This document has been specially prepared by Professor Kistiakowsky as convener of Working Group 1. It is intended to serve as a basis for discussion by the Working Group in Munich, and for working papers submitted by participants. The latter should not exceed 10 double-spaced typewritten pages, plus a 250 word abstract for possible publication in the Pugwash Newsletter.

27th Pugwash Conference

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G.B. Kistiakowsky (USA) XXVII-5

ON THE STRATEGIC ARMS RACE

For 20 years the central objective of Pugwash Conferences -- of their off-the-record discussions and of the public statements -- has been the strengthening of the forces for nuclear peace in ways accessible to the participants. Thus, to cite a few examples from recent years, the statement following the 22-nd Conference in 1972 welcomed the agreements reached in SALT I, but noted that the "measure of their true significance is not yet possible." It urged the elimination of all ABM deployments and the setting of strict limits on tests of strategic weapons subject to monitoring by national means, since ". . . the introduction of new technologies. . . is a primary factor, indeed in the view of many the dominant factor, in the strategic arms race." The statement urged other disarmament steps involving several types of weapons of mass destruction and emphasized the urgency of concluding the Comprehensive Nuclear Test Ban Treaty.

The statement from the next Conference in 1973 appealed against delays in reaching further disarmament measures in view of the rising threat of novel military technologies, which tend to overtake negotiations; it emphasized the importance of major reductions in existing deployments of strategic weapons of the superpowers, perhaps starting with the oldest hence least needed types; it rejected the need for peaceful uses of nuclear explosives as a valid argument against the comprehensive test ban treaty

and made an eloquent plea for the convening of a World Disarmament Conference after an adequate preparation, in which Pugwash offered to participate.

In 1974 the statement from the 24-th Conference reiterated grave concerns about the unhindered continuation of the arms race and gave only a qualified endorsement to the high-threshold underground test ban proposed at the June '74 Moscow Summit. The Conference noted a lack of unanimity of its participants on the economic value of peaceful nuclear explosions in context of its discussions of the urgency of the comprehensive test ban. It emphasized the possibly important contributions that unilateral arms control or disarmament measures, followed by reciprocal responses, could have, and in this connection welcomed the elimination of biological weapons, formalized in the 1972 Convention; it urged speedy progress on a similar comprehensive ban of chemical weapons.

The 26-th, and last, Conference ranged again over many topics. The statement noted that the participants were unable to reach unanimity on several major issues, for example on the need for providing more extensive public information by the countries engaged in disarmament negotiations about their weapons programmes and the extent of their civil defense preparations. The conflict between the insistence on the use of peaceful nuclear explosions and the comprehensive test ban was also not resolved. This problem and the concern about possible continued testing by the non-signatories led to a suggestion to conclude a CTB of only

limited duration, with the opportunity of subsequent revision. Civil Defence preparations were discussed and while some participants felt that these caused too much harm to efforts at disarmament for their low intrinsic value, others pleaded humanitarian aspects of Civil Defence and felt that it could not be a cause of misinterpretation as a part of preparations for a nuclear attack. It was recognized that the SALT-related agreements have failed to stop the qualitative arms race, and among other desirable measures was urged the suspension or banning of the tests of strategic cruise missiles. It was concluded that curbing military research and development is central to halting the nuclear arms race.

This brief listing of some high points in the discussions centered on strategic weapons gives an idea of the range of Pugwash interests in this domain. Of course, the preservation of nuclear peace depends on complex factors of political, military, economic and social character, many beyond the scope of the Pugwash deliberations. Events have taken a turn to the better in recent years, with respect to some of these, as exchanges between USA and USSR in the spirit of détente replaced cold war rhetoric. One hopes that Pugwash discussions have made some constructive contributions to these changes and the various arms control measures agreed to since 1959; at any rate, Pugwash proposals and recommendations frequently antedated in the past equivalent but usually more halting actions by the Goverments concerned.

The present paper is written in the hope of making a small contribution to the continuing Pugwash effort by a frank although

necessarily limited analysis of some forces feeding the nuclear arms race between the superpowers, a review of the present state of the arms race, and suggestions of a few key measures to slow the race. It is a very grim fact of modern life that notwithstanding their oral committments to peace, their solemn undertakings as the signatories to the Non-Proliferation Treaty of 1968 and several agreements of limited scope about arms controls, the superpowers are in an arms race that is in full sway. Besides increasing tensions and suspicions between the superpowers and consuming large resources, this arms race is also the prime stimulus to the world-wide spread of nuclear weapons -- the horizontal proliferation -- which further enhances the probability of a nuclear war. In toto then, the strategic arms race is the greatest threat to nuclear peace and its termination should be a matter of the greatest urgency.

A significant accomplishment of the USA-USSR SALT I Moscow agreement in 1972 was the treaty to limit the deployment of anti-ballistic missile systems (ABM's) to only two sites (later reduced to one each), to refrain from testing and deploying more advanced ABM systems, and from interfering with national technical means of gathering intelligence. It is of course highly debatable whether an effective active defence of extended soft targets, such as population centres, is possible; and if not the feasibility, then certainly the cost-effectiveness of active defence of even only the hard military point targets is in doubt.

In the United States the development of ABM has been underway since the mid-fifties, nurtured politically by intelligence information about such projects in the Soviet Union. By the late sixties the Johnson Administration began the deployment of the "Light" Sentinel ABM, the rationale being defence of population and industry against a limited attack but the deployment was discontinued. It encountered a strong public opposition as a step which some saw as a preparation to fighting a nuclear war. A later proposal by the Nixon Administration to defend instead only the Minuteman ICBM sites was justified by the arguments that Soviet Union's deployment of very large SS-9 type ICBM's then underway meant preparations for a counter-force strike against the Minuteman force. Even this limited deployment was strongly opposed in Congress and passed the Senate by only a single vote. In the Soviet Union meanwhile the build-up of the Moscow ABM defence system seemed to have come to an end, well before its completion. Thus, in neither country were the political forces which pressed for massive ABM deployment fully dominant. The SALT I treaty nevertheless undoubtedly saved both parties the expenditure of large resources that would have been otherwise dedicated to the objective, however elusive, of effective anti-missile defences.

The 1972 ABM treaty might have been of far greater importance had it been an expression of a genuine commitment of both parties to rejection of nuclear war as a totally unacceptable act because of accompanying mass destruction beyond anything witnessed in the

past. By implication the treaty seemed to suggest such a commitment since the self-denial of the ABM defences was tantamount to making the populations of USA and USSR hostages to the massive strategic forces of the two parties. Indeed, under the military conditions existing in 1972 any surprise counterforce attack by one party would leave undamaged most of a retaliatory force of the opponent, enough to allow him to inflict in the absence of ABM defences many times more than what Secretary MacNamara had called unacceptable damage to the populace and the civiliation of the agressor. By inference the treaty thus seemed to recognize that there can be no winner in such a war and hence that engaging in it would be totally irrational. Regrettably, the SALT I contracting parties appear to be taking steps more consistent with the opposite policy -- that of preparing to fight nuclear wars. Mutual deterrence is thereby being destabilized and the threat of war is growing.

Such steps, of course, are not a brand-new phenomenon. About 15 years ago the Kennedy administration, concerned by intelligence data about the expanding civil defence preparations in the Soviet Union, proposed a multi-billion dollar programme of fallout and blast shelters for the civilian population, complete with appropriate food and medical stockpiles, as well as plans for the training of the civilian cadres that would manage these shelters in time of war. Notwithstanding a major media campaign in its favour, the plan was buried by Congress which considered it a futile and dangerous step, not helpful to the preservation of

nuclear peace. The civil defence organization in the United States, in existence since World War II, continued to exist, but also continued to be financed as before on a very low annual level.

Meanwhile intelligence information was accumulating about a very large anti-missile installation, called Galosh by the Western sources, which was being built to protect Moscow. By the mid-sixties the Soviet Union began also a country-wide deployment of numerous new surface-to-air missiles and radars which, as subsequent events showed, were the components of an air defence system. Unfortunately, for a number of years Western information was technically so imprecise as to permit the US Defense Department spokesmen to insist that this system, nicknamed Tallinn, could be rapidly upgraded into a country-wide ABM installation. This "worst case" conclusion raised the spectre that America would be confronted by the Galosh and the Tallinn ABM defences, so extensive that most of the American missile warheads that might survive a Soviet first strike and be launched in retaliation to it would be destroyed in flight, not enough penetrating defences to inflict MacNamara's "unacceptable damage." Expectation of this outcome would end the state of mutual deterrence, they asserted, giving the Soviet Union military superiority.

This scenario, although rejected by more objective analysts in the USA, was unfortunately plausible enough so that it could be cited effectively in support of the proposed development of MIRV's. When deployed, these would multiply the number of warheads that might be delivered in a retaliatory strike, at the cost

of reducing the total "megatonnage" -- the explosive energy -- of strategic warheads. By the time SALT I agreement was signed American MIRV's were already being deployed.

Well before the time of the SALT I agreement the American advocates of arms controls began to stress two harmful aspects of the MIRV project. The more obvious one was that the numerical limits of SALT I on offensive missile launchers were thus being in effect circumvented, so that the strategic offensive forces could continue to grow. The second point, more serious from the point of view of the stability of mutual deterrence, was that each MIRV'ed missile with accurate guidance might destroy more than one missile in silo of the other side. Thus, MIRV development raised the possibility of counterforce tactics and even a surprise counterforce attack became more attractive -- at least in war-gaming. Therefore, MIRV's might destabilize the state of mutual deterrence just as ABM systems might. Perhaps more effectively, since the development of effective counterforce MIRV's is undoubtedly easier than development of effective defence for population and industry centres.

The counterforce purpose of MIRV'ed missiles -- since SALT I had eliminated ABM defences as their justification -- has been promoted publicly by various US Defense Department spokesmen, especially the former Secretary Schlesinger. He has belaboured the concepts of "flexible response," "controlled nuclear war," "limited strikes on hard military targets," etc. perhaps in efforts to reassure our NATO allies that the American "nuclear

sword" was still effective. These uses of MIRV's called for precision guidance and such is under development as MK 12A warheads and MARV. Mr. Schlesinger has also spoken of the desirability of massive civil defence measures in USA as part of preparation to fight "controlled" nuclear wars, but this proposal has fallen on deaf ears, at least up to this point, since the Americans are clearly unwilling to accept measures that are so obviously related to making nuclear war "thinkable."

While Pentagon spokesmen have consistently emphasized that they are not proposing and are not even considering a surprise attack on the Soviet Union, their descriptions of "surgical" strikes on hard targets, etc. have perhaps had the effect and have certainly had the intent of presenting nuclear wars as tolerable to the bystander civilians because, it was said, the casualties among them could be kept relatively low. Thus, the Annual Defense Report for Fiscal Year 1975 asserted that a Soviet missile attack on American ICBM installations would cause "well under a million" civilian deaths. These calculations have been challenged however and upon recalculation led to the finding that an attack strong enough to eliminate most of the American ICBM's would also cause some 15,000,000 civilian deaths or more, mostly by fallout downwind(1).

It would be quite wrong to leave the impression that discussions of ways to fight nuclear wars is limited to the Pentagon and other American sources. The Soviet military literature is replete with discussions of these strategic and tactical problems.

The big distinction arises from the differences in the socio-political nature of the two societies: the American discussions of matters relating to national security spill over into the public domain, in fact are frequently centered there and involve a wide spectrum of vocal opinion from extreme "cold war" hard-liners to advocates of unilateral disarmament. These, sometimes very acrimonious, discussions tend to influence to varying extent the subsequent acts of the American administrations. In contrast, the Soviet presentations and analyses are usually restricted to a limited domestic audience of those with the "need to know," to use an American military expression, or are auth ritative public expositions of governmental policies. Thus, the Marshall of the Soviet Union Sokolovski in his book on military strategy[2] discusses at length problems involved in fighting nuclear wars, noting that while nuclear-tipped missiles will be extensively used, the war will also involve massive land forces. He states that although missile attack is stronger than defence, the central objective of Soviet strategy is the defence by several means against such attack, combined with offensive actions against military targets and the industrial establishment of the enemy; these should be such as to lead to a rapid victory for the Soviet Union. On the whole there is no great difference between the doctrine of this book and that underlying more recent statements of the Pentagon spokesmen to which reference has already been made.

As already mentioned, the SALT I agreements also provided numerical limits for offensive missile launchers, to be in force

for five years. The American forces were limited to the then existing deployments -- 1,000 Minuteman silos and 54 of the much larger Titan ICBM's, as well as 656 launchers in nuclear submarines. The Soviet Union was allowed to complete the deployments then underway, to give it 1,618 land-based hardened launchers in a few years time (not more than 313 of which were to be of the very large size suitable for SS-9 missiles) and 740 launchers in nuclear submarines. Since that time the USA has proceeded apace to MIRV its missiles and the Soviet Union, it is said, has almost completed its launcher building programme and is now engaged in replacing single-warhead missiles with new MIRV'ed types.

The 1974 Vladivostok agreement took a step beyond SALT I by setting for both parties a common upper limit of 2,400 strategic launchers, including bombers, of which 1,320 could be MIRV'ed; at the time of this writing the agreement has not been formalized. As was feared by the sceptics, both sides are building up their forces to the agreed extremely high upper limits. Western sources now attribute to USA nearly 9,000 deployed strategic warheads, largely of fractional megaton explosive energy, and to USSR about 3,500 warheads, heavier and hence probably mostly in the megaton class, so that the total destructive energy in its strategic missile forces is considerably larger than the American total.

Some of the readers of this paper are undoubtedly aware of the intense public campaign by the military and civilian hard-liners in the United States which began in the summer of 1976 through leaks to the press of intelligence information and

inferences which purport to prove that the Soviet Union is engaged in a multifaceted effort to attain military superiority over the United States, to enable it either to dominate the latter politically or, if the United States is not submissive enough, to fight and win a nuclear war with it. The immediate objectives of this public campaign were to force the Carter Administration and the Congress into taking harder attitudes toward arms control agreements and into building up the military forces instead[3].

Central to this campaign, waged both publicly and within the government, are the interpretation or mis-interpretation of intelligence information on the Soviet activities. Unfortunately, there is considerable uncertainty inherent in all such interpretations, based on the analysis of information on past and current Soviet activities, when they involve projections a number of years into the future. If the extreme "worst case" projections are consistently chosen, as the American hard-liners seem to do, a case can be constructed indicating that present Soviet activities foreshadow preparations for a nuclear attack on the United States.

The Soviet Union has been engaged in testing new types (SS-17, SS-18, SS-19) of silo-launched ICBM's with greater throw-weights, with multiple independently targetable warheads and more accurate guidance. When fully deployed in silos that were in existence or being built in 1972 and which are being upgraded, a small fraction of these new ICBM's would suffice, it is asserted, to eliminate in a surprise attack most of the American silo-based ICBM's, those strategic bombers that are on the ground and missile submarines in port.

Even if these pessimistic estimates are accepted, the United States would still retain very many strategic nuclear weapons in submarines at sea, in the bombers on alert status and those (few?) silo-based ICBM's that would survive the surprise attack. Here the other component of the envisaged threat is supposed to enter the picture. It is the Soviet passive defence preparations which, the campaign claims, have been greatly accelerated in the last few years. It is asserted that they comprise numerous hardened facilities such as blast shelters for civilians, command centers, industrial plants and underground grain storage facilities. (It should be noted that in Kansas, USA, where the sub-soil geological formations are very favourable, large subterranean storage depots, some refrigerated, have been excavated and even office space constructed by industrial corporations.)

In addition, an all-embracing plan for the evacuation of civilian population from the main cities of the Soviet Union has been detailed. These preparations and measures, the American hard-liners assert, will reduce the effect of an American retaliatory strike to well below the limit of "unacceptable damage" criterion of MacNamara[4]. When confronted by this prospect and without fighting a war the United States would be forced to acknowledge the politico-military primacy of the Soviet Union.

While the doomsday predictions of this campaign are rejected by thoughtful observers, its revelations and other information have already had some effect on United States policies. There appears to be a growing consensus in Western defence circles that

the sum total of military efforts of the Soviet Union is more consistent with the intent to gain military superiority than with maintaining rough parity, to which oral committments have been made by both parties[5].

It is not possible to neutralize the political effects of the latest American hard-liners' campaign, any more than those of the earlier debates described in this paper, and of the still earlier campaigns about a bomber gap around 1950 and about the missile gap around 1960, solely by presenting factual evidence, because of the closed nature of Soviet Society. Consider as an example the Soviet civil defence programme as described in the open Soviet manuals which, in the interpretation of the American hard-liners, signifies advanced preparations to fight a nuclear war. According to their evaluation, these preparations, including evacuation plans, could be just as meaningful and as destabilizing to the state of mutual deterrence as a country-wide deployment of sophisticated anti-missile defences.

If one takes the trouble to inquire into the status of American civil defence one finds that its manuals claim the availability of fall-out shelters (usually the cellars of multi-story buildings) to more than 180 million Americans and list mines as possible blast shelters. But one need not engage in elaborate intelligence activities, in fact one needs but a short sojourn in American cities, to discover that the populace, except for the small civil defence officialdom, is totally uninvolved in these preparations so that it would require a lengthy and highly visible organizational

and educational effort by the US government to change significantly the present state of civilian unpreparedness.

The civil defence manuals of the Soviet Union seem to describe a state of even more advanced preparedness than those of USA, created by an organization which is commanded by an all-Union staff[2]. Does this description signify that the entire population has already been physically and mentally enrolled, so that an emergency plan could be instantly put into effect on an order from above or is the real situation not so very different from that in the United States in that it does not affect what constitutes unacceptable damage to the Soviet Union? Some American analysts conclude this[6] but the hard-line advocates maintain that the Soviet Civil Defence threatens the security of the United States (see reference 4). This question is of obvious importance to American military planners and, indeed, to all Americans who are concerned about defence matters and Soviet-American relations. It has no easy answer unless one accepts on face value the assurances of several authoritative Soviet spokesmen that their civil defence represents no threat to the USA. To get more substantive evidence is difficult since the actualities of civil defence are treated as confidential by the Soviet Union. Thus, the issue of civil preparedness causes suspicion and fears in hard-liner circles in America, no less than the provocative public remarks about counter-strikes, etc. by Pentagon officials and other such speeches by American hard-liners have caused in the Soviet Union.

I have discussed these past events and their inter-connections at some length because Academician Arbatov, reviewing the same fragment of history, as well as other issues, unrelated to Pugwash, of peaceful coexistence or detente, in an interesting article[7] puts the responsibility for the nuclear arms race bluntly on the United States. I must admit that he is essentially correct in assigning the initiative for most technological innovations, that is the start of new weapons systems, which keep the arms race percolating, to the United States (Marshall Sokolovsky, reference 2, has a different view of this), but Arbatov fails to carry his analysis for enough to recognize that these arms race-provoking actions were mostly induced by, or at least made much more difficult to oppose by, the assymetry in the scope of the outward flow of information about the activities and plans of the United States and the Soviet Union.

On one side, the reading of open semi-technical periodicals such as the Aviation Week, of the reports on Congressional Committee hearings, of the annual Posture Statement of the Defense Department, etc. gives the Soviet analysts not only an accurate knowledge of what the American forces are currently, but also what they will be in a few years time. On the other side, substantial intelligence efforts are needed to gain merely accurate estimates of current military capabilities of the Soviet Union, whereas the projection of the rates of production of new tanks and missiles and aircraft into the future, their expected performance, and the intentions behind these plans largely remain

in the domain of value judgements, hence invite a wide range of estimates, the worst possibility being usually such as to call for the taking of prudent anticipatory measures, i.e., new military R&D projects. This American reaction, considering the stimulus, does not differ substantially from that of any other country in similar circumstances.

Unfortunately, neither the lack of openness of Soviet Society nor the opportunities for mischief offered to American hard-liners by our open society are likely to alter soon, and this fact painfully dampens one's hopes for an early end to the arms race. This whole argument about who is responsible for the arms race is like that about which came first, the chicken or the egg. Without claiming any theological expertise I suggest that they were created at about the same time.

Where is the strategic arms race now? Both sides have stated that they have reached rough parity. Thus, the Soviet Union has now almost the maximum number of missile launchers it may deploy under the SALT I agreement; the United States still has all it had. Neither party has MIRV'ed all the 1,320 units it was allotted, but this process is continuing and the Soviet deployment of the SS-18 ICBM's with their large, numerous and accurate independently targeted warheads especially troubles the American side.

The Soviet Union is developing a very long-range submarine-launched missile and so is the United States, which is also building the giant Trident submarines to replace Polaris and to house these missiles. In addition to several new types of

silo-launched ICBM's, the Soviet Union is also testing (and deploying?) a land-mobile missile of intermediate range (SS-20). This is not a strategic weapon system according to the criteria accepted at SALT I, but it is troublesome because the addition of a third rocket stage would permit inter-continental range to be achieved, according to American sources. Thus, satellite intelligence would not distinguish SS-20 from a mobile ICBM. In response to the deployment of SS-18 the development of a mobile version of an improved and larger Minuteman ICBM, MX, has been started in America. It should be noted that an American unilateral interpretation of the SALT I agreement on offensive systems excludes the deployment of land-mobile ICBM's as not susceptible to quantitative numerical verification by the "national technical means."

The Soviet Union has begun deploying a new long-range bomber, Backfire in Western designation, which it regards as a tactical weapon system, while the American analysts attribute to it an inter-continental range with a nuclear bomb load if in-flight refueling is resorted to, and therefore they want to count it as a strategic launcher[8]. The United States has already built several test models of its new strategic bomber, B-1, but its huge cost and doubtful cost-effectiveness make questionable its future as a replacement for the B-52.

Last but certainly not least in this catalogue of major new strategic weapon systems about which substantial information is openly available are the modern versions of aerodynamic guided

missiles, the several models of subsonic cruise missiles being developed in the United States. Their distinctive new features are the relatively fuel-efficient turbo-jet and turbo-fan engines and sophisticated guidance systems that will enable them to fly long distances at very low altitudes and yet to strike their predetermined targets with high accuracy. In company with the strategic bombers, the future long range cruise missiles, being slow, pose no threat as a counter-force weapon but the completion of their development means the end to numerical monitoring of strategic forces by national means, since the cruise missiles like the land-mobile ballistic missiles will be virtually non-identifiable by satellites. The anticipated relatively low cost of cruise missiles means that they may be deployed in very large numbers. Being small and adaptable to launch from various stationary and mobile platforms they clearly will not be subject to count by "national technical means" of surveillance. Finally, the same adaptability to various launch platforms means that cruise missiles of considerably less than inter-continental range and not using strategic launchers might be used as strategic weapons. The distinction between strategic and tactical weapons systems thus might be washed out.

Confronted with these several grim perspectives and with the ineffectiveness of the past arms control measures, what realistic steps and measures among many theoretically possible ones should Pugwash urge in the public statement after its 1977 Conference and for which its members would hopefully lobby thereafter?

Clearly the superpowers must be urged to reach speedily an agreement on the numerical limits of offensive strategic arms and without delay proceed to negotiate a schedule of reductions in these numbers.

However, with several other Pugwash members I have believed and asserted for some time that numerical limitations alone, without effective restrictions on qualitative changes, i.e., on the introduction of new technologies, are ineffective in dampening the arms race. What happened to this race in the last few years only strengthens such conviction. Therefore, it is a welcome sign that the Government leaders of both the Soviet Union and the United States have on several recent occasions publicly recognized the importance of qualitative limitations.

A matter of central importance -- because it affects most of the new nuclear weapon systems -- is the conclusion of a Comprehensive Nuclear Test Ban Treaty which needs to be a multilateral treaty but must be initiated by the superpowers. Seismic detection has advanced so far now that while a single small underground nuclear test may escape identification, no militarily meaningful programme could do so. Nor could a non-weapons state be sure that its first and necessarily low-technology nuclear explosive device would have a small enough yield to escape positive identification. Because of several considerations and especially the threat of nuclear proliferation any propositions for a test ban that permits underground testing below some threshold should be

firmly rejected; such a treaty will do little to slow the arms race but instead will further delay the comprehensive ban.

Two main objections have been advanced publicly against the comprehensive ban. One is that the two countries which refused to sign the partial test ban of 1963, namely the People's Republic of China and France, may continue to test nuclear devices and hence dangerously advance their weapons technology instead of joining the Test Ban Treaty. There are several options for dealing with this problem, one being a clause in the treaty explicitly noting that continuing testing by non-signatories may be regarded as justification for the withdrawal from the treaty by one or more of the signatories on the grounds of a threat to their supreme national security interests.

The other obstacle to the CTB Treaty has been the desire to use nuclear explosives for peaceful purposes (PNE's) which years ago was raised by the United States but is now promoted by the Soviet Union as economically important. As has been seen in the example of India, the PNE's can be the formal justification for the development of nuclear explosives. At the last Pugwash Conference it was proposed therefore that the CTB Treaty exclude PNE's but be of only limited duration, the problem of PNE's being thus postponed for a few years when the CTB would come for renewal. Another alternative is for the CTB signatory weapons-states, including the superpowers, to accept for themselves the same restrictions regarding the PNE's as are imposed by the Non-Proliferation Treaty on the non-weapons signatory states. In

other words if, for instance, the United States were to decide to have one or more peaceful nuclear explosions it would contract with another weapons state, for instance with the Soviet Union, for the guarded delivery of a "black box" of specified dimensions containing an explosive device with a specified range of yields. The "black box" would then be emplaced, still under supervision of guards from the country of its origin and then the device would be exploded. Clearly, the details of guarding and of compensation need to be delineated more than could be done here but they do not seem to present insurmountable obstacles. The adoption of such a procedure would totally eliminate the possibility of using PNE's for advancing weapons technology and at the same time eliminate a major irritant felt by the non-weapons signatories of the NPT against the weapons states.

It is unfortunately wholly unrealistic to expect that SALT II or III agreements will lead to a complete cessation of the qualitative nuclear arms race, and the best one can hope for in the near future is the elimination of its most troublesome aspects. The prime target for elimination should be those systems or subsystems which encourage counter-force strategic planning. To this class belong the MIRV'ed ICBM's with precision guidance, and an agreement to cease their testing is a truly urgent need.

The deployment of weapon systems which cannot be adequately counted by national technical verification means threatens the very substance of SALT accords and must be prevented. In the first instance this means land-mobile ICBM's. Hence their field testing must not be undertaken or must cease by explicit agreement.

Very complex issues are presented by the cruise missiles, which, it seems, have already been inconclusively discussed in SALT I in 1975. The cruise missiles which are of tactical range are outside the scope of SALT but the testing of strategic range (i.e., turbo-fan engine equipped) cruise missiles can not be adequately monitored by "national means" and their subsequent deployment even less so. Furthermore, as already noted, cruise missiles of less than transcontinental range can be so deployed as to be a part of the strategic arsenal. The cruise missiles however are regarded by American Defense circles as the surest response to that drive for military superiority in which, they believe, the Soviet Union is engaged and therefore their elimination will be most strongly resisted.

In a different way the Backfire bomber problem is also not a simple one, since the deployment of Backfire for use on the Eurasian continent is outside the framework of the SALT agreements, but when it is considered as a transcontinental bomber over the North American continent it becomes a major addition to the Soviet strategic arsenal in view of relatively weak air defences it would encounter. Here some understandings about its deployment and especially about the availability of inflight refueling aircraft, are clearly called for unless all such bombers be counted as a strategic force.

One can go on considering further strategic offspring of new technologies but the usefulness of delving here into more

distant problems is very much in doubt. This Pugwash Conference, I am convinced, can achieve the most for the preservation of peace by urging the superpowers to reach agreements on the main issues: (a) the avoidance of further numerical expansion of strategic forces and a start on their reduction; (b) the agreement on the comprehensive nuclear test ban and (c) an application of brakes to the introduction of new or improved weapon systems, eliminating those designed for counter force strategy and those not subject to adequate monitoring by national technical means. If these agreements are achieved a great step forward will have been taken.

March, 1977
Cambridge, Massachusetts

REFERENCES

(1) See for instance testimony of Sidney D. Drell before the Senate Committee on Foreign Relations, January 19, 1977.

(2) Military Strategy, by Marshall of the Soviet Union V.D. Sokolovski and collaborators; 3-d edition; Moscow, 1968.

(3) For instance, summary articles by David Binder in New York Times, December 26, 1976 and January 3, 1977. Also John W. Finney, Ibid., February 6, 1977.

(4) D. Binder, New York Times, January 3, 1977. Interview with ex-chief of US Air Force intelligence.

(5) For instance the 1976 military review of the (London) Institute of Strategic Studies; also David Broder, New York Times, March 17, 1977 re Senate testimony by the director of the (American) Defense Intelligence Agency.

(6) Report by the Joint Committee on Defense Production; Civil Preparedness Review, Part 2. US Congress, March 1977; also Federation American Scientists, Public Interest Report, February, 1977; also reference (1).

(7) G.A. Arbatov in Pravda, a January, 1977 issue, and an updated version in the March, 1977 issue of the Bulletin of Atomic Scientists.

(8) Thus Admiral Moorer, the former Chairman of the Joint Chiefs, writing of the Backfire bomber stated that it: "... is superior to the B-52 and which only the B-1 could surpass." New York Times, March 15, 1977.

This document has been specially prepared by Professor Gutteridge as convener of Working Group 2. It is intended to serve as a basis for discussion by the Working Group in Munich, and for working papers submitted by participants. The latter should not exceed 10 double-spaced typewritten pages, plus a 250 word abstract for possible publication in the Pugwash Newsletter.

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W. F. Gutteridge (U.K.) XXVII-1

ARMS CONTROL AND DISARMAMENT - THE NON-NUCLEAR FIELD

During the last decade and a half a number of suggestions have been made for furthering the causes of arms control and disarmament. Some of the proposals have been ingenious, others technically intricate, and some simply based on practical commonsense, but the sum total of achievement has been relatively and disappointingly small. The inevitable conclusion from this is that there has been a lack of firm political will on all sides. Attempts have been made to place the responsibility firmly upon the nuclear powers for failing to take effective steps towards nuclear disarmament and the substantial reduction of nuclear weapons. To their failure has not only been attributed further nuclear proliferation but a lack of response to arms control and disarmament initiatives in other fields. Though they must clearly bear some responsibility for the general disappointment, not to say disillusionment, it is not reasonable for other countries to off-load their responsibility in this way.

A very important factor has been the failure to mobilize public opinion as well as to educate it on matters of disarmament. What may seem to be an attractive cause has not developed the expected political appeal. The reasons for this in turn are fairly obvious. There are psychological barriers which stem partly from ideological roots and hinder further progress. They contribute on all

sides to the failure to see and understand the points of view and motivations of other people, and by this means tensions and perceptions of threat are created and enhanced. The purpose of this paper is to review briefly some of the problems which have recurred regularly at Pugwash conferences over the last five years, to make some suggestions for their future development and possible solution and to indicate one or two areas where fresh initiatives might serve to create a favourable climate.

1. The Arms Trade in Conventional Weapons

The fact that the range and sophistication of conventional weapons is continually extending has been frequently confirmed. The arms trade is assuming more and more a commercial aspect with competition developing even to supply countries which clearly have no specific military needs. In a number of parts of the world technological, economic, and political factors, are converging to sustain rising arms levels, for which purchasers, as well as suppliers, must bear a responsibility. The question of some U.N. arms accounting system, enabling a ready review of arms acquisition and stockpiling, still remains largely unexplored, as does the possibility of devising an international code of conduct on the transfer of military equipment and devices. A recent Pugwash symposium has looked at some of the economic and social effects of new weapon systems when they are transferred, in particular to developing countries. A full knowledge of their consequences might have a restraining effect on purchases and lead conceivably to regional initiatives by groups of potential arms recipients.

2. Military Research and Development

The extent to which military research and development provides the dynamic force behind the development of new weapon systems and their rendering into commercial propositions is now scarcely in dispute. Tentative initiatives have been taken, notably in the United States, to consider at least the impact of new weapons programmes on the prospects for arms control, and may be worth supporting. There has also been a suggestion that the major arms suppliers should meet to agree on a limit to the levels of arms sales which they would be involved in over a period of time. The possibility of this on a worldwide or regional basis is worth investigation.

3. Force Reductions

It is apparent for all to see that the Vienna MFR talks have made little real progress, largely because of disagreements about the principles behind the conference. Technical problems relating to the balance of East/West military forces and their dispositions in Europe have been allowed to stand in the way of favourable developments. The argument that these have been prevented because of failure to exchange adequate information, is scarcely valid, since there is little prospect of equating exactly the different forces based in different localities, which are at the disposal of the two military blocs. Here, as elsewhere, military negotiations have not developed as they should because of lack of a clear political determination to find a solution, which is particularly urgent in Europe in the light of

the development of new weapons and strategic doctrines, on the part of both NATO and the Warsaw Pact. Some political steps towards the breaking down of sentiments of distrust are clearly desirable in Europe in order to provide the climate for arms limitation agreements. Successful progress in Europe, involving the majority of the world's major military powers, would be conducive to encouraging powers in the other part of the world to follow their example. The continuation of the MFR talks is not enough in itself even though they, in their own right, may indicate the unlikelihood of a major conflict breaking out on the continent.

It may be that in the European case the time has come, because of the massive stocks of weapons at the disposal of each of the major parties, for unilateral arms control and disarmament initiatives. It is possible that only in this way will the wall of distrust be breached and the way opened to a comprehensive and agreed disarmament or at least a force reduction plan. However, the mobilization of public opinion in favour of disarmament would be, for the country which took the initiative, a major task. It needs to be borne in mind that security is not exclusively a military concept. It has political, economic, historical, social and psychological aspects, and the development of co-operation in other fields, as stated at Helsinki, and which will presumably be further endorsed at the Belgrade conference this year, has a considerable part to play in improving the political climate and thus making more acceptable in national terms reductions in armaments or armed forces.

4. Special Military Problems

The urgent need for a ban on chemical weapons remains: progress has been slow even though there is the 1972 Convention on Biological Weapons as a model to follow. The urgency of the ban is, as has been said on previous occasions, convincingly illustrated by the development of the so-called binary weapons, which will very likely begin a new phase in the arms race in this field. It is this kind of development which makes necessary a far-sighted vision of the dangers which will inevitably arise without measures for arms control and disarmament if completely new military threats are not to be allowed to develop. It is precisely because the military applications of weather, climate, and other forms of geophysical modification have apparently not yet reached the stage where they could readily be used in war that action needs to be taken to achieve an effective restraint upon them. The capacity of modern warfare by other means to cause enormous ecological damage has already been demonstrated.

5. New Initiatives

It is evident that the prospects for arms control and disarmament would be better if there were throughout the world bodies of public opinion which perceived practical advantages of self-interest stemming from collaboration between countries to these ends. One reason why governments appear to have lacked the political will is that they have not in fact been subject to appropriate popular influences and pressures, partly because the direct advantages of reductions in expenditure and arms and in the size of military forces are not always easily perceived. In countries

where the armaments industry makes a major contribution to the economy the possibilities of a swift conversion programme to the satisfaction of peaceful social needs requires to be investigated and publicized. The prospect of large scale unemployment is not conducive to the development of peaceful attitudes on the part of populations: the problem of conversion applies not only to manufacturing plant but to trained personnel, scientists and technologists of all kinds however employed. There are, however, few countries in the world without major internal social and economic tasks to which they could be readily diverted, but from the standpoint of a Pugwash conference it is particularly important that the possibility of the diversion of resources (at present appropriated to the military) to the resolution of major world problems in the field of development should be fostered.

An interim step in the application of military resources to humane purposes might well be the development of international, regional, and local disaster forces based on military skills and equipment to cope with the wide range of national disasters which seem to be increasingly a problem in many parts of the world. There are also man-made disasters arising from explosions, fires, and toxic pollution on an increasing scale to the control of which military resources might be applied. Such measures would be most effective if there could, as a preliminary, be a freezing of military budgets at present levels. Such a step would not only prevent a further diversion of resources away from desirable social applications but would, because of the increasing cost of new weapons actually, and quite quickly, institute a process of arms limitation.

27th Pugwash Conference

Munich, Federal Republic of Germany, 24-29 August 1977

M.A. Markov (USSR)

XXVII-6

HAVE WE LEARNT TO THINK IN A NEW WAY?

"Learning to think in a new way" to preserve life on our planet is the motto of the historic Russell-Einstein Manifesto to mankind.

The words of the Manifesto were first heard 20 years ago, when top scientists from many countries got together in Pugwash, a small fishing village in Canada.

"We have to learn to think in a new way. We have to learn to ask ourselves, not what steps can be taken to give military victory to whatever group we prefer, for there no longer are such steps*; the question we have to ask ourselves is: what steps can be taken to prevent a military contest of which the issue must be disastrous to all parties?"

Have we learnt to think in a new way?

"We are speaking on this occasion, not as members of this or that nation, continent, or creed, but as human being, members of the species Man, whose continued existence is in doubt."

Have we learnt to think in a new way as human beings?

"Most of us are not neutral in feeling, but as human beings, we have to remember that, if the issues between East and West are to be decided in any manner that can give any possible satisfaction to anybody, whether Communist or anti-Communist, whether Asian or European or American, whether White or Black, then these issues must not be decided by war.* We should wish this to be understood, both in the East and in the West."

"These issues must not be decided by war."* Has the world understood that?

"There lies before us, if we choose, continual progress in happiness, knowledge, and wisdom. Shall we, instead, choose death, because we cannot forget our quarrels? We appeal, as human beings, to human beings: remember your humanity, and forget the rest.* If you can do so, the way lies open to a new Paradise; if you cannot, there lies before you the risk of universal death."

Have we been able to do so?

Do we forget about much of "the rest" in our efforts to resolve the main task: to make impossible the Third World War?

Have we learnt to think in a new way?

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* Emphasis added.

An analysis of international developments over the past decade reveals that we have been successful when we have thought in a new way as "members of the species Man", but we have suffered defeat when we have been unable to think in a new way and follow the methodological principles of the Manifesto, which formulates the idea of détente in a different language.

As regards the solution of the main task - making war impossible - the answer is, regrettably, negative. Not only have we not learnt to think in a new way, but sometimes we seem to have unlearnt to think altogether.

The arms race is continuing and even accelerating, contrary to all logic!

It would be wrong, however, to assert that the past twenty years saw no real steps along the "road to peace". The presumptuous pessimism of such a statement would foreclose the road to a reasonable future.

Let us look back on recent history.

Have we forgotten that intensive nuclear tests in the atmosphere, outer space and the sea threatened life on the planet long before nuclear conflict was possible?

Have we forgotten the declaration of 9,235 scientists, presented by Linus Pauling to the U.N. Secretary-General on January 13, 1958 warning of the grave danger of radioactive contamination by atomic tests?

As a result of multilateral agreements that grave danger for all things living has been essentially eliminated.*

This is but one positive result of international negotiations which go a long way to change the international climate. Here reason was prevailing.

A number of bilateral and multilateral agreements have been signed which have improved the international relations.

From the Helsinki meeting of the leaders of 35 states, the most representative forum ever in world history, there emerged a protocol formulating an agreed assessment of many aspects of our present and key tasks of the near future. Here reason was prevailing.

These are some concrete advances along the road to peace.

We are entering the fourth post-war decade. Let it be recalled that less than twenty years separated the first and second world wars. One can point to real steps along the road to peace taken when reason has prevailed, when we have been able to think in a new way.

Have we (in the broad sense) not behaved like members of the species Man when we agreed to ban atmospheric nuclear tests?

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* All the nuclear powers except China have stopped nuclear tests in the atmosphere, outer space and the sea.

Should we bow to presumptuous pessimism in the assessment of the existing international agreements forgetting their real historical role?*

Through a series of international efforts the threat of a nuclear war has receded.**

Here, too, reason has prevailed.

On the other hand, the material war preparations, far from ending, are being vastly intensified. According to the Stockholm International Peace Research Institute, the arms race annually devours 300,000 million dollars. Without a war the world lives according to war-time budgets. About half of all the Earth's scientists and engineers are involved in the death industry.

New concrete examples of this terrible process have appeared which the founders of the Pugwash Movement did not know. This faces the movement of scientists with new challenges.

Scientific and technological progress, like a genie let out of the bottle, in its imminent development in the field of possible applications, tends at crucial points to be ahead of possible concrete political solutions, leading to long delays in vitally needed agreements (as evidenced by the Geneva talks on limiting strategic offensive weapons):

(a) There has been enormous progress in the qualitative improvement of both nuclear and

(b) conventional weapons, which become increasingly "unconventional" (laser infra-red missile guidance, guns firing up to 1,000 shots per minute, etc.).

(c) There is a danger of scientific and technological progress being used to develop new types of weapons of mass destruction.

(d) New problems arise in connection with the proliferation of nuclear weapons and the substantial simplification of their manufacture.

(e) There is a growing risk of an accidental and unintentioned outbreak of a world war; improvement in the automation of launching mechanisms of modern

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* Albert Schweitzer, the famous humanist, wrote at the time about the significance of the Soviet Union's decision to stop nuclear tests. If Great Britain and the United States could come to the same reasonable solution, he wrote, mankind would be relieved of fear. It is instructive to recall the history of man's liberation from fear to appreciate better the importance of agreements reached.

** As witnessed by U.N. documents (the United Nations and Disarmament 1970-1975). The USSR claims the main credit for these proposals.

war technology makes it possible for a world holocaust to reach a point of no return within seconds.

(f) A new and sinister danger stems from the fact that a disaster can be triggered not only by irresponsibility of government leaders, but also by evil designs of gangster groups or individuals, or simply psychic derangement of the people who have their finger on the "pushbutton". There are more and more people who have their finger on the "pushbutton" as autonomous nuclear weapons systems are placed on bases scattered virtually all over the planet.

There was nothing like it in the early years after the development of the weapon.

In listing new phenomena in the world since the Manifesto, one must mention the rapid process of decolonization as a result of which a large number of new states emerged on the world arena; this gave rise to new problems unknown in the past which claim our attention. The Third World of non-aligned states is playing a growing international role.

Most important, the recent years have seen a new phenomenon which the authors of the Manifesto desired, but could not see, because it could not be realized at the time. This new phenomenon is détente.

The Manifesto came at the time of the Cold War which made direct peaceful dialogue between opposing sides impossible.

One of the main tasks along the road to peace* that faced the authors of the Manifesto was to make possible the beginning of a dialogue between East and West. At the time it seemed impossible to start such a dialogue without the mediation of third countries, for example India.*

The process of détente has permitted to start a direct dialogue between East and West, in other words, to realize what the authors of the Manifesto could only dream of. If the dialogue is to succeed in resolving the main problem to which the Manifesto is devoted, the most important thing now is not to allow ourselves to be distracted from the main behests of the Manifesto by the relative trivia of "all the rest".**

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* Bertrand Russell, "The Road to Peace", 1958

** Willy Brandt's fears, that the forthcoming Helsinki follow-up forum in Belgrade could be ineffective if reduced to mutual recriminations and charges of not observing the Helsinki accord, is essentially a fear that in the main the forum would turn out to be, not a forum of members of the species Man, to use the words of the Manifesto, but, say, a speculative exchange at which certain groups would haggle to obtain concessions.

Another new phenomenon which emerged in the last twenty years is the fact that the problem of disarmament has, in spite of everything, become the concrete subject of international talks.

The question suggests itself, is there still an area of activity for the Pugwash Movement whose initial task it has been to bring about inter-state talks and agreements, which are at present the concern of governments often enlisting the services of qualified scientists?

There are doubtless many specific problems on which scientists could say something new, something no one has said before. Yet, the main task in the solution of the global problems is to contribute to translating into life the message of the Manifesto. The only road to Man's survival is the road of negotiations in which the partners act as members of the species Man whose survival is at stake. And to "forget the rest".

An analysis of many of our setbacks in the quest for peace shows that they are very often attributable to "the rest". We have been unable to "forget the rest". As conceived in the Manifesto, "forgetting the rest" does not imply convergence and elimination of existing differences in ideology and social systems.

Mankind, if it escapes destruction which threatens it, will have its own history which will develop according to its inherent laws. Forgetting the rest does not mean forgetting all ideological and social differences existing in the world. The greatest minds in the history of our science, the authors of the Manifesto, call on us to "forget the rest" in talks and agreements aimed at avoiding the destruction of mankind, a threat that is becoming more and more real.

"All the rest" cannot be ignored, and it cannot be discussed as we move on our parallel courses along the road to peace. However, it should not impede our progress along the main road to peace.

Was the historical agreement on ending atmospheric nuclear tests logically impeded by the existing differences of social systems and ideology, i.e. "all the rest"?

"The rest" will inevitably be discussed and is being discussed. "The rest" inevitably accompanies us along the road to peace, but this movement must proceed along, so to say, parallel routes. It should not obstruct the General Movement to peace along a road signposted for members of the species Man.

It is the task of the Pugwash Movement to contribute actively to the implementation of the Manifesto. It must be said that not only responsible political leaders who direct the policies of states, but also the world public opinion, including scientific opinion, have yet to assimilate fully the ideas of the Manifesto.

More often than not, organizational initiatives of scientists in the past decade ran along auxiliary roads to peace. This period has seen few major initiatives of scientists, in particular the Pugwah Movement (for example, appeals to the U.N., heads of government and the world public opinion) inspired by the spirit of the Manifesto and speaking as "members of the species Man".

The main task then is to restore to the Pugwah Movement the character of universality and unity which forms the main content of the Manifesto, the character that makes the Movement significant and unique.

THE MANIFESTO AND THE ARMS RACE

One of the Manifesto's main points of departure can be briefly summed up in the following words:

There can be no winners in a Third world war.

Therefore, "we have to learn to ask ourselves not what steps can be taken to give military victory to whatever group we prefer, for there are no longer such steps" (Manifesto).

The question is, has this proposition now become out of date? And is this proposition of the Manifesto generally accepted at the present time?

But if this proposition is accepted then what is its significance in the present unprecedented arms race?

Digressing from the sociological, economic and several other aspects of the arms race it is expedient to ask, what are the motives for the purely military character of the arms race, what purely military considerations could lie at the basis of this point?

Evidently there is one reason: military strategists hope to gain purely military advantages; advantages which could promise military-technical progress.

But scientific and technological progress is nonpartisan, it serves any opposing side in the same way. And it is no secret that these sides carefully follow each other's "successes".

But the sides' material resources and scientific and technological possibilities are such that as soon as military advantages arise they are quickly lost. Thus the purely military point of the arms race is lost.

a. "First strike" strategy

But all the same, there are ideas of a purely military nature in achieving advantages in a possible military clash. What we are talking about is the "first strike" strategy.

One of the greatest temptations for military strategists is to achieve a decisive victory through a "blitzkrieg".

The conclusion is that this temptation ceases to be a temptation when an upper ceiling of military preparations has been reached whereby, in chess language, in such a situation it is not possible for "white to open and win".

In other words, as we advance towards complete disarmament, obviously, such a level of military preparations exist that the idea of a blitzkrieg is precluded. Perhaps a discussion should be initiated of such a specific stage as a definite stage in the process of universal and complete disarmament. The impossibility of a blitzkrieg, and the prospects of a drawn-out war demand other conditions for the unleashing of a military conflict. They demand global war preparations of the entire country or groups of countries.

b. The possibility of global war preparations

The possibility of a protracted war demands that armament be at a high technical level and the creation of a psychological climate, so to speak, of "military enthusiasm", or to put it simply, war hysteria.

Our history has already seen such zig zags and our future is not guaranteed against them if the arms race continues and if the chance of military détente is ruled out.

"I feel crushed", wrote Romain Rolland in his Swiss diary before the first world war. "I would like to die. It is terrible to live among this crazy humanity and to see the bankruptcy of civilization, feeling my own impotence. The greatest catastrophe in the history of the world for centuries - the ruin of our greatest hopes for the brotherhood of man."

At that time Romain Rolland could not imagine that an even greater catastrophe lay in wait two decades hence.

History has shown such an organization of mass insanity - this insanity is called nationalism and great-power chauvinism.

Albert Schweitzer apparently posed the rhetorical question, "What is nationalism?" and answered, "It is vile patriotism taken to a senseless degree and relating to its healthy and noble variety in the same way that the obsession of an idiot relates to normal human conviction."

Examples from the past are a warning to mankind. Mankind must keep a vigilant eye even on slight manifestations of this illness. History has shown us that nationalism is a disease of epidemic proportions.

In appropriate conditions epidemics arise and spread with terrifying speed. The idea of nationalism, and great-power chauvinism is the antithesis of the

basic tenet of the Manifesto which regards the problem of preserving life on earth from the viewpoint of the common interests of mankind.

Now it seems that future history is unlikely to repeat such a disaster, but, unfortunately, these historical zig zags are possible and, as past experience shows, cannot be foretold.

The world recently observed the thirtieth anniversary of the end of World War Two. In other words, that part of the world's population between the ages of 35 and 40 who hardly or do not at all recall living through the nightmare experience of the war years, is coming to dominate our planet. These people if they do not now completely determine its political climate will do so in the near future. Therefore, it is necessary to recall and remember the history of the last war, how it arose, the possible psychological climate, and the accompanying mass war hysteria. The lessons of the last war are very instructive.

c. The Pugwash Movement and the danger of military pacifism

With the invention of the machine gun many considered that war had become impossible and absurd, because the threat of destructive weapons, weapons of mass destruction, had become enormous. But this threat did not prevent wars breaking out.

Nobel, the inventor of dynamite, thought that the destructive power of the new weapon would make it impossible for a war to start. But wars broke out, despite the growth, if one can say, of the "coefficient of mass destruction" in the course of military conflicts.

With the appearance of the unusual, nuclear weapon, and with the threat of global destruction of life on earth, arose the realization that the use of this weapon was tantamount to self-destruction.

It seemed that the unusual nature of the weapon itself contained the impossibility of its use. However, this type of weapon is now being "improved".

It is a question of perfecting the targetability of the nuclear warhead launched from anywhere on earth. This leads to the temptation to assert that atomic weapons can be aimed at the destruction of military objects alone without harming civilians. Thus, from being the most inhuman weapon it somehow becomes the most "humanitarian" weapon, if one can use such inappropriate terminology. The well known idea about miniaturizing nuclear weapons and creating the so called clean-bomb completes the picture of mankind's "wellbeing" in a future war.

The duty of scientists is to warn the world about this god of war donning the mask of a pacifist, and to warn about the military strategists' temptation to unleash a preventive war for "humanistic" ends.

The history of war shows that wars of the past and present centuries each time become more and more cruel and more global.

The "gentlemanly" practice of declaring war has long since become a thing of the past: now war is begun with a surprise global attack.

Once more we hear the words of warning from the Manifesto, we must not hope "that perhaps war may be allowed to continue provided modern weapons are prohibited." A third world war, if it breaks out, will inevitably become global.* And in the process of the intense search for a new super weapon (we, unfortunately, believe in science though I would not like to use the word "unfortunately"), such a weapon may be created and it could turn out to be even more terrible.

The task of the scientists is to convince government leaders that it is possible for a previously unknown weapon of mass destruction to appear. The history of war shows that in the process of war it always has and always does appear in an unforeseen form (gas and tanks in W.W.I. and the nuclear weapons in W.W.II.).

d. The spread of nuclear weapons and the prevention of an unauthorized, accidental outbreak of nuclear war

The initiators of the Pugwash Manifesto also had no knowledge of this problem, the formidable danger of which is constantly growing.

"Jinn" was released from the bottle, and it only remains for us to search for different forms of limiting its spread and preventing its aggressiveness. The danger is that an accumulation of plutonium can take place in reactors designed for generating nuclear energy for peaceful purposes.

Once again we are faced with a global problem, which must be decided in the way recommended by the Manifesto.

The situation is such that the industrially developed countries selling reactors and fuel to other countries must, in the first place, in their conditions of sale, be guarantors of nuclear security. But would it not be expedient also to think about organizing a supreme global inspectorate, for example, within the framework of IAEA with extensive overall powers of control enabling checks to be made in particular of new reserves of plutonium.

The arms race, the spread of nuclear weapons, and the easier production of these weapons all increase the danger of an accidental, unauthorized outbreak of

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* No ban on individual types of weapons and no agreement limiting the general threat of war can reliably defend mankind. (J. Rotblat, History of the Pugwash Conferences. 1962, pp.60-64).

world holocaust. Several inter-state agreements exist on the prevention of various types of accidental, unauthorized outbreaks of nuclear war. Public opinion is naturally worried over the adequacy of these agreements for guarding against the possibility of the accidental appearance of a nuclear missile over the territory of another nuclear power. Should it not be considered expedient to discuss in the academic sphere all the, admittedly, numerous possibilities for such unauthorized nuclear event? This is also one of the global problems which can be decided in the way recommended by the Manifesto.

THE PUGWASH MOVEMENT AND THE PROBLEM OF GENERAL AND COMPLETE DISARMAMENT

Peoples and states are in practice left to "co-exist" according to the ancient slogan "If you want peace prepare for war" (Si vis pacem para bellum).

In its modern form one can discern an attempt to make out that this slogan is a recipe for peace on earth.

"Containment by mutual fear". And thus, inter-state and international relations in the civilized world at the end of the twentieth century have to be based on relations copied from animals devoid of human intelligence. Moreover, even when this animal principle is realized, it is replaced by the slogan (si vis pacem para bellum) which logically is not even connected with the doctrine of "containment by mutual fear". "Containment by mutual fear" is possible at any level of balanced arms reduction.

If you want peace, why do you have to prepare for war? Why in accepting this point is it necessary to step up the arms race?

At the basis of the concept of fear lies the legacy of the cold war. In particular, fear for ones own security. It is precisely this fear that is prompting the search for stronger and stronger guarantees of security for one's side. Hence the instability in the level of military preparations in the concept of fear.*

It follows from this analysis that we need to formulate a new slogan under which we could really stop military competition, bring about the desired reduction in the level of military preparations and ultimately realize the idea of general and complete disarmament.

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* Above we carelessly formulated this concept as the concept of containment by mutual fear. The word "mutual" merely serves as an embellishment. This concept of fear implies only one thing; "we" shall do the threatening and "they" or "you" have to be threatened. In reality, even the word "mutual" is undesirable in this concept.

In the new situation of détente, unlike when the Manifesto was published, this task is naturally and simply formulated as that of finding a way to reduce armaments without detriment to anyone.

Thus we pass from the ideology of "containment by mutual (?) fear" to "the principle of mutual security".

Clearly, there exists a slogan which can replace the slogan "containment by mutual fear" whose logical inconsistency has long been obvious.*

It is to be hoped that the formulation of a new slogan will be a turning point in our history, a turning point of the greatest significance.

It is necessary that the mutual mistrust which nourishes the arms race be replaced by a real feeling of security based on real material, technical and other aspects acceptable to all sides. How difficult it is to do this!!! But we have no alternative. We have to prepare for this and have to study persistently all the difficulties and possibilities of this slogan.

Discussion of the problem of general and complete disarmament has taken place at every session of the UN during the last five years. And one of the decisions contains a direct appeal to the academic world (resolution 2825C (XXVI).

Point (c) of this resolution states, "Declared that progress toward GCD would be promoted if universities and academic institutions in all countries were to study problems of the arms race."

The Pugwash Movement has failed to give a timely response to this UN** appeal. It is necessary to rectify this omission. Comprehensive research into the numerous and intricate problems associated with the idea of general and complete disarmament and its possible stages must be considered one of the basic tasks of the Pugwash Movement. The appropriate organizational forms for planning this work are also needed. A definite measure in this direction was submitted at the Pugwash Symposium in Kyoto: to organize special working

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* Bertrand Russell wrote in his book "The Road to Peace": "In fact thermonuclear weapons are defended by politicians solely as deterrents: that is to say, it is thought that they are useful only if not used. But, if their sole purpose is to prevent war, as we are told, it would seem simpler and more economical to have the deadlock admitted and the impossibility of war acknowledged." (B. Russell, The Road to Peace, 1955).

** To be more exact, no new concrete proposals followed this appeal.

groups within national Pugwash groups to study the problem of general and complete disarmament.

If the Pugwash Movement of scientists could to some extent respond to the UN appeal through such work, this alone would justify the Movement's existence and would ease the task of convening an international disarmament conference.

An international conference on disarmament could to a lesser extent attract the attention of the broad, in particular, scientific public to the many aspects of disarmament and initiate their serious study.

Judging by UN agendas the question of the conference or its initial form will be positively decided and our Movement must not be left behind.

A certain scepticism exists in scientific circles about the problem of general and complete disarmament which they do not consider to be a current issue. It would seem that scholars rather than politicians naturally look to the future. It is precisely among scientific circles that one would expect the problems of the future to be discussed. As a rule these problems are only considered by statesmen when they become problems of the present.

THE PUGWASH MOVEMENT AND THE WORLD'S GLOBAL PROBLEMS

a. Science and setting up a new economic order*

With détente, the need has naturally arisen for setting up a new economic order. Again this problem can be and needs to be solved in the way recommended by the Manifesto.

Again this is a global problem of organizing the world economy and, in principle, it can be solved without solving the numerous "remaining problems". Here again, the partners in the new economic order have the chance to act as "representatives of mankind".

The stormy process of decolonization will lead to the appearance of numerous new states. The emergence of groups of states with their own problems will demand the solution of many problems we have not previously encountered.

Military détente will liberate vast material resources so necessary to the peoples.

Projects of colossal potential will appear for improving living conditions on our planet. With the rational and global organization of a new economic order, unemployment will become a thing of the past. Science will play a greater role under the new economic order. Science has long since become a productive force

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* Here the term "New Economic Order" means those new economic relations, which under peaceful coexistence of states with different social systems must naturally come to mutual profit.

and the most advantageous sphere for capital investment. We scientists can responsibly declare to the world that science has unlimited resources for greater good, bringing full and productive employment to the whole ablebodied population. We appeal to the people of the world to set up a new economic order on earth, making the twentieth century one of universal flourishing and one of Peace and Science.

b. The problem of the environment

It has become a generally accepted fact that civilized society is meanwhile intensively working on the transformation of our planet, where nature had created conditions for the origin of life, into a wilderness destroying life.

Everybody understands that it is time to stop this destructive process but we are dragging our feet over making a decisive start. The problem of the environment, being a global problem, can be solved in the same way offered by the Manifesto.

c. The energy problem is associated with these same global problems.

d. At present, when thousands of millions of people on our planet are under-nourished, or, more to the point, starving, we are spending 300,000 million dollars a year on armaments and employing in the war industry half a million highly-qualified specialists who are so much needed for peaceful purposes. In effect, in peace time, we are waging an undeclared war of starvation on thousands of millions on people on this planet.

e. The rapid elimination of the economic and cultural differences between the industrially developed and the developing countries it seems would naturally ease the solution of the problems arising from the population explosion. We all appreciate that population growth in the industrially developed countries is considerably lower than in the developing countries.

CONCLUSION

We are led to the conclusion that many fundamental, global problems are essentially connected with the necessity of solving the basic task of stopping the arms race and subsequent disarmament.

In particular, many difficulties that are included in the "remaining problems" are engendered by mutual fear and suspicion. They are largely the consequences rather than the causes of our failure to solve global problems.

The disappearance of an atmosphere of mutual suspicion and fear in favour of peoples' security will lead to a new economic order and to peaceful cooperation among peoples in solving tasks common to all mankind.

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Information Circular No. 1 - May 1977

To : Participants in the 27th Pugwash Conference, Munich, 24-29 August 1977

From : M.M. Kaplan, Director-General

A. Arrangements for Arrival and Accommodations

1. Participants are requested to arrive during the day of 23 August. Costs for local hospitality (hotel and meals) will be paid by the FRG Pugwash Group until the morning of 30 August. Any additional costs will have to be covered by participants.

2. The cost for family members accompanying participants who share accommodations are $ 30 per day (including meals); single accommodations are $ 45 per day.

3. Headquarters for the Conference will be at Hotel Bayerischer Hof, 8 Munich 2, Promenadeplatz 2-6, telephone 22 88 71. Participants are requested to report there at the Pugwash information desk for assignment to rooms at the Bayerischer Hof or nearby hotels. Luncheons and dinners for all participants will be served at the Bayerischer Hof Hotel.

4. Pugwash desks will be established at the Munich airport and central railroad station to assist arrivals.

... 5. Please fill in the attached questionnaire and return it as soon as possible to the Pugwash Central Office as indicated.

B. Programme and Agenda of Working Groups

... 1. Enclosed you will find the programme and agenda of working groups, and the names of conveners of the eight groups.

2. Please confirm your choice of working groups on the enclosed questionnaire.

P.T.O.

3. Participants are expected to stay until the closing session when the adoption of the Council documents (see C. 1 below) will be discussed and the election of officers and Council for the next quinquennium will be held.

C. Documentation

1. Enclosed are three documents, prepared by the Pugwash Council after extensive discussions, for consideration by the Conference. Two of the documents (P.C. 1 and 2) contain suggestions for the organization of Pugwash including the election of officers and Council, and types of activities for the next five years. The third document (P.C. 3) is a draft for a public statement to be issued from the Munich Conference on the 20th anniversary of Pugwash. These documents will be discussed at plenary sessions of the Conference, and the finally agreed documents will serve as guidelines for the policy of Pugwash in the next quinquennium.

2. In addition to the enclosed documents, you will shortly begin to receive other working papers for the Conference. Please bring all documentation with you, as we cannot ensure sufficient additional copies at the Conference itself.

3. If you wish to submit papers for the Conference, they should reach the London Central Office by 1 July latest; otherwise they cannot be reproduced and circulated to participants before the Conference. Please restrict such papers to no more than ten double-spaced typewritten pages. You will have an opportunity to expand on your paper verbally in the working group discussions. An abstract of no more than 250 words should accompany each paper for possible reproduction in the Pugwash Newsletter.

26th Pugwash Conference
"Disarmament, Security and Development"
Mühlhausen, German Democratic Republic, 26-31 August 1976

K. Korhonen (Finland) XXVI-3

A COMPREHENSIVE STUDY OF NUCLEAR-WEAPON-FREE ZONES – ITS RESULTS AND THE POSSIBILITIES FOR A FOLLOW-UP

The Ad Hoc-Group of governmental experts from 21 countries, instructed to undertake a "comprehensive study of the question of nuclear-weapon-free zones in all of its aspects", transmitted its Study to the Geneva disarmament conference (CCD) on August 18, 1975. After a discussion in the CCD, the Study was transmitted to the UN and taken under consideration as an agenda item during the last General Assembly. The GA passed a resolution (3472 A-XXX) according to which the Secretary General has requested the member States to transmit their views, observations and suggestions on the Study.

A full circle of international discussion in various bodies has thus been made. The idea was born in the UN General Assembly; it went into its orbit, came back to the GA, went into orbit once again and will return to the GA in the coming months. There are risks that the results of the Study will be limited to this routine discussion only and that the wishes of the GA of 1974 that "further efforts concerning NWFZs would be enhanched by a comprehensive study" will not be fullfilled. Therefore, the problem of how to organize a useful follow-up to the Geneva Study could be a subject for discussion in Pugwash.

The results of the Geneva Study: points of consensus

As the Chairman of the Ad Hoc-Group, I was gratified to note that the Group was able to reach several important conclusions which were accepted by consensus. In accordance with the Study, the principal goals of the establishment of a nuclear-weapon-free zone are to spare the nations concerned from the threat of nuclear attack or involvement in nuclear war, thus increasing their national security; to provide additional means for averting nuclear weapon proliferation and for halting the nuclear arms race; to promote international détente and thus to create chances for additional arms control and disarmament measures; and to facilitate regional and international cooperation in the peaceful uses of nuclear energy. The dual purpose of a NWFZ was recognized in the Study; it was noted that while the establishment of such a zone is an instrument - and potentially a powerful instrument - to supplement the Non-Proliferation Treaty, it is also an independent measure in the field of arms control. It is clear that the provisions of a NWFZ would go beyond the scope of the Non-Proliferation Treaty.

A fact which is bound to increase the spirit of realism prevailing in the Study is a notion, accepted with consensus, that "one of the principal objectives of a nuclear-weapon-free zone is to increase the security of its prospective member States". It is easy to agree that "it is a sovereign right of each State to assess its own security needs and to adopt the measures required to strengthen its security". The same conclusion can also be based on Art. 51 of the United Nations Charter. Membership in a security alliance or any other security arrangement should not prevent a State from participating in a nuclear-weapon-free zone. On the other hand, the establishment of a nuclear-weapon-free zone

should not interfere with existing security arrangements in a way which would be interpreted by the States concerned as detrimental to regional and international security. The proper balance between the responsibilities of a zonal State and the existing security arrangements should be negotiated and consented to, in each case separately, by the zonal States and the extrazonal States having special security arrangements.

It was gratifying to note that the Group devoted a great deal of attention to the question of peaceful uses of nuclear energy. The Study underlines that the zonal States have the inalienable right to use nuclear energy for peaceful purposes, and that the IAEA should have an essential role in promoting peaceful uses of nuclear energy in the zone.

The creation of a nuclear-weapon-free zone could facilitate regional and international cooperation. Once a nuclear-weapon-free zone is created, an element of regional cooperation has been established that should be expanded to cover other possible fields of cooperation, especially peaceful nuclear energy.

In this respect, the establishment of regional fuel centers could satisfy, partly or wholly, the needs of zonal States in developing their nuclear power programs.

I believe that any distinctive economic advantage in the field of peaceful nuclear energy would enhance, perhaps in a decisive way, the attractiveness of membership in a NWFZ. The Nuclear Weapo Powers, especially, possessing the resources and the technology needed, are in position to provide these advantages to the potential zonal States. The NW Powers should be encouraged to do this, keeping in mind that the establishment of NWFZs lies in their interest from the point of view of the Non-Proliferation Treaty and that in many concrete cases some balancing advantages are necessary to the

states which are requested to consider membership in a NWFZ.

Points of "qualified opinions".

According to the terms of reference of the Group, each of the experts was entitled to incorporate in the Study his own opinion. At the first glance, the Study seems to be burdened with "qualified opinions" expressed by "some members", "several members", "many members", "one of the members" etc. However, in most cases it is a question of repetitions of the same points of disagreement which the experts, following the instructions of their respective governments, considered necessary to express.

Talking about NWFZs, we are dealing with some of most sensitive security questions of several states. It is therefore no wonder that the security guarantees given to the zonal states were considered to be of great importance and that this problem as such created the most distinctive disagreement inside the Group. It was clear that - generally speaking - the NW Powers and their allies held one opinion on the question of guarantees, and the non-aligned states another.

In my personal opinion, this gap is, fortunately, more one of principle than a real one. For all practical purposes, it can be bridged over. I have to agree in principle with the conclusion of the "most experts" (non-aligned) that arrangements for the establishment of a nuclear-weapon-free zone "... must provide for appropriate guarantees by the nuclear weapon States not to use or threaten to use nuclear weapons against members of the zone".

This conclusion in fact is only a logical extension from a number of other statements in the report adopted by consensus, such as the one saying that the purpose of a nuclear-weapon-free zone is "... to spare the nations concerned from the threat of nuclear attack ..."

I regret therefore that no consensus could be reached in the Ad Hoc-Group on the acceptance of the principle relating to the security guarantees. I feel that the failure is not due to any irreconcilable controversy on the principle itself, but rather to an understandable reluctance on the part of the nuclear-weapon States to commit themselves in advance to a generalized and abstract undertaking with possible claims for its instant and automatic application in all cases.

As far as the negotiations for establishment of a nuclear-weapon-free zone are concerned, I feel that the potential guarantor States - that is, the nuclear-weapon States - are entitled to participate from the early stage of the negotiations. Otherwise, satisfactory results in this problem of primary and crucial importance might not be possible to achieve and, thus, the whole idea of a nuclear-weapon-free zone might be endangered.

To the problem of guarantees is closely connected another one: the over-all behavior of the outsiders vis-à-vis a NWFZ. In my opinion, the status of a nuclear-weapon-free zone should be fully respected by all extrazonal States, especially by the nuclear-weapon States. The arrangements necessary for this purpose should be based on the provisions of an international treaty, concluded in negotiations between all parties concerned. I believe that unilateral commitments are not enough.

A follow-up ?

1) The Study of 1975 was the first comprehensive study on the subject which, although admittedly limited, clearly is gaining in significance as a measure of arms control. The idea of using NWFZs as a means against the threat of nuclear weapons wherever and whenever possible is worth promoting. There is a consensus in the world community, clearly reflected in the opinions of the

Ad Hoc-Group and expressed in the GA resolutions, that the United Nations can play a positive role in the question and that the GA and its organs should give its guidance and express its opinion in the matters concerning the establishment of various NWFZs.

Therefore, it would be natural to maintain the question under the auspices of the GA and to find a suitable and acceptable organizational framework for this purpose. It is up to the coming GA to agree on practical measures. Yet I believe that this Pugwash Conference, expressing its opinion that the question of the Nuclear Weapon Free Zones should be kept under serious consideration of the authorized UN organs, could facilitate the achievement of positive results.

2) A logical extension of the work of the Ad Hoc-Group of 1975 would be to undertake comprehensive studies on the question of establishing NWFZs in different geographic areas of the world. There is a strong consensus in the Study that conditions in which NWFZs might be viable differ considerably from region to region and that it is not possible or realistic, a priori, to set out precise guidelines for the creation of zones. At the moment, nobody knows how the conditions differ and what are the general guidelines for each of the geographic areas where the idea of a NWFZ has aroused interest. My idea is that separate special studies on principal level should be undertaken on the possibilities of NWFZs in different areas, e.g. Africa, Middle East, South Asia, The Pacific, Central and Northern Europe. While the purpose of the Study of 1975 was to provide all Member States with information about the possibilities of NWFZs in general, the purpose of the specialized area studies would be to provide the states of the area concerned with additional information about the possibilities of NWFZs in that specific area.

I hope also that this idea could be discussed at the Pugwash Conference and that a positive reaction could be given to it.

ERRATA

Page 2 Paragraph 4 Line 3 — For principle read principal

i.e. "..... the principal judicial organ....."

Page 6 Paragraph 5 Line 3 — After justify insert resistance against

i.e. ".... a principle to justify resistance against
i.a. any improvement....."

Annex II = United Nations General Assembly Resolution 2625 (XXV)

Annex III — Delete heading Swords into Plowshares

Replace with UN Charter

26th Pugwash Conference
"Disarmament, Security and Development"
Mühlhausen, German Democratic Republic, 26-31 August 1976

F.A.M. Alting von Geusau (Netherlands) XXVI-1

The Final Act of the Conference on Security and Cooperation in Europe (CSCE) and the Peaceful Settlement of Disputes

".... and we urge them (the Governments of the world), consequently, to find peaceful means for the settlement of all matters of dispute between them."

(The Russell-Einstein Manifesto).

In the Final Act of the CSCE, the peaceful settlement of disputes figures as one of the ten "Principles Guiding Relations between Participating States". According to the first alinea in the text on this principle: "The participating States will settle disputes among them by peaceful means in such a manner as not to endanger international peace and security, and justice".

The above formulation of this principle is rather similar to the one contained in article 2(3) of the United Nations Charter and to the second principle contained in UNGA Resolution 2625 (XXV) of 24 October 1970 (the Declaration on Principles of International Law Concerning Friendly Relations and Co-operation Among States in Accordance with the Charter of the United Nations).[1)]

The main difference between the Final Act and the other two texts referred to, lies in the word "will" in the Final Act and the word "shall" in the Charter and the Declaration.

The Final Act of CSCE expresses the intention of participating states to behave according to certain declared principles: they will settle ..... The UN Charter lays down obligations - reaffirmed by the 1970 Declaration - for its members: All Members shall settle their disputes by peaceful means...".

The Final Act is the outcome primarily of negotiations between states with different political, economic and social systems. According to Soviet doctrine such relations and the principles formulated for them are guided by the "higher" principle of peaceful coexistence between states belonging to two opposing systems. The Final Act, as a consequence, shows that the principle of peaceful coexistence precludes the re-affirmation of an obligation under general international law for the particular relations between states belonging to two opposing systems.

Thus, what appears at first sight to be a slight difference in the formulation of the principle of dispute-settlement by peaceful means leads immediately to the heart of our problem in East-West relations.

....By Peaceful Means.

The principle that disputes should be settled by peaceful means is correlated to the principle that States shall refrain in their international relations from the threat or use of force against the territorial integrity or political independence of any state. The one cannot be upheld without the other. Unlike the latter, however, the former requires more than simple declarations to abide by it. The observance of the principle to settle disputes by peaceful means requires agreement on the means, which can be applied. Otherwise settlement without resort to force becomes highly unlikely.

The proclamation of the principle without agreement on rules is at best meaningless, at worst an act of deception.

The Charter of the United Nations, therefore, contains a full chapter on the pacific settlement of disputes (see annex III), and another one on the International Court of Justice as the principle judicial organ of the organization.

During the negotiations prior to the adoption of the 1970 Declaration, no agreement could be reached on a further development of those rules. The Declaration restriced itself to stating: "Nothing in the foregoing paragraphs prejudices or derogates from the applicable provisions of the Charter, in particular those relating to the pacific settlement of international disputes".

During the CSCE negotiations Switzerland submitted a Draft Convention on a European System for the Peaceful Settlement of Disputes. A consideration by experts of this proposal is postponed until after the "review-conference" to be held in 1977 in Belgrade (see annex I). More disturbing than this postponement - sine die? - is the elaboration of the guiding principle on peaceful settlement of disputes itself. A comparison of this text with Chapter VI of the UN Charter, shows that the willingness of the states participating in CSCE to apply peaceful settlement procedures in their mutual relations falls short of their commitment as members of the United Nations.

Members of the United Nations did accept a power of investigation for the Security Council, they did accept the right of any member to bring a dispute to its attention. They did commit themselves to refer a dispute to the Council, should they fail to settle it by means of their own choice (as provided by articles 37 and 33).

The Final Act merely declares: "In the event of failure to reach a solution by any of the above peaceful means, the parties to a dispute will continue to seek a mutually agreed way to settle the dispute peacefully". In the absence of a specific reaffirmation of their Charter commitments, one has to conclude that the principle of peaceful coexistence restricts the choice of "peaceful means", in disputes between states belonging to two opposing systems, to those provided for in article 33(1) of the UN Charter.

The principle of peaceful coexistence thus reduces the acceptance of dispute-settlement by peaceful means to the willingness to negotiate. In disputes between states belonging to two opposing blocs, third-party settlement or resort to the International Court of Justice appears to be excluded.

Détente and the Peaceful Settlement of Disputes.

The scientists, who signed the Russell-Einstein Manifesto in 1955 urged the governments to find peaceful means for the settlement of all matters of dispute between them.

Today, inspite of détente, none have been found. As far as settlement of disputes by peaceful means is concerned, détente has not produced much progress compared to the cold war. East-West disputes still lie beyond the limits that states ought to observe in their mutual relations if they are to apply meaningful peaceful settlement procedures to them.

> "The factors that may place a dispute beyond the limits of adjudication (or quasi-adjudication) may also impair the possibility for negotiation, in the sense of discussion seeking a mutual accommodation through an emphasis upon common interests and common purposes. In circumstances when principles and criteria for adjudication or quasi-adjudication cannot be formulated, it is likely to be difficult to find common interests and common purposes. In a such a case, it may be necessary to shift the search for accommodation toward a give-and-take in which estimates of probable gain are measured against estimates of probable loss under varying assumptions".[2)]

The negotiations at the CSCE have been largely of the type identified by Katz at the end of the above quotation: a search for accommodation in which estimates of probable gain were measured by

both sides against estimates of probable loss. They gave little if any evidence of being discussions seeking a mutual accommodation through an emphasis upon common interests and common purposes.

The conclusion must be that, under conditions of détente, the possibilities even for settling disputes through negotiations remain seriously impaired; too much so to expect the experts to reach any meaningful result and to make the willingness to negotiate settlements much more than an exercise in deception.

Until the conclusion of the final act, we can, however, point to one area in which sufficient common interests were perceived to exist to seek mutual accommodation: arms-control.

The so-called balance of terror between the Soviet Union and the United States created the conditions for bipolar détente and modest results in arms-control negotiations. Under those new conditions, the CPSU reformulated the Leninist principle of peaceful coexistence and elevated it to the first and foremost principle of international law between so-called socialist and capitalist states.[3] In its new formulation, the principle now implies the renunciation of war - and especially war with nuclear weapons - as a means of settling international disputes with the United States, and their solution by negotiation. Quite significantly, a number of arms-control agreements concluded since, opened the possibility, by mutual consent, of third-party settlement (including reference to the International Court of Justice) of disputes that arise concerning the interpretation or application of the treaties concerned.[4]

As a consequence, the common interest to avoid nuclear war has created a condition in which other means than settlement by negotiation could be envisaged. Recent developments, unfortunately, indicate that such perception of common interest is disappearing also in the field of arms-control.

The Future of dispute settlement by peaceful means.

The concise analysis presented above indicates that the Final Act of the CSCE has not materially improved the prospects for a settlement of disputes by peaceful means in East-West relations. Further progress is unlikely as long as the participating

states maintain the attitudes, they have adopted sofar.

The solution of disputes through negotiations can be achieved only between states which are willing also to accept more advanced procedures of third-party settlement in their mutual relations. Conversely, states which do not accept such more advanced procedures are also unlikely to achieve solutions through negotiations.

A search for adequate peaceful means to settle disputes would therefore require a serious re-examination of approaches in all states participating in CSCE.

First of all, an effort - like the one proposed by the Swiss government - to refine and elaborate traditional procedures for the settlement of disputes is bound to be unpromising. Such traditional procedures - conciliation, arbitration or judicial settlement - can be effectively applied only between states having a high degree of common interest in the area in which a dispute might occur. Such a condition appears to exist only within well-defined areas of successful cooperation in which states have agreed to common rules of conduct and common institutions. Judicial settlement, e.g. of disputes arising out of the interpretation or application of the treaties instituting the (West) European economic communities, has proven to be an effective means. Arbitration of disputes arising from commercial transactions and contracts for industrial cooperation (mentioned in the Helsinki Final Act) might also be effective.

Disputes, however, which are likely to endanger international peace and security are essentially disputes beyond the limits of traditional settlement procedures. It is the absence of common interests between states, and the existence of a high degree of competition or hostility, which makes a dispute likely to endanger peace and security. Disputes endanger peace if they arise from or give rise to a broader conflict of interests, values or purposes. The principle of peaceful coexistence typically applies to relations between states having such conflicting interests, values and purposes. States which so characterize their mutual relations will have to seek peaceful means for managing their conflicts before they can agree on procedures for settling their disputes.

Secondly, disputes have identifiable objects and identifiable parties. Conflicts are processes of relations between states, characterized by competition.[5] States which find themselves in such relationship first have to seek peaceful means to manage their

conflicts. They have to devise means in their mutual relations by which conflict may be reduced, by which "thresholds" are built against conflict-escalation and resort to force. Among them are disarmament, confidence-building measures, improved communication, common institutions for crisis-management, and an extension of the areas of common interests.

The management of crises typically is a task which cannot be performed in direct negotiations between competing states (especially not if one side is more powerful than the other). For such a task one would need a European Security Council along the lines originally conceived for the UN Security Council by the US Government (i.e. not a Council to recommend or impose terms of a settlement, but a truly "neutral" Council bringing the parties together).

Thirdly, conflict management and dispute settlement requires a re-examination of the basic principles underlying mutual relations. Among them a re-examination of the principles of peaceful co-existence and of sovereign equality is our most urgent task.

Peaceful co-existence - even as amended since 1956 - expresses an ideological view of human affairs, dividing the world between two species: the good and the progressive (we) and the bad and the reactionary (they).[6] Such a division of the world, a division between allegedly opposed systems, is wholly artificial. It does not conform to the reality of the situation in Europe, where states are divided in many ways. Unless politicians give up their error of trying to fit the diversity of human values into a straitjacket of misconceived ideologies, European states shall not be able to solve their disputes peacefully.

Sovereign equality, meant originally to express the equality before international law, has over the years degenerated into a principle to justify - i.a. - any improvement of peaceful means for settling disputes. The principle has become an instrument to resist rather than strengthen rules and obligations under international law. It cannot be denied that political inequality presents us today with one of the most difficult problems in international relations; exposing smaller states - whatever their political, economic or social systems - to pressure, interference, intervention, the threat or use of force and invasion by great or more powerful states. The principle of sovereign equality which the world needs is that which protects the smaller states. A more advanced and better organized system for conflict-management and peaceful settlement of disputes would be the best means to uphold that principle.

"Annex I: Excerpts from the Final Act".

V. Peaceful settlement of disputes.

The participating States will settle disputes among them by peaceful means in such a manner as not to endanger international peace and security, and justice.

They will endeavour in good faith and a spirit of co-operation to reach a rapid and equitable solution on the basis of international law.

For this purpose they will use such means as negotiation, enquiry, mediation, conciliation, arbitration, judicial settlement or other peaceful means of their own choice including any settlement procedure agreed to in advance of disputes to which they are parties.

In the event of failure to reach a solution by any of the above peaceful means, the parties to a dispute will continue to seek a mutually agreed way to settle the dispute peacefully.

Participating States, parties to a dispute among them, as well as other participating States, will refrain from any action which might aggravate the situation to such a degree as to endanger the maintenance of international peace and security and thereby make a peaceful settlement of the dispute more difficult.

(ii) The participating States,

Reaffirming their determination to settle their disputes as set forth in the Principle of Peaceful Settlement of Disputes;

Convinced that the peaceful settlement of disputes is a complement to refraining from the threat or use of force, both being essential though not exclusive factors for the maintenance and consolidation of peace and security;

Desiring to reinforce and to improve the methods at their disposal for the peaceful settlement of disputes;

1. Are resolved to pursue the examination and elaboration of a generally acceptable method for the peaceful settlement of disputes aimed at complementing existing methods, and to continue to this end to work upon the "Draft Convention on a European System for the Peaceful Settlement of Disputes" submitted by Switzerland during

the second stage of the Conference on Security and Co-operation in Europe, as well as other proposals relating to it and directed towards the elaboration of such a method.

2. Decide that, on the invitation of Switzerland, a meeting of experts of all the participating States will be convoked in order to fulfil the mandate described in paragraph 1 above within the framework and under the procedures of the follow-up to the Conference laid down in the chapter "Follow-up to the Conference".

3. This meeting of experts will take place after the meeting of the representatives appointed by the Ministers of Foreign Affairs of the participating States, scheduled according to the chapter "Follow-up to the Conference" for 1977; the results of the work of this meeting of experts will be submitted to Governments.

(Annex II)

"The principle that States shall settle their international disputes by peaceful means in such a manner that international peace and security and justice are not endangered.

"Every State shall settle its international disputes with other States by peaceful means, in such a manner that international peace and security, and sustice, are not endangered;

"States shall accordingle seek early and just settlement of their international disputes by negotiation, inquiry, mediation, conciliation, arbitration, judicial settlement, resort to regional agencies or arrangements or other peaceful means of their choice. In seeking such a settlement the parties shall agree upon such peaceful means as may be appropriate to the circumstances and nature of the disputes;

"The parties to a dispute have the duty, in the event of failure to reach a solution by any one of the above peaceful means, to continue to seek a settlement of the dispute by other peaceful means agreed upon by them;

"States parties to an international dispute, as well as other States, shall refrain from any action which may aggravate the situation so as to endanger the maintenance of international peace and security, and shall act in accordance with the purposes and principles of the United Nations;

"International disputes shall be settled on the basis of the sovereign equality of States and in accordance with the principle of free choice of means. Recourse to, or acceptance of, a

settlement procedure freely agreed to by States with regard to existing or future disputes to which they are parties shall not be regarded as incompatible with sovereign equality;

"Nothing in the foregoing paragraphs prejudices or derogates from the applicable provisions of the Charter, in particular those relating to the pacific settlement of international disputes;.

Annex III

SWORDS INTO PLOWSHARES 426

CHAPTER VI *Pacific Settlement of Disputes*

Article 33

1. The parties to any dispute, the continuance of which is likely to endanger the maintenance of international peace and security, shall, first of all, seek a solution by negotiation, enquiry, mediation, conciliation, arbitration, judicial settlement, resort to regional agencies or arrangements, or other peaceful means of their own choice.

2. The Security Council shall, when it deems necessary, call upon the parties to settle their dispute by such means.

Article 34

The Security Council may investigate any dispute, or any situation which might lead to international friction or give rise to a dispute, in order to determine whether the continuance of the dispute or situation is likely to endanger the maintenance of international peace and security.

Article 35

1. Any Member of the United Nations may bring any dispute, or any situation of the nature referred to in Article 34, to the attention of the Security Council or of the General Assembly.

2. A state which is not a Member of the United Nations may bring to the attention of the Security Council or of the General Assembly any dispute to which it is a party if it accepts in advance, for the purposes of the dispute, the obligations of pacific settlement provided in the present Charter.

3. The proceedings of the General Assembly in respect of matters brought to its attention under this Article will be subject to the provisions of Articles 11 and 12.

Article 36

1. The Security Council may, at any stage of a dispute of the nature referred to in Article 33 or of a situation of like nature, recommend appropriate procedures or methods of adjustment.

2. The Security Council should take into consideration any procedures for the settlement of the dispute which have already been adopted by the parties.

3. In making recommendations under this Article the Security Council should also take into consideration that legal disputes should as a general rule be referred by the parties to the International Court of Justice in accordance with the provisions of the Statute of the Court.

Article 37

1. Should the parties to a dispute of the nature referred to in Article 33 fail to settle it by the means indicated in that Article, they shall refer it to the Security Council.

2. If the Security Council deems that the continuance of the dispute is in fact likely to endanger the maintenance of international peace and security, it shall decide whether to take action under Article 36 or to recommend such terms of settlement as it may consider appropriate.

Article 38

Without prejudice to the provisions of Articles 33 to 37, the Security Council may, if all the parties to any dispute so request, make recommendations to the parties with a view to a pacific settlement of the dispute.

NOTES

1) For a comparison of texts, see annexes I, II and III to this paper.
2) Milton Katz, The Relevance of International Adjudication. Harvard 1968. p. 39/40.
3) Tunkin, Droit International Public. Problèmes Théoriques. Paris 1965.
4) e.g. Article XI of the Antarctic Treaty; Article VI of the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction.
5) Compare this author's: European Perspectives on World Order. Leyden, Sijthoff. 1975. Chapter 9.
6) Compare, Halle, The Cold War as History. London 1967. p. 157.

26th Pugwash Conference
"Disarmament, Security and Development"
Mühlhausen, German Democratic Republic, 26-31 August 1976

Jorma K. Miettinen (Finland)

XXVI-15

The Tactical Nuclear Weapons and the Doctrines governing their usage are changing from Deterrent to real battlefield role

After having been mainly justified for a quarter-century as deterrents on the theatre level and as a link to the strategic level, the US and NATO theatre nuclear weapons have been slowly changing their role in recent years to weapons of more directly warfighting forces. This change started about 1968 when NATO finally accepted the "flexible response" doctrine after having debated it since the beginning of the 1960s.

A reduction of the excessive number of US tactical nuclear weapons in Europe was secretly begun in 1970 [1,2], and in 1971 and again in 1972 the US Secretary of Defence, Melvin Laird, mentioned in his Annual Defense Department Reports for FY 1972[3] and 1973[4]: "Research and development and weapon improvement programs are moving forward in this area, to insure that our weapons and the associated command and control systems have adequate capability and continue to emphasize minimum chance of accident."[4] In press interviews Secretary Laird described the modernisation in some detail.[5] In addition to better control and safety, greater flexibility, improved accuracy, smaller yield and less collateral damage were the features emphasised. "About $10 million to $20 million a year has been devoted to research and development on variety of smaller, cleaner weapons, including so called "suppressed-radiation" weapons."[5]

The smallness of the yields and the cleanliness of the weapons was first emphasized. Some journalists baptized these weapons as "mininukes" but this term was later banned because of a frightened reaction and opposition amongst the European Allies. At the CCD, the US Amabassador Martin tried to placate his anxious colleagues by explaining: "The term 'mininukes' is misleading in two important respects. First, the coinage of this new catchword itself conveys the false impression that we are talking about a radically new and futuristic family of weapons. Second, the diminutive element of the term 'mini-nuke' falsly suggests some miniature nuclear device which can be handled and used in the same manner as conventional weapons. I would like to correct both of these misinterpretations."[6]

In his diplomatic answer Ambassador Martin formulated the development trends so that he could categorically deny them. But he did not deny that modernization is taking place. Regarding this he said: "I wish to state categorically that the American Government has no intention whatever to treat such (new) tactical systems as interchangeable with conventional arms."

That a new kind of tactical nuclear weapons has been developed is, however, evident from US Congressional Hearings in 1973 (2, p. 49), in which the Director of the Los Alamos Laboratory discusses the so-called 'enhanced-radiation weapons' then under development. Such weapons are giving a high dose of prompt radiation, particularly fast neutrons to, eg., enemy in tanks: "I really don't know why people have not thought more on the use of these (deleted) weapons. It may be that people like to see tanks rolled over rather than just killing the occupants..."

It is, of course, a question of semantics whether these very small yield weapons probably deriving much of the yield from fusion are called a new kind of weapon. Their effects are very different from the usual type of tactical nuclear weapons because of the high neutron and gamma dose and low proportion of energy deriving from blast and thermal radiation. But the decision on the deployment of the enhanced-radiation weapons is evidently still pending.

It can be debated, of course, whether the nuclear threshold is lowered by developing more accurate and flexible weapons having very small yields, even though they would be well secured against unauthorized use. Because the weapons are more flexible, more suitable for forward defense, and have smaller yields, they are likely to be used earlier than the older varietes and this means a lowering of the nuclear threshold.

A more direct warfighting role of the tactical nulcear weapons is clearly emphasized also in the so-called Schlesinger Strategy. The purpose of this strategy is to make possible the use of nuclear weapons in smaller conflicts. For this purpose a more accurate and flexible arsenal is necessary. The role of the US and NATO theatre nuclear

forces is clearly stated in the report Secreatry James Schlesinger gave to the US Congress in April 1975.[7] The final communiqué of the NATO Nulcear Planning Group meeting in Oslo, 20-21 May 1976, states: "Ministers discussed the importance of the contribution of theatre nuclear forces to NATO's strategy of flexible response as a part of the NATO Triad of strategic, theatre nuclear and conventional forces. In particular, Ministers agreed on the need to improve the effectiveness of NATO's theatre nuclear forces, including their survivability. They emphasized their continued support for broad Allied participation in nuclear planning and in NATO's nuclear defence posture. Against this background, the subject of improving the effectiveness of NATO's theatre nuclear forces was highlighted in a paper forwarded by the United States and in related national comments and assessments from the NATO Military Authorities. Ministers took note with interest of programmes already underway for this purpose and in particular of development programmes described by the United States Secretary of Defense relating to various area, including improvements in nuclear artillery capabilities. They encouraged continued improvements in supporting fields such as security of nuclear weapons and communications as an integral part of the contribution of theatre nuclear forces to the overall posture of the Alliance".

About 26 June 1976 news in the world press told that the USA is going to replace all of its tactical nuclear weapons in Europe by a new generation of modernized such weapons. Thus, the decision for renewal has been made but we do not yet know precisely what the new arsenal will be like. It may well be that some of the decisions will be delayed until the new President is in office.

Total Numbers of US and Soviet Theatre Nuclear Weapons in Europe and Their Trends

The number of US tactical nuclear weapons in Europe was announced by Secretary Mc Namara in December 1966 to be 7 000 (see, eg., 9, p. 72) and in May 1966 General Norsted quoted Mc Namara to have stated that

"late last fall" (1965) it was 5 000.[10] From the two hearings[1,2] we learn that it continued to grow steadily until 1970 when a maximum was reached (see Fig. 1). This maximum must have been somewhere above 10 000. Then the removal of about 3 000 Honest John rockets and 500 Sergeant missiles began with the result that the total number was again reduced to 7 000 in August 1974 (announced by Secretary Schlesinger[7]). Early in 1975 the Pentagon planned a further reduction by 10-15 percent (ie. upt to 1 000 warheads) during 1976,[11] but this plan was later changed and a proposal was made in the Vienna MURFAAMCE negotiations on 16 December 1976 to include "as a one-time measure" a reduction of 1 000 US nuclear warheads in a package proposal which included, among other things, a reduction of 1 700 Soviet tanks.[12] The Warsaw Treaty Organization has expressed its delight that NATO has finally included the nuclear weapons in the negotiations but has rejected the "package" proposal as such. It knows that the USA had planned this reduction as a unilateral measure as a phase in its modernizatio n program and evidently would have realized it sooner or later anyhow. The nuclear capable F-4 aircraft are to be replaced by non-nuclear capable ones at the end of this year and this will mean a sizable reduction of nuclear bombs. Another category which may be removed is the ca. 300 Atomic Demolition Munitions which the USA has in Europe.[13]

Western Germany has refused to allow their prechambering fearing that they are too escalatory. Furthermore, they are replacable by earth-penetrating Pershing warheads under development (see Schlesinger[7], p. 18).

Thus, we may assume that the total number of US nuclear warheads in Europe in 1977 will be about 6 000, some 5 000 of them in Central Europe (Fig. 1).

The number of Soviet tactical nulcear weapons in Europe has been estimated to about 3 500 during the last five years by the London International Institute for Strategic Studies (see, eg., 14). However, many western observers believe that the number of nuclear warheads has been steadily growing during the 1970s, eg. Ericson.[14] General Brown considers that there is a practical parity.[15] This situation is illustrated in Fig. 1.

Articles on Effects of Small Yields and Enhanced Radiation ("Neutron Weapons")

Simultaneously with the change in the NATO doctrine towards use of smaller, more accurate weapons, articles describing the advantages of such weapons have begun to appear.[16,17)]

Cohen and Van Cleave[16)] discuss whether the Soviet Union is interested in developing smaller warheads. After a rather unconvincing quotation from a recent soviet work "Antitank Warfare" they conclude that "Purely for their own sound military reasons the possibility exists that the Soviets may have included in their TNW stockpile weapons holding a potential for low collateral damage."

This is, of course, wishful thinking. The Soviet doctrine does notrequire any miniaturisation of the nuclear warheads, nor is it practical for their tactical T5 rockets ("Frog 7" by NATO code) because of their poor accuracy, nor for the T7 (SCUD) missiles. For the Soviet Union the primary role of the theatre nuclear weapons is to deter the use of such weapons by NATO and for that purpose the present stockpile is just fine. If they have to use them, they will be used in connection with a major offensive operation for deep interdiction against preplanned targets - again, small yield would not be sufficient. For battlefield use the Soviet Union may have nuclear warheads in Kt-range for its 203 mm gun/howitzer M-55 (range 32 km) and its new 155 mm self-propelled howitzer designated by NATO M-1975 (estimated range 17.5 km), but this is not certain. It probably has no warheads in subkiloton range, because the use of such are never discussed in their doctrinal writings. Collateral damage in NATO countries will be decided by the Soviet warhead sizes, and there is no indication that these would be remarkably reduced.

Warschafsky[17)] describes the new radiation casualty criteria recently adopted by the US Army. The earlier criteria (650, 3 000, 5 000 rads) did not account for transient incapacitation and their descirption of casualties was inaccurate. The new criteria are:

1) Immediate Permanent Incapacitation (IP)

   A: 17 000 to 19 000, mean 18 000 rads. Personnel will become

incapacitated within five minutes and will remain so until death which will occur within one day.

B: 7 000-9 000, mean 8 000 rads. Personnel become incapacitated within five minutes and for physically demanding tasks remain so until death which occurs in one to two days.

2) Immediate Transient Incapacitation (IT)

2 500 to 3 500, mean 3 000 rads. Personnel will become incapacitated within five minutes of exposure and will remain so for 30 to 45 minutes. They will then recover but will be functionally impaired until death, which will occur in four to six days.

3) Latent Lethality (LL)

650-rad band (800 to 500 rads). Personnel will become functionally impaired within two hours of exposure. They may respond to medical treatment and survive this dose; however, the majority will remain functionally impaired until death in several weeks.

The corresponding radii of damage R_D of a 1 kt low airburst are:

Criterion	Dose rads	R_D meters
1) IP, A (physically undemanding)	18 000	400
IP, B (physically demanding)	8 000	500
2) IT	3 000	640
3) LL	650	760

The author then discusses with examples the proper "use of the criteria in the targeting process", concluding that "since almost all tasks during combat require some degree of physical activity, the 8 000 rad IP criterion would almost always be the highest needed for producing the desired immediate and permanent casualties".

Thus, the low yield and possibly even enhanced-radiation weapons are coming, rather low-key and without any protests from the part of the Western Europeans. The effects of these weapons resemble those of chemical

weapons, being even more nasty. Think about the large number of soldiers obtaining smaller doses than the 'recommended' 8 000 rads in the periphery of the affected area - those who obtain doses between 100 to 300 rads become casualties weeks later and some will die. The risk of genetic damage will be great. All weapons are "bad", but I think that the small-yield nuclear weapons are among the worst. The "smallness" and "cleanliness" entices real use.

The whole idea of "proper selection of radiation casualty criteria" to "optimize" the results on the battlefield has to me as a professional radiation protection scientist considerable overtones of revulsion, only exceeded by those produced by chemical weapons which in my mind maximise the perverse use of science. Nor do I think that a "deterrent" which has incalculable consequences to future generations should be introduced to the battlefield under the guise of a "clean" and "small" weapon. I think that this "deterrent" is more incredible than credible.

Remedial measures proposed

This is the time to introduce better measures for the security of Europe than the replacement of the theatre nuclear weapon arsenals by new varities. Détente is working satisfactorily although the progress is not so fast as many of us would like it to be. In the Vienna negotiations the figures of troop strengths have been revealed[18] and proove that, essentially, a parity prevails: against 977 000 NATO troops (777 000 ground, 200 000 air) the WTO has 965 000 (805 000 ground, 160 000 air). The Soviet Union has more tanks but most of them are older models which are penetrable by even the hand-held NATO anti-tank weapons. Since NATO has very large numbers of antitank weapons (the USA has been procuring annually 30 000 ToW's which is only one of over 10 varities in use by NATO) they can be considered to form a balance against the WTO tank superiority. All in all, there exists a rough balance in the Central Europe, as far as it is possible to measure such.

This would be the right time - or rather the time after the first agreement in Vienna - to agree about non-first use of nuclear weapons combined with a nuclear-free zone, even a narrow one (80-100 km). Militarily nothing would be lost, because launchers can exceed such a zone if the opponent breaks the agreement. On the contrary, true conventional defence would gain because the nuclear deal would require some bolstering of the conventional defence, and it is easier to plan a "stalwart" conventional defence when it is not necessary to devote so much attention to the dual response from the very beginning. - I am sure that many commanders curse the duality of preparations now necessary. If the non-first use agreement would include a 24 hr-notice, repudiation of the agreement would allow a serious but much less risky "nuclear warning" than, eg., a "demonstration shot" by a nuclear weapon which has often been proposed in the West.

I do not understand NATO's need to maintain such a cruel doctrine as is its "possible first-use doctrine". As long as the military balance in Europe is based on such a doctrine we remain in the era of cold war. A deterrence based on early, forward use of low-yield nuclear weapons is an incredible deterrence. In view of the up to 7 000 Soviet tactical nuclear warheads (of high yield!) it is rather a weakness than a strength in the NATO triad - a "leg" which cannot be used if needed in spite of all its sophistication. Nuclear weapons are so political weapons - chips in a political gamble - that they ought to be left to the Superpowers to play with. A Western Alliance is not likely to be very good in such a game against the WTO in which the more monolithic Soviet Union has the dominating position. Why, therefore, to choose deliberately a game instead of solid defence? Modern technology can provide conventional high-precision weapons, the PGMs, which can stop a "spearhaed of a tank assault" in a much safer way than the low yield nuclear weapons.[19] Defence must be based on a different, more solid basis than a play with dubious weapons.

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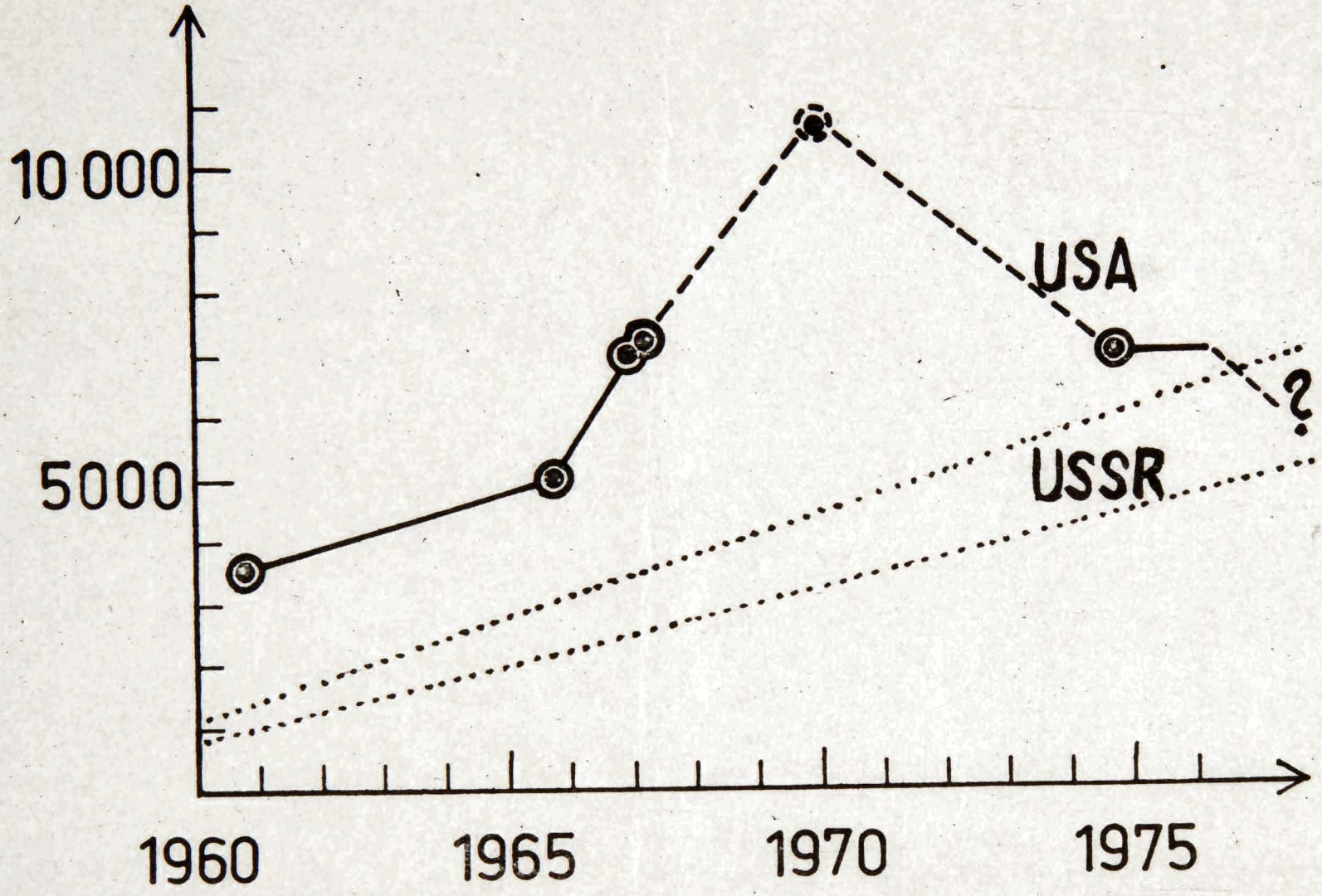

FIG. 1. CHANGES IN THE NUMBER OF US TACTICAL NUCLEAR WARHEADS FOR ARMY AND AIR FORCE IN EUROPE. THE 1970-MAXIMUM IS ESTIMATED (SEE TEXT). THE OTHER POINTS ARE FROM OFFICIAL SOURCES. CHANGES OF USSR TNWs ARE ESTIMATES.

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26th Pugwash Conference

Mühlhausen, GDR, 26-31 August 1976

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PROBLEMS OF LIMITING AND REDUCING STRATEGIC NUCLEAR ARMAMENTS AND OTHER WEAPONS OF MASS DESTRUCTION

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26th Pugwash Conference
"Disarmament, Security and Development"
Mühlhausen, German Democratic Republic, 26-31 August 1976

REPORT OF WORKING GROUP 1 (Prof. Gottstein, D FR)

PROBLEMS OF LIMITING AND REDUCING STRATEGIC NUCLEAR ARMAMENTS AND OTHER WEAPONS OF MASS DESTRUCTION

The first problem that the Working Group discussed was the status of the SALT talks. Concern was expressed about the negative effect on SALT and on arms control and disarmament which the large scale deployment of cruise missiles could have. Cruise missiles represent a new and very efficient and precise carrier of nuclear as well as conventional warheads. The strategic long range cruise missile should not be deployed since it could undermine past SALT agreements and would jeopardize prospects for future meaningful strategic arms limitations, and open another channel for an upward spiral of the arms race of action and reaction. All members agreed that the testing and deployment of cruise missiles as a strategic weapon should be banned. It was suggested that the verification of a ban on testing may be possible since non-intrusive technical means of inspection can differentiate long range strategic from short range tactical cruise missiles, provided the latter were built with specific physical attributes such as a type of jet engine, and in the present technological environment, with limited total volume.

It was suggested that such moves as banning the testing and deployment of cruise missiles, and not developing the Backfire bomber with a heavy, long range system, would help the conclusion of a SALT II agreement.

The SALT agreements contain some positive results in limiting ABM systems, in placing ceilings on the numbers of the most offensive weapons and in agreeing not to interfere with national technical means of verification. However, there were

differing views about the significance of these steps.

There was disappointment that SALT has not stopped the qualitative arms race and so far has done nothing to reduce the existing large numbers of strategic offensive weapons. The process of detente and the arms race cannot co-exist indefinitely.

It was agreed that SALT agreements which would halt the quantitative and qualitative arms race should be pursued vigorously. Many noted that the secrecy, complication, and protraction of the SALT negotiations have resulted in a disenchantment and loss of interest of the general public, and that future negotiations should provide more information about the issues discussed, and the position of the two sides on them. Lack of time prevented a detailed discussion of the items that should be on the agenda of SALT III. It was agreed that a substantial and comprehensive reduction of all types of strategic weapons should be achieved. It was proposed by some members that all long-range bombers and all land-based intercontinental ballistic missiles be phased out and that nuclear missile firing submarines be drastically reduced in order to get rid of the massive overkill capability.

The question of how to make the achievement of such goals more feasible was also raised; there is here great need for fresh ideas and Pugwash should try and do its best to contribute to their development.

Other nuclear powers should be encouraged to join at some point the process of substantial and comprehensive reduction of all types of strategic weapons.

It was noted that lack of progress in curbing vertical nuclear proliferation stimulates horizontal nuclear proliferation.

Some emphasized that the spread of nuclear weapons to more and more countries represents a bigger danger for peace than imbalances in some strategic indicators for the major nuclear countries.

Many members stressed the ineffectiveness of civil defence programmes designed against the nuclear threat, and the psychological damage they do to efforts at disarmament. Others felt that civil defence as such should not be attacked because it could save lives in some conditions and in some countries in which it could not be a cause of misinterpretation as preparation of nuclear attack. Governments were invited to provide more information about their civil defence measures and the reasons for them, and thereby to eliminate opportunities for misinterpretation.

The Group discussed the present stalemate in the arms control negotiations. It has been stressed that the 15 years exercise in arms control did not prevent an increase in armaments and that the arms race has become more intensive. It was felt that a basic departure from arms control is needed in the direction of real disarmament and the aim of general and complete disarmament.

Notwithstanding the continuing threat to civilization posed by the existing stockpiles of armaments, the Group felt that the positive aspects of the developments in the last decades should not be overlooked. A nuclear holocaust had so far been avoided. The factors which have favoured this desirable aspect of an otherwise most dangerous situation should be studied and strengthened. The psychological barriers, which stem in part from ideological roots, hinder further progress. They contribute, on both sides, to the failure to see and understand the points of view and the motivations of the other side, thereby creating tensions, and should be studied, made conscious, and removed as far as possible.

Many members felt that to advance progress for greater arms control and disarmament, the countries involved in negotiations

must provide more public information about their weapons programmes and strategies. In this way, those favouring and working toward such progress will be aided immensely as they attempt to influence their governments' position in this matter.

Some proposed as a confidence building measure that a consortium of non-nuclear-weapon states should establish a satellite system for the surveillance of the military activities of all countries and that the information acquired be transmitted to the United Nations to be made available to all. It was recommended that Pugwash should study the proposal.

The Working Group discussed the advantages and disadvantage of holding a Special Session of the United Nations on disarmament as a step toward the holding of a World Disarmament Conference. Most members felt that the effort was worthwhile, and that it might provide some results in encouraging governments to achieve major progress on disarmament. It was also felt that the Conference should be most carefully prepared and that participation should be at the highest level. A few, however, stressed the concern that this would be a mere exercise in propaganda that could damage rather than improve the international climate. Pugwash should help in the preparation of any such Special Session.

The Working Group discussed the difficult problem of how to curb military research and development which were felt to be particularly inflamatory. It was stressed that curbing of military research and development is central to the halting of the arms race. Some of the members noted a new development in the US whereby the US government was being required to prepare for the Congress arms control impact statements for many weapons programmes of the US government. These statements may have the result of postponing the development of new weapons programmes or the refusal of Congress to

appropriate funds for them. Some members noted that if other governments producing new weapons systems would undertake to provide similar impact statements of these weapons programmes, this could have a positive result. The tendency, however, will certainly be for governments to claim their weapons programmes as not incompatible with arms control policy and negotiations. Some members stressed the need to have such impact statements evaluated independently.

In the context of military research and development, it was agreed that it was essential to ban the testing of all sorts of new weapons of mass destruction. It was pointed out that such testing is generally verifiable by national means of control. This would impede development and production of such new weapons. It was suggested that unilateral steps of arms limitation and reduction by mutual example would facilitate the process of disarmament.

The Group discussed the possibilities for reducing the numbers of nuclear weapons, tactical as well as strategic. The Group expressed the conviction that the development of small nuclear weapons for use in battlefield situations is most dangerous, because it tends to blur the distinction between nuclear and conventional weapons, thereby making the use, as well as the spread, of nuclear weapons more likely and, furthermore, induce escalation towards general nuclear war. All available means should be attempted to stop it. It would, moreover, be most desirable to drastically reduce the numbers of tactical nuclear weapons ~~reduced~~ stationed in Europe and elsewhere, by agreement or otherwise.

As a means to prevent the development of novel types of nuclear weapons and of nuclear proliferation, all stressed the importance of achieving a comprehensive nuclear test ban treaty. A comprehensive nuclear test ban treaty would also have an important psychological and political impact conducive to disarmament. Many stated their objection to the threshhold test ban treaty, because it allows tests to an excessively high level and leaves a major loophole for "peaceful nuclear explosions".

Therefore, it should be renegotiated by the US and USSR governments, and made into a comprehensive nuclear test ban treaty. Some, however, emphasized that the threshhold treaty was a step in the direction of a comprehensive test ban and, therefore, should be accepted as such.

The validity and utility of the concept of nuclear deterrence was discussed, but the available time was insufficient for exploring the issue thoroughly. It was recommended that this subject be given high priority at the 1977 Pugwash Conference in Munich, taking into account the results of the 1975 Kyoto Symposium.

The Group favoured a ban on chemical weapons. With regard to the verification of such a ban, some members thought some degree of verificiation by satellite inspection feasible, others thought this very inefficient and open to misinterpretations. Some would encourage investigations into the feasibility of "minimally intrusive" inspections. All expressed the hope that Governments might find it possible to follow the example of the BW-Treaty by initiating the process by unilateral action and foregoing on-site inspections, while being aware of the intrinsic differences between bacteriological and chemical weapons. The argument was noted that the acceptance of the principle of non-inspection in this case might set a precedent for other cases in which application of this principle would be undesirable, but this argument was considered as non-overriding. The members believed that major progress towards a complete ban on chemical weapons and their renunciation by states could be achieved if the USA and USSR implemented their joint 1974 initiative at the Committee on Disarmament for the prohibition of super-toxic and other lethal agents of chemical warfare. The urgency of a ban on chemical weapons is convincingly illustrated by the development of so-called binary weapons, a new generation of chemical weapons, that could start a

new loop in the arms race spiral. It was also emphasized that greater efforts should be made to encourage more states to sign the Geneva Protocol of 1925 and the Convention on the prohibition of biological weapons.

Throughout the discussions in Working Group 1, members repeatedly expressed their conviction that the final goal in this field must be "general and complete disarmament", and that Pugwash should take an active role in stimulating progress towards this end.

26th Pugwash Conference
"Disarmament, Security and Development"
Mühlhausen, German Democratic Republic, 26-31 August 1976

REPORT OF WORKING GROUP 3

(W.F. GUTTERIDGE, U.K.)

EUROPEAN SECURITY AND CO-OPERATION ISSUES

1. Further Implementation of the Helsinki Agreement

1.1. The meeting of the leaders of 35 states which ended in Helsinki a year ago with the signature of the final act of the Conference on Security and Co-operation in Europe was an unprecedented event, which demonstrated that concerted decisions on a series of problems pertaining to European security can be taken. This act laid down a comprehensive set of principles and a programme aimed at the realization of conditions for co-operation and lasting peace in Europe.

1.2. Members of the Group were agreed on the need for serious efforts aimed at the successful implementation of the Helsinki Agreement: there were already tangible results in a number of fields; especially in economic, scientific and cultural co-operati

Participants from some countries felt that events outside Europe, inadequate progress with the MFR and SALT II talks and the effect of these on internal domestic politics had combined to diminish enthusiasm for the Helsinki Final Act. Others demonstrated the high degree of commitment of their governments and peoples to the realization of its objectives. There was, nevertheless, general agreement that substantial practical achievements would take time, that the principles were good and that, in any case, there was no alternative to detente if peace was to be consolidated in Europe. It was important to adopt a constructive attitude instead of emphasizing what other parties had not done; Pugwash scientists could play an important role

in the formation of such an attitude. At the same time they should encourage self criticism of the response of their own governments to the implementation of the agreement.

1.3. The Working Group examined the situation particularly in light of the forthcoming Belgrade Conference. Some members felt that in certain quarters there was a lack of enthusiasm for the agreement which manifested itself in the mass media and reflected an unnecessary distrust. In some cases, it was felt, governments have shown a cool attitude towards a document they have signed themselves. It was pointed out that, while some governments give different weight, importance and priority to each of the four "baskets" of the Final act; others regard the four parts of this act as equally important. Steps towards the realization of the provisions of the Final act relating to military and economic matters as well as free movement of people, information and ideas were bound to be difficult, because they involved legislative and other changes. The importance of understanding the roots of these different attitudes was emphasized, because inertia would be the result from a policy of "wait and see" what happened elsewhere.

1.4. The Final act was inevitably a compromise that needs implementation in the spirit of détente and a realistic approach according to the interests of different political and social systems.

2. A New Perspective for Europe

The Working Group felt that an attempt to envisage the kind of Europe which ought eventually to emerge would be helpful.

2.1. The view was expressed that, looking ahead 15-20 years, in Europe the military blocs should be dissolved and substantial disarmament and reduction in armed forces attained. To promote further and more effective European economic collaboration, within a framework in which there would be close contacts and mutual co-operation between the Council for Mutual Economic Assistance (C.M.E.A.), the European Economic Community (E.E.C.) and all European states, would be the objective. A Europe of the future would also be based on broad cultural co-operation, a prerequisite for which would be the substantial reduction of asymmetries in cultural exchange (in translation of books and literature, exchange of films, music, TV programmes, theatrical performances, scientific contacts and mutual projects etc.)

2.2. At present it was considered unrealistic to think in other terms than within a gradually changing pattern of relationships of the two clearly identified political and social systems. This also meant the continued recognition of existing sovereign states, whatever degree of economic and political integration might be achieved, on an equal basis and with guarantees of non-intervention in their internal affairs.

2.3. There was support for the view that within the foreseeable future a feasible all-European system could be established providing particularly procedures for the settlement of disputes. There was also some support for the view that provision should be made for third party

mediation.

2.4. A strong possibility existed of developing further international division of labour in fields such as energy and transport which would reinforce economic development and détente. A number of participants stressed the necessity of convening of European conferences on energy, on transport and on pollution, and other methods of broadening the field of economic co-operation without discrimination and without barriers.

2.5. Considerable concern was expressed that, while economic co-operation and exchange have increased, in recent times expanding economic contacts have not prevented an intensification of the arms race. This suggested that, whatever the progress towards co-operation on many levels, military confrontation would not be lessened without deliberate efforts in that direction.

3. The Conference on Mutual Force Reductions

The Vienna MFR Conference had not made real progress, perhaps because the principles on the basis of which the conference was convened had been subject to different interpretations. The spirit of Helsinki needed to be reasserted in this connection. There was general agreement that the technical problems relating to the symmetry and asymmetry of East-West military forces and dispositions in Europe were serious obstacles. It was stressed that the success of military negotiations depended upon a clear political determination to find a solution. This was particularly urgent in the light of the development of new weapons and strategic

doctrines on the part of both blocs. The nuclear armaments problem in Europe is becoming more critical as mininukes and other new technologies become available.

The first priority is to break the deadlock in Vienna by constructive steps aimed at a substantial measure of force reductions on both sides. The gradual development of the Confidence Building Measures as envisaged in the Helsinki Agreement is one important way of assisting this aim in that these are aimed at the core of the matter - the elimination of distrust. The question of whether the presence of neutral countries, other than those on the periphery of Central Europe, at the Vienna talks would be useful was a matter of debate.

4. Nuclear Weapon-Free Zone in Central Europe

The possibility of a relatively narrow nuclear weapon-free zone not involving the withdrawal of foreign nuclear weapons from European soil but rather the sterilization in this respect of, perhaps, the territory between the Rhine and the Vistula was canvassed. Doubts were expressed that this might simply prove another optimistic 'first step' which would be overtaken by new technology before it had been implemented and that consequently more radical proposals relating to the whole of Europe already discussed in Pugwash Conferences should have priority.

5. Scientific, Technological, Economic and Cultural Co-operation

Since the Helsinki agreement there had been a more positive attitude to international co-operation not only under the auspices of the regional offices of UN agencies. There was a

general optimism that projects were being initiated which would give a new dimension to such co-operation. A possibility existed, for example, that Western Europe might benefit from a supply of natural gas available in the North of the Soviet Union. The interchange of industrial products was of central importance but still presented some financial and technical problems. Because scientific collaboration had proved relatively easy it should be used to trigger technological co-operation. Participants felt, for example, that a determined assault might be made on projects such as the electric car. The manysided collaboration by socialist and capitalist countries in automobile manufacture already showed what could be achieved where interests coincided. Technological co-operation should be raised at least to the level achieved already in a number of scientific fields.

6. Some Problems Concerning Co-operation

The practicability and desirability of functional collaboration on well defined projects was wholeheartedly endorsed. Some participants, however, suggested a need for caution because beyond a certain point intimate co-operation could not go without involving changes for which the two social and political systems are not at present prepared. It was stressed that the continuation of effective co-operation depends on the evolution of the interests of the respective countries, groups of countries and systems and that efforts should be made to enlarge the area of mutual interests.

7. A Proposed Pugwash Symposium

A Pugwash Symposium suitably composed to consider the

possibilities might, if the Council agreed, be convened early in 1977 in good time before the Belgrade review meeting of the ECSE, dealing with Confidence Building Measures. A National Group could be found to sponsor this.

8. Permanent Machinery for European Security and Co-operation

The need for a small, and not necessarily fixed, nucleus of officials to co-ordinate co-operation on an all-European basis was highly desirable. It would not only act as a focus for information but might help to identify problems leading to a renewal of ~~distrust~~ uncertainty before they could take effect. Pugwash should do its best to promote such a development.

9. Europe and the World

Though the Working Group had concentrated on specifically European matters, it was strongly felt that every effort should be made to apply the principles agreed at Helsinki to problems in other parts of the world - especially the Mediterranean, the Middle East and the Developing Countries generally. A new system of European relations would assist the establishment of a new system of relationships on a worldwide basis.

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REPORT OF WORKING GROUP 4

DEVELOPMENT AND SECURITY

The problemsof Development and Security were mainly discussed by the Group from the standpoint of the situation in the Developing countries. The Group recognized, however, that these problems are also relevant to developed countries; it was recognized that even in the most advanced ones, there are aspects which should be given special attention, such as poverty, malnutrition, poor health and inadequate education for a part of their population.

Development

While economic growth is, at the root level, a necessary condition for development, it is not its objective. Among the genuine objectives of development are the eradication of poverty, access for all to adequate means of existence, work, the improvement of nutrition, health, and education; in short, raising the material, cultural and spiritual level of the deprived people.

All states should establish as well the conditions for the full development of the individual potentialities, through education, full access to information, freedom of expression and movement, the possibility of effective public participation in the political process, and the conditions under which peoples, including minorities, are able to retain and develop their own identity.

The Group acknowledges that there are many roads for development. This question was discussed in depth at the Madras Conference. Development strategies for the LDCs include broad international cooperation and international division of labour on the basis of equality between countries in different phases of

development as well as between LDCs, implications of a New International Economic Order to be elaborated, self-reliance of the LDCs which implies a national capacity for autonomous decision-making and implementation on all aspects of the development process, particularly including science and technology.

It attached much importance to the need for much greater assistance from DCs to the LDCs to create a world in which wealth is more evenly distributed.

The Group also recognized that the independence of a State is of paramount importance for its development.

Security

Throughout the discussion, security was considered in all aspects relating to development. In this context, security is constituted by freedom from threat, actual or potential, to national, self-reliant, independent development.

Among the security risks which are particularly relevant to LDCs are: (a) the fact that many of these states have borders not sanctioned by a long history of national consolidation; (b) vulnerability arising from excessive dependence of some of these countries on the continued maintenance of specific inputs (such as food and energy) and outputs (such as single agricultural or mineral exports); (c) dependence of many of these countries on continuous inflow of technical and scientific manpower and equipment for development.

Military Threats

Military aspects of interference in development are exceedingly frequent. In many instances, the military apparatus of a developing country is used internally as a means of oppression and interference with true development. Such a happening has often an outside subversive involvement, the magnitude of which is variable.

There are other instances where there is a direct outside military intervention in a developing country, as well as in developed ones, when the interests of a larger power are threatened. Further, the Group recognized that national liberation is a prerequisite to development, and took note of the liberation struggles in South Africa, Namibia and Rhodesia. It condemns the repressive measures adopted in these countries, and the support, including trade, that the oppressive regimes are receiving from some countries. Such support is anti-developmental. The Group urges that the international system should take all possible measures so as to prevent further blood-baths, and enable the peoples of these countries to embark on a path of independent development. In particular, developed countries should be discouraged from the selling of weapons to South Africa and Rhodesia.

Pugwash could play an active role in this explosive situation by arranging an encounter between scientist members of the majority and minority groups, utilizing its unique expertise and experience in such matters.

Non-Military Threats to Development

In the present world situation of food most countries are more or less in a difficult situation. This is even more so for the LDCs. In such an instance, the use of food denial as a weapon is morally unacceptable and utterly to be condemned.

The concept of triage has been invoked in relation to food distribution among the starving nations. According to this concept aid is to be concentrated on those countries where the problem seems to be most manageable. By implication, other countries are regarded as impossible to salvage. This utterly repugnant "life-boat ethic" is based on the assertion that there is not enough food to go around. This assertion seems not to be accurate.

On the contrary, it appears that, if correctly managed, there exist possibilities of producing more food, using presently available food, avoiding deterioration during transport and storage, so as to relieve the most urgent cases.

The Group also noted that an increasing number of LDCs will in the next few years have great difficulties in servicing their present burden of loans. There is a grave risk that in negotiating prolongations with creditors these countries will be forced to adopt economic policies which are not dictated by their genuine development needs.

The Group discussed the vulnerability of LDCs to transnational corporations arising from (a) their power and scale of operation, not effectively controlled by any state laws. (b) The developing countries are vulnerable to the pressures of these corporations in matters related to technology and equipment because of their monopoly. In some instances, because of the little diversity in their resources, the LDCs find themselves tied to some of these corporations.

Control over outward flow of raw materials and inward flow of finished goods results in a real exploitation of the LDCs. The counter measures to this situation again reside in the implementation of self-reliance.

International Scientific Cooperation in Developing Countries, and the Social Responsibility of Scientists

It is well recognized that international scientific cooperation has contributed substantially to the scientific and technological capability building in LDCs and to the solution of specific developmental problems, and that it will continue to do so in future.

Nonetheless there are fears in LDCs, which may or may not be valid, which have to be taken into account in order that international scientific cooperation in this domain may function more effectively.

There are, involved in this, ethical questions relating to the social and professional responsibility of scientists, and also practical questions relating to the credibility of individual scientists, and sometimes even international scientific organizations. The Working Group felt that this is a serious area in which Pugwash action is called for.

In this context the Working Group commends the initiative taken by the Indian Pugwash Group to organize an International Pugwash Workshop on Guidelines for International Scientific Cooperation in Relation to Developing Countries, in the early spring of 1977. Some points for consideration of this Workshop are given in the Appendix. We hope that the recommendations formulated at this Workshop will enable the Quinquennial Pugwash Conference at Munich in 1977 to finalize a set of guidelines, which may then be presented, in particular, to the 1979 World Conference on Science and Technology.

The Group notes there are several other issues of importance to which Pugwash could contribute at the 1979 Conference. It therefore recommends that the Council may set up a machinery, including inputs from national Pugwash Groups, to ensure that Pugwash makes an effective input into it. More specifically, it was suggested that a working background paper should be drafted, in order to be discussed at the 1977 Pugwash Conference. The hope was expressed that the 1977 Pugwash Conference will be able to submit, as one of the Non-government agencies, some concrete recommendations to be considered by the UN

Conference "Science and Technology for Development" in 1979.

The Working Group identified the following two basic principles which should govern international scientific cooperation in relation to developing countries:

(a) development policies and priorities must be defined within the developing countries themselves, and the international scientific community should be aware of the importance of self-reliant and autonomous development of each society, and also the difficulty of achieving self-reliance;

(b) it should be borne in mind that cooperation is not utilized as an umbrella to collect intelligence information or to threaten the security of a country.

The importance of proper understanding of diverse cultures of the world, which is so important for security, was recognized. This is both a problem of adequate teaching of history, and of adequate dissemination of news on contemporary events, both in DCs and LDCs.

History is often taught, from the early school level, in a narrow ethnocentric fasion, without sufficient appreciation of the richness of other cultures. This contributes to lack of communication, to misunderstanding and to suspicion. Therefore the Group suggests that UNESCO should take vigorous steps to tackle this problem. It is indeed a natural function and among the "raisons d'être" of UNESCO.

The mass media are extremely powerful means of communication. They must be utilized for betterment of knowledge and understanding of peoples from diverse socio-political systems and ethnic origins. There has often been inadequate and biased coverage of happenings around the world. In this connection the Group noted the steps that are being taken to set up a News Agency Pool of non-aligned countries.

APPENDIX

The Working Group had submitted to it a comprehensive list of factors which might impede or misdirect international scientific co-operation in relation to development. Without necessarily endorsing them, the Group wishes to bring them to the attention of Pugwash for further analysis at the Symposium on Guidelines for International Scientific Co-operation in Relation to Developing Countries.

These possible factors are:

a) remnants of colonial attitudes;

b) the difficulty of ensuring that collaboration between unequal partners is indeed beneficial to the weaker partner;

c) the inadequate appreciation of the importance of creating an indigenous self-reliant scientific capability, including the promotion of basic sciences, in the LDCs, and the fact that many collaborations have contributed little to the development of their own scientific self-reliance;

d) the involvement of almost half of the world's scientific and technological manpower in weapon development programmes;

e) the involvement of a large fraction of the remaining scientists with Transnational Corporations;

f) the fact that technical advice often has economic implications - buying of equipment, plants and spares, hiring more experts, etc. - where national commercial and economic interests of DCs or Transnational Corporations are involved,

g) the possible conflicts of interests which arise from such involvements of scientists, as also from the fact that a scientist, like anyone else, is bound to be influenced, consciously or unconsciously, by his national interests, and the interests of his permanent employers;

h) the propensity of scientists to seek solutions to socio-technical problems, including those of other cultures, in terms of technological fixes, ignoring or under-estimating the social, cultural and political factors in which such problems are rooted, and sometimes even ecological consequences;

i) the unfortunate legitimization by some scientists and other intellectuals, of pernicious concepts like triage, or the legitimizing role of scientists in the Vietnam war;

j) the knowledge that, on occasions, developing countries have been treated as testing grounds for new devices, techniques and chemicals, of little or no relation to their particular interests or problems;

k) the knowledge that scientists and other intellectuals have been used, sometimes unwittingly, as intelligence agents,

and the fear that even basic research may be used as a cover for research which has military or intelligence objectives;

l) the knowledge that 'collaborative' research has often led to the development of technologies which have then been monopolized by a developed country manufacturing firm;

m) the realization of the inadequacy of various past international assistance programmes, and development strategies and models, e.g. the fact that even in an area like health, bilateral assistance from advanced countries has sometimes adversely influenced health activities and the development of health services in the poor countries, and distorted their priorities or dissipated scarce local resources and skilled manpower;

n) a general feeling of disillusionment with past efforts, among the developing country scientists.

Some of the guidelines that may be considered in this context are:

a) LDC-DC co-operation must be on the basis of reciprocity and complementarity;

b) development with outside assistance must involve the people who are supposed to be the beneficiaries, and development strategies must not be adopted indiscriminately; the identification and ranking of needs and priorities should

be made by the people from LDCs themselves, in terms of the expected impact on social and economic development. The technical and administrative control of the project and the determination of policies must rest effectively with LDC agencies and personnel concerned;

c) objectives of the collaborative project must be clearly spelt out, and research plans notified in advance so as to avoid ambiguity and misunderstanding;

d) in case a collaborative programme starts as an unequal partnership, because of the level of development of the LDC in the field concerned, it should not involve a mere passive participation by the LDC. It must have a built-in manpower training component, so as to strengthen indigenous capabilities in the course of the programme, and thus foster self-reliance and self-sufficiency of the LDC;

e) collaborative agreements should involve local experts wherever possible, and in any case be designed to require the presence of foreign experts only for a minimal period;

f) any collaborative approach which makes an LDC continuously dependent on outside non-UN resources for research and development in a critical area, must be avoided;

g) LDCs must resist the temptation/tendency to cut off indigenous efforts at a crucial stage, because foreign assistance appears on the scene;

h) collaborative programmes which involve misuse of scarce but cheap brain-power in LDCs must be avoided;

i) training programmes in DCs should carry an assurance that the trainee from an LDC will be able to pursue his level of work upon return to his country, and that the work is relevant to an identifiable priority programme in the LDC concerned. As far as possible, LDC scientists should be trained in their own countries, or in their own or similar regions, so that they may gain confidence in solving problems in their own environment;

j) exchange of experience and co-operative projects between and among developing countries themselves should be encouraged and fostered, with a view to building up collective self-reliance;

k) no collaborative programme should involve any element, apparent or real, of secrecy. All data and materials must be shared between partners. When the results of collaborative research can be commercially exploited, the right of the LDC concerned, to utilize the results first, must be ensured;

l) all collaborative research, conducted in an LDC, must be conducted, not only in accordance with the LDC's own environmental standards, but with, possibly more stringent, international environmental standards as well;

m) it would be desirable to spell out, to the greatest extent possible, socio-economic and ecological implications of new technologies or strategies of development involved in a collaborative programme. If this is not possible for want of adequate data, concurrent studies should be commissioned as a matter of general policy, so that the necessary concomitant action may be taken in time;

n) scientists from LDCs should be cautious with regard to possible security implications of collaborative programmes; scientists from DCs should ensure that they are not unconscious tools of military-sponsored research projects;

o) international organizations should not lend their prestige and support to research or documentation projects at the request of any member state to be conducted in another state; for such projects, the agreements should be directly between the countries concerned;

p) international organizations must not allow themselves to be exploited for commercial purposes, e.g. for the promotion of products which may have a marginal

bearing on the crux of a problem of development;

q) when an assistance programme under the auspices of an international agency does not really require outside experts, what is needed being equipment only, acceptance of 'experts' or 'advisers' should not be insisted upon;

r) greater use should be made of experts, including consultancy organizations from the LDCs themselves;

s) it would be desirable for transnational scientific organizations not to depend on Transnational Corporations for their funding;

t) as urged in the COCOYOC Declaration, scientists everywhere should refuse to be used as tools for the purpose of denying another nation the right to develop itself; instead of helping to design the instruments of destruction and oppression, they should make their talents available for constructive purposes, to develop new technologies which benefit man and do not harm the environment.

26th Pugwash Conference
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A. Chayes (USA)
W. Epstein (Canada)
T. B. Taylor (USA)

XXVI-28

A Proposal

The key to arms control and disarmament is openness of information about military activities. Knowledge removes fear and suspicion and creates confidence.

Progress in the field of arms control between the USSR and the USA began when they acquired the capability to observe each other through surveillance satellites.

All recent agreements between these two powers rely on "national technical means of verification", which is a euphemism for satellite surveillance. This approach was carried further in the SALT agreement where the two parties agreed not to interfere with each other's satellites and not to use extraordinary means of concealment.

This was an important step forward, but it had one major deficiency. The information produced was available only to the party that launched the surveillance satellite. This meant that while the USSR and USA could be confident because they had knowledge of each other's activities and that each was complying with relevant agreements, these benefits did not extend to other countries. Moreover, the USSR and USA acquired information about military activities of other countries without any reciprocity.

We think it would create a climate of confidence that would contribute to international peace and security if similar information from satellite surveillance of the military activities of all countries were publically and universally available.

We therefore propose that a consortium of about a dozen non-nuclear weapon states, with representation from all geographical areas and social systems, should establish a satellite system for the surveillance of the military activities of all countries. The information acquired would be transmitted regularly to the United Nations to be made available to all on an unrestricted basis in a usable form. The consortium might include such countries as Canada, Federal Republic of Germany, Japan, Sweden, Yugoslavia, Poland, Mexico, Venezuela, Nigeria, Tanzania, India, Singapore, etc.

Until an independent launch capability is available, the US and/or the USSR should provide launch services.

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Report of the Director-General

Inaugural addresses can be a trial to listeners and speakers alike, and in my baptismal report to a Conference as your Director-General I do not intend to tax your patience more than is absolutely necessary. I cannot, however, proceed to the business at hand without paying tribute to my predecessors in the chief executive office, Professor Rotblat and Professor Feld, and to the Chairman of our Pugwash Council, Professor Nalecz. The care and devotion they have given to Pugwash activities and interests are known to all of us, and we are immensely grateful. I do not believe they would want more than this simple expression of thanks. They are here today, active as ever in the work of the organization, and this support eases considerably the tasks to be faced during the next year.

As you know, the Pugwash Movement originated in 1957, following the Russell-Einstein appeal for scientists of all sides to meet and dedicate their efforts to combat the peril facing humanity from nuclear war. Almost twenty years later we can claim to have made only little progress in lessening this peril, although we can at least be thankful for having been spared thus far from a nuclear conflict. This thanks, however, is meaningless to the millions who have died in scores of conflicts with conventional weapons that have occurred since World War II.

Yes, Pugwash can chalk up certain positive contributions towards arms control and disarmament, such as our work in relation to the Partial Test-Ban Treaty, the SALT talks, the Anti-Ballistic Missile Treaty, and the Convention on Biological Weapons.

But what do we witness today. As Epstein has pointed out, between 1960 and 1975 world military expenditures have increased from some 100 000 million dollars per year to three times that amount - which represents a magnitude of waste that is difficult to grasp. This is about three times as much as governments spend on health, about twice as much as they spend on education, and about thirty times as much

as the rich countries provide as aid to the poorer countries for their development - all this in the face of hundreds of millions in the poorer countries living on the edge of death from disease, hunger and poverty.

Not one nuclear weapon, airplane, ship, tank or rifle has been destroyed by agreement. Nuclear weaponry has increased in sophistication to an almost unimaginable degree, thanks to continued and enhanced underground and missile flight testing.

And now we face the possibility of spread of nuclear weapons capability to perhaps 15 or 20 or more additional countries in the next decade. Not that this capability will necessarily mean that nuclear weapons will in fact be produced by countries capable of doing so. But the continuing mistrust, international tensions and actual conflicts that permeate our daily lives underline the basic instability of the world we live in - a precarious state of mankind that Russell and Einstein, were they alive today, would find equally, if not more disturbing, than when they issued their profoundly moving plea of "remember humanity, and forget the rest".

These facts dictate why the main preoccupation of Pugwash since its inception has been, and continues to be, to prevent mankind from destroying itself. But even the bare goal of self-preservation requires many approaches, and I shall try to review some of the paths we have taken during the period covered in my report, which dates from the 25th Pugwash Conference held in Madras, India, in January of this year.

One of these developments really has its origin in the Pugwash Symposium on a New Design towards Nuclear Disarmament held in Kyoto, Japan, in August 1975. I refer to the Pugwash Workshop on the Feasibility and Implications for a Systems Approach Study to General and Complete Disarmament which will be held in Sukhumi, Georgia, USSR, next month from 25 to 30 September. Our colleagues in the Soviet Pugwash Group have kindly arranged to act as hosts for this meeting which is so central to the concerns of Pugwash. We look forward to the results of this meeting with intense interest because of its potentially very great importance to the future activities of our organization, about which I shall say more later on.

Just three days ago we completed here in Mühlhausen, as guests of the Pugwash Group of the German Democratic Republic, the Fourth Pugwash Workshop on Chemical Warfare. You will receive a copy of the report of this Workshop during the present Conference. You will note in the report that we point to the recent tragic accident in Seveso, Italy, as an example on a very small scale as to what the consequences could be, should highly toxic CW agents be used in a future conflict. Dioxin, the chemical involved in this incident, and although not a CW agent, is comparable to some of the V-agents used in nerve gases in terms of its acute toxicity and with regard to its delayed toxic manifestations. Dioxin is cheap, easy to produce, persistent, and difficult to decontaminate; and there is no effective medical treatment for its toxic actions.

An increasing number of highly toxic lethal and incapacitating chemical substances is being produced which could be considered potential candidates as chemical warfare (CW) agents. Even though, as with dioxin, they are not at present suitable militarily for use as CW agents, their existence points to the need for prohibiting their possible development as such. This is a matter which requires continual surveillance.

Our continuous activity in striving towards a complete ban on this dreadful class of weapons of mass destruction, similar to what we were able to achieve with respect to biological weapons, exemplifies the unique type of contribution Pugwash is able to make on such difficult questions of disarmament - technical expertise, original ideas, mutual trust between scientists of different and often opposing political beliefs, and the possibility of a frank exchange of views without the constraints of official negotiations at governmental level.

Following the Workshop on chemical warfare we held, again here in Mühlhausen, the 44th session of the Pugwash Council, our governing body. We have held two intensive days of discussions, which have included the mapping out of our future activities until our 27th Conference which will be held in Munich in August 1977, exactly one year from now. The 1977 Conference will be a quinquennial one at which we take stock of where we are, and what policies and directions we shall follow during the succeeding

five years. I shall take up some of the crucial questions we shall have to decide upon at that time towards the close of this report.

In our Conference during the next several days we shall be occupied with problems of disarmament, security and development. The topic headings of our working groups reflect the content of the discussions to take place: problems of limiting and reducing strategic nuclear armaments and other weapons of mass destruction; controlling the spread of nuclear armaments; European security issues; and development and security. The usual high calibre of participants attending our Conference ensures a corresponding level of discussions and recommendations.

I should like now to describe as briefly as I can the remaining Pugwash activities since the Madras Conference eight months ago.

A. The Madras Conference

Most of the concerns of the Madras Conference were related to problems of the economically underdeveloped countries, which contribute so greatly to the unstable world in which we live. Our efforts were primarily directed towards determining what should be done to ensure as far as possible their sound and independent development towards a better material life. This was the intention of the Pugwash Council in arranging the agenda. I shall cite a few examples.

1. You will recall that the Pugwash Symposium on "Self-Reliance" held in Dar-es-Salam in June 1975 (described in the Pugwash Newsletter of September 1975) was in a sense preparatory to the Madras Conference. In Madras the subject of self-reliance merged into a consideration of alternative development strategies for developing countries. The realization emerged that different approaches would be necessary because of the diverse socio-economic and political situations of these countries and the political and economic interests of the industrial powers.

In keeping with the concept of a new economic order that now preoccupies the UN and other bodies, but which continues to receive a cool reception from most of the "have" countries, the main principle re-affirmed in Madras was the need for developing "a national capacity for autonomous decision-making and

implementation on all aspects of the development process, particularly including science and technology". Basic needs such as full employment for the people - the greatest resource of these countries - and the provision of adequate health care and education were stressed, as well as sound uses of natural resources and a greater parity in international commercial exchanges between developing and developed countries.

A concrete suggestion for Pugwash action was in connection with the World Conference on Science and Technology scheduled for 1979, preparations for which are now getting under way. A project was proposed for Pugwash to identify possible breakthrough points in science and technology where concentrated collective efforts of scientists and institutions in both developed and developing countries could be expected within a reasonable time to make significant contributions to improving the economic and social levels of the poor countries, incorporating environmentally sound considerations. Possible examples noted were: increasing the efficiency of photosynthesis; pest-resistant crop varieties; direct nitrogen fixation; inexpensive sanitary procedures for water supply, waste disposal and housing problems; and improved procedures for dealing with tropical diseases including vector control, diagnostic, therapeutic and preventive agents (e.g. vaccines), especially for parasitic infections. This exercise would be accomplished by means of a Delphi-type enquiry using the expertise of Pugwash scientists in the first instance.

Since such an undertaking would be beyond the financial and secretariat resources of Pugwash we would have to seek outside financial aid. If such aid seems likely to be forthcoming, the matter would be submitted to the Pugwash Council, along with a specific formulation of the enquiry, for decision.

2. Another major topic covered at the Madras Conference was social and professional responsibilities of scientists and technologists in relation to development. After reviewing the needs and the suggestions for individual and governmental actions, and noting counter-productive pitfalls which exist in relation to international cooperation, the Conference forwarded for Pugwash action Prime Minister Indira Gandhi's suggestion made in her welcoming speech.

The suggestion was that Pugwash take the initiative in formulating a set of guidelines or code of behaviour for international scientific cooperation. This would be analogous to the Pugwash initiative in 1974 of a code of conduct for the transfer of technology which laid the basis for negotiations now under way in the UN.

At its meeting this past April the Pugwash Executive Committee decided to take the first step in implementing the Prime Minister's suggestion by arranging a special plenary session to discuss the matter at our present Conference. The Indian Pugwash Group have signified their willingness to act as host for an international Pugwash symposium on this subject for the early spring 1977.

3. A third working group in Madras explored in some depth the complexities and difficulties of achieving the new economic order greatly desired by most developing nations and those sympathetic to their aspirations. There was a sharp focus on essential issues, and the balanced presentation provide a welcome contrast to the flood of rhetoric surrounding these issues.

The working group felt that Pugwash could be particularly useful in adjusting scientific research in advanced countries to the needs of developing nations. Four areas of research were singled

out here: new sources of food in the developing countries themselves; health; non-traditional energy sources; and assisting developing countries in obtaining knowledge of their own resources. Several of these problems will be discussed in an international Pugwash symposium entitled "Feeding Africa", sponsored by the African Pugwash Group and tentatively scheduled to be held in Ghana or another African country in the spring of 1977.

4. Another working group dealt with current issues of nuclear arms control and non-proliferation, with emphasis on these problems in developing countries. Particular attention was given to the conclusions reached at the Pugwash Symposium in Kyoto in August 1975, especially in regard to the concept of deterrence and its counter-productivity for arms control and disarmament. Because of the fundamental importance of this subject, it will be taken up at the present Conference and in the 27th Conference in Munich in 1977. A major concern here was the threat of horizontal proliferation of nuclear weapons (spread to non-nuclear states) abetted by the continued vertical proliferation (qualitative improvement of weapons) on the part of the great powers.

The impact of programmes of peaceful uses of nuclear energy on nuclear proliferation was sharply discussed, and one aspect of this problem was considered in depth at the 26th Pugwash Symposium held in Wingspread, Wisconsin, USA, in May of this year entitled "International Arrangements for Nuclear Fuel Reprocessing". The proceedings of this Symposium will be published within the next few months.

5. Working Group 5 in Madras covered current issues of conventional arms control and chemical warfare, with special reference to developing countries. Subsequent developments were the third Pugwash Workshop on Chemical Warfare (CW) held in London in April, and the fourth CW Workshop held here in Mühlhausen a few days ago which I have already mentioned.

I shall now mention a few other items before turning briefly to the preparations for the important quinquennial Conference scheduled for 1977 in Munich, and some personal comments on the future of Pugwash.

The editing of the proceedings of the Kyoto Symposium (1975) is nearing completion and the volume will be published in English and Japanese as soon as possible,with the generous financial help of the Japanese Pugwash Group.

Two recent meetings with Pugwash involvement should be noted. The first was the 6th Course of the International School on Disarmament and Research on Conflicts (ISODARCO), sponsored by the Italian Pugwash Group. This meeting was held in Nemi (near Rome) from 22 June to 7 July with some 70 participants. The ISODARCO courses have established a deservedly high reputation for their content and organization, and the Italian Pugwash Group are to be congratulated on this effort - a fine example for other national groups. The second meeting was the International Youth Science Fortnight (held annually in London) during which one afternoon was devoted to Pugwash. Several hundred budding scientists were exposed to a panel of six Pugwash veterans, with mutually informative results.

Your Executive Committee met in London on 23 and 24 April It covered many housekeeping items arising from the Madras Conference and made decisions on the preparation and arrangements for the follow-up meetings mentioned previously, as well as two important meetings scheduled within the next few months. They are the meeting in Sukhumi, USSR, mentioned before; and the 27th Pugwash Symposium on "problems of militarily-oriented technologies in developing countries" in Feldafing (near Munich) on 23-26 November.

The item of most interest to our present Conference that was dealt with by the Executive Committee concerned the future activities and organization of Pugwash, which will be decided upon at our 1977 Conference in Munich. Specifically, a series of questions were posed for circulation to Council members soliciting their views for consideration by the Council meeting immediately preceding our Conference here. This questionnaire was published in the recent April issue of the Pugwash Newsletter in order to provoke thinking on this subject throughout the entire "membership" - a permissible term if defined as loosely as the Pugwash"Movement"itself. In

April the Executive Committee decided to adopt this mechanism as part of a process which will continue until the 1977 Conference itself. Definite proposals will then have been formulated by the Council and Executive Committee for consideration, possible modification, and eventual adoption by participants in the 1977 Conference. In this way we may have the benefit of the experience of previous quinquennial Conferences when there was insufficient time to deal adequately with the subject of the Pugwash future.

B. The Future of Pugwash

In completing this report, permit me a few personal reflections on where Pugwash stands at present, which directions we should take, and how we should go about it.

I respectfully advance these views on the basis of my association with Pugwash since the memorable third Conference in Kitzbühel and Vienna in 1958. During this time I have been, and remain, a working scientist in the field of microbiology and biomedical research - in the early days one of a sprinkling of biologists amongst the predominant physicists and chemists. I have had the privilege of associating with many of our colleagues active today, as well as with the Pugwash giants of the past - Russell, Powell, Topchiev, Millionshikov, Artsimovitch, Szilard, Rabinowitch, Sarabhai, Blackett, Cockcroft - amongst others. Merely to recite that roster of names, and the memory of their dedication to Pugwash ideals, is both inspirational and sobering, a feeling which I am sure you share. I shall do my best to fulfil the aims they envisioned for Pugwash, that it be worthy of their splendid contributions.

Our persistent concern at this time is with the future of Pugwash. We are a unique organization amongst many that are working against war and social injustice. It is worth noting why we occupy a special niche. There is little doubt that whatever effectiveness Pugwash has had to date has come about from the high quality of technical analyses on the questions addressed. These analyses have been brought to the attention of decision-makers at top levels of governments often of opposing viewpoints, who have given an attentive ear to our recommendations because of the scientific and moral authority behind the formulations. These are precious and perhaps

the unique assets of Pugwash as an effective force, and their retention should be a principal concern in choices for alternative actions by Pugwash.

It is not enough to issue reports, make periodic declarations such as our Kitzbühel-Vienna statement, or to endorse the Helsinki agreement on détente. It is doubtful that exhortations per se have been very effective; concrete action is urgently required to implement them. Pugwashites need no reminder that time is running short. This is the most compelling reason for a re-appraisal to determine how we can function with maximum effect.

The questions formulated by the Executive Committee on the future of Pugwash take into account the realities of limited finances and staff and, most importantly, the nature and priorities of Pugwash and its modus operandi.

As many of you know this set of problems has been debated by your Council and Executive Committee for more than two years, in the course of implementing the mandate of the last quinquennial Conference in Oxford in 1972. On such matters it is to be expected that different views are held, and it is possible that difficult choices may have to be made in our 1977 Conference.

Let me sketch briefly what I consider to be the core problems and choices that must be resolved.

1. Should Pugwash attempt to expand its operations and "membership" to become a mass movement with a broad public base? Any marked change towards a mass movement would of course have to take into account our present constraints of limited finances and secretariat. This approach has been rejected in the past, a feeling that seems still to prevail today. This does not however exclude, and actually encourages, a widening of active participation by leading scientists, including younger ones, in its meetings and activities. And here the principle of universality is most desirable: scientists from all countries should be involved, including those of the People's Republic of China whose continued absence at our meetings is highly regrettable.

2. What should be our priorities? Our major area of preoccupation during the past decades has been the prevention of nuclear war and

other forms of armed conflict. Linked with this during the past several years has been our increased concern for problems of the economically underdeveloped countries in achieving a betterment of their present low socio-economic levels. Our attention to environmental pollution, energy resources, population increase and technological developments such as genetic engineering should not be overlooked, but they have been subsidiary to the areas just mentioned. All are vast and highly complex fields, and Pugwash cannot make its unique contribution to all or even many of their aspects. Should we extend our presently limited resources and thereby perhaps dilute our contributions in certain areas, or should we concentrate on very selected problems? Can we formulate criteria of choice for our priorities?

3. In considering the questions just posed, we must face the increasingly important dimension of antagonisms between the "have" and "have-not" countries, and between the have-nots themselves, in the military, political and socio-economic spheres. Our views of the great powers as playing the central role in a possible generalized nuclear war may no longer be valid, particularly insofar as trigger events are concerned. Should Pugwash give more attention and emphasis than it has to many aspects of antagonisms and conflicts of interest between the rich and poor countries. However, as presently constituted and financed, Pugwash probably could not do this with any degree of effectiveness. And even if our organization is substantially modified to meet this challenge, can a unique role for Pugwash in this area be identified?

4. Finally, the formal structure of Pugwash and the functions and interrelationships of its governing bodies, national groups, and secretariat must be re-examined. A decision must be taken as to whether it should remain loose and relatively informal, or assume a more concrete organizational form. In my view the rather informal basis that has existed until now is both desirable and sufficient to ensure effective functioning, and should continue. It appears to me that a larger and more rigid bureaucratic structure would be unwise and less adaptable in our rapidly changing world.

These, to me, are the major and most difficult questions to be resolved at our Munich Conference in 1977. The other decisions to

be taken according to the questionnaire cited previously will, I am sure, be much easier to make. Your Executive Committee, Council and officers rely on your active concern and participation, individually and through your national groups. And in this process, as in our meetings, we must avoid the scoring of points for this or that establishment or political viewpoint; the UN and other organizations are welcome to that. For Pugwash such an approach would be fatal.

I am sure you share my conviction that Pugwash has an important role to play at this crucial stage of world affairs when the alarm signals are insistent and increasing. On certain questions our role could well be a decisive one. Our clear duty therefore is to ensure that Pugwash can and does respond effectively to the formidable challenges facing it. Each of us must accept and discharge that commitment in the spirit of Pugwash - with scientific integrity, mutual respect, flexibility, and tolerance of opposing viewpoints.

M. M. Kaplan

The Fourth Pugwash Chemical Warfare Workshop

Mühlhausen, GDR, 22-23 August 1976

Participants

Professor Z. Binenfeld (Yugoslavia)
Dr J. Franek (Czechoslovakia)
Professor E. Jacchia (Italy)
Dr M.M. Kaplan
Professor K.H. Lohs (GDR)
Docent J. Lundin (Sweden)
Professor J.K. Miettinen (Finland)
Mr J.P. Perry Robinson (UK)
Dr K.J. Schmidt (FRG)
Professor V. Vojvodic (Yugoslavia)

Agenda

1. Developments at the CCD since the third Workshop
2. Medical preventive measures for protection against nerve gases
3. New ideas on verification procedures
4. Preparations for visit to an organophosphorus production plant in the FRG, and consequent symposium around the time of the 1977 Pugwash Conference in Munich

List of papers submitted

Z. Binenfeld and V. Vojvodic: Medical protection against nerve gas poisoning: present situation and future possibilities

K.H. Lohs: Dioxin - a new warfare agent

K.H. Lohs: Regular medical checkings serving as a means of determining the state of health of all those who are employed in making and using organophosphorus compounds

J. Lundin: On arms control negotiations and on the ban on chemical weapons

J.K. Miettinen: Recent international developments in the field of chemical disarmament

Report from the Workshop

At its fourth Workshop, the Pugwash CW Study Group reviewed developments at the 1976 sessions of the Conference of the Committee on Disarmament (CCD), and the present international situation in the field of chemical disarmament, as an additional contribution to that of the Third Workshop held in London in April of this year. The purpose of the meeting, as at previous Workshops, was to focus on salient issues in which Pugwash efforts would contribute constructively to the attainment of a comprehensive ban on the development, production and use of CW agents, along with destruction of existing stockpiles. The main agenda item concerned preparations for an exercise involving an "on-site" visit to a large industrial plant manufacturing organophosphorus pesticides. The exercise would be designed to clarify the parameters of such on-site visits as part of the verification provisions in a comprehensive CW treaty.

Certain encouraging developments during the past few months were noted. These were:

(1) A revival of interest on the part of the USA in proceeding towards resolution of substantive issues. For example, the USA has put forward suggestions within the CCD on minimally intrusive measures of verification, and has announced a willingness to have observers witness the destruction of part of its stockpiles.

(2) The informal CCD meeting in July at which technical experts from several countries presented interesting working papers on scope, verification procedures, CW protection, and destruction of stockpiles.

(3) The tabling in August of a new draft CW treaty by the UK.

These developments, while encouraging in a certain sense, are still insufficient. All of them are based on the premise that the achievement of a comprehensive chemical-weapons ban will require many years at best, with at least ten years being needed for the destruction of present stockpiles. The graduated mechanisms now being envisaged for implementing such a ban are all very involved, with many potential pitfalls unless each step

is undertaken with a degree of mutual trust which clearly does not yet exist. For this reason, and in view also of the real danger of proliferation of CW weapons to countries not already possessing them, the Group considers it most regrettable that more urgent action at a high political level is not being taken to achieve the desired total ban within the near future, analogous to that achieved with respect to BW weapons. It is to be hoped that the long drawn-out process envisaged will be considerably shortened so that the world will be rid as soon as possible of this particular class of weapons of mass destruction.

Medical protective measures against organophosphorus (OP) CW agents

The Group reviewed developments in the field of medical protection only insofar as they related to mass-casualty situations from the employment of highly toxic phosphorus-containing CW agents. The present background situation is as follows:

Medical measures for preventive purposes in all situations relevant to OP agents are very subsidiary to the first line of defence which comprises physical protection (masks and protective clothing) and decontamination of affected areas. The main problems that would be encountered in treating OP poisoning in mass-casualty situations are that with existing possibilities of treatment:

(1) there is a very low limit to the dose of OP compounds that can be treated successfully; and

(2) even with available chemotherapeutic compounds (atropine, oximes) - and against poisoning by some OP agents such as soman there is no effective chemotherapy at all - their effective application requires prompt use and skilled follow-up. This, plus the impossibility of administering artificial respiration in the field to a large number of people, negates almost all possibility of dealing effectively with mass casualties.

In the past year or two there have been some interesting scientific developments, though not as yet applied practically, with respect to improved antidotes. There is now, for example, a definite possibility of developing potent oximes of low toxicity that are capable of penetrating the blood-brain barrier considerably better than existing oximes. Other theoretical but far-distant possibilities are the development of substances capable of inactivating OP compounds in the body prior to inhibition of acetylcholinesterase; and the development of immunization procedures against OP poisoning, using OP compounds as haptenic antigens. It must be stressed, however, that success in such endeavours that would result in practical measures would appear to lie in the relatively distant future.

Nevertheless, in view of the very small number of scientific workers engaged in such work, and their relative isolation from each other, Pugwash in the past has encouraged informal meetings of such workers from different countries in order to encourage exchange of information and experience, e.g. the meetings in Herzeg-Novi in 1974 and Helsinki in 1975*. The Group consider that such meetings should be continued, and that efforts should be stimulated to improve the dissemination of information relating to OP poisoning and therapy, and also with respect to protective equipment.

Non-organophosphorus CW agents, and the question of scope

The CCD negotiations have shown that one consequence of adopting a stepwise approach towards CW disarmament is that the definition of scope becomes a most sensitive matter. The Group reiterates its firm belief that the ultimate objective must be a fully comprehensive CW treaty, and notes that the latest draft treaty, tabled at the CCD by Britain, seems to fall short of this objective. Thus, in contrast to the 1972 BW Convention, the British CW draft does not appear to cover antiplant or antianimal agents; and there is also an obscurity of language

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* As reported in Pugwash Newsletter 13(3):177-180, 1976. The proceedings of the Herzeg-Novi meeting have just been published by SIPRI: Medical Defence against Chemical-Warfare Agents (Stockholm, 1976).

regarding incapacitating antipersonnel agents (psychochemicals, irritants, etc.).

In the reports from earlier Workshops, the Group has noted the existence of an increasing number of highly toxic lethal and incapacitating chemical substances other than OP compounds which could be considered as potential candidate CW agents. Even if not at present suitable for use as CW agents, their existence points to the need for prohibiting their possible development as such. This is a matter which requires continual surveillance and which underscores the need for a CW treaty that is fully comprehensive in scope.

The recent tragic accident in Seveso, Italy, involving dioxin (2,3,7,8-tetrachlorodibenzo-p-dioxin) demonstrates on a very small scale the consequences of what would happen should highly toxic CW agents be used in a future conflict. Dioxin is comparable to the V agents in terms of its acute toxicity, and it is in addition one of the most dangerous synthetic poisons known with regard to its delayed toxic manifestations. Dioxin is cheap, easy to produce, persistent, and difficult to decontaminate; and there is no effective medical treatment for its effects.

Verification and confidence building

In considering the problem of verification, the Group built upon the results of its earlier meetings, as summarized in the Final Reports from the three previous Workshops. These had emphasized the importance of incorporating in a CW treaty provisions for verifying stockpile destruction and CW-agent non-production; and the report from the London Workshop had envisaged procedures for both these purposes in which national and international verification organs worked in concert with one another, using a range of techniques not excluding on-site inspection visits.

It was recognized that mutual trust would be an essential component of a CW disarmament regime, for no verification procedures, however intrusive or elaborate, could ever provide complete assurance that a CW treaty was being fully observed. The conclusion reached at this Workshop was therefore that one

purpose of verification should be to enhance mutual trust in the treaty. To this end, verification procedures may be seen as a complement to other confidence building measures.

The Group noted the attention given to confidence building in the British draft, realizing, however, the inherent difficulty in the specific measure envisaged (the requirement that States declare their stockpiles upon signing the treaty but before its entry into force). It was recognized that declarations of stock would do a great deal to build confidence, and that for this reason governments should be urged to make such declarations on a unilateral basis, even before the signing of a treaty. The Group noted other areas where mistrust existed and for which remedies were possible. In particular, the Group recommends that governments should agree, in the spirit of the Helsinki Declaration, to give one another prior notification of CW defence exercises during military manoeuvres, and to invite foreign observers to witness the exercises in order to verify their non-offensive nature.

Another possible measure would be the exchange of information on the health care of people working with highly toxic OP compounds, who, of necessity, must receive regular medical examinations. People involved in the destruction or detoxification of OP CW agents, an essential part of CW disarmament, would come within this category. A procedure for such exchanges could provide a confidence-creating measure as part of a programme of national and international verification.

The Group noted again that its own meetings served as a measure of mutual confidence building.* For instance, the proposal made at an earlier Workshop concerning exchange visits to chemical-destruction facilities was now before the CCD, at the instigation of the US delegation. It was felt that this function of the Group could profitably be expanded. Accordingly further attention was given to the possibility of mutual exchange visits to chemical facilities for the purpose of gaining understanding of on-site

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* It is regrettable that the participants invited from the USA and the USSR were unable to attend this Workshop.

inspection techniques. The Group noted with appreciation the willingness of a major Federal German organophosphorus producer to receive such a visit at one of its plants, and a sub-group was set up to do the necessary planning*. A draft questionnaire has been prepared (somewhat along the lines the questionnaire developed during the Pugwash BW exercise); this will serve as a basis for refinement before and after the visit.

Finally, the Group considered that the Pugwash Movement as a whole could contribute further to the advancement of CW disarmament. National Pugwash groups should be encouraged to advertise more widely the dangers which chemical weapons present to the world, particularly at a time when sophisticated armaments are proliferating so widely and so rapidly.

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* The convener of this sub-group is Professor J.K. Miettinen. His address is Unioninkatu 35, Helsinki 17, Finland.

26th Pugwash Conference
"Disarmament, Security and Development"
Mühlhausen, German Democratic Republic, 26-31 August 1976

IN VITRO RECOMBINATIONS OF DNA MOLECULES AND WORLD AFFAIRS

Herbert Marcovich (France)

A new methodological development has recently raised great concern among biologists. This development consists in the possibility of recombining DNA molecules in the test tube, irrespective of their origins, and allowing them to be replicated in a bacterial cell. This technique, also called Genetic Engineering, overcomes some of the barriers which were developed during evolution with the consequence of isolating the genomes of the various species. A moderately skillfull biochemist is able, today, to recombine DNAs originating from species whose common ancestor might have lived in the distant past. New genetic sets, which most probably have never occured before, may be created in the laboratory. The perspectives opened by this breakthrough seem immense. However, as always in such circumstances, what is forseen is a mere extrapolation and amplification of the recent developments and probably beyond what is actually likely to happen.

Beneficial applications and also frightening consequences are anticipated in medicine and in biological technology, whether accidental or deliberate. Because of the latter, scientists actively working in the field have tried to assess the evil spin-off of genetic engeneering and have tried to establish guidelines for research in this area. Several meetings and

publications are the expression of this concern. Scientists of all disciplines, as well as laymen, have been informed that something has happened in biology which might endanger humans to an extent which no one is capable of predicting with any accuracy. A recent report from the NIH (June 23, 1976) is an up to date document on the three years history of DNA recombination in vitro.

This presentation aims at placing the problem of in vitro DNA recombination in context by reference to what occurs in vivo. Some consideration will be given to the latter so as to render understandable the essence of the new technology and, hopefully, to give to the non-specialist the fragrance of the arguments put forward by those who work in the field. But is fragrance enough to communicate the taste of the meal ? It must be pointed out that among the very ones who contribute actively to that research there are differences, with important nuances, in appreciation of the attitude to adopt.

I The natural Process

Genetic recombination is one of the basic motors of evolution. It is the process which results in new genomes being built from parental ones. If mutation, that is inheritable changes of the genotype, is the way to "invent" new traits, if Darwinian selection "picks up" suited individuals, recombination is the mechanism by which novel genetical sets are made by rearangement of preexisting ones.

It took the biosphere billions years to reach its present state. Species have differentiated and evolved in divergent directions ; they are now separated from each other

other by fences so efficient that no detectable genetic exchange whatsoever can take place between them. In fact, the definition of a species is based on the ability of its members to recombine, through sexuality, their hereditary characters.

Genomes are complex and elaborate systems, where the informational content is very high ; random events modifying of any/their properties may result in their complete destruction. molecular The most severe/damages occuring to a cell are changes in its genetic material, since there is little correction or compensation at that level. Indeed, the DNA is well protected against agressions by external agents such as radiations or chemicals by a complex system of repairing enzymes which, in very special cases, erase ultraviolet induced lesions (photoresto ration) or, more often, withdraw the damaged region replacing it by a newly synthetized material, almost always identical to the deteriorated one.

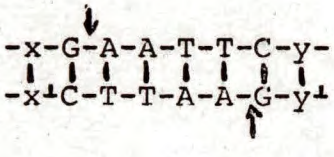
Speaking in teleonomic terms, it is understandable that "Nature" has raised barriers against any intrusion of unwanted material in a genotype.

Three types of defences exist :

a) Sexuality : No acquisition of novel DNA can be achieved if the two genotypes concerned are not in the same cell, the zygote. In higher organisms, Eucaryotes, the two parental genomes are present in equal amounts. In bacteria, Procaryotes, one cell is the receiver ; the other cell, the donor, contributes in most cases only a portion of its

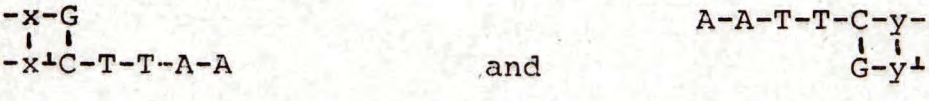
genome. We shall consider only procaryotes. Several mechanisms for genetic transfer exist in them. Transformation, which is the direct acquisition of DNA from the donor cell; Conjugation, which consists of a transfer of DNA via a cell to cell contact; and Transduction, which involves a carrier bacteriophage for the donor's DNA. All three processes play an important role in the technology utilized for genetic engineering.

b) Restriction and modification : A bacterial cell contains enzymes nucleases which degrade the DNA. Some of them cut it down to the level of its building stones, the nucleotides. Others cut the molecule into large pieces, some millions molecular weight. The latter, called Restriction enzymes, "identify" sequences of nucleotides where they produce the cut. This sequence is characteristic of each restriction enzyme. For instance, the enzyme EcoR1 recognizes the following :



where A= adenine, T= thymine, G= guanine, C= cytosine, and $\begin{matrix} x \\ \perp \\ x \end{matrix}$, and $\begin{matrix} y \\ \perp \\ y \end{matrix}$, any base pair.

The arrows indicate the sites where the strands are broken. The action of EcoR1 is to create molecules of the following structure :



The single strands so created are called "cohesive ends". The frequency of occurrence of the specific sequences depends on the length, which consists of a few base pairs for a given length of the DNA molecule. Because of this small number, any

DNA will have restriction enzymes specific sequences.

The important feature in this process is that the cut usually does not take place in homologous links of the two chains of the DNA molecule, but rather at symetrically located bonds/ a few bases distant, leaving by this token single stranded complementary sequences of bases as illustrated in the preceding scheme. This property is at the core of the genetic engineering technology. However, it was recently found that one could recombine DNA with no cohesive ends .

The actual DNA of the cell is not subject to such attack. It is "ignored" by the nucleases because it bears modifications consisting of radicals added to the DNA molecule according to a specific pattern. This is achieved through the action of Modification enzymes, proper to each case. As a consequence of Restriction-Modification, any DNA which does not have the modified pattern of the cell where it penetrates will be destroyed, unless modification enzymes operate on it before the intervention of the restriction machinery. This event is of a rather low probability (10^{-4} to 10^{-5}) but, owing to the size of the bacterial populations realized in current experimentation, is always present.

c) Homology : DNA from various species differ by their overall/average base composition. This may be explained as the consequence of divergence in Evolution, rendered possible by the degeneracy of the genetic code, i.e. that there exist several codons / (segments) specifying one amino-acid. There is some naivity in this statement, but it would take too long to/make explicit the proper nuances. The difference in base composition is a

dramatic one. More subtle differences exist between genomes of the same average base composition and, much more important, between the different sections of the same genome : there resides the homology property. Once an "alien" DNA has succeeded in penetrating a cell, once the Restriction defense has been neutralised by the modification system, homology appears to be the last, but extremely powerful, defense.

In order for recombination between two DNAs to occur, there must be breaks, free single stranded ends and homology for insuring the adaptation of the DNA fragments. This eventuality is very unlikely, since the probability of complementary single strand ends being produced is extremely low if the molecules do not pertain to the same species. On the other hand, genetic recombination between sister molecules is extremely frequent. Breaks at any place on the lenght of the chromosome will be able to match with the homologous site of the partner DNA. This mechanism is known as the break and rejoining process ; it is a very complex one ; the restriction enzymes do not seem to play any role in it. The ensuing exchange of genetic material maintains the complete integrity of the informational content of the chromosome, especially the location of every gene.

In summary, the three processes referred to make a spontaneous inheritable acquisition by a cell of a foreign DNA very unlikely unless the source is of the same species as the receiver. Their actual efficiency and their role during the early stages of evolution can reasonably be assessed, but is conjectural.

II DNA recombination in vitro

Biochemists have changed the picture and have introduced a new dimension to the problem of genetic exchanges. If a comparison is permitted, what occurred in Biology is the same kind of thing as has recently been described in nuclear physics ; "Nature" had operated nuclear reactors at Oklo, in Gabon, some billions of years ago, whereas modern technology...!

In vitro genetic recombination has become an easy task for biochemists since the discovery that restriction enzymes produce cohesive ends in DNA.

Treating DNA of different species by one restriction enzyme produces the same cohesive ends, which can then serve for anchoring the various fragments, irrespective of their origin. The welding of the segments so attached is achieved using an enzyme, the DNA ligase, which establises the solid covalent bond between the adjacent ends of the strands. As a consequence, one can insert a fragment of any DNA into a carrier adaptor segment of DNA able to penetrate, multiply and eventually operate within the host. The homology barrier is, hence, overcome.

III The biological system

This system has two components : the vector and the host. In the present type the host is the colon bacterium Escherichia coli, which is the organism whose genome is by far the best known. Many varieties of E. coli exist. The strain utilized currently is E. coli K 12, which was isolated a few decades ago and which is at variance with the normal host in the human bowels. The vector DNA may be either

the DNA of phage lambda or the DNA of a plasmid. (Plasmids are organelles having an autonomous replication ability in the host. They can carry metabolic or antibiotic resistant characters.)

Investigations are being pursued for developing other host-vector systems. Bacillus subtilis seems at present very promising.

IV The promises of genetic engineering

What can be forseen from the technological breakthrough is obviously beyond what is likely to occur. The predictions are all based on the fact that E. coli is currently grown in amounts as large as needed, in rigorously defined conditions and under biochemical as well as genetic control. Instead, the study of the mechanism of regulation in Eucaryotes suffers from the complexity of the system. For biologists, it is a dream, which tends to become reality, to dispose of a certain quantity of one gene of higher organisms in the test tube, functioning and responding to signals. This is what it is hoped will be obtained at first from the stand point of fundamental research.

Applications are obviously envisaged. Any protein or biological substance which is difficult to obtain directly from the normal producer would be obtained at low cost if synthetised by the responsible gene harbored in E. coli. This will be the case for scarce hormones and for antibodies. Agriculture would also benefit : for instance, the introduction of the gene for nitrogen fixation into bacteria present in the earth would be of a tremendous economical importance. However, the same technique could lead, deliberately or

accidentaly, to dangerous substances. The only difference between Dr. Jeckyll and Mr. Hyde is the choice of the DNA to be recombined. This DNA could be the one which controls the production of insulin, the recently detected sleeping factor, clotting factors, or perhaps the DNA of a cancer-inducing virus or a toxin-producing organism. At the present stage, very little is known on how to isolate the DNA of a given gene. Complicated and inefficient techniques achieve this goal in a few particular cases. What is done at the present are "Shotgun" experiments where all the DNA of an organism is chopped into pieces by the restriction enzymes and recombined with the chosen vector DNA. Such a procedure with mammal DNA could be hazardous, owing to the poor knowledge of how it can be contaminated by harmful viral genomes. If the danger of experiments with Eucaryotes DNA is mainly conjectural, it seems more real when dealing with some procaryotes, in particular those with which E. coli does not exchange genetic material. Aside from undefined new properties that this strain may acquire, there is a real anxiety about the recombination with genes controlling the production of such toxins as the botulinic, the tetanic, the diphteric or any others.

The essence of the fear is based on the ability of E. coli to multiply in the human intestines harboring or not a recombinant DNA, beneficial or detrimental. This means that, potentially, a strain escaping from a laboratory could invade the entire human population. Such a contamination has, in theory, nothing in common with chemical or radioactive contamination, since these, no matter what their level, can spread but not multiply.

The preceding may give the impression that the "evil" surpasses the "good". Actually, an increasing number of scientists use the genetic engineering technique for fundamental research. As for any useful achievement, any hazard must be taken into account. Would one seriously considerer stopping electricity production because of electrocution, or morphine production because of drug addition, and so forth ?...

The uniqueness of the situation created by genetic engineering is that biologists are aware of the size of the potential hazard, which is unequalled in other fields.

V The containment problem

The range of the potentially hazardous experiments is very wide, going from obvious dangers (toxin-DNA,...) to the inocuous (DNA from the viruses of E. coli, ...). Containment measures have been envisaged for various types of experiments.

a) Physical containment is easy to conceive, but has a rather limited efficiency since, in theory, one dangerous bug leaking out would be enough. It consists of sealed laboratories maintained under negative pressure, with sterilizing devices for all material which has to be taken out. However, as regards the people who perform the experiments there are no satisfactory solutions.

b) Biological containment combined with physical containment is much safer. First of all, it must be said that the strains of E. coli where the recombinant DNA is introduced

have been chosen for not having the restriction modification system ; this ensures a high efficiency of successfull DNA transfer in them, but also the destruction of that DNA were it to infect a wild type strain. In addition, the host strains are constructed with mutations which render them unable to grow outside the laboratory, owing to stringent, demanding recquirements, both chemical and thermal. The same applies to the vectors which cannot multiply / except in very restricted strains, and in particular have been chosen not to be able to recombine with the host DNA. These measures decrease considerably the probability of escape. Taken together, the various precautions lead to a probability which is difficult to assess, but amounts to some 10^{-12}, or possibly less, for a dangerous bug leaking out to contaminate the environment, in particular the human intestines.

One last remark on the containment question. All previous discussions assumed that the recombined DNA from Eucaryotes, once harbored by E. coli, is able to initiate the whole set of events which result in the synthesis of a specific protein. Indeed, it has been shown of such DNA replicates, that it is transcribed into its specific messenger RNA.

However, it seems that the translation machinery of the host does not understand at once the language of the Eucaryote messenger. This makes the problem of genetic engineering much more complicated and, in some respects, of increased safety. There are, however, reasons to believe that this problem will shortly be solved by inserting, with the foreign DNA, the necessary key for translating the message.

VI The ethical problem

The concern raised by the potential hazard has led to the creation of Committees in the USA and in Western European countries in order to regulate the safety measures.

Little is known on what is being done in the Eastern European countries and in China. These Committees are composed essentially of biologists mainly those active in the field. There was some protest about the fact that those who make the rules are the very ones to whom the rules are applicable. The argument is unfair for two reasons : 1) There will be a growing number of scientists who will use this technology for fundamental research. It must be emphasized that Biochemical Companies and the Military laboratories will also, if not already done so, they have enter the area. 2) The biological containment problem is a highly technical one, as well as the apraisal of the hazards of certains types of experiments. No one but the people in the field can contribute to the definition of the needed security, owing to their deep understanding of the problem.

In 1975, an international meeting was organized at Asilomar in California in order to evaluate the situation created by the recombinant DNA research, and to weigh the various arguments, pro and con, which were made at various preceding gatherings and discussions.

It was agreed that research should continue, provided that precautions be taken, depending on the particular system involved.

of the US National Institute of Health (NIH), An ad hoc Committee, working on this basis, drafted a series of guidelines which were discussed before being published in June 1976.

These guidelines are subject to revision in the light of knowledge acquired as the research proceeds.

They may be summarized as follows.

1° Experiments are classified according to their potential hazards, and the conditions to be fulfilled take into account the joint availability of the required physical and biological containment.

2° Any one who would perform work using genetic engineering should submit the project to the relevant Committee of his country for approval. It is of the highest importance to stress that the advice of the Committee will be grounded, not on the scientific legitimacy of the subject, but on the nature of the safety devices and biological containment utilized. It must be stressed also that some experiments are forbidden since there is not at present any reasonable safety measure that could be taken ; for example, recombination of the DNA from highly toxigenic bacteria and DNA from carcinogenic viruses.

3° It has been suggested by NIH that no grants would be given to projects which do not abide by the prescriptions.

4° As a counter part, the strains possessing the required property for biological containment will be at the disposal of any one who would ask for them. All the findings and the experience acquired will be open.

The disincentive for researchers to infring the rules are very strong, since all that is discouraged concerns matters

of safety. In addition, the specialization is such, the problems to attack so elaborate, that in order to perform a meaningful experiment with DNA from different species, the cooperation of scientists in various areas is necessary. Secrecy cannot then be kept, and it is in the end / more profitable to follow the regulations. This obviously does not apply to cases where secrecy is an important feature, e.g. industry and army. It is sad to recognize that there is apparently nothing that can be done. One must conjecture that the guidelines for DNA recombination in vitro will be followed, because there is nothing to gain by / not abiding by / them. The attitude of any scientist to cooperation with these guidelines / is a matter of personal ethics.

There is a last possibility for uncontrolled dangerous manipulation : a group of moderately trained biochemists may insert toxogenetic genes into E. coli and use that material as a / threat, for some political or other reasons. The / prevention is not easy to imagine, since such work can be performed at low cost, in complete secrecy, with moderate sophistication. No effective measures of immunisation are conceivable because of the scale and also because of the variety of toxins which can be involved.

VII Genetic engineering and public opinion

In this instance, as in many others, public opinion operates according to short circuits and information of insufficient accuracy, since the essence of the problem is far too difficult to be really understood at

that level. And yet information must be given to the public. People must express their views and these must be given due consideration. Even highly educated scientists have astonishing reactions. For instance, a protest came in one case against the implantation of a negative pressure laboratory in a given building, whereas nothing was said when the final decision, for practical reasons, was to put it a few tens of meters distant in another place. Many do not realise that the potential hazard does not concern the vicinity of the laboratory, as for chemical and radioactive substances. What is at stake is the possibility of an epidemic by the recombinant DNA, which would affect millions of people, if not the whole human race, although this is a very remote possibility.

Some recommend the prohibition of *in vitro* DNA recombinant experiments. This raises the problem of the freedom of scientific activity. From a practical stand-point, the control of genetic engineering at the level of the individual scientist is almost impossible. The techniques involved are common to many other areas of research in biology. If a scientist wanted to make in secret *in vitro* DNA recombination, there is little possibility that a colleague in a room next to him would be aware of it unless he deliberately watches what is going on. This means that for prohibition to be effective, there would need to be a post-doctoral policeman next to every biochemist, one knowledgeable in the field of molecular biochemistry, or alternatively all biochemical laboratories would need to be destroyed.

The problem of control for safety in genetic engineering is a world wide one. In principle, only one institute in the world needs to be engaged in potentially hazardous work without controls to diminish to a great extent the efficiency of the safety measures taken by others.

Little is known on what is, or will be, going on in laboratories other than the westerns/ones. No information is available on the situation in/the Soviet Union, in China and in Eastern European counties. Others, among the LDCs, are in/a good position to enter the play. There is little doubt, in view of their high scientific standard, that these have already performed in vitro DNA recombination. The size of the problem is of such a magnitude that valid scientists working in the area are likely to contribute decisively to all aspects of the issue, fundamental, applied or for safety.

It is perhaps proper in this forum to tackle the problem, for example, by creating a study group which, in close linkage with the existing Committees would use the same approach as the Pugwash Study Group on Biological Warfare.

Ultimately, for scientific questions credit must be given to scientists who, no less than any others, can make mistakes but who have in their hands information on which to make reasonable assessments. Interdictions by others would inevitably lead to obscurantism/and intolerance, as interdiction and censorship would in any other human activity.

SOLAR POWER the photochemical alternative

Billions of years ago nature developed the technique for converting sunlight into chemical energy. If man could harness this energy as efficiently as the plants do, he might find an ultimate solution to the energy crisis. Creation of an international research institute would be a good first step in this direction

E. Broda

The approaches to solar energy conversion which are most frequently considered are those designed to provide solar heat (through the use of solar collectors) or electricity directly (through the use of solar cells). Another approach, however, which promises to provide the best solution in the long run to the energy problems of mankind, is one which has been sadly neglected: the photochemical utilization of solar energy. This approach, for instance, is not even mentioned in the 1975 handbook *Energy R&D—Problems and Perspectives* of the Organization for Economic Cooperation and Development (OECD).

True, the use of solar heat, which is relatively easy technologically and economically, ought to be encouraged in every way, especially in hot countries with few other sources of energy. Many experts feel that house heating, hot water production, cooking and even the decentralized production of power by way of steam could be economical now in many circumstances, or in the near future, especially if the needed devices were produced commercially.

Solar cells for the production of electricity have reached efficiencies of 15 percent and more, and have proved their value in space research. At present, unfortunately, these solid-state devices, which collect the energy of the Sun and convert it directly into electric power, are very expensive. This is due to the cost of the preparation of the material. Breakthroughs in production methods would not contradict any known law of Nature. Cheaper cells in the future *are* possible; and research in that direction definitely ought to be pushed.

But it is a strange fact that so little attention has been given to the photochemical approach. Again no law

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of Nature stands in the way of the exploitation of solar energy at high yield. Moreover, the validity of the photochemical approach has already been demonstrated in the most striking way and on a truly gigantic scale. Nature invented the necessary technical process more than 3 billion years ago—that is, when the first photosynthetic organisms were born. Indeed all life, as we know it, is based on solar energy through photochemistry.

Photosynthetic bacteria are the forerunners and ancestors of the plants we see around us; plants are a later and more efficient model.Being less efficient than the plants, the photosynthetic bacteria ("purple" and "green" bacteria) are not so important any more in the household of Nature. Still we can be happy that a few dozen species at least survive. For research, these creatures are invaluable because their variant of photosynthesis is so much simpler than in the very advanced and complicated later organisms—the plants. The essence of bacterial photosynthesis and how it differs from plant photosynthesis was explained in simple chemical terms some 40 years ago by a genius from the Netherlands, Cornelius Van Niel.

Whether bacteria or plants, the aim of the organisms (let's not shun teleological terms) is in every case the utilization of solar energy for the production of hydrogen in a chemical form in which it is "loaded" with energy. (For the scientist, hydrogen at high chemical potential.) Energy-loaded hydrogen undergoes chemical reactions readily. It can be forced on an acceptor molecule even if the molecule is reluctant. In the reaction, the acceptor is "reduced." In photosynthesis in plants, the hydrogen comes from water and one speaks of the "photolysis" of water. Bacteria exploit other, less common, sources of hydrogen, for example, hydrogen sulfide.

Photosynthetic organisms use the energy-loaded hydrogen ultimately to force a reaction with carbon dioxide (assimilation). This abundant component of the atmosphere is then reduced to carbohydrates, proteins, fats, and the multitude of other plant constituents. For these reactions, certain mineral substances, including bound nitrogen and phosphorus, are also required. In reality, of course, the biosyntheses require many intermediate steps, many of which have already been elucidated by the biochemists. The steps are catalyzed by enzymes.

One should learn from the plants and be inspired by them in building up artificial photochemical systems for optimum production of useful substances.

Here we are not concerned with these details. From our point of view, what matters is the efficiency with which the energy of light is utilized by the photosynthetic organisms. In optimal conditions—in the laboratory—energy yields of 20 percent and more have been obtained with microscopic algae which lend themselves well to experimentation. That is, 20 percent of the absorbed solar energy has in these conditions been invested into the chemical energy of body matter (biomass). The conditions are not difficult to achieve. In the utilization of the biomass by man, the stored energy can be recovered.

Energy Plantations?

In view of the mastery and seeming lack of effort with which plants operate, "energy plantations" have again and again been suggested. Suitable plants, like alfalfa, sugar cane or poplar trees would be grown on large areas, and exploited as renewable sources of energy. Unfortunately, such schemes clash with the use of land to grow food and raw materials, like fibers, and it is unlikely that much useful farming land can be made available for energy plantations now or in the future.

Area, however, is not a limiting factor in the cultivation of suspensions of unicells, notably microscopic algae (Chlorella, Spirulina), as energy sources. Enormous harvests per unit area and time can be obtained in tanks. Quite possibly such processes will be economical one day.

A general consideration in energy farming is that the plant has not designed itself to serve man. It is not optimized for the production of biomass, and it cannot be. The plant has evolved so that it survives in the struggle for life. It does not produce biomass indiscriminately. Rather, it must use many of its resources to look after itself in other ways. The plant must search for and absorb water and minerals; it must protect itself against unfavorable weather; and it must struggle against competitors, predators and diseases. Last but not least, it must produce enough offspring.

Therefore one should not limit oneself to the use of plants as they are or as they possibly could be reconstructed; treatment and breeding have their limits. Rather, one should learn from the plants and be inspired by them in building up artificial photochemical systems for optimum production of useful substances.

As shown by Van Niel, plants (like photosynthetic bacteria) primarily make energy-loaded hydrogen. While the energy would, according to calculations, be sufficient for the production of hydrogen as a gas, the hydrogen is rarely released in the free form by plants. The plant needs the hydrogen for the reaction with carbon dioxide; therefore, a release as hydrogen gas would not make sense. Thus, after absorption of light, free hydrogen does not normally appear, though the production of small quantities of the gas can in

certain circumstances be demonstrated in the laboratory. Incidentally, the natural chemical form of the energy-loaded hydrogen within the plant is that of a well-defined protein, ferredoxin, in the reduced form. From the standpoint of energetics, the achievement of reducing ferredoxin equals that of making hydrogen gas.

In contrast to the plant, man would, if he had the capability, release and use the hydrogen gas. This would be introduced into a "hydrogen economy," so much discussed now in the context of the application of nuclear power. Hydrogen can be stored and transported cheaply through pipe lines. It is a clean, non-polluting material. It can be used for heat or to make electricity, preferably by means of fuel cells. It is a versatile chemical raw material and metallurgical reductant.

Finally, hydrogen helps to make food. It can replace oil in the running of farm machinery and transport. Moreover, it can be fed directly to suitable bacteria. These so-called hydrogen bacteria burn the hydrogen at room temperature rather rapidly by means of air, and they use the energy obtained to make body substance from carbon dioxide and minerals. In fact, they use the chemical energy of hydrogen in a rather similar way as photosynthetic bacteria or plants use the energy of light. The biomass of the hydrogen bacteria is nutritious feeding stuff for animals. It may even one day be eaten by man; after all, nobody objects to the eating of the lactic acid bacteria in yogurt or in sauerkraut.

The energy of each quantum of blue or green light is theoretically sufficient to decompose one molecule of water into hydrogen and oxygen. With long wave light, yellow and red, where the quanta are smaller, it will be necessary to pile up two quanta for the same result. But this trick has also been mastered long ago by plants, which indeed use long-wave as well as short-wave light. It is remarkable that the orderly piling-up of the energies of successive quanta has never been used in a man-made photochemical device.

How Plants Photolyze Water

Why have plants been able to photolyze water and man has not so far? The basic reason is simple. In the photochemical reaction, hydrogen and oxygen are not produced directly in the pure forms of stable gases. These end products can, as everybody knows, be kept in bottles and handled without much difficulty. But in photochemistry, at first unstable, reactive entities (atoms, radicals, etc.) are formed which eagerly react with each other; they "recombine." In this way, photolysis is immediately reversed, and the products are mutually annihilated to reform water. Therefore, in all photochemical experiments that have so far been done, the stationary concentration of the hydrogen during illumination was, unfortunately, minute.

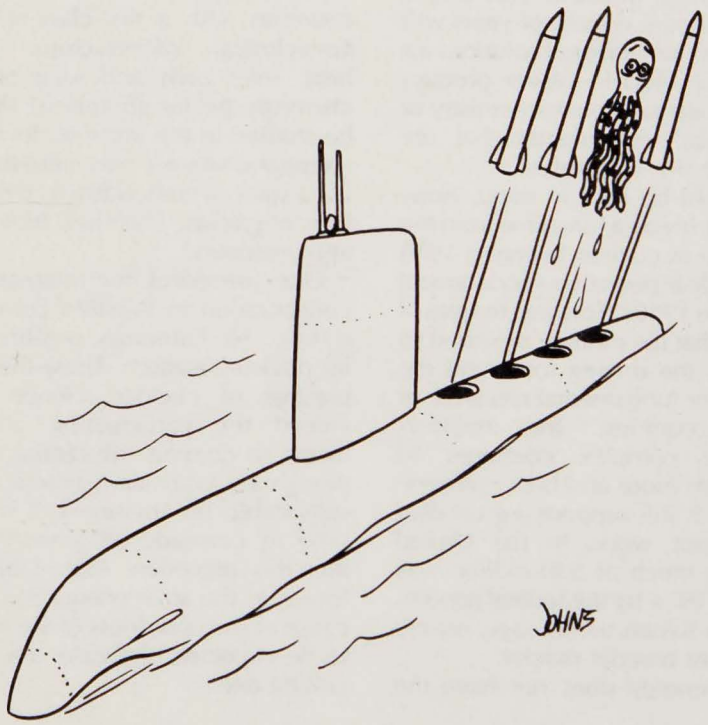
But this need not be so. After all, plants also have had to face the problem of recombination, and have solved it. The secret of the plant—and also of the photosynthetic bacteria—has been the introduction of the membrane principle. The cells are surrounded by membranes and they are also wholly or partly crisscrossed by membrane systems, as can be seen with the electron microscope.

The photosynthetic machinery is always contained in membranes around and within the cells. Their detailed structure is very complicated and only partly known so far, yet it is quite clear that the basic function of the membranes in photosynthesis is the separation of the products of the reaction. The hydrogen (or rather, the primary reducing agent) comes out on one side; the oxygen (or rather, the primary oxidizing agent) comes out on the other side of the membranes. Thus they are kept apart and are not vulnerable to each other. They cannot recombine.

In the plant cell, the oxygen is discarded as a useless by-product. (It is, incidentally, practically the only source of atmospheric oxygen.) The hydrogen, on the other hand, is used by the plant to build up body matter in reaction with carbon dioxide, as previously described.

The technical photolysis of water by man will also have to be based on the application of membranes. Hence fundamental work in membranology ought to be greatly expanded. The aim should be the production of membranes that are photochemically asymmetric, that is, that produce reductant and oxidant on different sides.

An argument often used against solar power is that the density of solar power is low. It is true that the number of watts per square meter



Solar energy research is not of particular interest to the military; it is a peaceful enterprise, and only lip service is being paid to it.

(the "solar constant") is only 1,340 at the top of the atmosphere with vertical incidence: solar power *is* dilute. Therefore considerable areas will have to be reserved for each major power station. A crude guess shows that with a penetration of only one-half of the radiation to the surface of the Earth, with an average angle of incidence of the rays as valid for temperate zones, and with an energy yield in hydrogen production of the order of 10 percent, the area needed per watt of power would have to be increased by a factor on the order of 100 to 200 greater than the corresponding solar constant.

Thus about 30 to 60 square miles would have to be reserved for each million people at a rate of energy consumption (all forms of energy) of one kilowatt per capita, as is typical for a large part of the world's population. Correspondingly more would be needed to provide 10 kilowatts per capita, as is typical in North America now. These figures assume that all energy to be used by man is supplied by sunlight, a wildly unrealistic assumption for a long time to come.

Gradually new technologies and procedures will have to be developed that are suited to low power densities, but area itself will not be a limiting factor. Enormous deserts (happily usually hot and cloudless) exist that cannot be used for agriculture now or in the near future. The area of the Sahara alone is 4 million square miles. The transport of the hydrogen or the electricity from solar energy stations in the deserts to the centers of world population is feasible. Of course, economic and political problems will arise between the desert owners and the energy consumers; this is a challenge that must and can be met. (Perhaps by that time we shall have learned a little from the oil problems.) For an even more distant future, areas of the oceans could be considered for floating solar power stations.

International Research

Fundamental research in solar energy is not really expensive. For the foreseeable future, nothing even remotely as costly as the equipment in some other laboratories for advanced research is required. But the very best scientists and engineers should be motivated to take part in such work. Success in research and development will not always be rapid. While low-temperature solar heat for warm water, for example, is easy to obtain, dozens of years will be needed for technical solutions for large-scale electric power production through solar photochemistry or other solar technologies that are economically acceptable.

It should be kept in mind, however, that it was a long time from the discovery of nuclear fission in 1938 until nuclear power was economical in the late 1960s. This was in spite of the fact that the military provided so much of the driving force and the finance for fundamental research. In many countries, the military-industrial complex continues to clamor for more and better plutonium, and it still supports a great deal of relevant work. In the United States as much as 530 million was spent in 1974 by the federal government on fission technology, mostly on the fast breeder reactor.

Solar energy does not have the benefit of being of particular interest to the military. On the whole, it is a peaceful enterprise. Therefore, to a large extent only lip service is paid to solar energy now. For instance, in the United States, federal spending on all solar energy projects reached only the pitiful level of $14 million in 1974. The situation is not better elsewhere. The trouble is that we are asked to commit ourselves to investments in peaceful research that probably (at least in respect to large-scale electric solar power) will not bear fruit for decades.

Yet precisely because of this lack of military applications, solar research and solar power as an enterprise of mankind might become important factors for world peace. And it is an area which lends itself well to international collaboration.

In view of the urgency of the matter, a center for international cooperation in the solar energy field should be founded. It would be a regrettable waste of money and scarce manpower to build up separate institutions in a hundred or more sovereign countries. This does not mean that all departments of an International Solar Power Institute, created perhaps under the aegis of the United Nations, ought to be under one roof. On the contrary, some parts should be in countries with strong sunshine, and others in countries with a first-class scientific-technical infrastructure. Solar heat, solar cells and solar photochemistry (water photolysis) should be studied in the Institute. Its international character may help to kindle a spirit of enthusiasm in the very best physicists, chemists, biologists and engineers.

One precedent for international collaboration in Western Europe is CERN, the European organization for nuclear research. There the new prestige of nuclear science convinced the participating governments to commit substantial funds though no equivalent practical results could be envisaged. It is now time to persuade all governments that this precedent should be followed in the solar energy field. Because of the usefulness of the results to be expected, the case is a compelling one. □

Report to UNESCO/WMO Solar Energy Symposium Geneva 1976

PHOTOCHEMICAL HYDROGEN PRODUCTION THROUGH SOLAR RADIATION BY MEANS OF THE MEMBRANE PRINCIPLE.

by

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Summary

Nuclear experts are considering a "hydrogen economy" where H_2 serves as a fuel to make electricity, as a chemical reactant, as a metallurgical reductant and as a source of food. Now H_2 could also be made by photolysis of water. Theoretically, a quantum of green light carries enough energy for the reaction $H_2O = H_2 + 0.5\ O_2$. With long-wave light, photolysis could be achieved by combination of 2 quanta. Yet attempts to photolyze water, in presence of sensitizers (photocatalysts), have failed. In the last analysis, this is due to re-combination of the primary, highly reactive, products of the photochemical reaction. A solution of the problem is to be found by the spatial separation of the primary products, i.e. by development of suitable membranes where these products, and therefore also the stable gases H_2 and O_2, come out on opposite sides. The feasibility of this "membrane principle" has been shown in Nature for 3 giga-years. Using membranes, all photosynthetic cells (photosynthetic bacteria and plants) succeed in the photo-production of a reductant (in many cases at least ferredoxin in the reduced form) with a redox potential equal to that of H_2 in neutral solution (-0·4 V). The reductant can, but need not, be used by the cells for CO_2 assimilation. In man-made technology, the reducing power would be diverted as H_2. Here it is not suggested to use or copy living cells. Rather their operation is to be studied so that technically useful membranes for water photolysis can be constructed abiotically. The scientific and practical aspects of large-scale photolytic H_2 production are discussed.

Strangely enough, the photochemical methods for the utilization of solar energy have not so far been given much attention. Yet precisely these methods may in the long run make the most important contribution to the solution of the energy problems of mankind.

A hydrogen economy is being widely discussed in connection with nuclear power. Hydrogen gas, ultimately to be obtained from water in thermochemical reaction cycles, is to be used for the provision of industrial and household heat, as a fuel for heat engines or, better, for galvanic cells for the generation of electric power, as a chemical reactant, e.g., for the production of liquid fuels, and as a metallurgical reductant. Hydrogen is easily stored, it is cheaply transported in pipe lines, and it is non-polluting.

Now hydrogen gas could alternatively also be made photochemically namely through the photolysis of water. Thermodynamically, one quantum of green light (56 kcal/einstein) is sufficient to split water according to the overall equation

$$H_2O = H_2 + 0.5\ O_2$$

Quanta of blue or violet light contain even more energy, while in the cases of yellow and red light the energies of 2 quanta would have to be combined for the photolysis of each molecule of water.

Some half-hearted attempts at the photolysis of water or of aqueous solutions have been undertaken (1). Of course, the light quanta have to be absorbed by a suitable sensitizer or "photocatalyst" to transfer the energy to the water. But no good success has ever been obtained, i.e., a stationary state was set up rapidly after the beginning of irradiation, and the hydrogen gas content of the system remained very low. Even when the products were constantly removed with a carrier gas, the quantum yield was very poor.

In the last analysis, this failure is due to the fact that the primary products in the photoreaction are not the comparatively inert gases H_2 and O_2, but radicals that are very reactive. In the homogeneous aqueous solution used, the reducing and the oxidizing radicals meet frequently, they recombine, and thereby annihilate each other. A technically useful solution of the problem would require the spatial separation of the oxidizing and the reducing radicals. This could be achieved by means of asymmetric membranes which are so constructed that the reducing radicals come out on one side, and the

oxidizing radicals on the other side. Membranes capable of such "vectorial" reactions (shortly: "vectorial membranes") have never as yet been built either in the laboratory or for industry. But there is no law of nature that would stand in the way. Vectorial membranes would enable us to obtain, separately and at high yields, the final products of photolysis, H_2 and O_2. The H_2 would be fed into the hydrogen economy (2).

The feasibility of this kind of approach has been demonstrated in a most impressive way and on a truly gigantic scale by the plants. About 3 giga-years (3.10^9 years) ago, the first plants, so-called blue-green algae, appeared in the biosphere. The basic reaction by which plants obtain the energy for their life functions is precisely the photolysis of water. The oxygen is discarded into the atmosphere, and indeed photolysis of water is practically the only source of oxygen on Earth. In physiological conditions, the hydrogen does not appear as a gas. This gas would escape and be worthless for the plants. H_2 production by plants has been demonstrated only in unusual conditions in the laboratory by Gaffron and others.

Yet the thermodynamic achievement of the plants in the photolysis of water is just as great as if they had liberated H_2. The reductant which, instead of H_2, is made by the plants is the reduced form of a well-defined protein, ferredoxin, which is distinguished by a content of iron and of sulphur in inorganic linkage. It so happens that the standard redox potential of the couple reduced/oxidized ferredoxin (- 0.4 volts) practically coincides with that of the couple H_2/H_2O (neutral). Consequently, it is just as difficult to force electrons on oxidized ferredoxin as it is to force them on hydrated hydrogen ions.

How did the plants achieve this seeming miracle? After all, they also had to deal with the problem of the recombination of the primary reducing and oxidizing products of photolysis. They solved the problem by introduction of the membrane principle, i.e., of vectorial membranes. Every photosynthesizing plant has complicated intracellular membrane systems for the photolysis of water. In the relatively primitive blue-green algae they criss-cross the whole cells, in the more advanced "eukaryotic" cells the membrane systems are housed in the specialized, membrane-enclosed, subcellular compartments known as chloroplasts.

In fact, the membrane principle had already been invented by the ancestors of the plants, the photosynthetic bacteria, of which some genera happily still survive and can be studied (3). These bacteria also use vectorial membranes to separate reductant and oxidant, but they are not capable of splitting water, and must use easier sources of hydrogen, i.e., compounds where the hydrogen is less firmly bound, notably H_2S. Both the photosynthetic bacteria and the plants apply one or the other of the chlorophylls, a group of related compounds, as a photocatalyst. In addition they all contain other photoactive pigments, e.g., carotenoids. These "accessory" pigments capture light outside the absorption bands of the chlorophylls and transfer the energy to the chlorophyll. It is certain that the blue-green algae have evolved from photosynthetic bacteria. Some microbiologists call them "blue" bacteria.

The photosynthetic organisms apply "reducing power" (directly or, more commonly, indirectly: reduced ferredoxin) for the assimilation of CO_2 and the building up of biomass. The necessary reactions do not require light, i.e., they are "dark reactions". Some of the reducing power is diverted to other purposes, notably (in many kinds of photosynthetic bacteria and blue-green algae) to the assimilation of N_2. The blue-green algae may be considered as the non-plus-ultra in bioenergetics. For their life and proliferation they need nothing but H_2O, CO_2, light and minerals.

The plants now fix, by order of magnitude, 10^{11} tons of carbon per year. They succed in utilizing long-wave (yellow and red) light, and the bacteria even make use of infrared light. In optimum conditions in the laboratory, namely, with dilute suspensions of algae, as little as about 9 quanta are needed for the fixation of each atom of carbon. This low quantum requirement corresponds to an efficiency in the utilization of the energy of the light for blue light of 20 %, and for red light even of 30 %. Of course, in more natural conditions (forests, fields) the efficiency is very much less. Even with very productive crops like sugar cane the upper limit is about 3 % only.

"Energy plantations" have often been suggested. Fields or forests are to serve the production of fuel. The crops are to be used either directly or by way of fermentation. However, mankind

is short of suitable land, and needs it for growing food and technical products, e.g., fibres, oil or rubber. An alternative approach is the production of fuel by way of algal suspensions. They have very high yields per unit area and unit time. It is also conceivable that desert areas could be applied provided water could be transported there cheaply. Economic success would be of great value. But at the moment the high price of the algae still indicates that a prohibitive amount of energy, in the form of implements, fertilizer, manpower, etc., goes into their production.

Here it is suggested to explore the utilization of man-made (non-biogenic) vectorial membrane systems. It is conceded that dozens of years of R and D work will be required. But in the end, such man-made systems may well be far more productive than natural systems. Again desert areas could be applied on a large scale. To obtain optimal conditions, we should learn from the bacteria and the plants, be inspired by them, but neither use nor even copy them. There are two interconnected reasons for this strategy.

First, man is interested in the provision of reductant (fuel), i.e., of biomass in biotic processes, and of H_2 in abiotic processes. Now while the achievement of the plants is most impressive, they are not one-sidedly optimized for the production of biomass. Biomass is for them not an aim in itself. To survive and to spread, plants must look after themselves in many ways: They must obtain and conserve water and minerals, they must resist inclement weather, they must defend themselves against parasites, predators and competitors, and they must run the machinery for proliferation. These activities must clearly go at the expense of overall photosynthetic yield. As the flexibility of the physiological processes in the plants has its limits, a depression in the overall photosynthetic yield remains even when man undertaken to supply the plants with water and minerals, to shield them from enemies, etc.

Secondly, the present plant stands at the end of a very long evolutionary line. It has evolved through mutation and selection. As is generally true in evolution, the separate, subsequent, steps cannot have been too large. Therefore the plant could develop the photosynthetic machinery only gradually on the basis of preexisting features, and the existing machinery must still retain part of the heritage. In other words, the plant has in its bioenergetic processes

reached what has in evolution been accessible to it, account being taken of the starting and intermediate conditions. Consequently, the properties of the machinery cannot be as good as if it had been designed rationally without any constraint due to evolutionary history.

To make this point clearer, another line of evolutionary change may be recalled. It is essential for man to be upright and to have his hands free for tool-making. A rational designer could in the creation of the mechanisms for movement of a biped similar to man have optimized for movement on two legs. In reality, in evolution we started off as fishes. They changed into quadrupeds, which only later gave rise to bipeds. Having inherited the organisms as a whole from our ancestors we could not entirely shed their anatomical and physiological features, or else our own body would not work at all. But this went at the expense of efficiency in upright movement. Varicose veins, testimony to the overloading of the circulatory system of the legs, are a dramatic, though not the most important, expression of inefficiency.

The conclusion is that man can hope to build artificial photochemical machinery on the basis of vectorial membranes that is superior to the natural machinery. Constraints exist neither due to the need to fullfill alternative tasks nor due to evolutionary history. We can learn from the plant wherever we want to, but we need not accept all the plant's features.

R and D work on the technical photolysis of water would not be expensive. No unduly large or complicated equipment for basic research work would be needed, nothing compared, e.g., to that in nuclear research stations. What is required are highly motivated scientists of top quality. To find them, the work must be given clear direction, high priority and public recognition ("prestige"). It would moreover be a tremendous advantage if efforts in different countries were combined in international collaboration rather than dissipated. The best thing would probably be an International Solar Power Institute ("ISPI"). It would have central direction but need not all be under one roof. On the contrary, it would be preferable to have some departments in countries with abundant sunshine and others in countries with excellent infrastructure.

While the photolysis of water is envisaged also for countries in temperate regions, the main advantages will be obtained in the hot deserts which are now practically useless. Naturally, the concentration of power production in such areas will lead to problems between nations. These problems ought to be studied in time, but surely solutions beneficial to all countries can be found.

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(2) BRODA, E.(1975). Großtechnische Nutzbarmachung der Sonnenenergie durch Photochemie. Naturwiss.Rundsch. 28, pp. 365-372.
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(3) See BRODA, E.(1975). The evolution of the bioenergetic processes. Pergamon Press, Oxford. 211 pp.

26th Pugwash Conference
"Disarmament, Security and Development"
Mühlhausen, German Democratic Republic, 26-31 August 1976

Agenda

1. Problems of limiting and reducing strategic nuclear armaments and other weapons of mass destruction:
   a) Current status of SALT and other negotiations on strategic nuclear arms.
   b) Examination of validity and utility of the concept of nuclear deterrence.
   c) Ways to obtain massive reductions in the numbers of nuclear weapons.
   d) A ban on chemical weapons and other non-nuclear weapons of mass destruction; the validity of deterrence as applied to chemical weapons.

2. Controlling the spread of nuclear armaments:
   a) The problem of nuclear non-proliferation and the spread of peaceful nuclear technology.
   b) Comprehensive test ban.
   c) The problem of peaceful nuclear explosions.
   d) Security issues, e.g. nuclear-free zones.
   e) Doctrines of use of nuclear weapons in conflicts.

3. European security issues:
   a) Implementation of the agreements of the Conference on Security and Cooperation in Europe.
   b) Progress of the Conference on Mutual Force Reductions.
   c) The problems of all-European cooperation in economic, scientific and other fields.

4. Development and security:
   a) Implications of the concept of security for developing countries: military and non-military aspects.
   b) Conventional arms race and the growth of military budgets.
   c) Inter-relationships between patterns of utilization of the financial resources of oil-producing countries and the arms race in the Middle East and elsewhere.
   d) Non-military threats to the security of developing countries: e.g. use of food, oil and other natural resources, manipulation of natural phenomena, role of multi-national corporations, and other activities.
   e) New directions for international cooperation for development, including code of behaviour for international scientific cooperation.

26th Pugwash Conference

"Disarmament, Security and Development"

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WORKING GROUP 1

PROBLEMS OF LIMITING AND REDUCING STRATEGIC NUCLEAR ARMAMENTS AND OTHER WEAPONS OF MASS DESTRUCTION

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	M. MILSTEIN	(USSR)
Members :	R. BJORNERSTEDT	(UN)
	F. CALOGERO	(Italy)
	V.S. EMELYANOV	(USSR)
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	G.B. KISTIAKOWSKY	(USA)
	BETTY LALL	(USA)
	KH. LOHS	(GDR) – Fritz Lange
	J. LUNDIN	(Sweden)
	J. K. MIETTINEN	(Finland)
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	R. PEIERLS	(UK)
	I.I. RABI	(USA)
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WORKING GROUP 2

CONTROLLING THE SPREAD OF NUCLEAR ARMAMENTS

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26TH PUGWASH CONFERENCE

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26-31 August 1976.

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K. SUBRAHMANYAM (INDIA)

THE NUCLEAR ISSUE AND INTERNATIONAL SECURITY

Developments since the 25th Pugwash Conference in Madras have tended to create increasing doubts regarding the conventional wisdom on nuclear weapon proliferation. It was one of the basic tenets of this conventional wisdom that a kind of domino effect operates in nuclear weapon proliferation. A sixth nuclear weapon power must inevitably lead to seventh, eighth, ninth and so on. High among the list of candidates for proliferation used to be Japan, Federal Republic of Germany and a number of European States with advanced technology. It is now quite obvious after the ratification of Non-Proliferation Treaty by Federal Republic of Germany and Japan this domino thesis on nuclear proliferation would need to be completely re-examined. The number of States which have not signed and ratified the Treaty and which have the technological and manpower base to go in for the manufacture of nuclear weapons, in the foreseeable future (next five to ten years) are so small in number it appears to be somewhat questionable to talk of proliferation as a general world phenomenon. It would appear more helpful in analysing the issue of proliferation of nuclear weapons if it is examined in the

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situational context of the individual states rather than as one that will fit in within the framework of a domino thesis analysis.

One hundred States have ratified the Treaty. Two nuclear powers have not signed the Treaty. Many other States are either too small or have not yet reached the technological sophistication for the purpose of manufacturing nuclear weapons through their own efforts.

Among the other States who have not signed or ratified the Treaty and who may develop a future potential to manufacture weapons, it is difficult to ascribe to all of them weapon intentions at least in the near future. It is not unlikely that at least some among them have decided to use their non-signature or non-ratification as bargaining leverages to secure various objectives. Some may seek to enhance their own security through enlarging the uncertainty for their neighbours. Others may seek to use the nuclear option against the rising aspirations of the majority of domestic population and yet others may use the nuclear option to put pressure on weapon countries to accept progressive disarmament measures. Since the nuclear weapon countries have made the nuclear weapon a symbol of power and prestige it is also likely that some of those who have not signed or ratified the Treaty intend to use their nuclear option as a surrogate for nuclear weapon prestige.

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The recent British decision to go in for independent manufacture of Tritium underlines the importance the British attach to the continuance of a modest nuclear force, which is not of high credibility and the prestige it confers on them. The debate in the U.S. Strategic Community on the number of warheads and throw weights etc., gives an impression that nuclear weaponry to-day is used in international politics somewhat on the lines gold stocks were used in international economics. Gold by itself was of limited use; its value largely depended upon its acceptance by the international trading community. Similarly to-day the major nuclear weapon powers are attempting to use their nuclear weapon stockpiles as an international currency of power. If this is so then it is only logical to expect other nations who have a nuclear option to use that as a symbol of power and prestige. It is unrealistic to expect that while the five nuclear weapon powers are to be permitted to use their weapons as the symbol of power and prestige other nations would not even attempt to derive some advantages out of that situation through the non-exercise of their option merely by remaining uncommitted to the Non-proliferation Treaty. It is the behaviour pattern of weapon powers and the legitimacy accorded by the international community to the use of these weapons as a currency of power which make it advantageous for nations with nuclear potential to

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reserve their option.

By and large there is general recognition that the probability of the use of nuclear weapons except in situations of extreme asymmetry is very low. But the nuclear weapon powers have continuously focussed attention on the weapons in order to project their own images as nations of power. The prestige and power attached to the weapons also came to be associated increasingly with nuclear technology. Therefore in the international game of power nations which cannot or do not want to exercise the nuclear weapon option have increasingly tended to use nuclear technology as a symbol of power. The non-nuclear nations which have signed the London Agreement on export of nuclear technology may be deriving some satisfaction that they are members of an exclusive club dealing with nuclear technology--an associate club of the five nuclear weapon powers. So long as nuclear weapons are coins in the international game of power the nuclear factor (either in terms of P.N.E., export of nuclear technology or reservation of nuclear weapons option) will be a crucial factor in international diplomacy. Those who have been looking at the nations of the world only in two categories--nuclear and non-nuclear--must learn to understand the multi-dimensional character of the nuclear factor in international relations. Just as domino thesis in regard to spread

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of communism in Asia proved to be too simplistic, so also would appear the domino thesis in the field of nuclear proliferation. In both cases the factor of nationalism tends to be grossly underestimated.

More the nuclear weapon powers proclaim that nuclear weapons in their hands are safe and they are unsafe only in the hands of other non-nuclear weapon powers and more they convince themselves of this myth greater is the bargaining power of non-nuclear weapon powers nations with weapon options in the international community. On the other hand if the nuclear weapon powers concede that there is still considerable danger of nuclear war among themselves then implicit in that will be an admission that the so-called Non-proliferation Treaty has not achieved its objective even in a partial measure. Secondly their credibility in regard to their intentions to achieve arms control and legitimacy of their demand that other nations should surrender their nuclear options diminish significantly.

As time goes by, some more nations which are to-day remaining outside the Non-proliferation Treaty may accede to it as they realise that they do need external assistance to develop their nuclear technology and such assistance cannot be obtained outside the regime of the Treaty. That may finally leave perhaps a slightly larger number of nations than the present number of five nuclear weapon powers with autarchic nuclear technology--five with nuclear weapons and

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perhaps a similar number of presently non-weapon nations with real and effective weapon options. Even this development may take quite some time to come about. Is that world necessarily a more insecure world than the present one? Or will the world learn to live with that situation as it has been living with the present number of nuclear weapon powers? The sense of insecurity about the world with increased number of nuclear weapon powers can be measured by the urgency displayed by the present number of five nuclear weapon powers to deprive the nuclear weapons of their power and prestige and take meaningful steps to reduce their weapon stockpiles. It may also be measured by the sense of urgency and concern shown by the international community in exerting pressure on the nuclear weapon powers to bring about the steps mentioned above. The developments of the last few years--the total absence of any pressures on the nuclear weapon nations to cut down their stockpiles, the relative complacency of the international community as witnessed by the negative results of the Review Conference on Non-proliferation Treaty, the increasing stockpiles of weapons, discussions on strategies to resort to first use of nuclear weapons etc., tend to lead one to conclude painfully that the world is more likely to adjust itself to increased number of nuclear weapon powers rather than take steps to reduce the nuclear weapon stockpiles and reverse the current direction of arms race. In other words

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it would appear there is a subliminal acceptance that the world of ten nuclear weapon powers is not necessarily a more dangerous world than that of five nuclear weapon powers.

Conventional wisdom also tried to deny the utility of PNE. The recent Treaty between U.S. and U.S.S.R. has established the viability and utility of peaceful nuclear explosions. Those nations who have been maintaining that the right to conduct peaceful explosions should not be mixed up with renunciation of weapon options are likely to feel vindicated by the latest Treaty. As further advances are made in the application of the PNE there will be increasing pressure from non-weapon States that they must have a share in the technology. The approach that nuclear spread can be halted by denying technology is an unrealistic one. Such an approach did not prevent U.S.S.R., U.K., France and China from becoming nuclear weapon powers. Versailles Treaty did not prevent Germany from developing aircraft, armour and other military technologies denied to that country under that Treaty.

The recent emphasis on placing constraints on transfer of nuclear technology by a group of supplier countries has evoked considerable resentment in the third world. This is seen as a manifestation of neo-colonialism and technological hegemony. While such an approach may slow down the development of nuclear

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technology in the third world by a few years it cannot altogether stop development of autarchic technologies in some of the major third world countries. The price of this strategy is to convert the nuclear issue into a confrontation between north and south and make the development of nuclear technology as a symbol of assertion of autonomy from neo-colonialist dependance.

This feeling that attempts to exercise control over nuclear technologies of third world countries has to it a dimension of technological hegemony is strengthened by certain developments in the developed countries. There is an attempt to entrust some of the sophisticated technologies, denied to the third world to multinational Corporations. While attempting to improve, impose very stringent safeguards on third world nation nuclear technologies, adequate concern has not been displayed on unaccountability of hundreds of kilograms of fissile material in the nuclear industries of the developed countries. Earlier, reference was made to inadequate concern about the dangers of nuclear war breaking out among the countries which have weapon stockpiles. For these reasons it would appear to many in the third world that the bogey of nuclear proliferation is being raised to sustain the technological imperialism of the erstwhile imperialist countries and their close associates. There can never be any credibility in the steps advocated to halt nuclear proliferation till the nuclear weapon powers disarm to a

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significant extent, stop their weapon production and submit all their installations to equitable international safeguards and controls.

The solution to the problem of safeguarding diversion of fissile materials is not to impose inequitable controls on developing countries but to evolve universally applicable safeguards. To put the fissile material production under multi-nationals will ensure the dominance of certain technologically advanced countries. No universal safeguards are possible unless the weapon production is discontinued and the weapons are reduced. Those arguing in favour of over-whelming majority of the nations of the world accepting obligations which five nations of the world would not accept are asking for an impossible solution.

Similarly advocacy of partial solutions not accepted in the industrial areas of the world to other parts of the world again smacks of neo-colonialism and modernised version of whiteman's burden doctrine. The nuclear free zone is a pathetic attempt to persuade the third world that what cannot be practised in Europe will be successful in their parts of the world. If Rapacki plan or Gomulka plan cannot be implemented in Central Europe where all countries have subscribed to the doctrine of non-proliferation what are its implications? It could mean that the countries concerned are not able to decide the issue

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by themselves and are subject to powerful outside influence. It could also mean that the countries concerned have not abjured their faith in the utility of nuclear weapons in safeguarding their security but are in the happy position of professing to be non-nuclear and having other nations' nuclear weapons available to them for their security. This is like a man calling himself celibate because he is not married to the woman he is living with or a person being a member of the Teetotalers' Society because he never pays for his drinks. In fact no country which permits nuclear weapons on its soil or which is a member of an alliance system which relies on resort to nuclear weapons in case of war can really be called a non-nuclear weapon country. The real criterion of non-nuclear weapon status is the renunciation of the doctrine of use of nuclear weapons in war. It is not enough if a country declares that it will not manufacture nuclear weapons, store nuclear weapons on its soil and allow other countries to bring nuclear weapons to its soil. So long as such countries depend on military alliances in which the partners have nuclear weapons and the latter believe in resorting to nuclear weapons as part of overall doctrine of war it is difficult to categorise them as non-nuclear weapon countries. There are reasons to believe that adherence to Non-proliferation Treaty by some of these countries is a quid pro quo for the nuclear weapon protection

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they receive. In other words they subscribe to the thesis of non-proliferation solely because they are integral parts of the system which is proliferating nuclear weapons. In the circumstances it is difficult to understand the thesis that countries could be members of nuclear free zone without its being detrimental to alliance arrangements they may have entered into.

It is often said that nuclear free zones enhance the security of member States because there will be a guarantee that nuclear weapon States will not use their weapons against them. What is this guarantee worth? The nuclear weapon States are not prepared to accept each other's guarantee about the no first use of nuclear weapons or treaties which guarantee frontiers in Europe. If the word of the Soviet Union to respect the frontiers in Europe is acceptable to the United States, then the latter should have no difficulty in entering into an international agreement on no first use. Nor China's 'no first use' declaration appears to be acceptable to other nuclear powers. In all these cases the nuclear powers appear to base their security doctrines more on a calculation of the capabilities of their potential adversaries than on their declared intentions. If so how can the non-nuclear weapon powers adopt a different criterion to judge the likely behaviour pattern of nuclear powers and accept their guarantees in regard to nuclear free zones? Such a guarantee will be relatively more credible if the nuclear weapon powers enter into a no first use agreement and reduce their

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stockpiles significantly. At a time when the arsenals of five nuclear weapon powers are many times what is required to incinerate the entire world and when they by their behaviour demonstrate that they do not accept each other's guarantees it is difficult to expect a high degree of credibility in the thesis that nuclear free zones enhance the security of nations. If it were so why has not Central Europe implemented Repacki and Gomulka plans?

With the exception of a few countries the entire industrialised belt in the north is in one alliance or the other which relies on resort to nuclear weapons as the basis of its security policy. It is believed and often proclaimed by the establishments of many of these countries that King Atom has been maintaining peace. In spite of almost all these countries subscribing to Non-proliferation Treaty none of them has taken any meaningful step to derate the role of nuclear weapons for their national security after the Treaty. (The Scandinavian Nuclear Free Zone was there even before NPT). In fact there has been considerable opposition to the proposal to reduce the number of tactical nuclear warheads located in Europe. Vigorous steps have been taken to modernise the tactical nuclear force. In these circumstances advocacy of Non-proliferation Treaty to the developing countries, overwhelming majority of whom are non-aligned seems to be an attempt at disarming the unarmed! The entire philosophy underlying the conventional wisdom surrounding Non-proliferation appears to

be a form of neo-colonialism.

If real advance is to be made towards the fundamental objectives of the Pugwash Movement the essential distinction between Non-proliferation thesis and the former have to be appreciated. There is considerable schizophrenic thought evolved around Non-proliferation. Non-proliferation, as proclaimed to-day in the world is a static concept, meant to ensure the dominance of the erstwhile imperialist powers, polarise the world into technologically advanced nations and technologically under-developed nations, perpetuate the salient role of nuclear weapons in strategic thought, continue the arms race and to serve as a decoy vis a vis the real issue, namely nuclear disarmament. In fact the years spent in advocating the Non-proliferation thesis are years wasted in regard to efforts which ought to have been pressed on to advocate nuclear disarmament. It is not fortituous that the strategic establishments of major nuclear powers are great supporters of Non-proliferation thesis.

Therefore the Pugwash Movement must recognise and proclaim that Non-proliferation thesis does not only not serve the imperatives of disarmament but has been a soporofic. Secondly it must also be recognised that no measure which distinguishes the industrialised nations from developing nations and seeks to impose differentiated obligations would constitute

a meaningful step towards disarmament and world peace. The partial nuclear free zones come under this category. It must be recognised that real proliferator of nuclear weapons is the military doctrines which rely on resort to use of nuclear weapons. Consequently so long as these doctrines are professed by the industrialised countries of the world nuclear proliferation cannot be stopped. If possession of nuclear weapons constitute a symbol of power, prestige and special privilege for nations it will be impossible to stop other nations from using nuclear technology and nuclear options to acquire varying degrees of power, prestige and special recognition.

If these factors are taken as the basis to formulate meaningful steps towards nuclear disarmament, then the following two points would merit the most serious consideration of this Conference. These aspects have already been discussed in the Pugwash Movement and what is sought to be done here is to delink them from the conventional wisdom on proliferation --

(i) The most important conclusion that emerged from the Kyoto Symposium is about the negative feed back the doctrine of deterrence constituted for nuclear disarmament and world peace. It was felt that research should be pursued to expose the basic untenability of doctrine of deterrence, the in-built logic in it to fuel the nuclear arms race, and its total inadequacy to deal with the complexities of the present day international political structure.

... p.t.o.

(ii) The Madras Pugwash Conference recommended for consideration a global nuclear free zone, since partial and restricted nuclear free zones in developing parts of the world only gave rise to an impression that while King Atom will preserve peace in the industrialised areas of the world, peace in developing areas will be preserved by keeping them unarmed nuclear-wise. In other words the partial nuclear free zone proposals look like the revival of the imperialist doctrine of white man's burden. The global nuclear free zone would extend undifferentiated treatment to all nations of the world wishing to join it and will not be a poor man's club with which the affluent nations would have nothing to do.

These two ideas if pursued further would help significantly to focus attention on the real issues underlying the current problem of international insecurity arising out of the existence of nuclear weapons and clear the fog of non-proliferation thesis which has been used to cloud the real issue and promote the interests of nuclear weapon powers.

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26th Pugwash Conference
"Disarmament, Security and Development"
Mühlhausen, German Democratic Republic, 26-31 August 1976

E. Broda (Austria) XXVI-2

A WORLD MADE OF PLUTONIUM?

In a Declaration on the 30th Anniversary of Hiroshima, J.T.Edsall, H.W. Kendall, G.B.Kistiakowsky, H.C.Urey and J.D.Watson, all American physicists, chemists or biologists of the first rank, wrote:

> "It was no mistake, following Hiroshima, to try to make use of nuclear energy for peaceful purposes. But it was a serious error in judgment in the following decades to devote resources to nuclear development to the virtual exclusion of other alternatives. It has also been unfortunate that the efforts to commercialize nuclear energy allowed safety and national security problems to receive less than the required consideration. The nation, on the thirtieth anniversary of Hiroshima, must take note of these facts, diminish the large growth rate of the nuclear program, and take other appropriate steps to ensure adequate energy for the nation."

Thus, starting from present widely held doubts about nuclear power, the question has been raised concerning the extent to which hopes for an important role for peaceful nuclear power were justified in the past. This indeed appears to be an important question. To the present author the search for an answer does not appear to be merely an academic exercise; it may help to find the right attitude for the future. True, to some people history just serves to justify present and future actions; in this case, the temptation to fit history retrospectively to presumed present needs is overwhelming. Others are ready to learn seriously from the true course of history. For this

purpose, one must compare the ideas, intentions and actions of men in the past with the historical developments which later actually occurred. With this attitude, the study of history is a real help in decision making.

It may be stated straight away that, in the view of the present author, it is not good enough to try to explain the swing of thoughtful scientists from enthusiasm to scepticism by saying that the technical and organisational difficulties of peaceful nuclear power were underestimated in the early days.

Hundreds of pioneers, in several countries, took part in building fundaments for nuclear energy, including nuclear weaponry. By no means all of them gave thought to the social and political consequences of their actions. Some were impressed by technical brilliance and the possibilities for steep carreers. Others had in mind mainly the presumed national interest of their own country. But a number of the pioneers had, to a smaller or larger degree, a feeling of responsibility towards mankind and its future. Among them, P.M.S.Blackett, J.Franck, F.Joliot and L.Szilard might be named. It is probably fair to say that, in broad outline, however much their views differed in detail, scientists of this kind considered:

A) Work on nuclear weapons is, in the face of the mortal danger of such weapons in Nazi hands, a bitter necessity.

B) There is a good chance that after the War the anti-Nazi coalition will succeed in building a peaceful world with restriction of nuclear technology to constructive uses.

I should in 1976 still say that in the circumstances it was reasonable to hold these views. But while after Hiroshima

and Nagasaki nuclear weapons fortunately were not (yet ?) applied to future killings, it can hardly be said that point B) has come true.

Whatever hopes were held in the 1940s, now terrible tensions exist between the nations. Peaceful coexistence and détente, in themselves limited objectives, are tender plants indeed. Some of the less responsible politicians advocate a return to the cold war -- in a world that is far more equipped with nuclear arms than the world of the 1950s. Some egregious persons weigh nuclear first strikes, whether in a situation of actual conflict, or even out of the blue sky. We are sitting on a volcano.

The arsenals of nuclear weapons continue to grow at a disheartening speed and the force of the weapons is being improved all the time. In spite of attempts to prevent proliferation, more and more countries are acquiring nuclear explosives and the capability for weapon production. The temptation grows to use the weapons for "quick, surgical operations", as the phrase has it, in the illusion that no escalation will occur and nuclear warfare can be limited. What are the consequences for peaceful nuclear power?

The unfortunate fact is that nuclear power for peace cannot be technically divorced from nuclear energy for war. Whether we want it or not, every power reactor is a factory of nuclear explosive. Each gigawatt-year of nuclear electricity gives rise to at least 200 kilograms of plutonium. Admittedly the efficiency of plutonium as a nuclear explosive depends on the isotopic ratio of plutonium 239 to plutonium 240, and a high isotopic ratio is, in turn, correlated with the price

of the kilowatt-hour. Nevertheless the fact remains that, from the technical point of view, any government in control of a sufficient capacity of nuclear power stations can freely decide on the quantity and quality of nuclear weapons. Who will maintain that the eagerness of certain countries with ample resources of fossil fuel to acquire nuclear technology is uninfluenced by military considerations ?

"Peaceful" nuclear power is, in our world with its multiple antagonisms, capable of becoming a factor for war. In a number of cases it has already been misused for the manufacture of weapons. In particular, the fast breeder reactors, objectionable also on other grounds[1,2], lend themselves to the production of plutonium of high weapons quality. True, the decision to prepare or commit aggression depends on social-political factors. But these factors are entangled with the facts of relative military strength. Could the European states of the past have tried to build colonial empires without their overwhelming technical superiority?

With the growing and spreading arsenals, the possibilities for mishaps, for human failure and for irrational decisions also increase rapidly. Be it recalled that the U.S. Minister of Defense, Schlesinger, by no means a dove, thought it advisable to issue a warning to the military five days before Nixon's resignation that "unusual" orders from the Commander-in-Chief of the armed forces, the President, were not to be obeyed...

Quite rightly, all over the world a lot of consideration has recently been given to safety in reactor operation, in the transport and treatment of irradiated nuclear fuels and in the storage of wastes (fission products and actinides). But the

safety problem is also subordinated to that of peace and war. The conditions of safety have been spelled out by our former Pugwash President, the Nobel laureate, H.Alfvén[3]:

> "Fission energy is safe only if a number of critical devices work as they should, if a number of people in key positions follow all their instructions, if there is no sabotage, no hijacking of the transports, if no reactor fuel processing plant or reprocessing plant or repository anywhere in the world is situated in a region of riots or guerrilla activity, and no revolution or war -- even a 'conventional' one -- takes place in these regions. The enormous quantities of extremely dangerous material must not get into the hands of ignorant people or desperados. No acts of God* can be permitted".

The problem of the nuclear toxicity of plutonium should likewise be seen against the background of the danger of war. As a chemical element, plutonium is indestructible; once produced, it lasts almost into all eternity, and it is practically the worst poison known to man. From the point of view of radiation protection, plutonium is an invention of the devil[1]. In their evolution through the ages, organisms have not developed to meet plutonium as a poison any more than as an explosive.

If we could reliably keep away all plutonium from human populations, we might manage. The toxicity of plutonium naturally remains hidden as long as it does not enter the biosphere.But imagine nuclear warfare. Enormous amounts of still unexploded plutonium would be scattered in finely dispersed form by nuclear bombs,shells and mines. In addition, power reactors with large loads of plutonium fuel would be damaged or destroyed. The toxicity is particularly

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* In the old language of shippers, "Acts of God" are unforeseeable events. E.B.

pronounced for plutonium in the form of an aerosol, as it induces lung cancer; in warfare, plutonium would precisely be spread as an aerosol. Dispersal of plutonium cannot be reversed or undone. A country made uninhabitable by plutonium will remain so. Moreover, winds will spread plutonium-laden dust, again partly as an aerosol, from the soils even further.

There is a danger of a breakdown of controls and services. It is absurd to think that the elaborate standards set up in conditions of peace could be upheld in conditions of war. But already in unstable peace conditions the temptation could increase in many countries to accelerate the race for more and better plutonium at the expense of technical safety, in respect to toxicity and otherwise.

The particular technical features of nuclear energy lead to exaggerated technical, economical and therefore political centralization. Each of Weinberg's[4] nuclear parks with 8 breeders and the needed reprocessing and waste disposal installations would represent a staggering investment and require all-powerful central direction. At the same time, these parks would be very vulnerable. Well before the advent of a plutonium economy a forest fire damaged a transformer station in Kelsterbach, near Frankfurt, in April, 1976. Within a short time, not only large parts of Germany, but almost all Austria lacked power. Very strong measures will presumably be taken to prevent nuclear parks from dropping out.

To ensure the needed centralisation, Weinberg proposes a doctrine-enforcing supranational authority, which is to last in perpetuity (sic), and for which in his view the Roman Catholic Church is the best example:

> "Each country now has its own Atomic Energy Commission that sets standards or, in some cases, actually monitors or operates reactors. Perhaps this will be sufficient forever. Yet no government has lasted continuously for 1,000 years; only the Catholic Church has survived more or less continuously for 2,000 years or so. Our commitment to nuclear energy is assumed to last in perpetuity -- can we think of a national entity that possesses the resilience to remain alive for even a single half-life of plutonium-239 ? A permanent cadre of experts that will retain its continuity over immensely long times hardly seems feasible if the cadre is a national body.
>
> It may be that an International Authority, operating as an agent of the United Nations, could become the focus for this cadre of expertise. The experts themselves would remain under national auspices, but they would be part of a worldwide community of experts who are held together, are monitored, and are given a long-term stability by the International Authority. The Catholic Church is the best example of what I have in mind: a central authority that proclaims and to a degree enforces doctrine, maintains its own long-term social stability, and has the connections to every country's own Catholic Church."

The features of a plutonium economy, a "world made of plutonium", are also reflected in the abridgments of civil liberties that are widely envisaged. Even in peace time, armed guards are to be used on a large scale to protect shipments of nuclear fuel. Police powers are to be expanded hugely. In studies for the NRC (National Regulatory Commission) of the USA[5] it has been proposed to subject the personnel of the nuclear power installations not only to investigations of their personal past and to constant supervision in respect to political views and foreign connections, but even to periodic psychiatric examinations. General paranoia would follow even in time of peace. How would it be in time of war?

The words of P.Handler[6] (the President of the US Academy of Sciences) stand, although later, under pressure, he modified his statement. In a speech "On the State of Man"

he discussed the consequences of an all-out commitment to the plutonium-generating breeder reactor as the world's primary source of energy, with 3000 nuclear parks, each with 8 breeder reactors:

> "That would mean putting 4 reactors on line each week for the next century and also replace those that wear out (2 per day at the final stage according to Weinberg. E.B.), an absolutely staggering task. When one adds the nightmare of the existence of the 15000 tons of plutonium required for that many breeder reactors, the health hazard in handling plutonium, the police effort required so that no plutonium is removed for the construction of illicit nuclear weapons, and the task of waste disposal, one need not invoke the possibility of a catastrophic accident to consider that this is an insupportable scenario".

To conclude this part of the paper: It is obvious that in the nuclear age war has become an enormously greater disaster than before. But it must also be realised that nuclear energy, even supposedly peaceful nuclear energy, is itself contributing to the danger that war does break out.The trend towards a plutonium economy makes the maintenance of peace more and more difficult. While clearly the struggle for peace must be waged on all levels, account must be taken of the doubly perilous role of nuclear energy. Moreover, the attempts to keep nuclear energy under control will make human life strained and precarious.

The eminent American scientists named at the beginning of this paper advocate a diminished growth rate of the nuclear program. Many other critics, in many countries, have also asked for delays. The main argument has been the need for better safety, to be obtained by technical progress. The criticism of the nuclear power development, as put forward here, is complementary. It refers with full force

precisely to a plutonium economy if and when it is successfully developed all over the world. The target is the idea of a mankind dependent on nuclear fission in all foreseeable future.

It is not realistic to call for an immediate full stop to reactor development. Too deep is the commitment of many countries, and too heavy the investment. E.g., France has gone "tout nucléaire". In the circumstances, supporters of nuclear energy unfortunately can point to the danger that even legitimate needs of the masses of the populations could not be met if nuclear power were stopped now, and no substitute were ready. However, it may not be too late to stop the development and the introduction of the most dangerous device, the fast breeders.

Be that as it may, support by all people of good will should be obtained for alternative approaches to the world energy problem, at least for the future. In addition to stringent energy conservation, an international crash programme for the development of solar energy is needed. This source of energy is inexhaustible. The power of sunlight, as it reaches the Earth, is 170 million million kilowatts, 40000 kilowatts per head.

Solar energy can serve not only heating, cooling and pumping needs, etc., but also the production of electric power on a large scale. In particular, the photochemical generation of hydrogen from water has extraordinary prospects[1,7,8]. Hydrogen is easily stored and transported. It is applicable to the production of heat and electricity, of liquid fuels and of food. It is non-polluting. Of course, large-scale scientific-technical results will require many years of work --

but so they did in the nuclear field, in spite of the generous support by the military-industrial complex.

An International Solar Power Institute under the United Nations would be of great help in concentrating forces and conserving skilled manpower and finance. The Institute, which should be geographically decentralized, would also exert strong influence in favour of world peace. The possibility of free collaboration of nations in this venture for all mankind, without danger to national sovereignty, would correspond to the realities of the international situation. Solar energy has high potential thermodynamically, technologically, economically and politically, but low potential militarily.

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"Disarmament, Security and Development"
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F. Csaki (Hungary) XXVI-5

SOME REMARKS ABOUT SECURITY AND COOPERATION IN EUROPE

Pugwash meetings have often tackled the problem of security, disarmament and cooperation in Europe. This circumstance is due to the fact that Europe plays a special role in the security of the world. This Pugwash Conference, however, is the first at which some new statement can be made about the political situation in Europe after the successful conclusion of the Helsinki Conference.

The signature of the document of the Helsinki Conference by the leaders of thirty-five countries has indeed been a great success. Perhaps it was because the elaboration of the document and preparation of the signature was such a great advance that a break, or at least a waiting, could be observed in international relations after the Helsinki Conference. Taking into consideration the fact that the Helsinki Conference was not an objective in itself but a measure for further advance in international relations, we may pose the question of why this period of calmness occurred.

The Political Situation in the USSR and the USA

One important feature of the Helsinki Conference was that it led not to a bilateral treaty, but to a multilateral treaty, opening the way for better mutual understanding among many nations. The paramount importance of the superpowers, however, cannot be forgotten. In asking about the causes of this calmness, we must concentrate our attention on the foreign policy of the nations involved. Perhaps we are not very far from the answer if we look at the political situations in the Soviet Union and the USA. In the former, the Soviet nation prepared itself for the 25th Congress of the Communist Party, whereas in the latter, this year is devoted to the presidential election.

Foreign Policy of the USSR

At the Congress of the Communist Party, first secretary Leonid Brezhnev maintained and supported the trend of détente. Let us quote some thoughts:

> The struggle to consolidate the principles of peaceful coexistence, to assure lasting peace, to reduce and later also to eliminate the danger of another world war was, and remains, the main element of our policy towards the capitalist states. It may be noted that considerable progress has been achieved in this area in the past five years.

The passage from the cold war, from the explosive confrontation of two worlds, to détente was largely connected with changes in the correlation of world forces. But much effort was required for people -- especially those responsible for the policy of states -- to become accustomed to the thought that not brinkmanship but negotiation of disputed questions, not confrontation but peaceful cooperation. is the natural state of things.

In many ways, the results of the Helsinki Conference are projected into the future. Perspectives for peaceful coexistence have been outlined in a number of fields -- economy, science, technology, culture, information and growth of contacts between people. Some other measures, too, have been defined to further confidence between states, including the military domain. The main thing now is to translate all the principles and understandings reached in Helsinki into practical deeds. This is exactly what the Soviet Union is doing and will continue to do. Recently we made certain proposals for expanding all-European cooperation in a number of important spheres. We shall continue to apply our efforts in this direction, and expect the same approach from all other participants in the all-European Conference.

Thus, there are gains, and substantial ones, in the matter of arranging peaceful relations in Europe.

The turn for the better in our relations with the United States of America, the largest power of the capitalist world, has, of course, been decisive in reducing the danger of another world war and in consolidating peace. This has beyond question contributed to the improvement of the international climate in general, and that of Europe in particular. Acting in complete accord with the guidelines set by the 24th Congress, we have devoted very great attention to the objective of improving relations with the United States.

As a result of the negotiation with US President Nixon in Moscow and Washington, and later of the meetings with President Ford in Vladivostok and Helsinki, important mutual understanding in principle has been reached between the leaders of the Soviet Union and the United States of the necessity of developing peaceful equal relations between the two countries. This is reflected in the whole system of Soviet - US treaties, agreements and other documents. Unquestionably, the most important of these are "The Basic Principles of Relations Between the Union of Soviet Socialist Republics and the United States of America", the Agreement on the prevention of nuclear war, and the series of strategic arms limitation treaties and agreements. What is the main significance of these documents? Cumulatively, they have laid a solid political and juridical foundation for better mutually beneficial cooperation between the USSR and the USA in line with the principles of peaceful coexistence. To a certain extent they have lessened the danger of nuclear war. Precisely in this we see the main result of the development of Soviet-US relations in the past five years.

Foreign Policy of the USA

The line in the United States was, however, not so direct. Immediately after the Helsinki Conference there were many critical remarks about the results of the Helsinki Conference, asking if the results of detente were in favour of the Soviet Union and the socialist countries and , on the other hand, unfavourable for the United States and the capitalist countries. In recent months, President Ford has been in a hard race

in his own party for the presidential nomination with his competitor Reagan and , perhaps as a tactical move, he stated that in future he will omit completely the word détente from his political vocabulary. Ford said in a television interview: "I don't use the word détente any more ..... I don't think it is applicable any more."

White House officials said later that Ford was not signalling a change in foreign policy and, during the interview, Ford said that Henry Kissinger, an architect of détente, was a victim of "political criticism." He said that Kissinger could stay in the cabinet "as long as he wants to be Secretary of State". Ford said:

> I think what we ought to say is that the United States will meet with the Soviet Union, China and others and seek to relax tensions so that we can continue a policy of peace through strength.
>
> If we are strong militarily, which we are, and if we continue that strength, we can negotiate with the Soviet Union, China and others to maintain that peace. Détente is only a word that was coined. I don't think it is applicable any more.

At the same time, Secretary of State Henry Kissinger was often seriously attacked for his foreign policy based on détente. At the very end, he remarked: "I prefer not to stay." The news agencies reported: Secretary of State Kissinger plans to resign even if President Ford is elected to his own term next fall, he said in a broadcast interview made public Sunday night. Kissinger replied:

> I don't want to tie the conduct of foreign policy to me personally. If a foreign policy is well designed, then it should be able to be carried out by many people. So, on the whole, I prefer not to stay.

In the mean time, President Ford and Henry Kissinger defended their positions.

For the Continuation of Détente

We may agree that there is no alternative to détente, especially in the light of the enormous stockpiles of nuclear weaponry. We must not forget that the world expenditure for armament is about three hundred billion dollars per year. I think there is no need for clarification and argumentation in Pugwash that there is indeed no alternative to détente.

We may hope that after the events of the presidential elections -- independently of the persons involved -- the trend in the foreign policy of the US will once more support détente, perhaps even more efficiently. So much the more, as responsible politicians in the United Kingdom, France, Germany etc. have often expressed their views about the importance of détente and the socialist countries continuously support détente.

European security and cooperation are closely connected. The former ensures a basis for the latter, and the development of the latter promotes the former.

Not speaking of the circumstance that signature of the Helsinki document could not completely remove the obstacles to the building of confidence among nations, we must not wait for a quick breakthrough in European cooperation. We may remark, however, without exaggeration, that more can be done than has been done in recent months for the benefit of European security and cooperation.

The security of Europe should be maintained and we must look for any good measure which can pave the way for better mutual understanding among nations and for broadening cooperation.

I believe that Pugwash may make some good contributions in this respect.

26th Pugwash Conference
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Betty G. Lall (USA)

Slowing the Momentum of the Arms Race: A New Approach

A. Background

Scholars and policy-makers concerned with international peace and security continue to search for ways to stop the momentum of the arms race, now well into its third decade. The chief means to date to achieve this objective has been international negotiation. First there were the various commissions of the United Nations (Atomic Energy, Conventional Armaments, and Disarmament, and later the Disarmament Commission's five-member Subcommittee). Then came the Three Nation Test Ban Negotiations, the Surprise Attack Conference, the Conference of the Committee on Disarmament, the Strategic Arms Limitation Talks, and the negotiations for Mutual and Balanced Force Reductions in Europe.

It cannot be concluded that negotiation has totally failed, but it clearly has not resulted in substantial progress. While it should not be abandoned as a mechanism for reducing and eliminating weapons, it might be assisted if other methods could be pursued simultaneously.

Among the reasons why negotiation has yielded such limited progress is the manner in which decisions are made today in developing and producing new weapons systems. The major nations have built specialized bureaucracies whose principal job is to maintain their defense establishment in a perpetual state of modernization. Modern weapons systems require long lead time before they are produced and become fully operational. This fact alone suggests that the building of these increasingly sophisticated weapons has little direct relationship to the actual threat of war

or to the state of international tension. In many States, especially those with market economies, private companies are compelled constantly to invent new weapons systems to "sell" to the Defense Department; if they fail the company fails; stockholders lose their investments; workers lose jobs; communities suffer economic depression; and political leaders lose influence for failing to maintain this continuous flow of defense contracts to their communities. No doubt even in other States with non-market economies there is pressure on military leaders to assure their political bosses that their weapons are not becoming obsolescent and that new systems are on their way.

As new weapons systems move from the early research stage to later stages of development, testing, production, and deployment, they become more difficult to control or eliminate through international disarmament and arms control negotiations. The weapons acquisition process accumulates impressive vested interests; the enormous investment of funds in a new weapons system causes national political leaders to be reluctant to dismantle it until it has been in operation for several years.

Another factor obstructing the efforts to slow the momentum of arms purchases is that the people responsible for arms control and disarmament policy and negotiations usually have not had up-to-date information about new weapons systems, and particularly about the early research and development activities which may have an important bearing on arms control policy and negotiations. Such research programs often become buried in a maze of defense authorization and appropriations data. For example, the U.S. program to construct an ICBM began in the early 1950's; yet this strategic weapon was not made the serious subject of negotiation until 1969.

And by 1976, the number of strategic delivery vehicles had not been reduced; their warheads continue to increase to a very high level. In over twenty years of development and seven years of international negotiation, the effective quanta of these major weapons of the arms race remain essentially untouched by international disarmament and arms control negotiations.

B. Arms Control Impact Statements - A Potential Solution

Late in the fall of 1975 the U.S. Congress passed legislation establishing a process for determining the impact of new weapons systems on the arms race. The process could reveal this impact when a weapons system was in an early stage of development.

The legislation specifies that military programs involving nuclear weapons, programs involving other weapons with an estimated total program cost in excess of $250 million, or an annual cost of over $50 million, or any other program which may have a significant impact on arms control policy and negotiation shall be subject to analysis and assessment. The agency preparing legislative or budgetary proposals for such weapons programs must furnish the Director of the Arms Control and Disarmament Agency (ACDA) "on a continuing basis... full and timely access to detailed information"[1] about them. The Director of ACDA "as he deems appropriate, shall assess and analyze each program [mentioned above] with respect to its impact on arms control and disarmament policy and negotiations, and shall advise and make recommendations, on the basis of such assessment and analysis, to the National Security Council, the Office of Management and Budget, and the Government agency proposing such program."

When the National Security Council [which is composed of the President, Vice President, Secretaries of State and Defense] decides

1. The phrases in quotation marks are contained in the legislation as a new Section 36 of the Arms Control and Disarmament Act.

that a weapons programs, of the type mentioned above, does have an impact on arms control and disarmament policy and negotiations, the request to the Congress for authorization or appropriation for such weapons system or program "shall include a complete statement analyzing the impact of such program on arms control and disarmament policy and negotiations."

C. Action by Congress

The new legislation provides that any one of seven different committees of the Senate and House of Representatives may request from the Director of ACDA his advice "on the arms control and disarmament implications of any program with respect to which a statement" on the arms control and disarmament impact was submitted as part of the budgetary request. The committees are the Senate Committees on Foreign Relations, Armed Services, and Appropriations; the House Committees on International Relations, Armed Services, and Appropriations; and the Joint Committee on Atomic Energy.

Some of these committees, especially the House Committee on International Relations and the Senate Committee on Foreign Relations, have already established a procedure whereby they will evaluate the impact statements submitted to them. Experts at the Congressional Research Service, or those under contract to that agency, will advise the Congressional committees about them.

D. Implications of the Legislation

It is important to note that agencies involved in research, development, testing, and production programs for weapons must furnish the Director of ACDA with information on a continuous basis. Thus, one of the past difficulties in attempting to control weapons at early stages of development is potentially removed. As soon as a weapons program reaches the expenditure level of $50 million a year or an estimated $250 million as its total cost, the information flow begins. For nuclear weapons programs the dollar limitation does not exist. Moreover, for other weapons programs or policies the information flow can begin at a lower level of expenditure. The House of Representatives Committee on International Relations pointed out the reason for this provision.

> "Included in this intent are items of 'seminal' nature, such as major philosophical or doctrinal changes in defense posture or new weapons concepts in various stages of research and development." 1

Key to the effectiveness of the legislation is the kind of analysis prepared by the Director of ACDA. This will be the basis for any decision by the National Security Council to attach its statement of impact to defense budgetary requests to the U.S. Congress.

The legislation does not specify what, if anything, should be done if an ACDA assessment of a weapons program indicates that it would have a negative or countervailing effect on arms control policy or negotiations in process. It might be presumed that strong ACDA leadership would bring such a finding to the National Security Council, the Secretary of Defense, and possibly to the President. Much depends on the character of the ACDA leadership.

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1. House of Representatives, 94th Congress, 1st Session, "Arms Control and Disarmament Act Amendment of 1975," June 11, 1975, page 11.

If a conflict arose would the weapons system be abandoned, postponed, developed at a slower rate, or would the arms control policy be altered? The answer to this question cannot yet be known because the legislation has not been implemented. The Executive branch has stated that the legislation was passed too late to have it applied to the budgetary process beginning in January, 1976. It was anticipated, however, that ACDA would undertake to prepare impact statements on twenty to thirty weapons programs for consideration during 1976, but as of late July no impact statements had been sent to the Congressional committees authorized to receive them. The plan for 1977 is to assess 100 weapons programs.

Of crucial importance to the efficacy of the arms control impact statements as a means of slowing down the arms race and as a contributor to more successful arms control and disarmament negotiations, is the criteria to be used by ACDA in making its assessments. While the legislation does not require ACDA to reveal its criteria they will undoubtedly become known because Congress is likely to require such information as part of its analysis of the materials submitted to it by the Executive branch. For example, at what point in the development of a new weapons system should it become the subject for international negotiation? To what extent should the rate of research and development of a weapons program be slowed in order not to have it complicate already delicate and difficult negotiations? Will there be times when a new weapons program should be delayed altogether pending the outcome of negotiations? Should new weapons programs serve as bargaining chips in negotiations? Should research contracts for verification be let simultaneously with contracts for the weapons themselves so as to assure that means of verification will be available? What are reasonable time periods

that should be set to give negotiations time to succeed pending decisions to proceed with a weapons program from one stage of development to another?

It is possible that the impact statements will also affect the formulation of arms control and disarmament policy. This effect could be both positive and negative. It could be positive because the ACDA personnel responsible for formulating policy would have much more inofrmation to work with. Similarly, the Congress would also have more data with which to judge the adequacy of the policy. Policy might become more comprehensive and long range than its present ad hoc and limited approach. Theoretically every weapons system is a candidate for control, reduction, or elimination. However, if the weapons program can be identified by ACDA at an earlier stage the result could be both a savings of money and a reduction in tension among nations provided such identification leads to a postponement of the development of that program and its eventual control through international negotiation. During the current arms race in the overwhelming majority of cases the introduction of new weapons, as well as existing weapons deployed in new places, have been a source of tension and not the reverse. ICBM's, the intercontinental bomber, MIRV's, and ABM's are examples. A significant exception is the solid fuel long-range missile on submarines. However, the above positive implications are not likely to reach their full potential and effectiveness unless similar approaches are adopted by the other major arms producing countries.

On the negative side there could be increased pressure put on ACDA, the National Security Council, the President, and Congress by weapons producing agencies either to assess the impact of a

weapons system as being of no consequence to the success of arms control policy or negotiations, or if the impact was considered harmful to arms control efforts the policy itself should be changed. For example, in the 1950's and early 1960's military leaders resisted successfully all efforts to include ICBM's as active and serious subjects for reduction and control in international negotiations.

One might also argue that with more information flowing about new weapons programs other countries will be stimulated to begin development of similar weapons earlier. This would provide more competition for the initiator of the weapons program and not give it a so-called military advantage. That is a negative possibility. But the same situation can be made positive. All weapons eventually become the subject of international arms control and disarmament negotiations. Usually, however, they do not become so until they are almost obsolete, or ~~that~~ when other countries have caught up with the leader in the weapons program. If new weapons systems would become subjects for negotiation sooner, as pointed out earlier, the savings in funds could be enormous not to speak of the additional advantage of reducing international tension.

E. Arms Control Impact Statements and Other Countries

At the present time arms control impact legislation is known to exist only in the United States, and as we have observed, it is too early to determine its full benefits. Clearly, the introduction of similar arms control impact statements in other countries would further promote a decrease in the arms race momentum, reduce international tensions, and promote successful international arms control and disarmament negotiations.

For some countries the Academy of Sciences would be an approp-

riate institution to be given the responsibility to prepare arms control impact statements. Such academies consist of eminent scientists many of whom possess a deep understanding and an intimate knowledge of their country's defense establishment. Moreover, many of these same scientists also advise on arms control negotiations. They may have broader perspectives about how national security is to be achieved than those who work only or primarily in the military area. The scientists often have access to the necessary information, indeed many of them are the original source of the ideas which are the basis for new weapons.

It can be anticipated that should some governments decide to request their Academies of Science to prepare arms control impact statements on their weapons programs this function and its results will not be made public. This would be unfortunate because scientists in other countries would not be able to know or discuss the results of the analysis, or to use them to reinforce their own efforts to use this means to slow the acquisition of new weapons. Still, the decision by governments to require the preparation of arms control impact statements for new weapons programs would be a step forward. It would be another means to demonstrate that arms control and disarmament may be more important for the security of nations and their economic and social well being than the constant push to develop and possess new weapons systems.

In conclusion, the purpose of this paper is to alert fellow scientists to the arms control impact statements as a promising new development in achieving arms control and disarmament, to encourage the adoption of this approach in appropriate forms in other countries, and to stimulate careful scrutiny of the way the process is working so as to improve chances of positive results.

26th Pugwash Conference
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V.S.Emelyanov (USSR) XXVI-18

Concerning the Question of Atomic Power Energetics and Proliferation of Nuclear Weapons

The latter half of the 1950 s and the first half of the 1960s were keynoted by a substantial headway made in the sphere of nuclear engineering.

The successful construction and exploitation of the very first atomic power stations importantly contributed to converting our time into an age of atomic energy.

In July 1954 the world's first atomic power station was put into operation in Obninsk, 107 kilometres from Moscow. This station has been operating successfully for over two decades now. Ten years after its launching, at the Third World Conference on the Peaceful Uses of Atomic Energy convened by the U.N. at Geneva in 1964, the most prominent specialists of all countries unanimously confirmed that the world had entered a new epoch, when atomic energy would be called upon to replace coal, oil and natural gases.

The conference heard a stern warning from men of science about the urgent need to stop the consumption of coal, oil and natural gases which are indispensable raw materials for rapidly developing chemistry. The conference participants were acquainted with plans for the construction of a considerable number of atomic power stations. It was predicted that by the close of this century, up to 30, 40 and even 50 per cent of the energy consumed by the industrially developed countries would be sup-

plied by atomic power stations. Everything went well and nobody voiced any alarm or concern. All were unanimous in giving a favourable appraisal of the new source of energy.

But during the last five years, there began to appear more and more pronouncements at international scientific forums and in the press about the dangers presented by atomic power stations. One of the greatest hazards is seen by the authors of these statements in the fact that the plutonium which accumulates in the fuel elements of the reactors during the operation of atomic power stations can be extracted from them and used for the production of nuclear weapons. And this, it is alleged, can undermine the treaty on the non-proliferation of nuclear weapons insofar as it will enable practically all the countries possessing atomic power stations to obtain plutonium suitable for the production of nuclear weapons.

Some of the scientists have also issued a warning about the possibility of stealing plutonium from atomic power stations, manufacturing nuclear bombs from it and using the latter for criminal purposes.

Those who are sounding the alarm in connection with the imaginary danger presented by atomic power stations apparently forget that the plutonium used by the latter exists not in a free state but in the fuel elements--a medium of exceptionally high radioactivity, and that in order to extract it, these elements must necessarily be processed at special factories, which is far from simple and entails great expenses.

Consequently, plutonium can be stolen not from atomic

power stations but from the factories to which the fuel elements are delivered for processing and extracting plutonium. There are not more than ten such factories in the world today. Just as uranium-235, plutonium can be used both as a nuclear explosive and as nuclear fuel. Thus, any nuclear reactor, while consuming nuclear fuel and releasing energy, at the same time transforms part of nuclear-inactive uranium-238 into nuclear-active plutonium.

Every nuclear reactor performs two functions: it releases energy and produces new nuclear fuel--plutonium. The choice of the nuclear reactor depends on the aims it is designed to achieve: to produce energy or plutonium. In other words, what serves as a by-product: energy or plutonium? When the primary product is plutonium, the efforts of the designers and operating personnel are directed towards ensuring the production of plutonium corresponding to the requirements of the manufacture of nuclear weapons and facilitating the technology of its extraction.

On the other hand, if the basic designation of the reactor is generation and utilization of energy, the designers will make every effort to ensure that the heat-producing elements operate reliably and as long as possible without replacement. In conformity with these aims, the required construction is chosen along with the materials needed for its manufacture.

These aims sharply differ in nuclear reactors intended for generating energy and for obtaining plutonium.

The same also applies to the reactor operation system.

A power station reactor must operate as long as possible without the replacement of fuel elements. This is nec-

essary to make its exploitation economically profitable, for frequent replacements tend to increase the cost of generated energy.

The reactor intended for the production of plutonium, on the contrary, requires that these elements be frequently replaced so as to prevent the accumulation in plutonium used for the production of nuclear weapons of dangerous isotopes which tend to slow down the nuclear processes. To clean plutonium-239 of these isotopes is a very complicated and costly process.

It is thus obvious that it is simpler and more reliable to produce plutonium for nuclear weapons in reactors specially intended for this purpose than to use atomic power station reactors.

But even in this case it is practically impossible to steal plutonium from the reactor. The enormous radioactivity of the fuel elements is a reliable safeguard against this. On the other hand, plutonium can be stolen from the plutonium factories processing heat-producing elements.

This circumstance has prompted new ideas to people who fear the possibility of plutonium being stolen and used for terroristic and other criminal aims.

At one of the conferences I happened to hear such arguments:

"It will probably prove impossible to stop the construction of atomic power stations but it is quite feasible to stop the construction of new plutonium factories."

This was followed by putting forward the idea of establishing "plutonium-free zones."

"But in this case the nuclear fuel resources will be re-

duced considerably," I remarked. "It is commonly known that natural uranium contains only 0.7 per cent of the nuclear-active isotope--uranium-235. But even so only a fraction of this meagre quantity can be practically used. And what is to be done with plutonium if it proves impossible to extract it?" I asked.

"Let it remain in fuel elements to be stored in special depots," was the answer given by one of the authors of the new conception.

Apart from this, it should be borne in mind too that the presence of plutonium alone is not sufficient by far for the production of nuclear weapons. It is fitting and proper to recall in this connection that even in a country like Britain, which is famed for its high level of scientific and technological development, it took prominent scientists and engineers several years to develop only a neutron detonating fuse for the first British bomb, to say nothing of many other extremely complex tasks that had to be solved.

Hence, the warnings issued by a number of authors about the possible stealing of plutonium by criminal elements and making nuclear bombs with it seem quite strange, to say the least. One of the participants in the international scientific symposium which took place in Sweden in 1973, comparing atomic power stations with a Trojan horse, arrived at the paradoxical conclusion that nuclear engineering, as it were, undermines not only the national security of developed countries but also the security of the whole of mankind.[1] And a year later, in 1974, a bulky volume

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[1] D. Krieger, "Nuclear Power: A Trojan Horse for Terrorists. Nuclear Proliferation Problems." SIPRI. Stockholm. Almqvist and Wiksel, 1974, pp. 187-88.

devoted to the same subject appeared in the U.S.A. under the title "Nuclear Theft: Risks and Safeguards."[1] One is prompted to ask in this connection: Is it not simpler for representatives of the criminal world to steal ready-made nuclear bombs from the nuclear-weapon depots scattered all over the world? This danger is far more real, though not a word is said about it. It looks as if someone needs to divert the attention of public opinion from the danger presented by nuclear armaments and to rivet it instead on the fictitious danger ascribed to atomic power stations.

At a symposium held in Canada in 1966, I drew attention to the possibility of stealing nuclear weapons from NATO depots. One of the participants promptly declared that this was completely precluded because nuclear weapons were fitted with electronic locks which the thieves could not open.

Efforts are being made to persuade the public that it is much easier for the criminals to produce atomic bombs than to open the locks at nuclear-weapon depots.

Some logic indeed! Atomic power stations are dangerous while the nuclear-weapon depots scattered all over the planet present no danger whatever because they are locked by an electronic device. Quite noteworthy is the fact that the exceptionally vigorous campaign against the construction of atomic power stations coincides in time with the incipient relaxation of international tension. The opponents of detente and disarmament

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[1] Mason Willrich, Theodor B. Taylor, "Nuclear Theft: Risks and Safeguards." Billinger Publishing Company, 1974.

exert their efforts precisely in order to divert the resentment of public opinion from nuclear weapons and to shift it to atomic power stations.

The real means to prevent the spread of nuclear weapons is the complete cessation of all nuclear tests in all environments by all countries without exception, and the termination of the nuclear arms race, including means of delivery.

It is necessary that all states undertake not to employ or to threaten the use of nuclear weapons, and, in general, that they commit themselves to refrain from the use or threat of force in relations with other states under any circumstances.

As to nuclear energy, it is important to ensure that it be used exclusively for peaceful purposes and that all obstacles to the use of this greatest achievement of our epoch are removed.

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B.T. Feld (USA) XXVI-9

A NEW LOOK AT NUCLEAR WEAPON-FREE ZONES

1. Generally speaking, the concept of nuclear weapon-free zones is intended to serve three purposes:

a. Reassurance to the inhabitants of the zone that -- in case of outbreak of a conflict involving nations within the zone and even if such conflict should involve nuclear weapon states and the eventual use of nuclear weapons outside the zone -- they will be spared from the threat and danger of nuclear attack. In this sense, it serves as a security supplement to the Nuclear Non-Proliferation Treaty.

b. Reinforcement of internal political and economic barriers, within the nations of the zone, against pressures for the independent acquistion of nuclear weapons. Such pressures can arise from a diversity of causes: from justifiable concerns for the survival of a nation in a hostile international or regional atmosphere to the time-honoured practice (among nations as well as individuals) of "keeping up with the Joneses".

c. Progress towards the ultimate goal of eliminating nuclear weapons from the arsenals of all nations. The larger the fraction of the earth which is covered by nuclear-free zones, the greater will be the pressures and the incentives for extening this area to cover the entire globe. Since the concept of a nuclear-free zone, as it is now understood by most of its serious advocates, includes guarantees to the members of the zone of no-first-use of nuclear weapons by the nuclear weapons powers, such zones do indeed represent a serious stage in the universal acceptance of the non-useability of nuclear weapons. The non-first-use concept appears , in turn, to be a prerequisite for the acceptance of an eventual ban on the production, deployment and use of nuclear weapons.

2. The concept of nuclear-free zones has recently been considered in a special study by the U.N. Conference of the Committee on Disarmament (CCD/467, also U.N. document A/10027/Add.1). The general consensus (but not universal agreement) of the participants in the study was that a nuclear weapon-free zone agreement should contain the following elements:

(a) Agreement by the zone members

i) Not to develop or to accept possession of nuclear weapons on their territories.

ii) Not to deploy or to permit deployment of nuclear weapons on their territories.

iii) To permit appropriate provisions for control to verify compliance.

(b) Nations outside the zone would agree to respect its nuclear weapon-free character. In particular, the nuclear weapon states would agree formally (as part of the treaty establishing the zone) not to use or threaten to use nuclear weapons against any zone member as long as this member complies with its treaty obligations.

(c) There are a number of collateral issues on which general agreement is more difficult to achieve: questions of transit of nuclear weapons; so-called peaceful nuclear activities, including peaceful nuclear explosions; treatment of territories or possessions of nuclear powers that lie within the zones; other security arrangements and alliances of zone members, especially with nuclear weapon states; supplementary security guarantees to zone members. Such issues are very complex and their resolution may differ from zone to zone, making each zonal negotiation a separate problem.

3. For reasons such as those mentioned above, only few nuclear-free zone arrangements have thus far been negotiated: the Antarctic Treaty (1959); the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (1963); the Treaty (of Tlatelolco) for the Prohibition of Nuclear Weapons in Latin America (1967); the Treaty for the Prohibition of the Emplacement of Nuclear Weapons and Other Means of Mass Destruction on the Sea-Bed and the Ocean Floor and in the Subsoil thereof.

Other nuclear-free zones have been proposed -- Central Europe; the Balkans, the Adriatic and the Mediterranean; Africa (south of the Sahara); Northern Europe; the Middle East; South Asia. In each case, special problems, relating to one or more states in the proposed zone, have prevented its successful establishment. Even in the Latin American case, which is the only populated area where a nuclear-free zone exists, some important states (e.g. Cuba, Argentina) are not yet parties to the treaty, while others (Brazil, Chile) have expressed various reservations, including the right to conduct "peaceful" explosions. Among the five admitted nuclear weapon states, only

the USSR has not yet formally accepted the Zone's nuclear-free status (Protocol II), owing to ambiguities concerning the right of transit of nuclear weapons through nations in the area and the waters surrounding it.

4. In the end, the prospects for equivalent treaties in other areas seem rather remote at this time, in spite of the very strong desires of many nations to enter into such arrangements. For this reason, some participants in the 25th Pugwash Conference in Madras, India last January proposed the following variant of the nuclear-free zone idea. (This is essentially a revival of some elements of an idea which was current in the 1950s, to my knowledge first proposed by Sweden, of a "non-nuclear club" of the non-aligned nations.) : those nations which were prepared to do so could, together, form "a World Nuclear-Free Zone to be established by Treaty or other instruments to which all nations of the world would be asked to accede ... the areas encompassed by such a zone need not be contiguous and ... the zone would be feasible even though only a limited number of countries become parties in the first instance."

In response to the suggestion of the Madras Working Group that Pugwash might develop a formal proposal that "could then be presented to the UN and other world organizations for their consideration and, hopefully, action", I have prepared the following text for a draft World Nuclear-Free Zone Treaty. The wording is based on existing treaties (especially the Treaty of Tlatelolco) and agreements, and is intended to serve primarily as a basis for further discussion and consideration.

A Treaty for a World-wide Zone of the Prohibition of Nuclear Weapons

Preamble: In the names of their peoples, the Governments of the States which sign this Treaty,

Desiring to contribute towards ending the arms race, especially in nuclear weapons,

Recalling that the establishment of militarily denuclearized zones can be a significant means for achieving universal nuclear disarmament at a later stage,

Desiring to undertake all measures possible to strengthen world peace and security,

Convinced that the incalculable destructive power of nuclear weapons and the inevitable after-effects of a nuclear war could endanger the survival of the human species,

And that the proliferation of nuclear weapons would make their eventual elimination enormously difficult and would increase the danger of the outbreak of a nuclear conflagration,

And that the continuing military denuclearization of regions now free of nuclear weapons will not only be beneficial to the peoples of these zones, but will exert a benign influence on other regions of the earth,

Agree as follows:

Article 1

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

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

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

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

Article 2.

For the purpose of this Treaty, the Contracting Parties are all those States, irrespective of their locations, for whom the Treaty is in force.

Article 3.

For the purposes of this Treaty, the territory of a party State shall include all the land, sea and air-space over which its sovereignty is recognized by established international law. However, in the case of States that, de jure or de facto, exercise international responsibilities for territories non-contiguous with their main bodies, such territories may, with the agreement of the States party to the Treaty bordering thereon, be separately accepted as contracting Parties to the Treaty.

Article 4.

For the purposes of this Treaty, a nuclear weapon is any device which is capable of releasing nuclear energy in an uncontrolled manner and which has a group of characteristics which may be appropriate for use for warlike purposes.

Article 5.

All the Parties to the Treaty have the right to participate in the exchange of equipment, materials and scientific and technical information for the peaceful uses of nuclear energy,

in accordance with this Treaty and under appropriate international supervision and through appropriate international agencies and procedures.

Article 6.

For the purpose of verifying compliance with the obligations entered into by the Contracting Parties in accordance with article 1, the following controls shall be put into effect:

1. Each Contracting Party shall negotiate appropriate agreements with the International Atomic Energy Avency for the application of safeguards to its nuclear activities; the scope and nature of such safeguards shall be determined by the same provisions as govern signatories to the Treaty on the Non-Proliferation of Nuclear Weapons.

2. The Contracting Parties shall submit to the Atomic Energy Agency such reports and other information as it shall require to verify compliance.

3. The Secretary-General of the United Nations may request any of the Contracting Parties to provide him with complementary or supplementary information regarding any event or circumstance connected with compliance with this Treaty, explaining his reasons. The Contracting Parties undertake to co-operate promptly and fully with the Secretary-General.

4. The International Atomic Energy Agency has the power to carry out special inspections in the following cases:

(a) In accordance with the agreements referred to in paragraph 1 of this article.

(b) When so requested, the reason for the request being stated, by any Party, which suspects that some activity prohibited by this Treaty has been carried out or is about to be carried out, either in the territory of any other Party or in any other place on such later Party's behalf.

(c) When requested by any Party which has been suspected of or charged with having violated this Treaty.

5. The International Atomic Energy Agency shall promptly report the findings of its inspections to the Secretary-General of the United Nations, who shall initiate any necessary action required through appropriate procedures provided by the Charter of the United Nations.

6. The costs and expenses of any special inspection carried out under paragraph 4

above shall be borne by the requesting Party or Parties, except where the Secretary-General of the United Nations concludes on the basis of the report on the special inspection that, in view of the circumstances existing in the case, such costs and expenses shall be borne by the IAEA.

7. The Contracting Parties undertake to grant the inspectors carrying out such special inspections full and free access to all places and all information which may be necessary for the performance of their duties and which are directly and intimately connected with the suspicion of violation of this Treaty. If so requested by the authorities of the Contracting Party on whose territory the inspection is carried out, the inspectors designated by the IAEA shall be accompanied by representatives of said authorities, provided that this does not in any way delay or hinder the work of the inspectors.

8. The IAEA shall immediately transmit to all the Parties, through the Secretary-General of the UN, a copy of any report resulting from a special inspection. Similarly, the IAEA shall send through the Secretary-General, for transmission to the United Nations Security Council and General Assembly, and for his information, a copy of any report resulting from any special inspection carried out in accordance with the provisions of this article.

Article 7.

Unless the Parties concerned agree on another mode of peaceful settlement, any question or dispute concerning the interpretation or application of this Treaty which is not settled shall be referred to the International Court of Justice with the prior consent of the Parties to the controversy.

Article 8.

1. This Treaty shall be open indefinitely for signature by all States members of the United Nations, and by the non-contiguous territories of States members, as provided in article 3.

2. This Treaty shall be subject to ratification by signatory States in accordance with their respective constitutional procedures.

3. This Treaty, of which the Arabic, Chinese, English, French, Hindi, Spanish, Swahili, and Russian torts are equally authentic, and the instruments of ratification shall be deposited in the archives of the United Nations.

4. This Treaty shall enter in force as soon as, both

(a) it has been ratified by twenty States members of the United Nations, and

(b) the additional protocol has been ratified by at least three of the permanent members of the United Nations Security Council.

Additional protocol.

In the names of their peoples, the Governments of the States which sign this protocol,

Agreeing with the need for the Treaty as set forth in its Preamble,

Desiring to contribute, in so far as it lies within their power, towards the eventual total elimination of nuclear weapons in a world at peace,

Have agreed as follows:

Article 1.

The statute of denuclearization in respect to warlike purposes, as defined, delineated and set forth in the Treaty for a World-Wide Zone of the Prohibition of Nuclear Weapons of which this instrument is an annex, shall be fully respected by the Parties to this Protocol in all its express aims and provisions.

Article 2.

The Governments represented by the undersigned undertake, therefore, not to contribute in any way to the performance of acts involving a violation of the obligations undertaken by the Contracting Parties.

Article 3.

The Governments represented by the undersigned also undertake not to use or threaten to use nuclear weapons against the Contracting Parties of the Treaty for a World-Wide Zone of the Prohibition of Nuclear Weapons, so long as said Parties shall continue to adhere to their obligations under said Treaty and so long as said Treaty shall remain in force.

Article 4.

The duration of this Protocol and the provisions regarding ratification, authentic texts and deposition shall be the same as those of the Treaty for a World-Wide Zone of the Prohibition of Nuclear Weapons.