possible to exclude from the destruction records non-toxic elements present in the composition of chemical agents destroyed.

Conclusion:

Effective monitoring of the destruction of declared stocks of chemical weapons is feasible provided that preparatory work and chemical analyses are undertaken, and that statistical records are kept -- in terms of the basic substance -- of the quantity and quality of chemical agents destroyed.

CCD/540
3 August 1977
Original: English

JAPAN

Working paper on focal depth resolvability of a multi-array stations system

1. Introduction

Since the early 1960's, seismic array stations have been developed in order to detect and locate underground nuclear explosions of small yields. The array station cannot only enhance the S/N ratio but also can locate seismic events by itself, for the slowness of P waves and the azimuth to epicentres can be calculated from the statistical processing of digital seismograms obtained by many seismographs.

The location capability of a single array station is, therefore, equivalent to that of several single stations of conventional type with sensitive seismographs distributed uniformly around the epicentre. However, it is a serious problem that the single array system is very low in the resolution of focal depths.

As mentioned in the Working Paper CCD/524, the epicentre location capability can be improved by combining the data of a multi-array stations system. This possibility was demonstrated by a computer simulation, showing that seismic events of mb over 4 1/4 occurring throughout the world can be located with an accuracy of $\pm$ 30 km by a network of 15 array stations properly distributed in the world. This simulation was, however, limited to evaluate the location capability only for very shallow events.

Usually, data obtained from a single array station is processed under the assumption that events occur near the earth's surface. If the focal depth, which is very important for the verification of underground nuclear tests, is taken into account, the location accuracy itself should also be made higher in the case of the multi-array stations system.

To demonstrate this, the conventional technique of hypocentre determination using arrival times at different stations was applied to the multi-array stations' data processing. A new computer program for this purpose was developed to make a simulation for determing both epicentre and focal depth and also to evaluate the resolvability of the method by use of multi-array stations data.

2. Discrepancies between epicentral distances calculated from epicentres determined by NORSAR and USGS

The epicentre determination at a single array station is made under the assumption that seismic events occur near the earth's surface, but the events actually take place at a depth ranging from the surface down to about 800 km. The epicentre is, therefore, always determined at a more distant place than the true epicentre by the array system, depending on the focal depth.

Discrepancies between distances calculated from epicentres given by USGS and NORSAR were statistically studied using data from June to December 1974, and the results are shown in Fig. 1.

It is evident from Fig. 1 that NORSAR epicentral distances from focal depths less than 33 km are fairly close to those by USGS's.

On the other hand, events with focal depths deeper than 33 km were located at more distant places by NORSAR relative to USG's epicentres. Peaks in the histograms for deeper events become rather flat because of fewer data.

The tendency that epicentral distances given by NORSAR for very shallow events are generally shorter than those by USGS may be explained by the difference between the local crustal structure near the array station and the standard structure used in the calculation of travel times.

The result shown in Fig. 1 shows that data of multi-array stations can determine focal depth as well as epicentre by using the tables of slowness versus distance for various focal depths. Furthermore, the application of station correction in various seismic zones to each array data will improve the accuracy of hypocentre determination.

3. Tables of slowness versus distance for various focal depths

In order to determine a hypocentre (epicentre and focal depth) by using the data of multi-array stations, tables of slowness as a function of epicentral distance for various focal depths are required. Therefore, based on the tables of P travel time compiled by Herrin (1968), the slowness was calculated by the following procedures:

(1) Original travel times are smoothed.

(2) Travel times for every 0.1°, of epicentral distance are interpolated from the smooth travel time.

(3) Slowness for every 0.5° of epicentral distance are calculated.

(4) The slowness is smoothed.

The tables of slowness thus calculated are given in Table 1, and some of the tables are graphically shown in Fig. 2.

Slowness for epicentral distances less than 5° and larger than 95° are unreliable for lack of the number of significant digits of travel times for the slowness calculation.

By taking the accuracy into consideration, data for epicentral distances ranging from 10° to 95° were used in the simulation. As seen in Fig. 2, there exist systematic variations in the curves of slowness versus distance among various focal depths.

Concretely speaking, a maximum difference of 200 km in epicentral distances for the same slowness exists for focal depth h = 0 km and 100 km. Furthermore, the maximum difference of 500 km is seen for h = 0 km and h = 300 km, and 1000 km for h = 0 km and h = 600 km, respectively. This harmonizes well with the result shown in Fig. 1. Thus, the focal depth as well as epicentre can be determined by these differences, if multi-array stations are used.

4. Epicentre and focal depth determination by data of multi-array stations

Slowness and azimuth obtained from the existing array stations in the world seem to be successfully applied to the hypocentre determination. In view of the fact that focal depth is one of the most important factors in distinguishing underground nuclear explosions from earthquakes, the depth resolvability of the present procedures for determining hypocentre should be elucidated.

The present simulation for investigating the depth resolvability was made by modifying the computer program used in the previous document (cf. Working Paper CCD/524).

To compare the epicentre location capability of the present data processing with the previous result given in Working Paper CCD/524, 15 stations whose location and detection capabilities are completely the same as those in the previous case, were also used in the present simulation (cf. Table 2). The main difference between the present and previous programmes is as follows:

(1) Epicentral distances from 15 stations were calculated from slowness using Table 1 for a certain fixed depth.

(2) Next, by changing the focal depth, epicentres and corresponding variances were calculated by the method of least squares.

(3) The epicentre having the minimum variance and the corresponding depth was adopted as the final hypocentre.

Fig. 3 shows the relationship between the accuracy for slowness (standard deviation σn) and the depth resolution for various magnitude (the focal depth is assumed as 0 km in this case).

The accuracy for the azimuth determination was assumed to be 3/4° throughout the present simulation. It is evident from Fig. 3 that most hypocentres determined by the present method agree with the assumed ones providing that the errors in slowness and azimuth are very small (say less than 0.0001). This result verifies that the programme is correct.

Needless to say, the number of events whose determined focal depths differ from the assumed ones, increases with decreasing accuracy of the slowness, but in any case the number of events which were determined deeper than 20 km is less than 30 per cent of the whole data.

Comparing the statistical result shown in Fig. 1 and the relationship of slowness versus distance in Table 1, the actual standard deviation for slowness may be less than 0.01. The application of the station correction to the observed slowness will give a more reliable result in the hypocentre determination. Similar simulations were made by changing the standard deviation and range focal depths. The frequency of the determined depths is shown in Figs. 4 and 5.

As seen in Figs. 4 and 5, the maximum frequency appears at depths assumed in the simulation, and the percentage of the number of data around the assumed depth against the total number of the determined depths is more than 70 per cent, except for the focal depth of 75 km and the standard deviation for slowness of 0.05 in Fig. 5.

The result shows that the depth resolvability of the present method for shallow earthquakes becomes lower, if the hypocentre is determined by changing the focal depth mechanically from 0 km to 800 km. Therefore, in order to obtain more reliable results, the hypocentre determination should be performed by the following steps:

(1) The epicentre is calculated under the assumption that the focal depth is very shallow.

(2) Based on the epicentre obtained from step (1), the range of focal depth is assigned in accordance with the epicentre location. The hypocentre of the second approximation is repeatedly determined by using various tables of slowness versus distance, corresponding to the assigned range of depth. The depth range should be determined from past information, and should be stored in a computer in advance.

Fig. 6 shows the cumulative percentage as a function of the discrepancy of assumed and determined epicentres in degree for the standard deviation of 0.05 in slowness at various focal depths. For events of more than 70 per cent, their epicentres were determined with discrepancies of less than 0.3 degrees from the assumed location irrespective of focal depth.

In order to compare the capability of epicentre location of the present method with the previous results of Working Paper (CCD/524), maps of contours for threshold magnitudes are given in Fig. 7. Even though the location capability in both cases is approximately the same, the accuracy of the determined epicentre is considerably improved with the present method.

5. Conclusion

In the previous Working Paper (CCD/524), a computer simulation on multi-array stations system was reported from the viewpoint of the location capability. The focal depth, however, was not considered.

In view of the fact that the focal depth is one of the most important factors for verifying underground nuclear explosions, a focal depth resolvability of the system was studied in this paper. For this purpose, a computer simulation was made by modifying the programme used in the previous Working Paper.

The result given by the present simulation made clear that the depth resolvability of the multi-array stations system consisting of 15 LASA and British type array stations is of an order of 10 km for very shallow events and 50 km for deeper events, respectively. And, seismic events of mb over 4 1/4 occurring throughout the world can be located within an accuracy of $\pm$ 20 km by the network. The capability epicentre location is almost the same as in the previous case, but the accuracy of the determined epicentre is considerably improved.

The slowness as a function of epicentral distance will depend to some extent on regional variations in the structure of the upper mantle as well as the crustal structure near the station. The accuracies for both epicentre and focal depth will, therefore, be improved, if the station corrections for slowness, which can be evaluated from the accumulated data on each station for various seismic areas in the world, can be applied to observed slowness in the course of hypocentre determination.

If the epicentre and focal depth are determined by applying appropriate station corrections to observed slowness, the epicentre will be determined with approximately the same accuracy as mentioned above without reducing the depth resolvability, even though the number of stations is not as many as 15, but only 10.

In order to develop an actual computer program for determining the epicentre and focal depth with multi-array station data, many actual raw data are required. To improve the present method, real data obtained by existing array stations in the world should be examined as a part of the proposed experimental exercises, during a certain period of time.

Captions

Fig. 1 Statistical results on distance discrepancies between epicentres determined by USGS and NORSAR for various focal depths.
Ordinates; percentage
Abscissa; epicentral distance calculated by USGS epicentre minus epicentral distanc by NORSAR

Fig. 2 Slowness (second/degree) versus epicentral distance (degree) for some focal depths.

Fig. 3 Histogram of determined focal depths for various standard deviations of slowness and various magnitudes.

Fig. 4 Histogram of determined focal depths for various depths assumed (standard deviation of slowness $\sigma n = 0.05$ sec/degree). Numerals attached in the plot show the assumed focal depths.

Fig. 5 Histograms of determined focal depths for shallow and deep events (_____: assumed depth h = 500 km, standard deviation of slowness $\sigma n = 0.0001$ sec/degree, ...: h = 500 km, $\sigma n = 0.05$, _ _ _: h = 75 km $\sigma n = 0.05$).

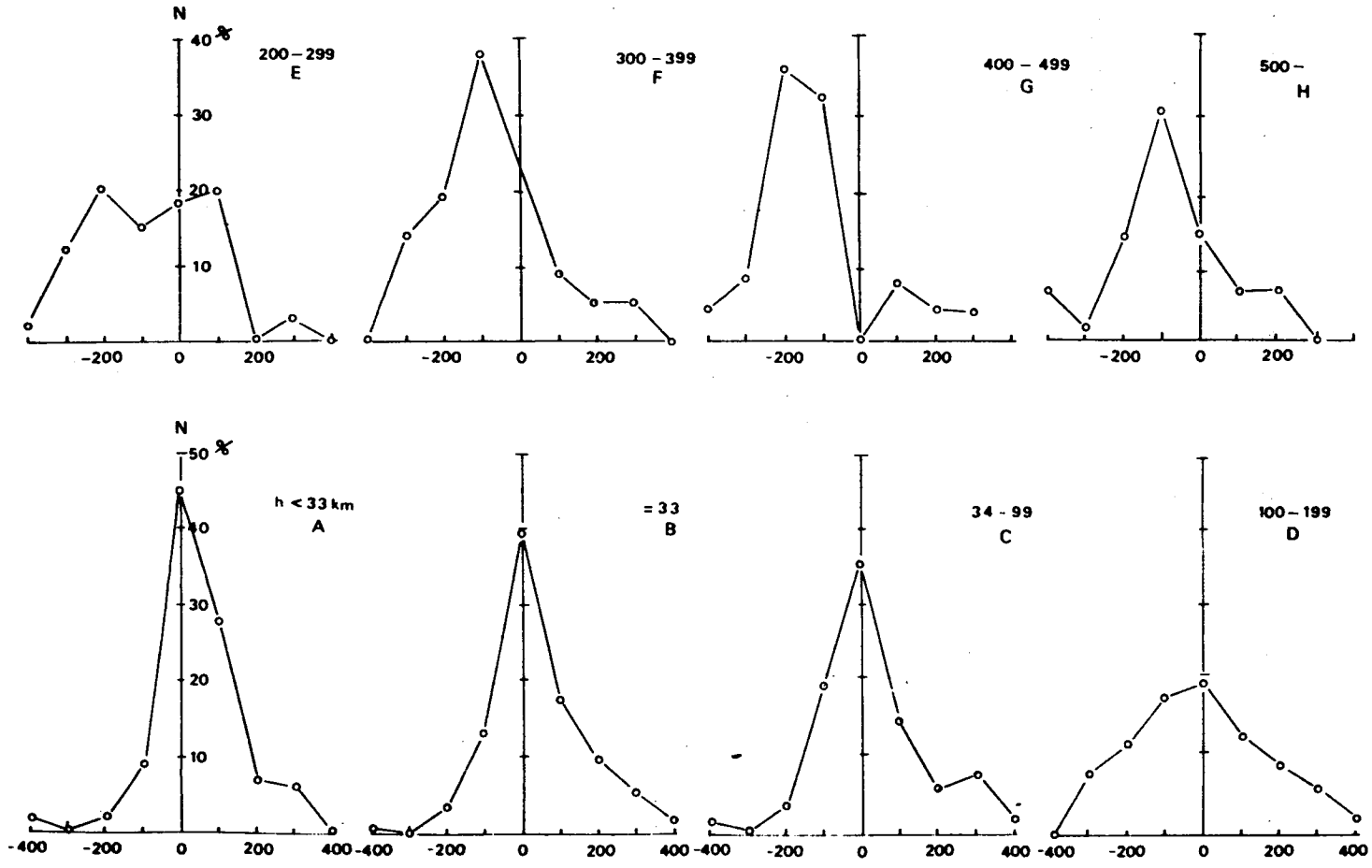
Fig. 6 Cumulative percentage of distance discrepancies for various focal depths (Standard deviation of slowness $\sigma n = 0.05$ sec/degree).

Fig. 7 Epicentre location capability of 15 array-stations (solid circles).
(1) Assumed focal depth h = 0 km
standard deviation of slowness = 0.05 sec/degree
(2) h = 15 km, $\sigma n = 0.05$.

Table 1 Slowness as a function of epicentral distance for various focal depths, calculated from Herrin's P travel time tables.

Table 2 List of stations and detection capability used in the simulation.

Fig. 1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C
100 – 199
D
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-200
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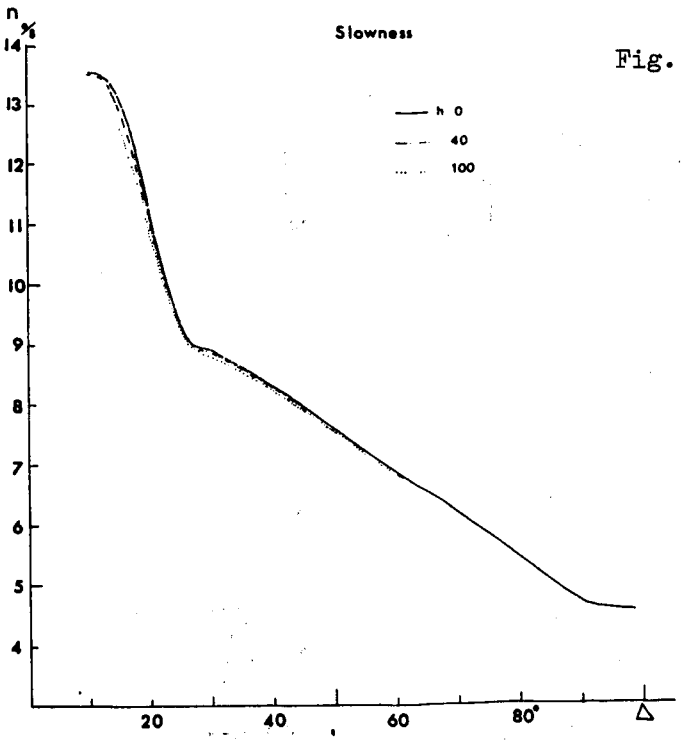
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Fig. 2

Fig. 3

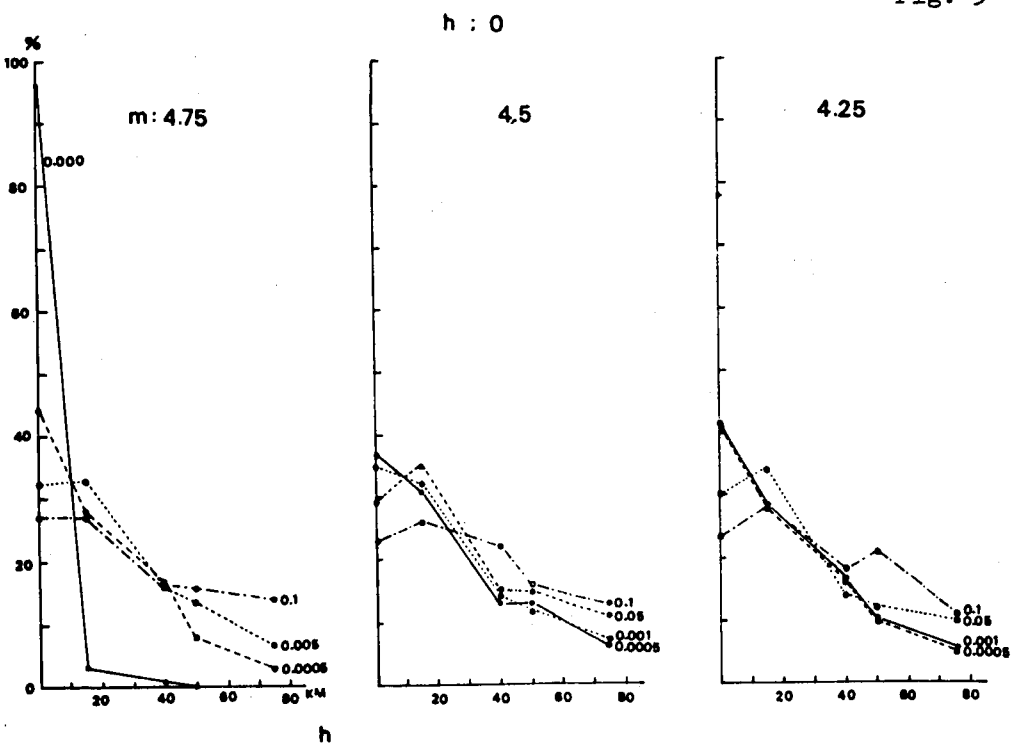
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Fig. 4

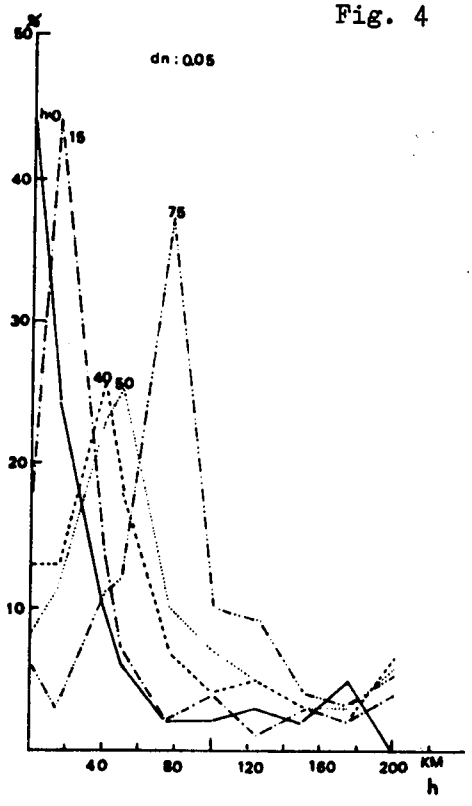
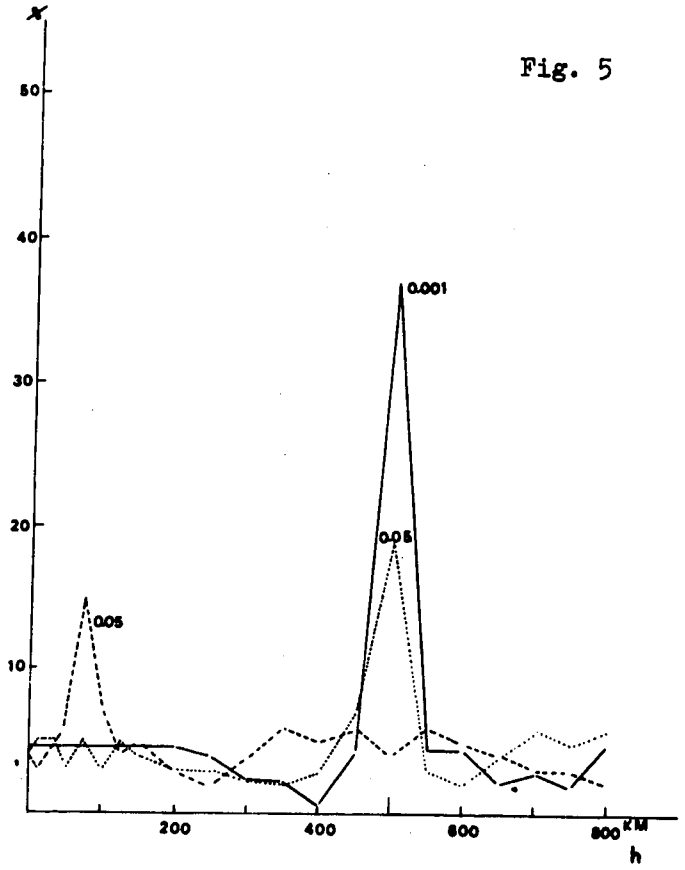


Fig. 5



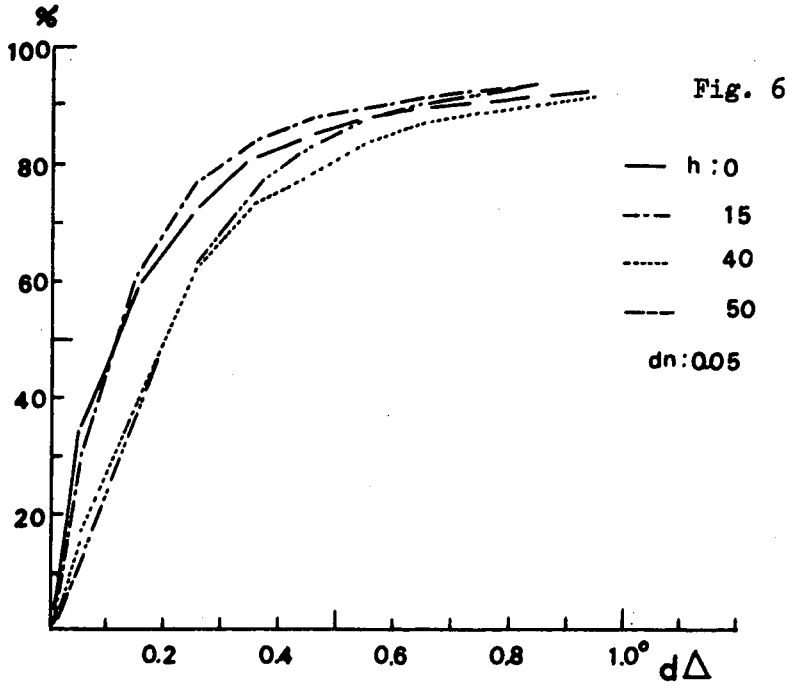
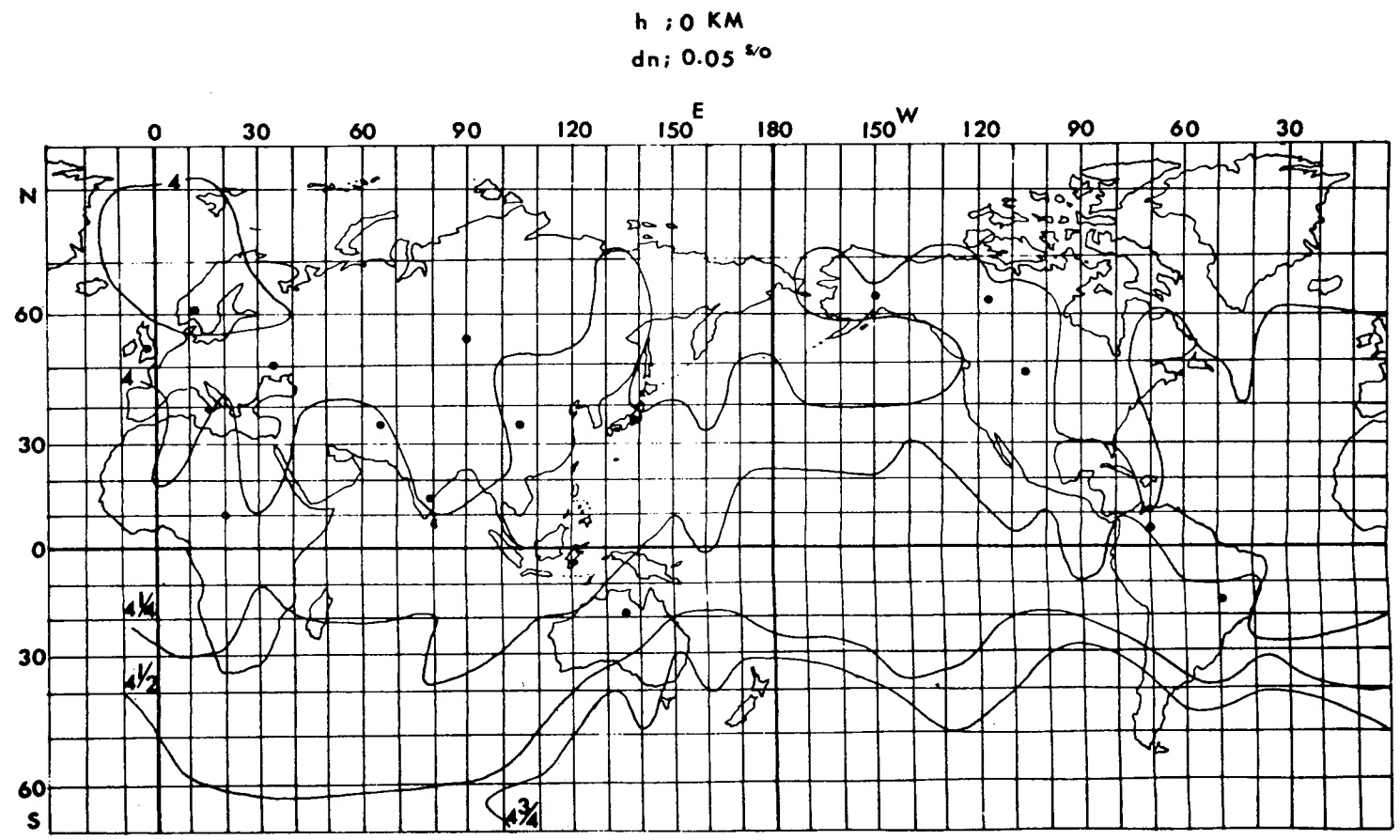


Fig. 6

Fig. 7 - 1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4 3/4

Fig. 7 - 2

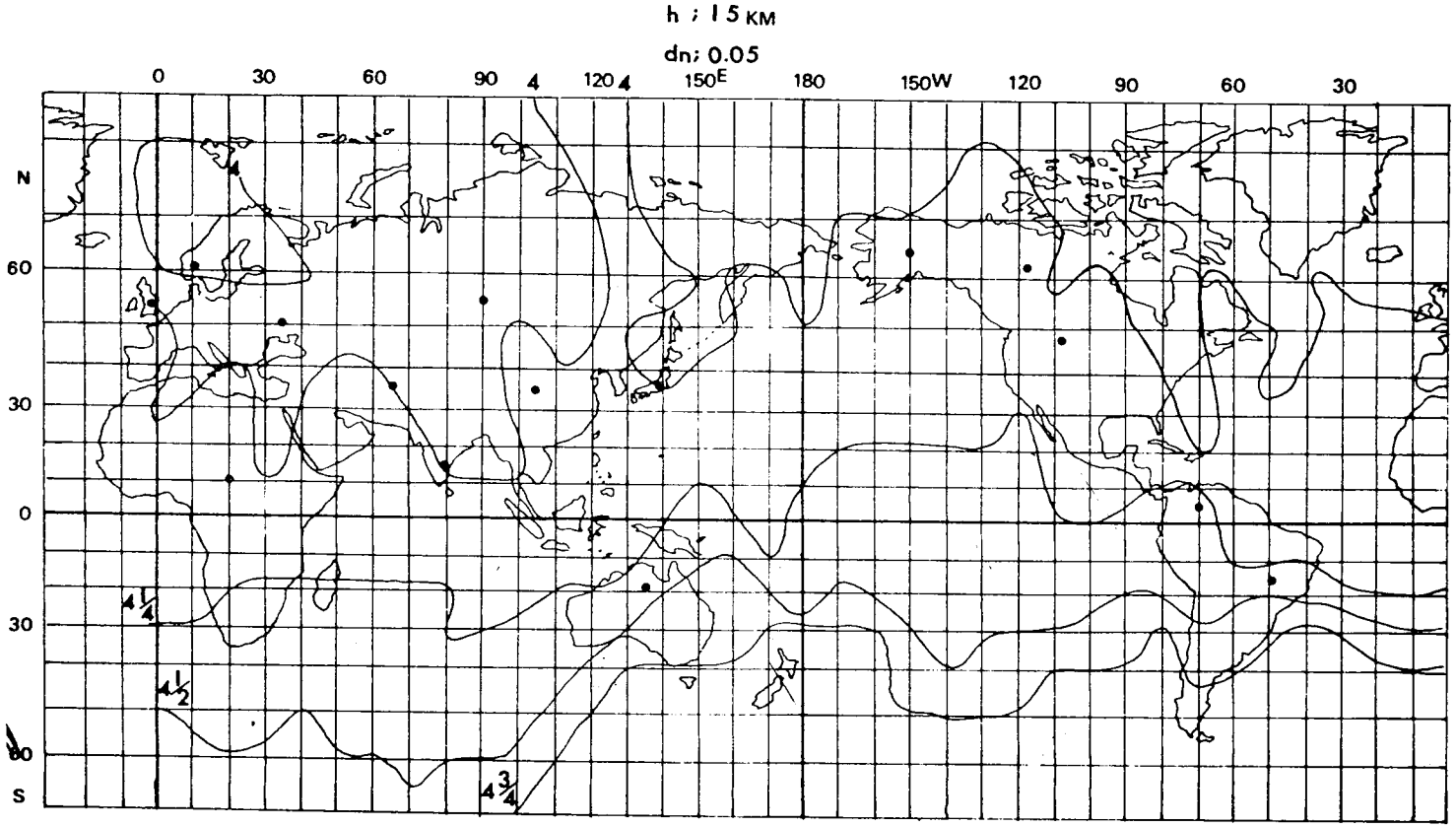
h ; 15 KM
dn; 0.05
0
30
60
90
120
150E
180
150W
120
90
60
30
N
60
30
0
30
60
S
4 1/4
4 1/2
4 3/4

TABLE OF SLOWNESS CALCULATED FROM THE HERRIN S TABLE

DIS /H	0	15	40	50	75	100	125	150	200	250	300
0.0	19.595840	15.644294	10.662200	9.158600	6.336803	4.496909	3.237016	2.377067	1.359464	0.804648	0.509448
0.5	18.642593	15.865438	11.934221	10.962493	8.908112	7.361697	6.172545	5.253550	3.957347	3.115392	2.536746
1.0	17.518341	15.729848	12.906970	12.375683	11.011355	9.779234	8.710212	7.791532	6.338034	5.260203	4.447587
1.5	16.327576	15.723681	14.097440	14.019624	13.310267	12.548019	11.566205	10.425125	8.778529	7.448277	6.489609
2.0	14.727685	14.409883	13.795842	13.799121	13.518477	12.978068	12.522935	11.615039	10.215360	8.947146	7.851792
2.5	13.770382	13.654346	13.662981	13.643359	13.469182	13.147104	12.716204	12.213615	11.102578	9.998777	8.965016
3.0	13.583593	13.631786	13.723451	13.698339	13.542982	13.303766	12.979959	12.590135	11.697205	10.748888	9.802846
3.5	13.673968	13.707122	13.695229	13.667620	13.550872	13.375711	13.122326	12.819665	12.080837	11.268038	10.425599
4.0	13.729024	13.709758	13.700055	13.672286	13.570884	13.426137	13.219531	12.969161	12.358809	11.664598	10.897796
4.5	13.687465	13.695570	13.689415	13.667884	13.582582	13.450551	13.284047	13.067327	12.548150	11.921442	11.352071
5.0	13.695082	13.688581	13.683830	13.661579	13.592132	13.462151	13.320974	13.135693	12.678596	12.130252	11.518993
5.5	13.679589	13.674818	13.676619	13.649678	13.587946	13.474581	13.344977	13.182045	12.766945	12.278125	11.726820
6.0	13.669314	13.670110	13.668952	13.642486	13.572167	13.487269	13.362995	13.213497	12.833244	12.385568	11.885856
6.5	13.662807	13.666092	13.652880	13.638965	13.561509	13.490102	13.375481	13.231480	12.881919	12.464606	11.998861
7.0	13.658865	13.654220	13.638616	13.628061	13.560309	13.484940	13.375097	13.240715	12.912973	12.524025	12.073750
7.5	13.646228	13.640157	13.630491	13.613522	13.556982	13.478615	13.372579	13.242717	12.932108	12.560916	12.133986
8.0	13.633349	13.626939	13.621663	13.599791	13.544636	13.469712	13.366984	13.241447	12.943556	12.584570	12.182575
8.5	13.620326	13.613593	13.607959	13.586934	13.530112	13.454597	13.352281	13.231759	12.940569	12.593241	12.212262
9.0	13.608266	13.600216	13.592159	13.572544	13.517780	13.437939	13.332561	13.210484	12.921465	12.587234	12.222691
9.5	13.590025	13.584420	13.580670	13.560819	13.503578	13.423381	13.309779	13.182261	12.892591	12.567194	12.214590
10.0	13.571944	13.574630	13.569301	13.549142	13.489225	13.401109	13.280824	13.153300	12.864046	12.542008	12.189997
10.5	13.560038	13.556182	13.551799	13.532673	13.469817	13.368156	13.246742	13.119426	12.828982	12.506312	12.154757
11.0	13.549490	13.539787	13.530482	13.512067	13.445271	13.327909	13.208949	13.070389	12.782582	12.456245	12.114678
11.5	13.531284	13.523213	13.511467	13.489655	13.408112	13.289118	13.159291	13.012130	12.724274	12.401311	12.009489
12.0	13.512248	13.510324	13.490771	13.464215	13.361432	13.240317	13.096266	12.952664	12.660357	12.360011	12.003615
12.5	13.494182	13.489599	13.463356	13.430515	13.307380	13.177002	13.027357	12.890981	12.582233	12.264355	11.921895
13.0	13.468345	13.453969	13.424588	13.382087	13.248911	13.100035	12.951569	12.811899	12.492710	12.172000	11.831886
13.5	13.425822	13.403668	13.370912	13.314866	13.171596	13.012595	12.867501	12.712716	12.394733	12.071338	11.742026
14.0	13.365764	13.343464	13.295863	13.231647	13.077078	12.915778	12.769001	12.604691	12.290896	11.965987	11.643170
14.5	13.287750	13.263197	13.202406	13.133552	12.973151	12.810756	12.653689	12.493205	12.173980	11.850069	11.529778
15.0	13.187639	13.163762	13.092501	13.025739	12.858665	12.692383	12.526290	12.369528	12.043094	11.718199	11.404428
15.5	13.071149	13.044908	12.963064	12.899462	12.725069	12.554555	12.387521	12.223025	11.899945	11.573116	11.272419
16.0	12.940805	12.910037	12.820940	12.752650	12.573674	12.404478	12.233258	12.064425	11.743906	11.432498	11.136439
16.5	12.795549	12.755182	12.663901	12.586125	12.407247	12.237785	12.065248	11.897384	11.579638	11.288530	10.991260
17.0	12.630056	12.581926	12.491176	12.407372	12.225809	12.051910	11.885016	11.719664	11.410958	11.128446	10.841734
17.5	12.447550	12.391497	12.291685	12.213606	12.033098	11.855294	11.692577	11.534164	11.242578	10.955670	10.687297
18.0	12.232647	12.183746	12.071372	12.003278	11.825579	11.657212	11.493499	11.349463	11.066733	10.785826	10.533091
18.5	12.006500	11.958600	11.840227	11.776862	11.603857	11.449030	11.295591	11.136473	10.879220	10.618750	10.378292
19.0	11.770839	11.716866	11.610860	11.542431	11.382192	11.234096	11.093073	10.951722	10.689306	10.449819	10.229959
19.5	11.528738	11.476136	11.379191	11.308329	11.164613	11.019077	10.885580	10.749030	10.509570	10.282204	10.062087
20.0	11.287813	11.239697	11.140471	11.078104	10.944614	10.809682	10.679694	10.557422	10.338797	10.130831	9.937179
20.5	11.048656	11.005064	10.903278	10.849734	10.719824	10.600327	10.481877	10.369503	10.168059	9.978666	9.791761
21.0	10.813016	10.764662	10.674435	10.630489	10.504178	10.395801	10.293589	10.188564	9.998980	9.821784	9.655531
21.5	10.577248	10.537472	10.455601	10.418896	10.302399	10.199748	10.107561	10.010631	9.838908	9.678941	9.528668
22.0	10.356936	10.327372	10.247823	10.215722	10.113957	10.021372	9.931305	9.855517	9.688197	9.544398	9.412737
22.5	10.155691	10.126599	10.057687	10.018764	9.932784	9.854122	9.766726	9.696839	9.551910	9.419712	9.304861
23.0	9.971093	9.937897	9.877406	9.837409	9.760686	9.690115	9.618436	9.547705	9.427602	9.308058	9.208301
23.5	9.793792	9.757512	9.706368	9.673549	9.604306	9.535864	9.478465	9.417062	9.313790	9.214941	9.129059
24.0	9.627665	9.597760	9.549239	9.525879	9.468645	9.405601	9.353927	9.305357	9.209187	9.137388	9.066308
24.5	9.477218	9.456152	9.414899	9.394635	9.344126	9.295298	9.245947	9.204610	9.128550	9.071305	9.014678

DIS /H	0	15	40	50	75	100	125	150	200	250	300
25.0	9.346547	9.337339	9.297753	9.277595	9.234680	9.197377	9.158831	9.120814	9.064487	9.015737	8.969918
25.5	9.236377	9.227182	9.198925	9.178425	9.141232	9.113037	9.067137	9.058154	9.011537	8.971305	8.940478
26.0	9.148055	9.133474	9.116538	9.097642	9.072558	9.047070	9.026332	9.006691	8.970514	8.950857	8.926981
26.5	9.074205	9.058314	9.046086	9.035930	9.017941	8.996582	8.979129	8.964020	8.943156	8.923820	8.921883
27.0	9.016594	9.006291	8.987884	8.987701	8.969315	8.960818	8.948702	8.937911	8.921619	8.911397	8.910009
27.5	8.970933	8.968637	8.951018	8.950878	8.934737	8.936132	8.928947	8.925405	8.911489	8.900955	8.891434
28.0	8.941154	8.938448	8.932875	8.929625	8.918996	8.921212	8.911683	8.912418	8.906896	8.887820	8.864509
28.5	8.920158	8.920821	8.920752	8.916719	8.916043	8.909591	8.898465	8.895654	8.880585	8.871317	8.857883
29.0	8.911655	8.911174	8.908175	8.909018	8.907896	8.900391	8.886802	8.878787	8.863377	8.847674	8.817724
29.5	8.905977	8.903502	8.897697	8.897844	8.889746	8.860994	8.870402	8.860135	8.838950	8.819543	8.800586
30.0	8.894063	8.883796	8.881131	8.880197	8.863593	8.858740	8.850383	8.838999	8.818317	8.792089	8.779297
30.5	8.868861	8.861104	8.858858	8.853578	8.839299	8.832108	8.827580	8.812835	8.791216	8.768951	8.748576
31.0	8.839697	8.835923	8.829443	8.826116	8.816071	8.807352	8.799811	8.791694	8.769029	8.750732	8.722028
31.5	8.812248	8.811711	8.803124	8.801066	8.792368	8.781089	8.771491	8.767926	8.746610	8.728543	8.690407
32.0	8.789613	8.789194	8.777281	8.780224	8.771561	8.759423	8.749958	8.741203	8.722440	8.708203	8.678897
32.5	8.769921	8.767215	8.756075	8.758796	8.747286	8.737416	8.729289	8.711495	8.690730	8.669057	8.645505
33.0	8.747809	8.740694	8.732986	8.730531	8.719824	8.710170	8.701639	8.688100	8.664753	8.639689	8.607898
33.5	8.720173	8.712883	8.707665	8.700418	8.692577	8.681005	8.669845	8.662354	8.637506	8.609124	8.577620
34.0	8.689348	8.689134	8.680120	8.673807	8.668973	8.654150	8.638832	8.631459	8.607778	8.580169	8.555341
34.5	8.659186	8.662648	8.653403	8.649609	8.637730	8.629157	8.612632	8.599511	8.573626	8.551087	8.526873
35.0	8.632805	8.631005	8.624895	8.616761	8.602790	8.599183	8.590199	8.569694	8.547370	8.519515	8.491515
35.5	8.609528	8.599406	8.593303	8.581329	8.573730	8.564376	8.560625	8.540604	8.517543	8.481367	8.458173
36.0	8.579387	8.569565	8.560547	8.552406	8.545033	8.529569	8.520954	8.511625	8.479815	8.447795	8.425753
36.5	8.539760	8.537418	8.529164	8.526730	8.511692	8.490037	8.482296	8.479987	8.440576	8.421623	8.391366
37.0	8.500788	8.502253	8.494475	8.491978	8.475425	8.462472	8.449016	8.441343	8.409904	8.389082	8.352783
37.5	8.468833	8.470417	8.457924	8.452280	8.444503	8.431075	8.416587	8.401011	8.379101	8.348758	8.318791
38.0	8.440618	8.439279	8.420535	8.419636	8.408475	8.398055	8.381417	8.368401	8.343289	8.311858	8.290443
38.5	8.407602	8.401157	8.389048	8.386433	8.373388	8.359430	8.346428	8.338308	8.309731	8.286537	8.262193
39.0	8.370779	8.362206	8.357121	8.350244	8.342591	8.320437	8.313455	8.304583	8.280015	8.257794	8.228583
39.5	8.330977	8.330740	8.323862	8.315171	8.309695	8.287925	8.279855	8.270243	8.247000	8.220529	8.190346
40.0	8.299186	8.298088	8.291057	8.284186	8.269936	8.259417	8.248270	8.236642	8.213428	8.162275	8.154778
40.5	8.269524	8.262856	8.258921	8.248325	8.233167	8.229240	8.215352	8.201088	8.179952	8.149686	8.129094
41.0	8.237639	8.228062	8.224602	8.214043	8.208984	8.197001	8.183287	8.168368	8.147552	8.117188	8.098932
41.5	8.201611	8.196856	8.184891	8.182805	8.179627	8.157673	8.146714	8.136418	8.111642	8.082310	8.058942
42.0	8.171135	8.161969	8.167098	8.149963	8.140931	8.120758	8.110491	8.099839	8.077909	8.049002	8.016566
42.5	8.139557	8.125704	8.115652	8.113699	8.098528	8.088253	8.075132	8.063016	8.039662	8.018045	7.981780
43.0	8.100369	8.090715	8.085567	8.080566	8.062102	8.057365	8.040896	8.029422	8.000851	7.983963	7.949358
43.5	8.056710	8.058872	8.051032	8.046951	8.029632	8.023026	8.009926	7.997405	7.967020	7.947460	7.916884
44.0	8.020633	8.025829	8.012416	8.010937	7.997997	7.988400	7.977797	7.965675	7.937039	7.909925	7.883063
44.5	7.990987	7.987660	7.979408	7.975258	7.967111	7.952518	7.942089	7.928878	7.902797	7.874756	7.850830
45.0	7.961007	7.952797	7.946170	7.941392	7.930406	7.914390	7.901610	7.891668	7.865458	7.839459	7.816673
45.5	7.922168	7.918868	7.906559	7.901785	7.891371	7.880043	7.863288	7.854240	7.829052	7.800313	7.771121
46.0	7.880468	7.882010	7.869537	7.863372	7.851904	7.841050	7.826213	7.815176	7.791113	7.759681	7.724333
46.5	7.841559	7.841015	7.833649	7.826918	7.813957	7.799727	7.790332	7.770077	7.749197	7.719147	7.689592
47.0	7.807310	7.798381	7.795196	7.791797	7.771965	7.760888	7.748277	7.731159	7.709612	7.682157	7.655841
47.5	7.770584	7.758494	7.751241	7.750112	7.731961	7.728201	7.708391	7.699756	7.671607	7.650084	7.621982
48.0	7.728501	7.719279	7.711439	7.710505	7.698037	7.686726	7.669321	7.669782	7.637883	7.618561	7.589934
48.5	7.687143	7.685142	7.676004	7.671170	7.663051	7.643261	7.637632	7.632047	7.603822	7.582198	7.557756
49.0	7.650614	7.648179	7.639913	7.635295	7.627644	7.608035	7.602218	7.588259	7.567773	7.544413	7.521343
49.5	7.618734	7.611502	7.604198	7.599100	7.580536	7.577601	7.567019	7.551764	7.520087	7.507436	7.483921

DIS ZH	0	15	40	50	75	100	125	150	200	250	300
50.0	7.580566	7.579331	7.566840	7.564738	7.551311	7.544817	7.528710	7.519655	7.496086	7.471017	7.448116
50.5	7.545417	7.541454	7.530699	7.529771	7.515080	7.506529	7.493855	7.486225	7.467075	7.435965	7.414042
51.0	7.513525	7.503962	7.493805	7.492159	7.482498	7.471156	7.462565	7.443535	7.431505	7.406075	7.380350
51.5	7.478571	7.469872	7.461328	7.451151	7.448277	7.435958	7.429305	7.406200	7.391175	7.368824	7.348165
52.0	7.440060	7.439076	7.428480	7.418407	7.409654	7.405901	7.391120	7.378020	7.357450	7.332851	7.314620
52.5	7.399141	7.402115	7.388811	7.391796	7.371658	7.372007	7.352071	7.348937	7.324156	7.301122	7.278965
53.0	7.362546	7.361432	7.352441	7.357380	7.339915	7.330542	7.321484	7.310637	7.287450	7.268743	7.238503
53.5	7.329450	7.322935	7.318785	7.311083	7.305367	7.288546	7.288462	7.271194	7.248511	7.230552	7.200749
54.0	7.299476	7.291133	7.287035	7.272697	7.268903	7.254917	7.252169	7.238057	7.211442	7.190167	7.164710
54.5	7.260511	7.258255	7.246985	7.244318	7.231619	7.226254	7.213374	7.203072	7.180677	7.158230	7.129413
55.0	7.222041	7.220828	7.211174	7.214250	7.199643	7.193104	7.178504	7.170015	7.148925	7.125474	7.094966
55.5	7.190523	7.184220	7.176145	7.177217	7.163642	7.156702	7.140119	7.132268	7.111198	7.090502	7.067127
56.0	7.159227	7.148555	7.143152	7.139728	7.127053	7.120116	7.104247	7.094690	7.073071	7.052060	7.033956
56.5	7.115237	7.112045	7.101729	7.100348	7.091611	7.081919	7.069882	7.057616	7.039710	7.014233	6.993055
57.0	7.072139	7.075365	7.063898	7.059454	7.051049	7.041730	7.033568	7.019282	7.002161	6.978365	6.952705
57.5	7.039613	7.039564	7.030517	7.022565	7.010302	7.004174	6.993075	6.979931	6.959252	6.938220	6.919084
58.0	7.008363	7.000348	6.995702	6.988957	6.972213	6.967162	6.955935	6.948633	6.921089	6.899727	6.857667
58.5	6.972558	6.963197	6.957427	6.953954	6.946330	6.930653	6.924088	6.918658	6.890422	6.865567	6.853035
59.0	6.934702	6.927060	6.920308	6.913190	6.912178	6.895761	6.892026	6.880223	6.861936	6.839094	6.821568
59.5	6.898726	6.889818	6.886621	6.879634	6.875923	6.865111	6.855626	6.846634	6.829633	6.810099	6.790549
60.0	6.859262	6.856762	6.854495	6.850128	6.837766	6.829638	6.818965	6.806716	6.790836	6.776757	6.759859
60.5	6.822370	6.830673	6.816847	6.821487	6.805623	6.795039	6.790945	6.779619	6.764451	6.741785	6.723382
61.0	6.793595	6.801039	6.784336	6.788179	6.778012	6.768840	6.760509	6.753696	6.733572	6.718604	6.691993
61.5	6.770319	6.767403	6.756521	6.755318	6.748507	6.739130	6.726631	6.722456	6.703689	6.689412	6.661219
62.0	6.730693	6.735270	6.726783	6.725643	6.716482	6.704659	6.693679	6.686656	6.672415	6.652868	6.634363
62.5	6.704601	6.701136	6.691719	6.696968	6.682721	6.669735	6.665629	6.656453	6.638596	6.614298	6.603252
63.0	6.672667	6.664469	6.656608	6.666357	6.649649	6.639604	6.633085	6.627062	6.604334	6.588886	6.569585
63.5	6.639601	6.632259	6.629766	6.627940	6.614653	6.605346	6.598626	6.593225	6.571433	6.561486	6.533085
64.0	6.601096	6.598719	6.599556	6.595655	6.580211	6.573485	6.566452	6.553576	6.537306	6.522652	6.501946
64.5	6.567103	6.565353	6.562666	6.561586	6.553635	6.544484	6.530481	6.521193	6.503220	6.485990	6.470516
65.0	6.530517	6.530412	6.525493	6.523332	6.521983	6.510206	6.494761	6.491690	6.472452	6.451607	6.436836
65.5	6.502377	6.501190	6.490193	6.483688	6.485193	6.472010	6.461695	6.461971	6.449940	6.419183	6.402349
66.0	6.473736	6.463326	6.456519	6.449980	6.441916	6.436859	6.431396	6.421163	6.404221	6.382201	6.372912
66.5	6.440633	6.431628	6.423019	6.422275	6.408650	6.411986	6.398608	6.383212	6.371598	6.351282	6.343180
67.0	6.405656	6.401692	6.394519	6.393800	6.382480	6.383347	6.365462	6.354549	6.340256	6.324733	6.303678
67.5	6.367949	6.370238	6.360443	6.360661	6.351362	6.343516	6.332691	6.328960	6.306262	6.292149	6.275153
68.0	6.332326	6.330591	6.325490	6.322634	6.315393	6.298542	6.300146	6.293611	6.269181	6.254585	6.228992
68.5	6.297961	6.290951	6.286427	6.285667	6.274750	6.260270	6.263293	6.250960	6.232572	6.211500	6.193748
69.0	6.269164	6.257753	6.251755	6.250601	6.239454	6.230677	6.221341	6.211698	6.195311	6.171961	6.152279
69.5	6.231781	6.219138	6.214221	6.212518	6.199165	6.197096	6.181169	6.170566	6.158010	6.128626	6.108223
70.0	6.186534	6.181133	6.179667	6.172571	6.164242	6.153749	6.145065	6.129748	6.112717	6.088837	6.051267
70.5	6.140827	6.142431	6.134443	6.130748	6.123912	6.106043	6.102520	6.085500	6.064020	6.046088	6.021106
71.0	6.102172	6.100125	6.089145	6.086472	6.080781	6.064347	6.057674	6.034275	6.023628	6.012809	5.988006
71.5	6.062336	6.052919	6.047317	6.041605	6.033550	6.022471	6.015432	6.012597	5.986688	5.969975	5.951899
72.0	6.015640	6.010945	6.011176	6.001651	5.990117	5.981236	5.970362	5.966766	5.944113	5.925407	5.912800
72.5	5.970261	5.973692	5.963348	5.960456	5.949949	5.942225	5.933736	5.924397	5.907673	5.888329	5.878197
73.0	5.934587	5.930661	5.918955	5.920147	5.913798	5.909080	5.892366	5.887427	5.872162	5.853074	5.839715
73.5	5.901802	5.890362	5.880829	5.883626	5.873812	5.872960	5.859607	5.849809	5.839005	5.822140	5.800728
74.0	5.862856	5.857258	5.853217	5.848736	5.840052	5.836512	5.830968	5.811179	5.802721	5.789972	5.765095
74.5	5.826211	5.830048	5.823532	5.810534	5.805267	5.799612	5.796183	5.782855	5.766675	5.754050	5.732671

DIS ZH	0	15	40	50	75	100	125	150	200	250	300
75.0	5.789677	5.794310	5.786963	5.776576	5.775249	5.765879	5.757392	5.756189	5.733014	5.713953	5.702118
75.5	5.753718	5.757335	5.747162	5.747755	5.745684	5.729741	5.721405	5.721196	5.700736	5.673700	5.665119
76.0	5.715953	5.720627	5.711976	5.713825	5.702508	5.691614	5.684592	5.673626	5.661968	5.637828	5.621058
76.5	5.688598	5.677187	5.675036	5.671659	5.658492	5.652093	5.648779	5.630142	5.621661	5.604165	5.579526
77.0	5.651866	5.631665	5.632735	5.630224	5.620255	5.615372	5.607392	5.598969	5.582135	5.572165	5.544298
77.5	5.607450	5.590302	5.593633	5.590940	5.585041	5.576309	5.563748	5.563295	5.542647	5.532695	5.511113
78.0	5.562144	5.556721	5.555366	5.552436	5.542095	5.535248	5.524081	5.522620	5.501620	5.484188	5.471917
78.5	5.519686	5.519037	5.513868	5.510252	5.500806	5.493569	5.486157	5.478827	5.460872	5.438557	5.426733
79.0	5.470194	5.480915	5.471806	5.472061	5.460395	5.452606	5.448805	5.440834	5.418863	5.404540	5.380287
79.5	5.444242	5.441359	5.434523	5.432546	5.420530	5.414933	5.408870	5.402481	5.382339	5.373312	5.357182
80.0	5.410335	5.404986	5.391611	5.392698	5.381398	5.379230	5.370400	5.360414	5.344521	5.331507	5.310684
80.5	5.370028	5.369563	5.350654	5.353677	5.350590	5.343225	5.332058	5.319503	5.310289	5.289618	5.271842
81.0	5.326542	5.327396	5.315311	5.317363	5.315532	5.303139	5.295925	5.278934	5.273424	5.252770	5.232274
81.5	5.290426	5.288584	5.283457	5.276690	5.273295	5.263414	5.259710	5.242754	5.236657	5.213638	5.198507
82.0	5.240415	5.241348	5.246010	5.236639	5.228797	5.219357	5.212458	5.203673	5.191223	5.171082	5.152527
82.5	5.206648	5.203901	5.202012	5.199833	5.187439	5.176912	5.165385	5.162647	5.140838	5.122208	5.105890
83.0	5.163444	5.160625	5.152103	5.151905	5.144348	5.133478	5.121789	5.114022	5.092881	5.075350	5.055376
83.5	5.122114	5.112221	5.101792	5.099362	5.095415	5.088905	5.082691	5.063346	5.050200	5.032189	5.012170
84.0	5.074105	5.064375	5.055022	5.050343	5.044431	5.037508	5.031427	5.020035	5.003392	4.989755	4.972505
84.5	5.020272	5.017744	5.010675	5.009530	4.998759	4.989452	4.980960	4.960832	4.959935	4.944100	4.932867
85.0	4.972264	4.971438	4.973374	4.968043	4.959545	4.950158	4.944728	4.940270	4.924064	4.907834	4.898510
85.5	4.934521	4.930406	4.937224	4.933190	4.923872	4.917449	4.914467	4.901667	4.891546	4.879369	4.866144
86.0	4.905806	4.901248	4.901911	4.902196	4.892500	4.887193	4.881112	4.870173	4.857000	4.853310	4.840033
86.5	4.877108	4.873992	4.864923	4.865295	4.860390	4.852821	4.846311	4.842032	4.833150	4.823402	4.812352
87.0	4.868682	4.866951	4.834610	4.828552	4.827198	4.823850	4.818339	4.814381	4.808591	4.798117	4.780036
87.5	4.818688	4.815764	4.806923	4.799738	4.801494	4.799023	4.792524	4.788969	4.781180	4.767831	4.757706
88.0	4.789432	4.788671	4.778276	4.780457	4.781514	4.771331	4.769551	4.764116	4.752788	4.742952	4.734880
88.5	4.761867	4.757130	4.749462	4.758577	4.752810	4.743167	4.749283	4.740685	4.732768	4.725130	4.718067
89.0	4.737587	4.728165	4.730844	4.732100	4.722636	4.722834	4.726757	4.720910	4.710307	4.711278	4.700838
89.5	4.716561	4.709708	4.717545	4.709383	4.707186	4.707209	4.705836	4.699986	4.692269	4.690990	4.682387
90.0	4.697146	4.701541	4.703081	4.692124	4.698943	4.687666	4.688305	4.685486	4.679394	4.673779	4.666257
90.5	4.683091	4.691107	4.681516	4.682533	4.683527	4.671855	4.675022	4.672192	4.668995	4.661112	4.653747
91.0	4.671820	4.673726	4.665083	4.669600	4.664781	4.661246	4.662873	4.660572	4.654840	4.651356	4.642742
91.5	4.657950	4.654119	4.649893	4.655242	4.645667	4.646754	4.649480	4.639860	4.640523	4.633722	4.632280
92.0	4.640651	4.630220	4.630174	4.641941	4.631013	4.633251	4.633565	4.628990	4.626346	4.621765	4.621060
92.5	4.630659	4.628380	4.627205	4.629950	4.623700	4.626549	4.620992	4.620695	4.612516	4.612069	4.614284
93.0	4.621986	4.614388	4.619591	4.615446	4.622724	4.623816	4.610593	4.617435	4.603983	4.602373	4.603146
93.5	4.610011	4.605599	4.612981	4.604076	4.611063	4.612360	4.599862	4.603594	4.599809	4.592840	4.592603
94.0	4.595933	4.604593	4.604419	4.598223	4.594322	4.595334	4.588806	4.593503	4.594950	4.587009	4.584109
94.5	4.591537	4.604105	4.594090	4.590759	4.581528	4.582998	4.583736	4.583644	4.588149	4.582522	4.581947
95.0	4.588306	4.591160	4.584831	4.582034	4.581703	4.579767	4.583109	4.578203	4.579208	4.577024	4.575695
95.5	4.581987	4.575739	4.577553	4.576203	4.584620	4.579523	4.582354	4.573425	4.574663	4.578633	4.571161
96.0	4.577867	4.567926	4.573060	4.576244	4.582830	4.576695	4.579843	4.574860	4.571891	4.574965	4.570355
96.5	4.577518	4.571925	4.573472	4.574385	4.572134	4.572948	4.575936	4.573116	4.569554	4.566781	4.568897
97.0	4.570821	4.573669	4.566903	4.567583	4.563874	4.567055	4.570541	4.567414	4.559921	4.561462	4.567356
97.5	4.559905	4.568757	4.559010	4.561666	4.567867	4.562730	4.563516	4.568205	4.561343	4.567200	4.568206
98.0	4.562944	4.558305	4.562578	4.566967	4.573684	4.569711	4.562246	4.571315	4.568130	4.572158	4.566601
98.5	4.571420	4.565304	4.571001	4.572274	4.567513	4.575907	4.567799	4.566903	4.573355	4.566725	4.562550
99.0	4.768302	4.765360	4.764250	4.766569	4.758304	4.769865	4.768703	4.765695	4.761012	4.766779	4.765993
99.5	3.982663	3.985504	3.981477	3.982570	3.973921	3.984482	3.986668	3.982639	3.975804	3.984163	3.985336

DIS /M	350	400	450	500	550	600	650	700	750	800
0.0	19.595840	15.664294	10.667200	9.158600	6.336603	4.496909	3.237016	2.377067	1.559464	0.804648
0.5	18.642593	15.645438	11.934221	10.962493	8.904112	7.361697	6.172545	5.253550	3.957347	4.113392
1.0	17.518341	15.729848	12.908970	12.375683	11.011355	9.779234	8.710212	7.791532	6.338034	5.260203
1.5	16.327576	15.723681	14.097440	14.019824	13.310267	12.348019	11.366203	10.425125	8.778529	7.448277
2.0	14.727685	14.409883	13.795842	13.799121	13.518477	12.978668	12.522935	11.615039	10.215360	8.967168
2.5	13.770382	13.654348	13.662981	13.643559	13.469182	13.147104	12.716204	12.213615	11.102378	9.998777
3.0	13.583593	13.631786	13.723451	13.698339	13.542982	13.303766	12.979959	12.596135	11.697203	10.746888
3.5	13.673988	13.707122	13.695229	13.667620	13.550872	13.375711	13.122328	12.819663	12.088847	11.268038
4.0	13.729024	13.709758	13.700055	13.672286	13.570884	13.420137	13.219531	12.969161	12.358809	11.643596
4.5	13.687465	13.695570	13.689413	13.667864	13.582582	13.450551	13.284047	13.067327	12.548130	11.921442
5.0	13.695082	13.688581	13.683830	13.661579	13.592132	13.462151	13.320974	13.135693	12.678396	12.130252
5.5	13.679589	13.674818	13.678619	13.649678	13.587946	13.474581	13.344977	13.182045	12.768943	12.278125
6.0	13.669314	13.670110	13.668952	13.642466	13.572167	13.487269	13.362995	13.213497	12.834244	12.385568
6.5	13.662807	13.666092	13.652860	13.638965	13.561509	13.490102	13.375481	13.231480	12.881919	12.464606
7.0	13.658865	13.654220	13.638616	13.628061	13.560309	13.484940	13.375097	13.240715	12.912973	12.524023
7.5	13.648228	13.640157	13.630391	13.613422	13.556982	13.478613	13.372579	13.242717	12.932108	12.560916
8.0	13.633349	13.626939	13.621463	13.599791	13.544636	13.469712	13.366984	13.241447	12.943336	12.584570
8.5	13.620326	13.613393	13.607959	13.586934	13.530112	13.454597	13.352281	13.231759	12.940569	12.593241
9.0	13.608266	13.600216	13.592159	13.572544	13.517780	13.437939	13.332561	13.210484	12.921465	12.587284
9.5	13.590025	13.588420	13.580670	13.560819	13.503578	13.423381	13.309779	13.182261	12.892591	12.567194
10.0	13.571944	13.574630	13.569301	13.549142	13.489223	13.401109	13.280824	13.155300	12.864048	12.542006
10.5	13.560038	13.558182	13.551799	13.532673	13.469817	13.368156	13.246742	13.119426	12.828982	12.506312
11.0	13.549490	13.550787	13.540482	13.512067	13.445271	13.327909	13.208949	13.070389	12.782582	12.456243
11.5	13.531284	13.523213	13.511467	13.489655	13.408112	13.289118	13.159291	13.012130	12.724274	12.401311
12.0	13.512248	13.510324	13.490771	13.464215	13.361432	13.240317	13.096208	12.952064	12.660357	12.340011
12.5	13.494182	13.469599	13.463358	13.430315	13.307580	13.177002	13.027357	12.890981	12.582233	12.264355
13.0	13.460345	13.453969	13.424588	13.382097	13.248911	13.100035	12.951569	12.811699	12.492710	12.177000
13.5	13.425822	13.403608	13.370912	13.314864	13.171596	13.012395	12.867501	12.712716	12.394733	12.071338
14.0	13.365764	13.343464	13.295863	13.231647	13.077078	12.915778	12.769001	12.604631	12.290896	11.965987
14.5	13.287750	13.263197	13.202406	13.133552	12.973151	12.810756	12.653689	12.493205	12.173980	11.850069
15.0	13.187639	13.163762	13.092501	13.025739	12.858663	12.692353	12.526290	12.369328	12.043094	11.718199
15.5	13.071149	13.044908	12.963664	12.899442	12.725069	12.554555	12.387521	12.223025	11.899943	11.573116
16.0	12.940805	12.910037	12.820940	12.752650	12.573674	12.404478	12.233258	12.064425	11.743966	11.432498
16.5	12.795549	12.755182	12.663901	12.586125	12.407247	12.237785	12.065248	11.897386	11.579638	11.268330
17.0	12.630056	12.581926	12.491176	12.407372	12.225809	12.051910	11.885016	11.719664	11.410958	11.128446
17.5	12.442550	12.391497	12.291685	12.213804	12.033098	11.855294	11.692577	11.534144	11.242578	10.955670
18.0	12.232867	12.183766	12.071372	12.003278	11.825579	11.657212	11.493499	11.349463	11.066733	10.785828
18.5	12.006500	11.958600	11.860227	11.776862	11.603657	11.449030	11.295591	11.156473	10.879220	10.618750
19.0	11.770639	11.716866	11.610860	11.542431	11.382192	11.234096	11.093073	10.951722	10.689306	10.449819
19.5	11.528738	11.476136	11.379191	11.308329	11.164613	11.019077	10.885560	10.749050	10.509370	10.288204
20.0	11.287813	11.239697	11.140471	11.078104	10.944614	10.809682	10.679694	10.557422	10.358797	10.130831
20.5	11.048856	11.005064	10.903278	10.849734	10.719824	10.600327	10.481877	10.369503	10.168059	9.976866
21.0	10.813016	10.764662	10.674635	10.630489	10.504178	10.395801	10.293589	10.188506	9.994960	9.821786
21.5	10.577288	10.537472	10.455601	10.418696	10.302399	10.199746	10.107561	10.016831	9.838908	9.678961
22.0	10.356934	10.327372	10.247823	10.215722	10.113957	10.021372	9.951305	9.855517	9.688197	9.544598
22.5	10.155691	10.128599	10.057687	10.018756	9.932784	9.854122	9.766726	9.696039	9.551910	9.419712
23.0	9.971093	9.937897	9.877406	9.837409	9.760886	9.690115	9.618636	9.547705	9.427602	9.308056
23.5	9.793792	9.757512	9.706368	9.673549	9.604506	9.535888	9.478445	9.417062	9.313790	9.214961
24.0	9.627665	9.597760	9.549239	9.525879	9.468045	9.405601	9.355927	9.305357	9.203187	9.137588
24.5	9.477218	9.456152	9.414899	9.394635	9.346128	9.295298	9.265947	9.204610	9.128550	9.071393

DIS /M	350	400	450	500	550	600	650	700	750	800
25.0	9.366547	9.357359	9.297753	9.277595	9.234660	9.197377	9.158551	9.120814	9.066487	9.015737
25.5	9.236377	9.227142	9.198925	9.178425	9.141232	9.113037	9.087137	9.058154	9.011537	8.971303
26.0	9.148053	9.133474	9.116538	9.097642	9.072558	9.047070	9.026332	9.006891	8.970514	8.959837
26.5	9.074295	9.058314	9.046086	9.035930	9.017941	8.996582	8.979129	8.964020	8.943156	8.923820
27.0	9.016594	9.006291	8.987884	8.987701	8.969315	8.960818	8.948702	8.937911	8.921819	8.911397
27.5	8.970933	8.966637	8.951018	8.950678	8.934737	8.936132	8.928947	8.925405	8.911489	8.900955
28.0	8.941154	8.938448	8.932875	8.929675	8.918994	8.921212	8.911683	8.912416	8.900898	8.887820
28.5	8.920158	8.920821	8.920752	8.916719	8.916043	8.909591	8.898465	8.895654	8.889585	8.871317
29.0	8.911655	8.911176	8.908175	8.909618	8.907896	8.900391	8.886802	8.878787	8.863379	8.847676
29.5	8.905977	8.903502	8.897697	8.897844	8.889746	8.880999	8.870402	8.860135	8.834950	8.819363
30.0	8.894063	8.863796	8.881131	8.880197	8.863393	8.858740	8.850383	8.838999	8.818317	8.792089
30.5	8.868861	8.861104	8.858858	8.853578	8.839299	8.832106	8.827580	8.812635	8.791218	8.768951
31.0	8.839697	8.835923	8.829443	8.826116	8.816071	8.807352	8.799811	8.791698	8.769029	8.750732
31.5	8.812248	8.814711	8.803124	8.801066	8.792368	8.781089	8.771491	8.767920	8.746610	8.728543
32.0	8.789613	8.789194	8.777281	8.780224	8.771561	8.759423	8.749958	8.741203	8.722440	8.700293
32.5	8.769921	8.767215	8.756075	8.758796	8.747286	8.737416	8.729289	8.711495	8.690736	8.669057
33.0	8.747809	8.740694	8.732986	8.730531	8.719624	8.710170	8.701639	8.688100	8.664753	8.654689
33.5	8.720173	8.712883	8.707665	8.700418	8.692577	8.681005	8.669845	8.662354	8.637506	8.609123
34.0	8.689348	8.688134	8.680120	8.673807	8.668973	8.654150	8.638632	8.631459	8.607778	8.580169
34.5	8.659186	8.662068	8.653403	8.649609	8.637730	8.629157	8.612632	8.599511	8.573626	8.551087
35.0	8.632805	8.631005	8.624895	8.618761	8.602790	8.599183	8.590199	8.569694	8.547370	8.519315
35.5	8.609528	8.599406	8.593303	8.581389	8.573730	8.564376	8.560623	8.540604	8.517543	8.481367
36.0	8.579387	8.569545	8.560547	8.552406	8.545633	8.529569	8.520954	8.511623	8.479813	8.447795
36.5	8.539760	8.537918	8.529164	8.526730	8.511692	8.496037	8.482296	8.479987	8.440576	8.421623
37.0	8.500788	8.502253	8.494475	8.491978	8.475425	8.462472	8.449016	8.441343	8.409904	8.389062
37.5	8.468833	8.470417	8.457924	8.452280	8.444503	8.431075	8.416587	8.401011	8.379101	8.348758
38.0	8.440618	8.439279	8.420535	8.419636	8.408475	8.398053	8.381617	8.368401	8.343289	8.311858
38.5	8.407602	8.401157	8.389048	8.388433	8.373388	8.359430	8.346428	8.338308	8.309781	8.288537
39.0	8.370779	8.362206	8.357121	8.350244	8.342591	8.320437	8.313433	8.304583	8.280015	8.257798
39.5	8.330977	8.330740	8.325862	8.315171	8.309695	8.287925	8.279855	8.270243	8.247000	8.220529
40.0	8.299186	8.298688	8.291057	8.284186	8.269936	8.259417	8.248270	8.236642	8.213620	8.182275
40.5	8.269524	8.262836	8.258921	8.248325	8.233147	8.229240	8.215352	8.201088	8.179952	8.149688
41.0	8.237639	8.228062	8.224607	8.214083	8.208984	8.197001	8.183287	8.168368	8.147552	8.117188
41.5	8.201611	8.196854	8.186891	8.182805	8.179827	8.157673	8.146714	8.136418	8.111642	8.082310
42.0	8.171135	8.161969	8.147098	8.149943	8.140931	8.120758	8.110491	8.099639	8.077909	8.049082
42.5	8.139557	8.125704	8.115652	8.113699	8.099528	8.088253	8.075132	8.063018	8.039667	8.018045
43.0	8.100369	8.090715	8.085567	8.080566	8.062102	8.057365	8.040898	8.029472	8.000851	7.983983
43.5	8.056710	8.058872	8.051032	8.046951	8.029632	8.023026	8.009926	7.997405	7.967020	7.947680
44.0	8.020833	8.025829	8.012416	8.010937	7.997997	7.988400	7.977797	7.963625	7.937049	7.909925
44.5	7.990987	7.987680	7.979408	7.975258	7.967111	7.952518	7.942089	7.928878	7.902797	7.876758
45.0	7.961007	7.952797	7.946170	7.941392	7.930406	7.914390	7.901618	7.891066	7.865858	7.839659
45.5	7.922168	7.918808	7.908559	7.901785	7.891371	7.880043	7.865288	7.854240	7.829057	7.800313
46.0	7.880468	7.882010	7.869537	7.863372	7.851904	7.841050	7.826213	7.815176	7.791113	7.759661
46.5	7.841559	7.841015	7.833649	7.826918	7.813957	7.799727	7.790332	7.770877	7.749197	7.719167
47.0	7.807310	7.798381	7.795194	7.791797	7.771965	7.760888	7.748277	7.731159	7.709612	7.682157
47.5	7.770586	7.756494	7.751241	7.750112	7.731961	7.728201	7.708391	7.699756	7.671602	7.650084
48.0	7.728501	7.719279	7.711439	7.710505	7.696037	7.686726	7.669321	7.669782	7.637083	7.618561
48.5	7.687143	7.685142	7.676004	7.671170	7.663051	7.645261	7.637632	7.632847	7.603622	7.587198
49.0	7.650816	7.644179	7.659913	7.635295	7.627066	7.608035	7.602218	7.568239	7.567773	7.544613
49.5	7.616734	7.611502	7.604196	7.599100	7.589836	7.577601	7.567019	7.551764	7.529087	7.507436

DIS /M	350	400	450	500	550	600	650	700	750	800
50.0	7.580566	7.579331	7.566840	7.564788	7.551311	7.544617	7.528710	7.519635	7.496686	7.471017
50.5	7.545417	7.541454	7.530699	7.529771	7.515080	7.506529	7.493655	7.486225	7.467075	7.435965
51.0	7.513525	7.503962	7.493805	7.492159	7.482498	7.471156	7.462563	7.443533	7.431365	7.406075
51.5	7.478571	7.469872	7.461426	7.451151	7.448277	7.435958	7.429303	7.406200	7.391175	7.369823
52.0	7.440060	7.439076	7.428480	7.418607	7.419654	7.405901	7.391120	7.378020	7.357450	7.332651
52.5	7.399141	7.402113	7.388811	7.391796	7.371658	7.372007	7.352071	7.349937	7.324158	7.301122
53.0	7.362346	7.361432	7.352441	7.357380	7.339913	7.330342	7.321484	7.310637	7.267450	7.268763
53.5	7.329450	7.322935	7.318785	7.311083	7.305367	7.288546	7.288462	7.271194	7.246511	7.230552
54.0	7.299476	7.291133	7.287035	7.272637	7.268993	7.254917	7.252169	7.238057	7.211442	7.190167
54.5	7.260511	7.258255	7.246985	7.244318	7.231619	7.226254	7.213374	7.203072	7.180677	7.158240
55.0	7.222041	7.220628	7.211174	7.214250	7.199643	7.193104	7.178504	7.170015	7.148925	7.125673
55.5	7.190523	7.184220	7.178145	7.177217	7.163642	7.156702	7.140119	7.132268	7.111198	7.090502
56.0	7.159227	7.148555	7.143152	7.139728	7.127063	7.120116	7.104247	7.096690	7.073071	7.052060
56.5	7.115237	7.112045	7.101729	7.100348	7.091611	7.081919	7.069882	7.057616	7.039710	7.014233
57.0	7.072139	7.075365	7.063898	7.059454	7.051049	7.041730	7.033560	7.019282	7.002161	6.978365
57.5	7.039613	7.039566	7.030517	7.022565	7.010002	7.004176	6.993073	6.979931	6.959252	6.938228
58.0	7.004363	7.000340	6.995702	6.988957	6.972213	6.967162	6.955935	6.948433	6.921089	6.899727
58.5	6.972558	6.963197	6.957427	6.953954	6.946330	6.930653	6.924088	6.918658	6.890627	6.865567
59.0	6.934702	6.927060	6.920408	6.913190	6.912178	6.895761	6.892026	6.880223	6.861938	6.839093
59.5	6.898726	6.889818	6.886621	6.879634	6.875923	6.865111	6.855620	6.840634	6.829833	6.810096
60.0	6.859262	6.856762	6.854495	6.850128	6.837768	6.829638	6.818965	6.806717	6.796836	6.776757
60.5	6.822370	6.830673	6.818847	6.821487	6.805023	6.795039	6.790945	6.779819	6.764441	6.741785
61.0	6.793595	6.801059	6.784336	6.788179	6.778012	6.768840	6.760508	6.753696	6.733572	6.718604
61.5	6.770319	6.767403	6.756521	6.755318	6.748507	6.739130	6.720631	6.722054	6.703689	6.689412
62.0	6.739693	6.735270	6.726783	6.725643	6.716482	6.704659	6.693679	6.686036	6.672415	6.652848
62.5	6.704601	6.701136	6.691719	6.694968	6.682721	6.669735	6.665629	6.650433	6.638596	6.614298
63.0	6.672647	6.666469	6.656668	6.664357	6.649849	6.639804	6.633065	6.627662	6.604534	6.598866
63.5	6.639601	6.632259	6.629766	6.627960	6.614653	6.605346	6.598526	6.593225	6.571433	6.561656
64.0	6.601096	6.598719	6.599556	6.595655	6.580211	6.573485	6.566452	6.555576	6.537306	6.522652
64.5	6.562103	6.565353	6.562604	6.561586	6.553635	6.544486	6.530481	6.521193	6.503220	6.483990
65.0	6.530517	6.530412	6.525390	6.523332	6.521983	6.510206	6.494761	6.491690	6.472452	6.451607
65.5	6.502377	6.501190	6.490193	6.483688	6.485193	6.472010	6.461695	6.461971	6.440940	6.419163
66.0	6.473736	6.463326	6.456519	6.449980	6.441916	6.436659	6.431395	6.421163	6.404221	6.387201
66.5	6.440633	6.431628	6.423019	6.422275	6.408650	6.411986	6.398808	6.383212	6.371599	6.351282
67.0	6.405656	6.401692	6.394519	6.393690	6.382480	6.383347	6.365442	6.354549	6.340256	6.324733
67.5	6.367949	6.370238	6.360443	6.360461	6.351562	6.343516	6.332891	6.328960	6.306262	6.292189
68.0	6.332326	6.330391	6.325490	6.322834	6.315393	6.298542	6.300146	6.293611	6.269141	6.254585
68.5	6.297961	6.290951	6.288427	6.285847	6.274750	6.260270	6.263293	6.250946	6.232577	6.213500
69.0	6.269164	6.257753	6.251755	6.250801	6.238654	6.230677	6.221341	6.211698	6.198311	6.177961
69.5	6.231761	6.219136	6.214221	6.212518	6.193165	6.197096	6.181169	6.170566	6.158010	6.128626
70.0	6.188536	6.181133	6.179687	6.172571	6.164242	6.153749	6.145065	6.129748	6.112717	6.068837
70.5	6.140827	6.142431	6.134445	6.130748	6.123912	6.106043	6.102520	6.086500	6.064026	6.048688
71.0	6.102172	6.100125	6.089145	6.086472	6.080781	6.064347	6.057574	6.054275	6.023626	6.012409
71.5	6.067346	6.052919	6.047317	6.041605	6.033550	6.022471	6.015432	6.012597	5.986686	5.969975
72.0	6.015830	6.010945	6.011376	6.001651	5.990117	5.981236	5.979362	5.966766	5.948113	5.925607
72.5	5.970261	5.973692	5.963348	5.960454	5.949949	5.942225	5.933738	5.924397	5.907673	5.868329
73.0	5.934587	5.939861	5.918955	5.920147	5.913996	5.909080	5.892366	5.887427	5.872162	5.853073
73.5	5.901802	5.890362	5.880629	5.883626	5.878812	5.872940	5.859607	5.849669	5.839065	5.822168
74.0	5.862656	5.857258	5.853217	5.845736	5.840652	5.830512	5.830968	5.811179	5.802721	5.789972
74.5	5.826211	5.830048	5.823532	5.810534	5.808267	5.799612	5.796183	5.782053	5.766675	5.756050

DIS /M	350	400	450	500	550	600	650	700	750	800
75.0	5.789677	5.794310	5.786963	5.776574	5.775249	5.765879	5.757392	5.750189	5.735014	5.714953
75.5	5.753718	5.757335	5.747162	5.747755	5.745684	5.729741	5.721405	5.721196	5.700734	5.674700
76.0	5.715953	5.720627	5.711976	5.713825	5.702508	5.691614	5.684592	5.673826	5.661968	5.637828
76.5	5.688598	5.677187	5.675036	5.671659	5.658492	5.652093	5.648779	5.630142	5.621661	5.604165
77.0	5.651866	5.631665	5.632735	5.630224	5.620255	5.615372	5.607392	5.598969	5.582135	5.572165
77.5	5.607450	5.590302	5.593633	5.590940	5.585041	5.576309	5.563748	5.563295	5.542647	5.532695
78.0	5.562144	5.556721	5.555366	5.552436	5.542095	5.535248	5.524081	5.522620	5.501620	5.484188
78.5	5.519666	5.519037	5.513868	5.510252	5.500806	5.493569	5.486157	5.478827	5.460872	5.438557
79.0	5.479194	5.480915	5.471806	5.472061	5.460395	5.452606	5.448605	5.440834	5.419863	5.404540
79.5	5.444242	5.441359	5.434523	5.432546	5.420530	5.414935	5.408870	5.402481	5.382339	5.371312
80.0	5.410335	5.404986	5.391611	5.392698	5.381398	5.379230	5.370400	5.360414	5.344521	5.331507
80.5	5.370028	5.369363	5.356654	5.353677	5.350590	5.343225	5.332058	5.319303	5.310289	5.286618
81.0	5.326542	5.327396	5.315411	5.317363	5.315532	5.305139	5.295925	5.278934	5.273424	5.257770
81.5	5.290426	5.282584	5.283457	5.276690	5.273295	5.263414	5.259710	5.242754	5.236657	5.213638
82.0	5.249415	5.241348	5.240010	5.236639	5.228297	5.219357	5.212458	5.203873	5.191223	5.171082
82.5	5.200848	5.203901	5.202012	5.199833	5.187439	5.176912	5.165385	5.162647	5.140848	5.122208
83.0	5.163444	5.160625	5.152103	5.151905	5.144348	5.133478	5.121789	5.114022	5.092681	5.075350
83.5	5.122114	5.112221	5.101792	5.099362	5.095415	5.088905	5.082691	5.063346	5.050290	5.032189
84.0	5.074105	5.064375	5.055022	5.050343	5.044431	5.037508	5.031427	5.020033	5.003392	4.989755
84.5	5.020272	5.017744	5.010675	5.009530	4.998759	4.989452	4.980960	4.980832	4.959945	4.944100
85.0	4.972264	4.971438	4.973474	4.968043	4.959545	4.950158	4.944728	4.940270	4.924064	4.907834
85.5	4.933521	4.930406	4.937224	4.933190	4.923872	4.917449	4.914467	4.901667	4.891548	4.870369
86.0	4.905806	4.901248	4.901911	4.902196	4.892500	4.887193	4.881112	4.870173	4.857000	4.853310
86.5	4.877108	4.873992	4.864923	4.865295	4.860390	4.852821	4.846311	4.842032	4.833150	4.824402
87.0	4.848682	4.844951	4.834610	4.828552	4.827198	4.825650	4.818339	4.814381	4.808591	4.798117
87.5	4.818648	4.815764	4.806923	4.799738	4.801494	4.799023	4.792524	4.788949	4.781180	4.767031
88.0	4.789432	4.788671	4.778276	4.780457	4.781514	4.771331	4.769551	4.764116	4.752788	4.742952
88.5	4.761867	4.757130	4.749462	4.758577	4.752810	4.743167	4.749283	4.740685	4.737788	4.725140
89.0	4.737587	4.728165	4.730844	4.732100	4.722636	4.722834	4.726757	4.720916	4.710307	4.711278
89.5	4.716561	4.709708	4.717545	4.709383	4.707186	4.707209	4.705636	4.699966	4.692269	4.690990
90.0	4.697146	4.701361	4.703081	4.692174	4.698943	4.687666	4.688305	4.685486	4.679394	4.674779
90.5	4.683091	4.691107	4.681516	4.682533	4.683527	4.671855	4.675022	4.672192	4.668995	4.661112
91.0	4.671820	4.673726	4.665083	4.669600	4.666781	4.661246	4.662873	4.660572	4.654860	4.651358
91.5	4.657950	4.654119	4.649893	4.655242	4.645667	4.646754	4.649680	4.639850	4.640523	4.633722
92.0	4.640651	4.639270	4.639174	4.641941	4.631013	4.633251	4.633565	4.628990	4.626346	4.621785
92.5	4.630659	4.628480	4.627205	4.629950	4.623700	4.626549	4.620992	4.620695	4.612516	4.612089
93.0	4.621986	4.614388	4.619591	4.615446	4.622724	4.623816	4.610593	4.617435	4.603983	4.602373
93.5	4.610011	4.605599	4.612981	4.604076	4.611063	4.612360	4.599802	4.603596	4.599809	4.592860
94.0	4.595933	4.604593	4.604419	4.598223	4.594372	4.595334	4.588806	4.593503	4.594950	4.587009
94.5	4.591537	4.604105	4.594090	4.590759	4.581528	4.582998	4.583738	4.583044	4.588149	4.582572
95.0	4.588306	4.591160	4.583831	4.582034	4.581703	4.579767	4.585109	4.578203	4.579208	4.577024
95.5	4.581987	4.575739	4.577553	4.576203	4.584620	4.579523	4.582354	4.573425	4.574663	4.578633
96.0	4.577867	4.567926	4.574960	4.576244	4.582830	4.576995	4.579863	4.574060	4.571891	4.576985
96.5	4.577518	4.571925	4.573672	4.574385	4.572134	4.572968	4.575930	4.573110	4.569554	4.568781
97.0	4.570821	4.573869	4.566903	4.567483	4.563874	4.567055	4.570541	4.567414	4.559921	4.561042
97.5	4.559905	4.568757	4.559010	4.561060	4.567867	4.562730	4.563510	4.568205	4.561365	4.567200
98.0	4.567944	4.558305	4.562578	4.566967	4.573884	4.569711	4.562246	4.571315	4.568140	4.572158
98.5	4.571420	4.565306	4.571001	4.572276	4.567513	4.575907	4.567799	4.568903	4.573555	4.568725
99.0	4.768302	4.765360	4.768250	4.768569	4.758306	4.769865	4.768703	4.765895	4.761012	4.768774
99.5	3.987665	3.985504	3.981677	3.987570	3.973921	3.984482	3.988688	3.982039	3.975884	3.984169

Table 2

station	λ	ϕ
ALP	-147° 44.60'	65° 14.00'
BAO	-47 59.49	-15 38.09
EKA	-3 09.55	55 19.98
GBA	77 26.17	13 36.25
ILPA	50 44.00	35 25.00
LAO	-106 13.33	46 41.32
MAT	138 12.53	36 06.25
NAO	10 49.94	60 49.42
WRA	134 21.05	-19 56.87
YKA	-114 36.28	62 29.57
IM1	90 00.0	55 00.0
IM2	-70 00.0	5 00.0
IM3	20 00.0	10 00.0
IM4	65 00.0	35 00.0
IM5	105 00.0	35 00.0

CCD/541
5 August 1977
Original: English

UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND

Prophylaxis against nerve agent poisoning

The administration of drugs to prevent casualties from nerve agent poisoning as a prophylactic measure and after poisoning in the therapy of the effects of absorbed agents, has been under study for many years. In many countries, the results of such studies have been published in the medical and scientific literature and have contributed to the saving of life from poisoning by insecticides related in their mode of action to the chemical warfare nerve agents. The United Kingdom has consistently followed this practice of open publication, and the present study reported in this paper is in the nature of a progress report. The general status of medical protection against nerve agent poisoning was reviewed in a recent Yugoslav working paper (CCD/503).

It was reported some 30 years ago that cats could be protected against the lethal effects of the organophosphorus compound DFP (diisopropyl phosphorofluoridate) by pretreatment with the carbamate physostigmine. Subsequent work in the United Kingdom and elsewhere led to the development of oximes for treatment of organophosphorus poisoning. These act by reversing the combination between the organophosphorus compound and the enzyme cholinesterase, but in the particular case of poisoning by soman (1,2,2-trimethylpropyl methylphosphonofluoridate) the oximes are relatively ineffective because the combination becomes irreversible. A British report published in 1970 showed that preadministration of physostigmine and atropine gave appreciable protection against poisoning by soman and that certain other carbamates were effective in protecting guinea pigs against soman poisoning whereas a number of competitive anticholinesterases were inactive.

This work has been followed up and after a preliminary screening test for protection against soman, four carbamates have been studied for their ability to protect against a number of nerve agents in a range of experimental animals: rats, rabbits and guinea pigs. Supporting pretreatment was also given with the oxime P2S (pralidoxime mesylate), which was also given therapeutically (i.e. after nerve agent poisoning) along with atropine. The carbamates studied were pyridostigmine, mobam, physostigmine and decarbofuran, and nerve agents used were

soman, sarin (isopropyl methylphosphonofluoridate), tabun (ethyl dimethylphosphoramidocyanidate) and VX (ethyl S-2-diisopropylaminoethyl methylphosphonothiolate).

Estimation of maximum sign-free dose of carbamate

Pairs of animals were given intramuscular carbamate in serial doses, differing by a factor of 2, and were observed for a period of 3 hours. The times of occurrence of unmistakable signs of anticholinesterase poisoning (tremors, muscular fasciculations, unsteadiness, inco-ordination or salivation) were noted. When two consecutive doses were found such that signs were evident at the upper but not at the lower dose an additional test was carried out using a dose three quarters of the higher dose. If that dose caused no signs it was accepted as the maximum sign-free dose; otherwise the dose immediately below it was used. The time taken for a minimally toxic dose to produce signs of poisoning was used in protection experiments as the appropriate time interval between pretreatment and the administration of the organophosphate ("pretreatment interval").

Safety ratio of carbamates

Acute toxicities were determined in guinea pigs for the four carbamates and the safety ratio expressed as follows:

$$\text{Safety ratio} = \frac{\text{LD50}}{\text{Maximum sign-free dose}}$$

Protection experiments

Animals were injected intramuscularly with a carbamate, with or without P2S (15 mg/kg). After the appropriate pretreatment interval the organophosphate was given subcutaneously followed one minute later (or at signs of poisoning if they appeared earlier) by therapy with 17.4 mg/kg atropine sulphate usually mixed with 15 mg/kg P2S (im). (In experiments in which carbamate was given without prophylactic P2S, the therapeutic dose of the oxime was 30 mg/kg.) LD50 values, based on 24 hour mortalities, were calculated by the method of moving averages. The results of the protection experiments are expressed as the

$$\text{Protective ratio} = \frac{\text{LD50 organophosphate in treated animals}}{\text{LD50 organophosphate in untreated animals}}$$

RESULTS

Comparison of carbamates

Of the four carbamates, three (pyridostigmine, mobam and decarbofuran) appeared to be slightly superior to physostigmine in protecting guinea pigs against soman poisoning, as shown in Table 1. The safety ratios of the effective carbamates

varied widely, from 7.5 (physostigmine) to more than 100 (mobam), indicating that the effective protective dose of a carbamate is not a fixed proportion of the lethal dose. Carbamate pretreatment did not prevent the occurrence of signs of anticholinesterase poisoning although the response to soman was variable. With physostigmine, pyridostigmine and mobam signs of poisoning began to occur two to three minutes after poisoning with doses of soman below 4LD50: recovery was quickest with physostigmine pretreatment (the animals were markedly less affected by two hours) and slowest with mobam. Recovery in pyridostigmine-treated animals was not so smooth as in animals pretreated with other carbamates: there were recurring short periods (five to ten minutes) during which the animals relapsed and showed more severe signs of poisoning. In decarbofuran pretreated guinea pigs, the signs of poisoning appeared more slowly (up to 20 minutes) and lasted for a shorter time.

With higher doses of soman (6LD50 or more) the carbamate pretreated animals became prostrate, with irregular breathing, within five to ten minutes and this state lasted for several hours. With decarbofuran the animals, although severely affected, did not show the same degree of inertia. With all the carbamates, the surviving animals were usually recovered, or very much improved, by 24 hours after soman poisoning.

Variation in the dose of carbamate

The protection afforded against soman poisoning decreased, by a variable amount, as the dose of carbamate was reduced from the maximum sign-free (Table 1). Nevertheless, all four carbamates gave significant protection (Protective ratio >4) at one quarter of the sign-free dose. Raising the pretreatment dose had only a slight but variable effect: the protection afforded by pyridostigmine was raised slightly whereas that by mobam was reduced. However, the signs of soman poisoning were more severe and prolonged.

Duration of carbamate protection

The time course of the protection depended on the carbamate. Pyridostigmine and mobam gave maximum protection one hour after injection and physostigmine and decarbofuran 30 minutes after. Pyridostigmine had the longest duration action (about four hours) and decarbofuran the shortest (two to three hours).

Variation in supporting treatment

The effectiveness of carbamates in the treatment of animals poisoned by soman depends upon supporting treatment with atropine. It may be expected that inclusion of an oxime in the treatment would not influence the protection afforded against

soman poisoning but would reinforce the protective action against poisoning by "oxime responsive" organophosphate anticholinesterases. The effect of varying the supporting treatment on the protection afforded to carbamate-treated guinea pigs was determined against poisoning by sarin and VX ("oxime responsive"), tabun (poisoning by which is not resistant to oximes generally but only to P2S), and soman.

Pyridostigmine, in the absence of any supporting treatment, did not afford protection against poisoning by any of the organophosphates but neither did it sensitize the guinea pigs to their lethal effects. In combination with atropine therapy, protection was given against tabun or soman poisoning and only marginal protection against sarin or VX, although the latter was raised considerably by incorporation of P2S into the therapy. Dividing the P2S treatment into prophylaxis and therapy gave increased protection against soman and VX poisoning but not against sarin. The result for tabun was anomalous in that dividing dose of P2S markedly reduced the protection.

Species differences in protection

The protection afforded to rats, guinea pigs and rabbits by carbamates pretreatment supported by atropine/P2S therapy against organophosphate poisoning is summarized in Table 2. The drug treatment was most effective in guinea pigs and, with the exception of sarin, less effective in the rabbit. In was ineffective in the rat apart from providing some protection against VX poisoning.

The maximum sign-free dose and the appropriate pretreatment time interval were determined for each carbamate in each of the species as described earlier.

DISCUSSION

The protective action of carbamates against organophosphate poisoning no doubt depends primarily upon the ability of the carbamate to inhibit acetylcholinesterase, forming a semi-stable carbamylated enzyme which can spontaneously break down to liberate the enzyme. The fraction of the enzyme in the tissues that was carbamylated would be protected against phosphonylation by organophosphate. The gradual decarbamylation of the enzyme in parallel with the relatively rapid removal or destruction of the organophosphate would release sufficient acetylcholinesterase to maintain life.

The usual treatment for organophosphate poisoning is a combination of atropine and oxime. This is not effective against poisoning by soman or (as far as P2S

is concerned) tabun. The present study has shown that additional pretreatment with a suitable carbamate gives protection against poisoning by either of these oxime-resistant organophosphate without reducing the effectiveness of the atropine-P2S treatment against poisoning by the oxime sensitive organophosphates, sarin and VX. It is thus possible that a combination of pretreatment with a carbamate with oxime-atropine therapy could form the basis of a treatment that would be effective against poisoning by any organophosphate antiacetylcholinesterase, including all of the chemical warfare nerve agents.

TABLE 1

The Protection of Guinea Pigs against Soman Poisoning by Pretreatment with Different Doses of Carbamates

Carbamate	Pretreatment Interval (min)	Dose Multiple of Maximum Sign-Free Dose	Protective Ratio (95% limits)	Safety Ratio of Dose of Carbamate
Physostigmine	10	1	6.5 (4.7- 9.0)	7.5
		0.5	7.5 (5.4-10.3)	15
		0.25	6.0 (4.3- 8.5)	30
Pyridostigmine	30	4	10.1 (6.4-15.1)	13.8
		2	10.1 (8.0-13.3)	27.5
		1	8.0 (6.6- 9.6)	55
		0.5	5.8 (3.7- 9.2)	110
		0.25	4.0 (2.9- 5.6)	220
Mobam	20	4	6.9 (4.6-10.5)	>29
		2	7.3 (4.2-17.3)	>58
		1	8.0 (5.9-10.9)	>117
		0.5	7.5 (5.8- 9.8)	>234
		0.25	4.7 (3.4- 6.2)	>468
Decarbofuran	10	1	7.5 (5.6-10.0)	23
		0.5	6.2 (4.4- 8.9)	46
		0.25	4.6 (2.7- 5.1)	92

Conditions: P2S (15 mg/kg) and carbamate were given (i.m.) at the pretreatment interval before soman (s.c.). P2S (15 mg/kg) and atropine sulphate (17.4 mg/kg) were given (i.m.) 1 min. after soman.

$$\text{Protective Ratio} = \frac{\text{LD50 Soman in treated animals}}{\text{LD50 Soman in untreated animals}} \qquad \text{Carbamate Safety Ratio} = \frac{\text{LD50}}{\text{Maximum Sign-Free Dose}}$$

TABLE 2

Response of Different Species to Carbamate Prophylaxis Against Organophosphorus Poisoning

Species	Carbamate (Dose)	Prophylactic Time Interval (min)	Protective ratio (95% limits)			
			Tabun	Sarin	Soman	VX
Guinea Pig	Pyridostigmine (0.1 mg/kg)	30	22.0 (16.1-29.9)	21.5 (15.6-32.9)	5.3 (3.9-7.1)	17.9 (12.6-25.4)
	Mobam (2.5 mg/kg)	20	6.3 (5.5- 7.3)	23.0 (9.8-54.0)	5.0 (3.6-6.9)	23.6 (16.2-34.7)
Rabbit	Pyridostigmine (0.1 mg/kg)	30	4.6 (3.3- 6.5)	27.0 (19.6-37.6)	2.7 (1.8-4.1)	5.0 (2.9- 8.7)
	Mobam (2.5 mg/kg)	20	6.9 (4.5-10.5)	38.0 (22.5-45.7)	6.0 (4.5-8.0)	9.4 (6.4-14.3)
Rat	Pyridostigmine (0.075 mg/kg)	20	1.2 (0.9- 1.7)	1.5 (1.1- 2.1)	1.7 (1.3-2.2)	5.0 (2.6- 9.7)

Conditions: P2S (30 mg/kg) and atropine sulphate (17.4 mg/kg) (i.m.) given therapeutically 1 min. after the organophosphate (s.c.)

CCD/542
11 August 1977
Original: English

FOURTH PROGRESS REPORT TO THE CONFERENCE OF THE COMMITTEE ON DISARMAMENT BY THE AD HOC GROUP OF SCIENTIFIC EXPERTS TO CONSIDER INTERNATIONAL CO-OPERATIVE MEASURES TO DETECT AND IDENTIFY SEISMIC EVENTS

1. In pursuance of the decision of the CCD of 22 July 1976, the Ad Hoc Group of Scientific Experts to Consider International Co-operative Measures to Detect and to Identify Seismic Events held its fourth session from 25 July to 5 August 1977 in Geneva, under the Chairmanship of Dr. Ulf Ericsson of Sweden. The first week of this session was devoted to informal consultations among the experts in which most members of the Group participated.

2. Scientific experts and representatives of the following Member States of the CCD attended the session: Bulgaria, Canada, Czechoslovakia, Egypt, German Democratic Republic, Federal Republic of Germany, Hungary, India, Italy, Japan, Mongolia, Netherlands, Pakistan, Peru, Poland, Romania, Sweden, Union of Soviet Socialist Republics, United Kingdom, United States of America.

3. Following previous invitations by the CCD, in addition to scientific experts of Member States of the CCD, scientific experts of the following States took part in the discussions of the fourth session: Australia, Belgium, Denmark, Finland, New Zealand and Norway.

4. According to its timetable, revised at the third session, the Ad Hoc Group reviewed drafts towards its final report relating to the following subjects:

Chapter 4: Selection of seismographic stations for a global network.

Chapter 6: Data centres for detection and location of seismic events and for reduction of identification parameters.

Chapter 7: Estimated costs to establish and operate the specified system of international co-operative measures.

Chapter 8: Estimated capability of the specified system of international co-operative measures.

Chapter 9: Proposals for Experimental Exercises.

Appendix: Problems with the estimation of yields from seismic signals.

After thorough discussion, instructions and guidelines were given to the Scientific Secretary and to the Conveners of groups of experts on the chapters mentioned for the re-drafting of the texts. Similarly, guidelines were adopted for the drafting of the introduction and the summary of the report.

5. In order to assure the completion of its work in time, the Ad Hoc Group finalized its schedule. Accordingly the second draft of the report will be circulated among experts in December 1977 in order to facilitate its review and approval during the last session.

6. The Ad Hoc Group adopted a draft agenda for its last session and designated experts from among its members to prepare the remaining drafts of the report.

7. The Ad Hoc Group took note with satisfaction of the attendance at its meeting of an expert from Peru who offered the co-operation of a number of seismological stations in Peru.

8. At the same time, in the Ad Hoc Group's continued deliberations on the various aspects of the specification of an international system for the detection and identification of seismic events, including the composition of a network of stations, the view was repeatedly expressed that for reasons of efficiency and scientific precision co-operation of all CCD Member States, and other States, with seismological stations in Central and South America and in Africa would greatly facilitate the successful completion of its work.

9. The Ad Hoc Group envisages holding its final session at the Palais des Nations, Geneva, from 27 February to 10 March 1978, subject to confirmation by the CCD. The first week of this session, the period between 27 February and 3 March 1978, is intended to be devoted to discussions of working parties dealing primarily with the introduction and the summary of the Report.

CCD/543
17 August 1977

Original: English

FINAL DOCUMENT OF THE REVIEW CONFERENCE OF THE PARTIES TO 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

The Final Document is circulated as a document of the Conference of the Committee on Disarmament pursuant to the decision taken by the Committee at its 759th plenary meeting on 4 August 1977.

/For the Final Document, see SBT/CONF/25./

CCD/544*
19 August 1977

English only

LETTER DATED 19 AUGUST 1977 FROM THE COUNSELLOR OF THE PERMANENT MISSION OF FINLAND TO THE UNITED NATIONS OFFICE AT GENEVA ADDRESSED TO THE SPECIAL REPRESENTATIVE OF THE SECRETARY-GENERAL TO THE CONFERENCE OF THE COMMITTEE ON DISARMAMENT CONCERNING CHEMICAL AND INSTRUMENTAL VERIFICATION OF ORGANOPHOSPHORUS WARFARE AGENTS

Upon instructions from my Government, I have the honour to forward to you herewith a booklet "Chemical and Instrumental Verification of Organophosphorus Warfare Agents" prepared for the Ministry for Foreign Affairs of Finland by the Advisory Board for Disarmament. I would be most grateful, if you could take appropriate steps to have the booklet distributed in the Conference of the Committee on Disarmament as an official document.

(Signed) Juhani Muhonen
Counsellor

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* A limited distribution of this document has been made to the members of the Conference of the Committee on Disarmament. Additional copies are available from the Foreign Ministry of Finland in Helsinki.

CCD/545*
23 August 1977
ENGLISH
Original: English/Spanish

MEXICO

Working paper containing a preliminary draft comprehensive programme of disarmament

INTRODUCTION

In its resolution 2602 E (XXIV) of 16 December 1969 the United Nations General Assembly declared the decade of the 1970s as a Disarmament Decade and inter alia requested the "Conference of the Committee on Disarmament, while continuing intensive negotiations with a view to reaching the widest possible agreement on collateral measures, to work out at the same time a comprehensive programme, dealing with all aspects of the problem of the cessation of the arms race and general and complete disarmament under effective international control, which would provide the Conference with a guideline to chart the course of its further work and its negotiations".

A number of suggestions and documents were submitted to the Conference of the Committee on Disarmament during 1970. In its resolution 2661 C (XXV) of 7 December 1970, the General Assembly inter alia expressed "its appreciation of the important and constructive documents and views submitted at the Conference of the Committee on Disarmament, including the working papers on a comprehensive programme of disarmament submitted by the Netherlands on 24 February 1970 and by Italy on 19 August 1970, and the draft comprehensive programme of disarmament submitted by Mexico, Sweden and Yugoslavia on 27 August 1970, and of the comprehensive programme of disarmament submitted to the General Assembly by Ireland, Mexico, Morocco, Pakistan, Sweden and Yugoslavia on 1 December 1970". In the same resolution, the General Assembly recommended to the Conference of the Committee on Disarmament "that it take into account in its further work and its negotiations" the comprehensive programme of disarmament submitted by Ireland, Mexico, Morocco, Pakistan, Sweden and Yugoslavia (document A/8191) "as well as other disarmament suggestions presented or to be presented in the future".

In 1974 and 1975 the General Assembly adopted resolutions (3261 A (XXIX) and 3470 (XXX)) which, in reviewing the implementation of the purposes and objectives of the Disarmament Decade, urged that new efforts should be made to negotiate effective disarmament measures. At the 1975 session of the CCD Romania submitted a document

* Incorporating document CCD/545/Corr.1 of 25 August 1977.

entitled "Steps to be taken within a disarmament programme" (CCD/449). At the 1976 session Nigeria submitted a working paper on Conclusions of the Mid-Term Review of the Disarmament Decade (CCD/510) in which it referred inter alia to the adoption of a comprehensive programme as a primary obligation of the CCD during the Disarmament Decade.

On 10 December 1976 the General Assembly adopted resolution 31/68 in which inter alia it urged "the Conference of the Committee on Disarmament to adopt, during its 1977 session, a comprehensive programme dealing with all aspects of the problem of the cessation of the arms race and general and complete disarmament under strict and effective international control, in accordance with General Assembly resolution 2602 E (XXIV) proclaiming the Disarmament Decade".

The present comprehensive programme of disarmament has been prepared in accordance with that request of the General Assembly.

In the light of the contents of resolutions 2602 E (XXIV) and 31/68 it would seem fully justified to state that the General Assembly's request means that the comprehensive programme of disarmament should embrace not only the work of the Conference of the Committee on Disarmament but all negotiations conducted and other acts performed in this matter, in whatever place and form they are carried on, and that the programme should include effective procedures to facilitate the co-ordination of such activities and to ensure that the United Nations General Assembly is kept informed of their progress so as to be able to perform its functions, including the continuous appraisal of the situation, properly.

It seems advisable to point out that the term "disarmament" is used here in the same sense in which it has been used in the various forums of the United Nations: that is, as a generic term which encompasses and may designate any type of measures relating to the matter, whether they are measures for the prevention, limitation, reduction or elimination of armaments or for the reduction of military forces.

I. OBJECTIVE

The aim of the comprehensive programme is to achieve tangible progress in order that the goal of general and complete disarmament under effective international control may become a reality in a world in which international peace and security prevail and the New International Economic Order is attained.

II. PRINCIPLES

1. The measures provided for in the comprehensive programme should be carried out in accordance with the joint statement of agreed principles for disarmament negotiations of September 1961, taking into account the obligations assumed in

various treaties on disarmament, the relevant resolutions of the United Nations and any new factor or possibility arising in this area.

2. The highest priority should be given to disarmament measures dealing with nuclear and chemical weapons.

3. Parallel to the negotiations on partial disarmament measures, including measures to prevent and limit armaments and measures to reduce armaments, the problem of general and complete disarmament should be given intensive treatment in order to facilitate further clarification of positions and possibilities, including the revision and updating of the existing draft treaties submitted by the USSR and the United States of America respectively, or the submission of new proposals.*/

4. The principle of balanced disarmament should be kept in mind. This principle relates both to a numerical reduction of armed forces and certain types of weapons to predetermined levels, and to sets of disarmament measures whereby an over-all balance is achieved that all parties consider satisfactory from the standpoint of their own security. The militarily important Powers will have to make particular efforts to reduce the disparity between them and other countries. It is understood that the final solution with regard to the limitation and reduction of conventional armaments can only be achieved in the context of general and complete disarmament.

5. Methods of verification form an essential part of disarmament measures. In devising such methods it must be recognized that 100 per cent certainty can never be attained with any such system. A single method of control is rarely sufficient. A combination, in which several methods reinforce one another, should as a rule be employed in order to obtain the necessary assurances that a particular disarmament measure is being duly implemented by all parties.

6. The comprehensive programme is correlated with other United Nations programmes for the maintenance of international peace and security. Progress in the former should not, however, be made dependent on progress in the latter, and vice versa.

7. It should be kept in mind that, in concluding disarmament agreements, any adverse effects on the scientific, technological or economic future of nations must be avoided.

8. Efforts in support of the link between disarmament and development, envisaged in General Assembly resolution 2602 E (XXIV) on the Disarmament Decade, should be intensified in order to promote negotiations relating to disarmament and to ensure

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***/ The absence of such revision and updating has of necessity left this comprehensive programme of disarmament, and in particular sections III.B.1 and 3, incomplete.**

that the human and material resources freed by disarmament are used to promote economic and social development, particularly in the developing countries.

9. The steady acceleration of the arms race is incompatible with the efforts aimed at establishing the New International Economic Order, as defined in the Declaration and Programme of Action on the Establishment of a New International Economic Order, contained in General Assembly resolutions 3201 (S-VI) and 3202 (S-VI) of 1 May 1974, and in the Charter of Economic Rights and Duties of States, contained in General Assembly resolution 3281 (XXIX) of 12 December 1974. Those efforts entail, more than ever, resolute action by all States to achieve the cessation of the arms race and the implementation of effective measures of disarmament, particularly in the nuclear field.

10. Appropriate changes should be made in the organization and procedures of multilateral organs of negotiation on disarmament in order to secure the participation of all nuclear-weapon States.

11. The United Nations, which has specific responsibility for disarmament under the Charter, should be kept informed of all measures, whether unilateral, bilateral or multilateral, adopted in that connexion.

12. Public opinion should be supplied with adequate information about armaments and disarmament, so that it may bring its influence to bear to strengthen disarmament efforts.

III. COMPONENTS AND STAGES OF THE PROGRAMME

A. Disarmament treaties in force or in preparation

1. The results achieved so far in the disarmament field constitute partial or collateral measures which facilitate the pursuit of the final objective of general and complete disarmament under effective international control and form part of it. Those results consist mainly of the following multilateral instruments at present in force:

(a) The Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare, 1925 (Geneva Protocol);

(b) The Antarctic Treaty, 1959;

(c) The Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and under Water, 1963;

(d) The Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, 1967;

(e) The Treaty for the Prohibition of Nuclear Weapons in Latin America (Treaty of Tlatelolco) and its two Additional Protocols, 1967;

(f) The Treaty on the Non-Proliferation of Nuclear Weapons, 1968;

(g) 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, 1972;

(h) The Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction, 1975.

Special attention should be paid to the fulfilment of the obligations arising from those treaties, to the review conferences provided for in some of them and, where applicable, to the adoption of measures designed to supplement them.

2. Efforts and negotiations to reach agreement before the end of the Disarmament Decade on the treaties, conventions and proposals which have been under consideration for some time by the General Assembly, the Conference of the Committee on Disarmament and other competent international organs should be urgently intensified. This work has included consideration of:

(a) A complete prohibition of all nuclear-weapon tests;

(b) The prohibition of the development, production and stockpiling of chemical weapons and the destruction of stockpiles of such weapons;

(c) Further measures in the field of disarmament, in particular those aimed at achieving important qualitative limitations on and substantial reductions in strategic nuclear-weapon systems with a view to eliminating such systems from the arsenals of States;

(d) The establishment of additional nuclear-weapon-free zones.

B. Other disarmament measures

1. Measures for whose implementation the political will of the two principal nuclear-weapon States is essential */

(a) **Nuclear weapons and other weapons of mass destruction**

(i) A moratorium upon or the cessation of the testing and deployment of new strategic nuclear-weapon systems;

(ii) A ban on flight testing of delivery vehicles for nuclear weapons;

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*/ See foot-note to section II, para. 3, above.

(iii) The cessation of production of fissionable materials for military purposes and the assignment of existing stocks to civilian uses;

(iv) A freeze or limitation on the deployment of all types of nuclear weapons;

(v) A solution to the problem concerning prohibition of the use of nuclear weapons or of the threat to use such weapons;

(vi) The complete prohibition of all techniques of environmental modification for military or any other hostile purposes;

(vii) The prohibition of new types of weapons of mass destruction.

(b) Conventional armaments and armed forces

(i) Further prohibitions of the use of the sea-bed and the ocean floor, and of the subsoil thereof for military purposes;

(ii) The setting of ceilings for the level and types of conventional armaments and for the numerical strength of armed forces;

(iii) The elimination of foreign military bases and the creation of zones of peace;

(iv) The limitation and regulation of the international transfer of conventional weapons;

(v) The reduction of the military budgets of the States permanent members of the Security Council and of any other State with comparable military expenditures.

2. Measures for which the political will of the States directly concerned may be sufficient

(a) Nuclear weapons

The establishment of nuclear-weapon-free zones.

(b) Conventional armaments and armed forces

(i) The convening, on the initiative of the States of the region, of regional conferences for the prevention and limitation of armaments;

(ii) The conclusion of regional non-aggression, security and disarmament treaties on the initiative of the States concerned;

(iii) The reduction of military expenditures.

3. Elimination of armaments

In accordance with the joint statement of agreed principles for disarmament negotiations of 1961, the final stage of the comprehensive programme should consist of the conclusion of a treaty on general and complete disarmament under effective international control, providing for the prohibition and elimination of nuclear

weapons and the reduction of conventional armaments and armed forces to the levels required for the maintenance of internal order and international peace.*/

IV. THE MAINTENANCE OF PEACE AND SECURITY

1. It is undeniable that there is a close relationship between disarmament, international security, the peaceful settlement of disputes and the creation of a climate of confidence.

2. During the period of negotiations on the disarmament measures listed above, parallel negotiations should be carried on in the appropriate organs for the establishment or development of machinery and procedures for peaceful settlement and peace-keeping within the United Nations in order to increase international peace and security and to ensure that they are maintained.

3. Agreement on such measures will facilitate the success of efforts for disarmament, just as the adoption of disarmament measures will create favourable conditions for strengthening international security. Nevertheless, as has already been pointed out above, progress in one of these spheres should not be made dependent on progress in the other, and vice versa.

V. PROCEDURE

1. The General Assembly should examine annually the progress made in the implementation of the comprehensive programme. Every three years the General Assembly should examine the comprehensive programme and revise it as appropriate.

2. A thorough study should be made of the question of convening at an appropriate time an adequately prepared world disarmament conference, and of its institutionalization.

3. Until such time as a world disarmament conference is convened, the General Assembly should hold regularly -- for instance, every three years -- special sessions devoted to disarmament.

4. The practice of requesting the Secretary-General to prepare, with the assistance of expert consultants, authoritative studies on specific questions relating to the arms race and disarmament should be continued.

5. In view of the growing complexity of disarmament questions, States Members of the United Nations should endeavour to strengthen their Ministries of Foreign Affairs and their permanent missions in this field.

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*/ In this matter more than others, the revision and updating of the draft treaties submitted by the Soviet Union and the United States in 1962 are essential.

6. The United Nations Centre for Disarmament should be continuously strengthened and efforts should be made to ensure periodic publication of the United Nations Disarmament Yearbook.

7. More conferences and scientific interchanges should be held between scientists and experts from various countries on problems of the arms race and disarmament.

8. Universities and other academic institutions should be encouraged to hold continuing courses and seminars to study problems of the arms race, military expenditures and disarmament.

9. The intensification of exchanges and publication of relevant information and data should provide an atmosphere of greater sincerity and trust between States and a steady increase in knowledge of and interest in these matters among the public.

10. A world-wide "Disarmament Day" should be established under the auspices of the United Nations.