the nuclear future

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1. the need for arms control

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The fundamental problem facing mankind is the development of a method of allowing peaceful change to take place in the present international system of sovereign and independent states. It seems inevitable that, for the foreseeable future, states will have power in the military sense; the problem is how this power can be controlled or managed to minimise the risk of war in a dynamic world society. In the nuclear age, when even limited wars would almost certainly lead to unimaginable destruction, this problem takes on a special urgency.

A systematic programme of arms control and arms reduction would probably simplify, but not solve, the task of the peaceful management of the power of states and thus lead to a more secure world. The converse argument, namely that the greater the power of a state the less likely are others to interfere with it and, therefore, that high levels of arms, even to nuclear levels, are likely to lead to greater stability, seems wrongly to assume that all leaders of states will use their power in a responsible manner.

Once the necessity for arms control is agreed the question arises of the present prospects for it. This question is greatly complicated by the rate at which technological revolutions now occur compared with the slow speed with which arms control negotiations proceed. In the past three decades there have been three military technological revolutions: in the development of nuclear energy; in the development of intercontinental missiles; and in communications and control systems. In the same period lengthy arms control negotiations have produced: the Partial Test Ban Treaty (1963); the Treaty Governing the Activities of States in the Exploration and Use of Outer Space (1967); the Treaty of Tlatelolco for the Prohibition of Nuclear Weapons in Latin America (1967) and the Non-proliferation Treaty (1968). The first three of these were minor successes. The successful negotiation of the Non-proliferation Treaty was an achievement of some importance, although it will be some time before it is known whether or not this treaty is viable.

In the future, further major technological developments can be expected; there is no reason to assume that the rate at which these will occur will decrease. Many technical and scientific fields have the potential to produce significant military innovations, such as biological warfare, defence against missile attack, psychological warfare, intercontinental missiles of very high accuracy, and the military use of space vehicles.

In addition to the vertical increase in the number of technological innovations there is a horizontal spread of each of them. Typical of this is the spread of nuclear energy. It is desirable to consider this in some detail, for firstly, a nuclear energy programme can provide a state with the option of acquiring nuclear weapons which are, at present, the most credible weapons of mass destruction; secondly, nuclear programmes have become of great importance to some of the smaller powers; thirdly, attempts have been made to control the military use of nuclear facilities and useful lessons can be learnt from these efforts; fourthly, there are important implications for the future of the Non-proliferation Treaty; and finally, to indicate the complexities of the issues facing any country which wishes to adopt an arms control policy.

The substance used as the fissile material for nuclear weapons is either plutonium-239 or uranium-235, but an important distinction has to be made between these. Judging from the experience of all the present five nuclear-weapon powers, it seems that the use of uranium-235 is necessary, or at least preferable, for the fissile material for thermonuclear weapons; the technical reasons for this are still classified. Plutonium-239 is produced in nuclear reactors whereas the separation of uranium-235 from natural uranium for use in nuclear weapons is a difficult operation involving a complex industrial process. For these reasons it is justifiable to consider separately nuclear capabilities which could lead to the acquisition of nuclear weapons and those which could lead to thermonuclear weapons.

2. implications of nuclear energy

The development of nuclear power started relatively slowly but in the past decade it has progressed and spread with a rapidity that has exceeded all expectations. In the 15 years since the first small 5MW (MW=megawatts (one million watts) of electricity) nuclear power plant went into regular operation at Obninsk in the Soviet Union, nuclear power has progressed from the experimental to the commercial stage and is now signficantly contributing to the world's almost insatiable demand for electricity. An indication of the rapidity with which nuclear energy has developed is given by Table 1 in which the yearly increase in the total world-wide installed nuclear capacity is shown. In a single decade, nuclear industries have been developed in several industrialised countries to an extent which will enable them to construct and install large nuclear power plants which would produce power at economically justifiable costs in many areas of the world.

Public and private power utilities in many countries are already operating and constructing nuclear plants on a purely economic basis. At present there are 107 power reactors, with a total capacity of 20,000 MW, installed in 16 countries. In the next five years at least six additional countries will have nuclear power reactors, and the total installed capacity will exceed 113,000 MW, produced by at least 255 reactors (Table 2). By 1980 the amount of electricity which will be produced by nuclear power is estimated to be greater than 300,000 MW.

TABLE I

TOTAL INSTALLED NUCLEAR POWER CAPACITY UP TO 1974

year	(MW)	year	(MW)
1954	5	1965	7527
1955	5	1966	8843
1956	207	1967	10685
1957	297	1968	13462
1958	1157	1969	19938
1959	1390	1970	30745
1960	1560	1971	49365
1961	2137	1972	71547
1962	2836	1973	90570
1963	4567	1974	113640
1964	6113	1980	> 300000

The estimates for the projected nuclear capacity in the future are being continually revised upwards as confidence in the competitive position of nuclear plants grows. Long range calculations show that, in several countries of the world, nuclear power may provide more than 50 per cent of the electric power requirements by the end of this century. The nuclear power programme in the United States is of particular interest as an illustration of the likely future pattern in the industrialised countries. The use of electricity in the United States has doubled roughly every ten years throughout this century, and is at present increasing twice as fast as the gross national product and more than five times as fast as the population. Electric power production is America's largest industry, with a present capital investment of about £3,500 million per year. At present, the major electrical energy sources in the United States are coal, gas, water power and oil, with nuclear power only supplying about one per cent of the installed generation capacity. However, with the knowledge that conventional sources of energy will not be adequate to satisfy future demand in the United States and with the establishment of the economics of nuclear power, the electric utilities are rapidly turning to nuclear fuel to meet future requirements. In addition to the 24 nuclear plants already in operation, and producing over 7,000 MW, about 30 are under construction and over 50 more in the planning stage. It is estimated that in 1980 about 30 per cent of her total generation capacity will be in nuclear plants. At this time, the United States may generate at least 150,000 MW by nuclear reactors, which will represent about 50 per cent of the total world capacity of nuclear power. Orders for nuclear plants now represent about 40 per cent of the total new orders for steam-electric power plants, and this percentage will undoubtedly increase rapidly with time.

An important feature of the American nuclear power programme is the increas-

TABLE 2

COUNTRIES OPERATING NUCLEAR CAPACITY

	No. of power reactors 1969	installed nuclear power capacity (MW)	No. of power reactors 1974	installed nuclear power capacity (MW)
Argentina	—	—	1	319
Belgium	1	10.5	3	1500
Bulgaria	—	—	2	800
Canada	2	226	13	6513
Czechoslovakia	1	150	2	480
Finland	—	—	2	600
France	9	1648	13	3693
West Germany	9	982	15	3450
East Germany	1	70	3	1570
India	3	580	6	1180
Israel	—	—	1	200
Italy	3	597	5	1232
Japan	3	534	12	5422
Netherlands	1	51.5	2	451
Pakistan	—	—	1	125
Spain	2	593	7	2343
Sweden	2	145	5	2154
Switzerland	2	357	6	2013
Taiwan	—	—	1	300
USSR	15	1682	24	4210
United Kingdom	29	5353	42	13055
USA	24	7029	89	62029
	107	20008	255	113640

ing capacity of the plants. At the end of 1968 the nuclear power plants had capacities of less than 500 MW; all but three of the plants under construction will exceed this capacity and at least seven will exceed 1,000 MW. Many more are in the planning stage. Studies have indicated that nuclear plants of up to 3,000 MW are technically feasible provided that engineering problems associated with the production of pressure vessels and turbines are solved. It is only within the past few years that it has been realised that power plants larger than about 600 MW were economically and technically feasible; this is a main reason why estimates of nuclear capacity have been conservative.

Another interesting feature of the American programme concerns the locations of the nuclear plants. At present, these plants are concentrated in New England, California, the northern Atlantic seaboard and the Great Lakes region, which are all areas of high fuel costs in which nuclear plants offer a clear economic advantage over fossil-fuelled plants. The areas are also among the most highly populated and industrialised areas of the United States and therefore they require large base-load plants. Other areas of high fuel costs, such as parts of the Midwest and the Pacific Northwest, do not have a high enough electrical power demand to justify nuclear plants of a size sufficient to be competitive. In the next decade nuclear plants will be constructed along the Atlantic seaboard to Florida and will be more numerous in North Central America. It is unlikely that nuclear power will be competitive with other fuels in areas like the Appalachian Mountains (coal) or in Texas (oil and natural gas) or will be used to supply areas of low population density.

The United Kingdom has most of its population concentrated in a few highly industrialised areas and nuclear energy is, therefore, a particularly suitable source of electricity. The first phase of the British programme, representing an investment of approximately £750 million, has just been completed and has developed nuclear power to the point where it is competitive with coal for the production of electricity. The generating authorities plan to invest a further £750 million to obtain another 8,000 MW by 1975. At that time about 25 per cent of the total energy from all sources of electricity production (150 million tons of coal equivalent) will be produced by nuclear reactors. A similar pattern is emerging in the countries of western Europe. In West Germany between 25,000 and 30,000 MW are likely to be installed by 1980. France will probably have 17,000 MW by 1980. In Belgium, a nuclear capacity of up to about 4,000 MW is likely by 1980. By the end of 1970 Italy will be ordering, on average, one 650 MW power plant each year for several years. Although firm plans have not been announced for the period 1970-1980, there is little likelihood that the pace of the nuclear energy programme will diminish. The growing competitiveness of nuclear plants and the rising demand for energy is likely to lead to an installed nuclear capacity in Italy of at least 12,000 MW by the end of the next decade. In the Netherlands, it is estimated that 2,000 MW of nuclear energy will be installed by 1980. It can, therefore, be concluded from the present indications that, by 1980, the installed nuclear capacity in the EEC will be at least 60,000 MW.

Japan is yet another example of an industrialised nation with large concentrations of population, which regards its environment as being specially suited to nuclear power and, in fact, Japan plans to have installed about 20,000 MW by 1980. The Soviet Union has large reserves of fossil fuel, but these are not necessarily in the place where needed and she has been operating nuclear reactors since the early 1950s. Generally speaking, Soviet reactors are sited so that they supply power to large industrial areas which are far removed from sources of conventional fuels. Because of the transportation costs of fossil fuels, nuclear power is, under these conditions, the cheapest form of power. Some of the developing countries, like India and Pakistan, are attempting to solve their problem of limited fossil fuels by embarking on ambitious nuclear power programmes.

It can be concluded from these few examples that nuclear energy programmes will develop very rapidly in those countries in which there is a highly developed technology, large electric power networks and a shortage of fossil fuels.

Nuclear power will also be used in developing areas to encourage industrialisation. The prospect of very large (greater than 1,000 MW) nuclear power units introduces the concept of vast energy centres containing agro-industrial complexes which, apart from generating electricity, synthesise chemicals for fertiliser and desalinise water for irrigation. A 1,000 MW plant could support the production of sufficient fertiliser to provide for an agricultural complex producing enough grain to feed about three million people with 2,500 calories per day, could produce about 50 million gallons of desalinated water per day for irrigation, and in addition could provide energy for a large aluminium plant, for example. The attractions of such nuclear powered multi-purpose industrial complexes for a developing country like India are clear. Nuclear power, therefore, offers the prospect of an energy abundant world, although it should be emphasised that, in some environments, fossil fuelled power plants have an important role to play.

Apart from the direct benefits arising from lower electricity generation costs compared with fossil fuelled plants, there are other benefits arising from a nuclear power programme. Nuclear power stations have greater siting flexibility. A 1,000 MW plant is being built 17 miles from the Toronto centre. Nuclear power programmes encourage technical spin-off which assists the commercial develop-

ment of various products and processes. Accident rates in nuclear power stations are low; no fatal nuclear accident has occurred in 500 reactor years of operation. The transportation problems associated with reactor fuel are less serious than those for other fuels. Atmospheric pollution from nuclear stations can be reduced to negligible levels. The use of nuclear power minimises the exploitation of accessible supplies of organic substances, which are required in large and increasing quantities for the rapidly expanding chemical industry, for fossil fuels. The total peaceful benefits arising from the use of nuclear reactors for power production are so substantial that the development of nuclear energy should not, and could not, be impeded.

In addition to power reactors there are a large number of research reactors scattered throughout the world. In fact, there are nearly 400 of these in 50 countries. These reactors are, in general, relatively small in output, have little military significance, and are used for teaching, for research and for gaining experience in reactor technology. However, the research reactors of Israel and Jugoslavia, for example, provide enough plutonium to produce nuclear weapons at the rate of about one and a quarter per year respectively.

the nuclear fuel cycle and capabilities

The nuclear power reactor generating electricity, which performs the same function as the steam boiler in a conventional thermal power plant, is just an industrial plant in the so-called "nuclear fuel cycle". This term emphasises the cyclical nature of nuclear energy which creates new fuel at the same time as it consumes fuel. This new fuel can also be used as a source of energy creating still further fuel, and so on. The fuel for present day reactors is contained in uranium. As this "burns" plutonium is produced. The starting point of the cycle is, however, natural uranium which is found in a number of ores. Uranium is mined by conventional underground and open pit methods and by place-leaching.

There is no major difficulty in extracting uranium from its ores but several processing steps are involved before it is in a form suitable for use in a reactor. The ore is processed in mills to extract uranium in the oxide form (U_3O_8), known as "yellow cake".

About 0.2 to 0.3 tons of natural U_3O_8 per MW-year electricity production are required to operate each of the various types of thermal reactor systems at present in commercial operation. Except for heavy water reactors, the initial uranium requirement is about one ton of natural U_3O_8 per MW installed. One ton of uranium oxide (per MW-year) is comparable with about 15,000 tons of coal to produce the same amount of electricity.

Uranium oxide is dealt with in one of two ways, depending upon whether it is wanted to provide fuel for a reactor burning natural uranium or one burning enriched uranium. In the first case the oxide is converted to either uranium metal or uranium dioxide (UO_2) and then made into fuel elements which are inserted into the reactor core. In the second case, the yellow cake is converted into the gaseous compound, uranium hexafluoride, and enriched in a gas diffusion plant where the content of uranium-235 is increased from the natural value of 0.7 per cent to between two and three per cent. Enriched uranium hexafloride is then converted into uranium dioxide powder and made into fuel elements.

A given fuel element in a reactor may yield heat continuously for up to three or four years before it is removed; even after this time only about one or two per cent of the fuel is burned up. During this period neutron bombardment has converted some of the uranium-238 to plutonium-239, which can also be used as a fissile material. The amount of plutonium bred from uranium-238 per MW-year of electrical power ranges from 0.2 Kg in the case of enriched uranium reactors to about 0.5 Kg in the case of natural uranium reactors. Plutonium is worth about £4,000 per Kg and a typical 1,000 MW reactor can produce more than £800,000 worth of plutonium annually.

The fuel elements are chemically reprocessed in a separation plant to recover the unused uranium and the plutonium by-product.

A country with a nuclear power programme will gradually accumulate a stock of plutonium-239. Unless the country owns a plutonium separation plant it must arrange for its spent fuel elements to be sent to some other country that has a separation plant and is willing to separate and return the plutonium. Apart from its potential use in nuclear weapons, plutonium is used as fuel for breeder reactors. These reactors produce considerably more plutonium than they consume and they are, therefore, very economical in their use of fuel compared with thermal reactors in which only one or two per cent of the fuel is utilised. The proven resources of uranium ore, available at less than ten dollars per pound, will last only until the 1980s and the prospect of a shortage of uranium available at economic prices is causing considerable attention to be paid to the development of "breeder" reactors. It is expected that the successful performance of experimental plants should lead to large scale commercial use of breeder reactors in the 1980s. A breeder reactor is the most productive source of plutonium. It is possible by a suitable design to convert uranium-238 in the core of the reactor, and uranium-238 placed around the core, into plutonium at a rate faster than the rate of consumption of the original uranium-235. The efficiency of this process is increased if plutonium is used in the fuel because more fast neutrons (that is those with a relatively high velocity); which are the most efficient for converting uranium-238 to plutonium-239, are available from the fission of an atom of plutonium-239 than are obtained from the fission of an atom of uranium-235. The fuel for a breeder reactor is, therefore, normally plutonium mixed with uranium depleted in uranium-235. A fast breeder should be able to produce about 140 Kg of plutonium for every 100 Kg used. The fact that breeder reactors are likely to be the power producers of the future means that plutonium is now a very valuable material and that, when breeder reactors become widespread, the amount of plutonium disseminated throughout the world will indeed become extremely great.

Having accumulated a stock of separated plutonium, a country wishing to produce nuclear weapons is faced with the task of designing, constructing and testing the weapons. It must then create and maintain a credible delivery system, which is costly, and for which a large industrial base is required. In some countries, India and Israel for example, the existing aircraft could be modified to deliver nuclear weapons and, therefore, the cost of a nuclear-weapon programme will vary considerably according to its sophistication.

The UN report, *Effects of the possible use of nuclear weapons and security and economic implications for states of the acquisition and further development of these weapons,* estimated that a "small high quality nuclear capability" would cost £2,300 million, corresponding to an average annual cost of £230 million for ten years. This estimate was based on a hypothetical programme comprising two stages each of five years' duration. By the end of the first stage, a nuclear force of from ten to 15 bombers and from 15 to 20 nuclear weapons would be established and during the second stage the force would be expanded to include from 20 to 30 thermonuclear weapons, 100 intermediate range missiles and two missile launching nuclear submarines. To build installations in which nuclear warheads could be produced, approximately 1,300 engineers and 500 scientists would be needed. To produce over ten years and deploy 50 intermediate range ballistic missiles it is estimated that "a peak labour force of 19,000 men directly applied would be needed, over 5,000 of them scientists and engineers with access to high speed electronic computers. Skilled personnel would include physicists, aerodynamic, mechanical, and other engineers and large numbers of production workers, including machine operators and welders. The suggested fleet of 50 bombers would require a

minimum of from one to two million man-hours of skilled and unskilled labour just to assemble. The design and development stage would absorb an additional two million or more engineering man-hours, which would involve highly skilled efforts in aerodynamics, stress analysis, design work and flight testing. The French and British costs for their military nuclear programmes to date have been estimated at about £3,800 million.

Outside the nuclear-weapon countries, plutonium separation plants have been built in India, Japan and Italy. There is one in Belgium which is owned and controlled by ten members of the European Nuclear Energy Agency. Plans for building a separation plant in West Germany are in an advanced state. The defence budgets of India, Italy, West Germany and Japan are respectively about 600, 800, 2,100 and 490 million pounds. So far as the first three are concerned, the impact of the necessary increase in their budgets to finance a nuclear weapon programme would be large but by no means impossibly so. In the case of Japan, a major switch of national resources would be needed to achieve a nuclear capability, since at present, her defence expenditure is only about one per cent of the gross national product.

The conclusions to be drawn from this are:

1. Sixteen countries are at present producing large quantities of plutonium from their nuclear power reactors. This number will increase to 22 within the next five years.

2. Of these countries, four (India, Italy, Japan and West Germany) can, or will shortly, be able to separate plutonium from spent reactor fuel elements, on their own territory.

3. Each of these four countries has the necessary industrial base and could, although with varying degrees of difficulty, afford the economic cost of producing a small high quality nuclear force within a relatively short time of, say, five years.

4. Two other countries (Canada and Sweden) have the capacity to produce such a nuclear force and could afford the cost, but they rely on others for the separation of plutonium.

5. Some of the remaining countries, like Israel, Czechoslovakia or Belgium, could probably produce a comparatively primitive nuclear weapon and use existing vehicles to deliver it.

6. The amounts of plutonium disseminated throughout the world will increase rapidly with time. At present about 5,000 Kg of plutonium are produced in reactors per year. This figure will increase to over 100,000 Kg by 1980. The minimum quantity of plutonium-239 needed for the production of a nuclear weapon may be assumed to be about 5 Kg. The future use of fast breeder reactors will be an added factor in increasing the amounts, and probably the spread, of plutonium.

uranium separation

At present, the production of weapons-grade uranium-235 is confined to the nuclear-weapon powers. Uranium-235 is separated from natural uranium in a gas diffusion plant. The existing diffusion plants (the United States has three, the Soviet Union has two, and Great Britain, France and China have one each) were built to provide uranium, enriched to about 94 per cent uranium-235, for use in nuclear, and particularly in thermonuclear, weapons. Such diffusion plants are vast enterprises, costing at least £400 million to construct and £100 million per year to operate, use an enormous amount of electric power and cover a large area. A much smaller plant would be sufficient to produce enriched uranium for those nuclear reactors which use this as fuel, since a much smaller degree of enrichment is required for this purpose. Euratom is at present considering building a diffusion plant to supply enriched uranium fuel for the countries of the EEC.

Enriched uranium can also be produced by a gas centrifuge technique, although

apparently only China uses this method. Development work on gas centrifuges has been done by the United States, Great Britain, West Germany, the Netherlands, Australia and Japan. The technical problems which prevented the earlier production of gas centrifuges have now largely been solved; it is expected that they will eventually be used by some of the non-nuclear weapon states. This has very serious implications for the proliferation of nuclear weapons and the Non-proliferation Treaty. A gas centrifuge plant would consume much less power than a gas diffusion plant and would be easier to conceal.

motives for acquiring nuclear weapons

The reason why a given state acquires nuclear weapons are complex and differ in each case. It appears, however, from the experience of the present nuclear weapon powers, that the main factors determining whether or not the near-nuclear-weapon powers will take up their option on nuclear weapons will be status or security, or a mixture of both. It seems to be thought that somehow nuclear weapons enhance the status of a power even though this view cannot be supported from available evidence. Britain, for example, is generally reckoned to have lost status in the period since she acquired nuclear weapons. In international relations, however, perceptions are more important than facts. If the state in question is a signatory of the Non-proliferation Treaty then presumably the importance of status as a factor will decrease, if the treaty comes into force, since it will be apparent that any gain in status acquired by having nuclear weapons will probably be outweighed by the loss of prestige caused by violating a treaty obligation. Status is likely to be a large factor in the calculations of Japan and West Germany. Japan may argue that, as the third greatest industrial state, she should have nuclear weapons to retain her influence in Asia, which she might feel is threatened by China. West Germany may feel the need for nuclear weapons to give recognition of her position in Europe, particularly in view of the continuing importance which France and Great Britain place on their nuclear power. This might also apply to Italy. India, however, is likely to be motivated by her perceptions of a threat from China. Sweden may argue that she needs nuclear weapons to protect her neutrality. Since the Non-proliferation Treaty can probably be used as a political means of inhibiting the near-nuclear-weapon states from acquiring nuclear weapons for reasons of status, it is likely that the implementation of the treaty would effectively inhibit all these states, except India who, in any case, is unlikely to sign the treaty in its present form. This oversimplified argument cannot, of course, be carried too far. If India, for example, acquired nuclear weapons then Japan might also do so in spite of any obligations under the treaty. The main reason for Japan's action would still be status, but this factor might become so strong under these conditions that it tipped the balance.

This still leaves a large number of other states who are acquiring a stock of fissile material on their territories. Some of these may take their obligations under a treaty less seriously and the future may prove that it is these states that are the main danger so far as proliferation is concerned. A new government, for example, may not regard itself bound by obligations undertaken by a previous regime, particularly after a revolution.

3. existing control systems

To guard against the possible diversion for military purposes of some of the massive quantities of plutonium which will soon become available throughout the world clearly requires some form of control system. Any system of control, usually referred to as a safeguards system, which is both practicable and efficient and which, in addition, will cause only acceptable inconvenience to commercial practices and normal operational procedures, is very difficult to devise and implement mainly because of the great complexity of the nuclear energy industry. The operations involved in this industry range from the initial location and mining of uranium ores to the construction and operation of nuclear power reactors; within this range are a large number of more or less separated, highly technical operations and it is only rarely that all of these are within the boundaries of a single country.

The existing systems which attempt to provide international control of nuclear energy are: the bilateral safeguards systems of Canada, Great Britain, and the United States; the Western European Union (WEU); the European Nuclear Energy Agency (ENEA); Euratom; and the International Atomic Energy Agency (IAEA). The object of these is to secure international control, under international inspection, of weapons (typically nuclear) and warlike material (typically plutonium-239 and uranium-235); the systems are based on the review of the design of nuclear facilities, visits by inspectors, the examination of operating records or control of the reprocessing of fuel elements.

Very few nuclear facilities have, in fact, been constructed in other countries by the nuclear powers, without safeguards. The main exception is France, who has in the past been prepared to export reactors without any guarantee, for example, the Dimona reactor in Israel, although there is some evidence that this policy has changed. A small reactor was built in India by Canada without safeguards, but this experience has not been repeated. A second reactor, now being built by Canada, carries the provision for mutual inspection with a Canadian reactor in Ontario. The United States exports reactors to members of the European Economic Community on the basis that Euratom is itself a suitable inspecting agency. The Soviet Union does not maintain formal safeguards; the reactors exported from the Soviet Union have mainly been small and it is argued that there is no need for special arrangements to ensure that the fissile material produced by them is not put to military use. The normal practice, however, seems to be that the fuel elements are returned to the Soviet Union for processing. Plutonium is, therefore, not stockpiled outside the Soviet Union.

Up to now safeguards have usually taken the form of bilateral agreements of inspection and guarantees between the country providing the nuclear facility, for example Canada, Great Britain or the United States, and the receiving country. There is a growing tendency for exporting countries to rely on the International Atomic Energy Agency to provide safeguards. The United States, for example, has transferred to the agency safeguards and responsibilities assumed under bilateral agreements between the United States and 13 countries.

the United States bilateral system

The United States bilateral safeguards system anticipated the adoption of a more comprehensive international system and its development was, therefore, a short term solution to the safeguards problem. The first agreement for co-operation in civil uses of atomic energy was signed with Turkey in 1955 in which the transfer of nuclear material was limited to that required to fuel a research reactor and was, in any case, not to exceed 6 Kgs of uranium-235 contained in uranium enriched to a maximum of 20 per cent. Since then agreements have been signed with nearly 50 countries.

Following the Atoms for Peace Programme, initiated by President Eisenhower in his address to the United Nations in December 1953, the United States Congress enacted the Atomic

Energy Act of 1954. Section 123 of this act states that any agreement for co-operation with foreign states by distributing nuclear material shall contain a guarantee by the foreign state that any material transferred under the agreement shall not be used for nuclear weapons or for research on or development of nuclear weapons or any other military purpose. The bilateral agreements of the United States with other governments for co-operation in civil uses of nuclear energy emphasise that any material, equipment or device made available to the government pursuant to the agreement will be used for civil purposes only. The bilateral safeguards provisions closely follow the provisions proposed by the IAEA and contemplate a future assignment of safeguards responsibilities to the agency—"the parties will consult with each other to determine in what respects and to what extent they desire to arrange for the administration by the International Agency of those conditions, controls and safeguards required by the International Agency in connection with similar assistance . . . under the aegis of the International Agency".

The United States has the right under the agreements to review the design of facilities supplied by them and also the design of facilities using or processing nuclear or moderator materials so supplied. The receiving country must keep accountability and operating records and report periodically on these facilities. Maintenance of records and submission of reports are also required on nuclear material supplied by the United States and on material produced in facilities using such material or in facilities supplied by the United States. The United States has the right to conduct safeguards inspections on such material and facilities. Inspectors are to be accorded access to all places and data, and permitted to make any independent measurements that are necessary to account for the material subject to safeguards. The receiving country undertakes to facilitate the application of safeguards and guarantees that the material and equipment will not be transferred outside its jurisdiction unless this is agreed by the United States. In the event of non-compliance with the above safeguards requirements and guarantees the United States has the right to suspend or terminate the agreement for co-operation and to require the return of the nuclear material and equipment. The United States Atomic Energy Commission maintains a division of international affairs to administer the safeguards contained in the bilateral agreements. So far about 800 inspections have been made.

In the bilateral agreement between the United States and Euratom the community guarantees that no material, equipment or device supplied by the United States pursuant to the agreement will be transferred from the community's control except by agreement with the United States. The community has agreed to make its safeguards system compatible, within reason, with that of the IAEA. The United States does not inspect the uses made of materials or equipment supplied to Great Britain or Canada.

The first trilateral agreement, providing for the transfer to the IAEA of safeguards responsibility for nuclear materials and equipment supplied bilaterally, was signed in September 1963 by the United States, Japan and the IAEA. Under this agreement the agency took over responsibility for nuclear material and facilities supplied by the United States, including eight reactors, their enriched uranium fuel and other special nuclear material being used in various research and development facilities. Fissile material produced in these facilities is also safeguarded. This trilateral agreement has been followed by similar agreements with several other countries. The bilateral systems of Canada and the United Kingdom are essentially similar to the US system.

Western European Union

This regional settlement is largely military in character and came into being after the failure of the more far reaching European Defence Community. The agreements which set up the WEU were signed in 1954 by Belgium, France, Italy,

Luxemburg, the Netherlands, the United Kingdom and West Germany. The WEU was designed to absorb a re-armed West Germany into Europe with a greater degree of control over the level of West German forces and arms than could be achieved by NATO. Under the agreements West Germany renounced, until at least 1998, the production on its territory of nuclear, biological and chemical weapons. West Germany also agreed not to produce missiles, sea mines, warships of over 3,000 tons, submarines of over 350 tons, warships with non-conventional power and bombers. There were, however, conditions stated by which these restrictions could be varied.

France, Italy and the Benelux countries agreed that when production of nuclear, biological or chemical weapons had begun on their territories the levels of stocks they would hold was to be decided by the WEU Council by a majority vote. The six continental countries, that is the seven minus the United Kingdom, further agreed to report to an Armaments Control Agency, established by the 1954 treaty, on the major armaments held by their forces and also agreed that the quantities of these armaments should be approved by the WEU Council. The agency was to verify, by inspection, that these restrictions were being observed.

No method of enforcing the restrictions has been worked out. The council's powers when the "effective production" of nuclear, biological and chemical weapons has actually started are vaguely defined and, in the case of the French nuclear programme, have not been exercised.

The council claims that it "has not received any notification" from France that effective production of weapons has started. The treaty deems weapons-grade plutonium to be a nuclear weapon in itself. France began the production of this material in 1956 when her reactor at Marcoule started operation. Since then two more reactors have begun producing weapons-grade plutonium, probably giving a total production of about 100 Kg per year since 1959. Nuclear testing and the development and deployment of delivery systems continues. The agency would, in any case, not be able to effect anything in the way of control since it has been refused permission to recruit experts in nuclear weapons or to carry out inspections in the nuclear weapons field.

The Armaments Control Agency has been instructed to accept the levels actually reported by the relevant governments as the appropriate levels. Its present activity is, therefore, mainly to check and confirm that the levels reported are accurate. The agency has an international staff of about 50 persons and an annual budget of about £170,000. The agency works by cross checking budgetary and other data provided by member governments and by the physical inspection of military installations, depots, shipyards, etc. The inspection covers levels of production and stocks of war material. In the case of West Germany it is also supposed to confirm that no weapons prohibited by the treaty are being produced.

The physical inspections are limited in scope and are of doubtful value. The treaty requires that the inspections should not be routine but "in the nature of tests carried out at irregular intervals". Also it is required that the inspectors should be "accorded free access on demand to plants and depots". Neither provision has been met. France has not taken any steps to ratify the convention (signed in 1957) which contains the necessary regulations and, until this convention comes into force, the agency is not authorised to carry out inspections in the way laid down in the treaty. All it can do is to carry out so called "control exercises". It asks the permission of governments and private firms to visit installations, giving at least one week's notice. Such inspections are clearly not in accordance with the spirit of the treaty.

The agency has, however, carried out a series of experimental visits to a few laboratories and factories in West Germany which might be able to produce biological and chemical weapons and reported that no such weapons were being produced. Lack of qualified staff and

authority prohibit it from doing the same thing in the nuclear weapons field. The "control exercises" are completely inadequate. The agency has the facilities and the power to inspect only a tiny proportion of all armaments subject to inspection and only a small number of installations capable of producing prohibited weapons could be visited to confirm that they were not producing these weapons. The agency is clearly hamstrung by the governments which formed it. Once the political obstacles to West German rearmament were removed the states of the WEU showed little interest in applying the arms control provision of the 1954 treaty to themselves.

As the authority which ensures that the treaties by which West Germany renounces the production of nuclear weapons and certain other armaments are obeyed, the WEU can claim to be successful, but this is about the only success that it can claim. West Germany is not prohibited by the treaties from manufacturing nuclear weapons abroad or obtaining these weapons from other countries. These gaps would, to a large extent, be filled by the Non-proliferation Treaty.

The experience of the Armaments Control Agency has been of a largely negative character and limited to the cross checking of budgetary and other statistical data; in this latter field, however, valuable experience has been gained. Little, however, has been learnt about the techniques of physical inspection and control.

the European Nuclear Energy Agency

This agency of the Organisation for Economic Co-operation and Development set up a control system before the IAEA came into operation. The object of this safeguards system is to ensure that "the operation of joint undertakings established by two or more governments or by nationals of two or more countries on the initiative or with the assistance of the agency, and materials, equipment and services made available by the agency, or under its supervision, by virtue of agreements concluded with the government concerned shall not further any military purpose". The members of ENEA are Austria, Belgium, Denmark, France, West Germany, Greece, Iceland, Italy, Ireland, Luxemborg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey and the United Kingdom. The controls are based essentially on the same concepts as those of the IAEA and Euratom safeguards systems.

A noteworthy difference is that an independent judicial tribunal, known as the European Nuclear Energy Tribunal, consisting of seven independent judges, has been set up which is competent to consider appeals against decisions concerning the application of the safeguards regulations and decisions prescribing the sanctions which the agency may impose. The president of the tribunal can grant a warrant for the execution of inspection measures which are resisted by an installation. Sanctions may include the suspension or termination of the delivery of materials, equipment or services supplied by the agency or under its supervision. It may even be required that such materials and equipment are returned. The tribunal may, however, also order the agency to make reparations for any unreasonable damage caused by the agency or by its staff in the performance of their duties, including inspections. The ENEA system has provided valuable experience and knowledge concerning the practical aspects of the application of a safeguards system but may become redundant as a result of its middle position between the Euratom and the IAEA systems.

Euratom

The treaty establishing Euratom came into force on 1 January 1958. It was set up by the six countries of the EEC (Benelux, France, Italy and West Germany) to build a Community nuclear energy industry for peaceful purposes. Euratom shares the European Parliament and the Court of Justice with the Common Market and the European Coal and Steel Community. It has its own Council

of Ministers, each member representing one member state, and a five man commission which is independent of the member states. Euratom co-ordinates research within the EEC and promotes research in its own centres. It contracts specific tasks to national centres or firms and has joined international projects such as the European Nuclear Energy Agency project at Winfrith in the United Kingdom (the Dragon project). To develop this nuclear energy industry Euratom has:

(a) formed a common market for all nuclear materials and equipment;

(b) established a low or suspended external tariff towards non-member countries;

(c) established a plan for free movement, within the EEC, for atomic workers;

(d) introduced an insurance convention for large scale atomic risks;

(e) established joint enterprises of importance to the community, which enjoy special privileges.

Euratom has nuclear co-operation agreements with Canada, the United States and the United Kingdom. About 25 other countries have missions or delegations accredited to Euratom. The Euratom safeguards system is based upon agreements with third countries each of which stipulates that materials supplied to Euratom should be used for non-military purposes. All enterprises have to report on their equipment and have to make regular declarations to the commission of stocks, transfers and transactions of nuclear material.

Euratom inspectors visit installations and undertake physical and accountancy checks on materials held. Enterprises which fail to carry out their obligations are liable to various types of penalty including, in the last resort, the denial of access to fissile material. Euratom's control system was the first to have legal force over a number of nations. The inspection system is similar to that of IAEA except that Euratom maintains a relatively larger number of inspectors. Euratom will negotiate, on behalf of the Euratom countries, agreements with the IAEA for the verification of their obligations under the Non-proliferation Treaty. The future of Euratom is, however, not at present clear. This is mainly due to a lack of common policy for nuclear development and of overall co-ordination. There is a danger that Euratom may be reduced simply to adding its programme to those of the member countries rather than co-ordinating policy for the growth of a strong nuclear industry within the EEC.

the International Atomic Energy Agency

The IAEA came legally into existence in 1957; it now has 102 members. The total number of safeguards agreements is at present 40, involving 30 countries. However, the reactors covered by these agreements represent less than 8 per cent of the capacity of existing civil reactors. Recently, Mexico became the first state to place its entire nuclear programme under the agency's safeguards to ensure that the work is for peaceful purposes only. The statute of the IAEA authorises the agency to apply safeguards: when it grants assistance to a state at the latter's request; when the parties to a bilateral or multilateral agreement on co-operation in nuclear matters request the agency to apply safeguards to installations and materials covered by this agreement; and when a state requests the agency to apply safeguards to any or all of its activities in the field of nuclear energy. The statute requires the agency to "ensure, so far as it is able, that assistance provided by it, or at its request, or under its supervision or control, is not used in such a way as to further any military purpose". The agency is also required to "conduct its activities in accordance with the purposes and principles of the United Nations to promote peace and international good will . . ."

The statute lays down the way in which verification shall be carried out. The agency is given the right:

(a) to examine the design of facilities and to approve them only if the agency is sure they will not serve any military purpose and will permit the effective application of safeguards;

(b) to require the maintenance and production of operating records to ensure the accounting for special fissile materials;

(c) to ask for reports periodically on the operation of the reactor designed to ensure that the agency will know what nuclear fuel has been received and what plutonium has been produced;

(d) to approve the means of processing irradiated fuel;

(e) to send into the territory of states inspectors designated by the agency after consultation with the state concerned; these inspectors have rights of access to persons, places and data which are relevant to the use of nuclear materials, equipment or facilities;

(f) to require the observance of any health and safety measures prescribed by the agency.

Unless a state submits all its nuclear activities to safeguards, the application of the system remains limited to specific nuclear installations and materials. The IAEA safeguards system must operate in such a way that the applications of safeguards does not hamper the economic or technological development of a state. Commercial and industrial secrets which the agency staff may meet while implementing safeguards must be protected. The statute details sanctions which can be applied in the event of a state not complying with its safeguards obligations. The non-compliance will be reported to the agency's board of governors; the board will call on the state to remedy the non-compliance; if the state persists in its non-compliance the board may curtail or suspend the agency's assistance and call for the return of material and equipment made available and/or suspend the membership rights and privileges of the state; the board of governors must report to the Security Council and all members of the United Nations and the agency. The statute itself is, however, not enough to operate the safeguards system. The board of governors has, therefore, drawn up the necessary operating procedures. When the agency was asked for the first time, by Japan in 1958, to supply assistance, in the form of the provision of a quantity of nuclear fuel to which safeguards would have to be applied, a set of interim procedures was used.

In 1961 the board adopted a system for reactors of up to 100 MW thermal (about 30 MW) power. This was, in effect, confined to small research reactors. In 1964 the system was extended to power reactors, which are the important producers of plutonium. The board also decided to review the 1961 safeguards document. As a result, a new document was produced, and accepted in 1965, which constitutes the basis of the present safeguards operation. The new system applies primarily to special fissile material which means: plutonium-239; uranium-233; uranium enriched in the isotopes 235 and 233; any material containing one or more of the foregoing; and such other fissile material as the board of governors shall from time to time determine.

Not included is uranium depleted in the isotope 235, or thorium. In 1966, the agency's safeguards were further extended to cover facilities for the reprocessing of reactor fuel after use. Provisions for safeguarding nuclear materials in conversion plants and fabrication plants were approved by the board in 1968. The present safeguards system now includes the entire nuclear fuel cycle except uranium enrichment plants. An important point on the safeguards document is the provision for review from time to time in the light of technological developments and experience.

The maximum frequency of routine inspections of a reactor, and of the safeguarded nuclear material in it, shall be determined from whichever is the largest of the following quantities: the facility inventory, the annual throughput, or the

maximum potential annual production of fissile material. In the case of small quantities, for instance up to one Kg of plutonium, no inspection takes place. In the case of 55-60 Kg of plutonium, 12 inspections may take place annually. If even larger quantities are involved inspectors have the right of access to the installations at all times. The frequency of inspections for reprocessing plants and the safeguarded nuclear material in them depends on the annual throughput. If this is less than five Kg of plutonium the plant may be inspected twice a year, otherwise it can be inspected at all times. Moreover should the throughput exceed 60 Kg, continuous inspection is envisaged.

Inspection activities are required to be the minimum consistent with the effective application of safeguards. During an inspection the inspector may audit the records and accounts; verify the nuclear material under safeguards, either by physical inspection, measurements or sampling; examine any facility under safeguards, including checks of measuring instruments and operating characteristics; and check operations generally. Inspectors may not operate any facility or direct the staff in any facility. One week's notice of any inspection must be given. Before an inspector is sent for duty in any state, the government of the state is consulted. If it accepts the nomination the government shall co-operate as much as possible in allowing the inspector to function on its territory. The inspection apparatus consists of the Inspector General, the Director of the Division of Safeguards and Inspection, and the ten officers of the agency whom the Director General has been authorised by the board of governors to use as inspectors. In addition, 16 other agency staff members are available to assist in inspections when particularly specialised knowledge is required. The fundamental basis of the agency's safeguards system depends upon an agreement between the agency and the state concerned. The agency's main business in the field of safeguards has so far arisen from requests by the parties to bilateral agreements to apply safeguards to the arrangement and from the unilateral requests by the UK and USA to apply them to a number of reactors.

The Tlatelolco Treaty for the Prohibition of Nuclear Weapons in Latin America and the Non-proliferation Treaty each provides for the verification of obligations by a state party to the treaty. Both these treaties do two things. Firstly, they impose on certain signatory states (in the case of the Non-proliferation Treaty, the non-nuclear-weapon states) an obligation not to manufacture or otherwise acquire nuclear weapons. Secondly, they require each non-nuclear-weapon signatory state to negotiate an agreement with the IAEA for the verification of its obligation; this means the application of IAEA safeguards to the entire peaceful nuclear programme of the state.

Responsibilities under these particular treaties have placed the IAEA in a position of pre-eminence with respect to the other safeguards systems. The IAEA has already negotiated many safeguards agreements, one of which involves all the nuclear activities of a state. The groundwork for the agreements to be negotiated under the Non-proliferation Treaty has, therefore, already been laid. Although it is likely that these agreements will all be similar, some will be more complex than others since they will have to cover materials, equipment and facilities produced by the country concerned and also those imported from one or possibly several other countries. It is inevitable that negotiations for the more difficult cases will take a long time, a factor recognised by the treaty which allows for a negotiation period of up to two years. In particular, countries in western Europe are concerned about the future of Euratom and the development of peaceful nuclear activities within the Common Market.

4. the non-proliferation treaty

If the Non-proliferation Treaty comes into operation it will be by far the most significant international arms control agreement reached since the second world war. The negotiations which led up to the treaty illustrate the difficulties of obtaining such agreements in the modern world, the complexities of the issues involved and the long time taken to negotiate an agreed draft. Serious international discussions may be said to have started in 1961 with the "Irish resolution" to the General Assembly of the United Nations which, in fact, formed the basis of the final treaty. The resolution called for an agreement by which "nuclear states would undertake to refrain from relinquishing control of nuclear weapons and from transmitting the information necessary for their manufacture to states not possessing such weapons, and states not possessing such weapons would undertake not to manufacture or otherwise acquire control of such weapons". It is important to stress that both the original resolution and the treaty itself aim at the *non-acquisition* of nuclear weapons rather than the non-proliferation of these weapons.

Very shortly after the adoption of the Irish resolution, agreement was reached on the organisation of a disarmament committee to consist of 18 members, namely, Brazil, Bulgaria, Burma, Canada, Czechoslovakia, Ethiopia, France, Great Britain, India, Italy, Mexico, Nigeria, Poland, Roumania, the Soviet Union, Sweden, the United Arab Republic and the United States. This committee was an enlarged version of the Ten Nation Disarmament Committee, consisting of five western and five communist countries, set up early in 1960. This committee itself grew out of the sub-committee (Canada, France, Great Britain, the Soviet Union and the United States) set up in 1954 by the United Nations Disarmament Commission, which was formed by a resolution of the General Assembly in January 1952.

The first session of the Eighteen Nation Disarmament Committee (ENDC) opened in Geneva in March 1961, but France was not represented there, and, in fact, has continued to remain absent from the committee. A remarkable fact which has emerged from the debate, both inside and outside the ENDC, over the years has been the almost unanimous agreement concerning the necessity to prevent the emergence of a sixth nuclear weapon state. Even the states which are closest to being able to produce nuclear weapons have supported a non-proliferation agreement. Although many arguments have taken place about the form and details of a treaty, the principle of non-proliferation seems to have been almost universally accepted. There has been virtually no serious suggestion that a given state should actually acquire a national nuclear force. This climate of opinion was reflected in a series of United Nations resolutions calling on all states to negotiate a non-proliferation treaty and to refrain from producing nuclear weapons in the meantime.

nuclear defence within alliance systems

Discussions in the ENDC between March 1961 and the signing of the Partial Test Ban Treaty on 5 August 1963 were primarily concerned with this treaty. Non-proliferation was frequently mentioned in the ENDC during 1964 but Soviet objections to proposals in NATO at that time for a multilateral nuclear force, including West German participation, made any agreement on a treaty impossible. During the eighth session of the ENDC, between July and September 1965, however, an earnest debate on non-proliferation began in accordance with the recommendation of the United Nations Disarmament Commission, comprising all United Nations members, which had met earlier in 1965 in New York. As a result, the Soviet Union and the United States submitted separate draft treaties to the United Nations and the ENDC respectively. These drafts were not too dissimilar except that the Soviet draft included the provision that "parties to the treaty possessing nuclear weapons undertake not to transfer such weapons in any form, directly or indirectly through third states or groups of states, to ownership

or control of states or groups of states not possessing nuclear weapons, and not to accord to such states or groups of states the right to participate in the ownership, control or use of nuclear weapons", and that the American draft included an undertaking "to co-operate on facilitating the application of International Atomic Energy Agency or equivalent international safeguards on all peaceful nuclear activities . . ." and specifically mentioned the agency as a possible means of inspection.

The debates which followed mainly concerned questions of nuclear defence within alliances. Since the American draft did not preclude the setting up of a multilateral nuclear force within NATO it was unacceptable to the Soviet Union. The Soviet position was that any access to nuclear weapons by, for example, states in a multilateral force, would constitute proliferation and, in particular, the policies of the West German government were strongly attacked. At this time the West Germans thought they saw in a non-proliferation treaty the possibility of a bargain with the Soviet Union concerning reunification. They were also interested in the possibility of co-operating in a European nuclear force. The western position was that while NATO should be entitled to make plans for its collective defence, this did not mean that any non-nuclear weapon state should acquire the right or ability to use nuclear weapons by its own decision. This view did not rule out the possibility that some future new federation of states would acquire the nuclear status of one or more of the original states. It was argued that this would not amount to proliferation since it would involve no transfer of nuclear weapons. At the end of 1966 the Soviet Union and the United States had a series of private meetings which resulted in a wide measure of agreement on the important articles for a non-proliferation treaty. Further discussion took place meantime within the eastern and western alliances. In the western alliance there were discussions on the arrangements concerning nuclear decision making and participation in a possible future European nuclear force after the signing of a non-proliferation treaty, but there was an apparent cooling off of American support for the multilateral nuclear force. It was mainly this that enabled some agreement to be reached on the details of a treaty by the Soviet Union and the United States.

civil uses of nuclear energy and security guarantees

When the disarmament committee reconvened in early 1967 the discussion centred on the principles and methods of international control and inspection of peaceful nuclear activities to be incorporated in the treaty. At this time new difficulties arose, largely outside the committee, within European and Asian countries and Euratom, from fears that the distinction between the present nuclear weapon states and the others might lead to discrimination in civil nuclear energy development. Concern was also expressed by certain non-nuclear weapon countries regarding the absence of guarantees against nuclear blackmail.

No agreed Soviet-American draft had been published at that time, but a press leak in January 1967 had indicated that the respective texts of Article 3 of the separate American and Soviet draft treaties had been consolidated in such a way that all the peaceful nuclear activities of the non-nuclear weapon states were brought under the exclusive inspection of the IAEA, while leaving the nuclear weapon states entirely free from inspection. Furthermore, it was suggested that the intended Article 3 included an obligation on all the signatories to the treaty not to provide any non-nuclear weapon state with fissile material or with specialised equipment for peaceful nuclear purposes unless subject to IAEA safeguards.

It was during this period that the commercial and economic consequences of the tremendous expansion planned by the nuclear energy authorities of the industrialised countries, and the opportunities for exporting nuclear facilities to the developing countries, were fully realised. Together with the development of fast

breeder reactors by certain countries and the rapid growth of domestic nuclear energy industries, these considerations naturally led to serious objections in some countries to any suggestion that they should accept a position of nuclear inferiority. For example, in a statement to the Bundestag on the proposed non-proliferation treaty, the West German Foreign Minister, Willi Brandt, stated in April 1967 that the Federal Government considered it fundamental to support the conclusion of a non-proliferation treaty, but he also enumerated certain standards by which his government would evaluate a universal non-proliferation treaty. He stated that there were essentially four types of problem involved: the unhindered use of nuclear energy for peaceful purposes; a clear commitment to general disarmament; a guaranteee of the security of all states; and no adverse effects on regional efforts towards unification. Brandt also dealt with the question of co-operation between Euratom and the IAEA in the area of controls and stated that he considered such co-operation desirable, necessary and possible. He quoted Article 28 of the agency's safeguards system of 1965 which makes express provision for the acceptance of other control systems. He assumed that the IAEA would take over the supervision of the provisions of the Non-proliferation Treaty concerning the use of fissile material, but made no mention of equipment and other facilities. So far as the effect of the proposed treaty on the western defence alliance was concerned, he regarded West German membership of the Nuclear Planning Group of NATO as ensuring her continuing influence on the nuclear planning of the alliance and mentioned assurances he had received that a non-proliferation treaty would not affect the Atlantic Alliance in the nuclear area. He did, however, stress that the difficulty of this subject lies in keeping open future defence possibilities in the "Atlantic as well as in the European framework".

An issue causing considerable comment in some of the Common Market countries was the effect of a non-proliferation treaty on the supply of fuel and fissile material for peaceful purposes. An uninterrupted supply of nuclear fuel, particularly enriched uranium, is of vital importance to West Germany, Italy, Belgium and the Netherlands for their power reactors. This fuel must, at present, be obtained from the nuclear weapon states; in effect, so far as the Common Market countries are concerned, this means the United States. The supply of American material comes exclusively through Euratom, but fears were expressed in 1967 that complications might arise after a non-proliferation treaty. In dealing with this question Herr Brandt explained that, in accordance with written assurances, the agreement between Euratom and the United States would not be affected by a non-proliferation treaty. These assurances convinced the West German government that its supplies of nuclear fuel and material were assured.

In a statement to the ENDC in August, 1967, Amintore Fanfani, Italian Foreign Minister, stated that an ideal non-proliferation treaty should meet at least the following conditions: it should safeguard the security of countries which renounce nuclear weapons; it should recognise the legitimate aspirations of all countries to benefit from the peaceful use of nuclear energy and the resulting technical and industrial progress; it should not thwart efforts to unify and consolidate existing European institutions; it should not hinder the as yet unknown possibilities of progress in science, technology and the economy of states through too rigid formulae of unlimited duration; and lastly, it should direct the nuclear weapon states towards practical and concrete measures of nuclear disarmament. General Eedson Burns, the Canadian representative to the ENDC explained, in August 1967 that his government had always accepted that a non-proliferation treaty in its essence must be to some extent discriminatory, but that it was the only alternative to allowing the continued spread of nuclear weapons. He urged, however, that discrimination between the nuclear-weapon and the non-nuclear-weapon states should be minimised and pointed out that it would help to achieve this if the nuclear-weapon powers sub-

mitted all their peaceful nuclear activities to IAEA control.

In March 1967 Mahomedali Chagula, the Indian External Affairs Minister, in a statement to Parliament stressed that a satisfactory agreement on non-proliferation would have to take into account the peculiar circumstances in which certain countries are placed. He pointed out that India had a special problem of security against nuclear attack or nuclear blackmail and that this aspect would be taken into full account before India's final attitude to a non-proliferation treaty was determined. First, he explained, India was a non-aligned country and, as such, was not a member of a military alliance or under the protection of any kind of nuclear umbrella; secondly, she was far advanced in nuclear technology; and finally, she faced the continuing threat of China, a nuclear power. For these reasons India would require a "credible guarantee" for her security before signing a non-proliferation treaty.

use of civil nuclear explosives

There was also much discussion during the first eight months of 1967 of the potential use of nuclear explosives for civil purposes. For example, in March 1967, in an address to the Diet, Takeo Miki, the Japanese Foreign Minister, stated that when it becomes possible in the future for nuclear explosions to be utilised for peaceful purposes, the opportunities for such utilisation will have to be secured for non-nuclear-weapon countries. A more forceful position was taken by S. Correa da Costa, the Brazilian representative to the ENDC, who stated, in May 1967 that Brazil had no intention of acquiring nuclear weapons, but would not waive the right to conduct research without restriction and eventually to "manufacture or receive nuclear explosives that will enable us to perform great engineering works, such as the connection of hydrographic basins, the digging of canals or ports—in a word, the reshaping of geography, if necessary, to ensure the economic development and the welfare of the Brazilian people". It was stressed that Brazil would not accept any measure which would impose upon her the "permanent status of technological under development". Jorge Casteñeda, the Mexican representative, pointed out that the Treaty of Tlatelolco permitted explosions for peaceful purposes which do not constitute an explosion of a nuclear weapon, as defined in the treaty. Vishnu C. Trivedi, the Indian representative, supported these statements. Alva Myrdal, the Swedish representative, in a statement to the ENDC in June 1967, pointed out that any nuclear explosive device might be used as a nuclear weapon since the structure of both is very similar and therefore that it was necessary to prohibit the manufacture of such devices in a non-proliferation treaty. This was also the view of the Soviet, American and British representatives.

the joint Soviet-American draft treaty

After the discussion of these various issues the co-chairmen of the ENDC, the United States and the Soviet Union, were able to submit, in August 1967, identical drafts of a non-proliferation treaty to the ENDC. This draft, however, left the safeguards clause (Article 3) blank because of the failure to resolve the difficulties expressed by certain western European countries, particularly West Germany and Italy, about the effect of IAEA control on the future of Euratom and the nuclear industries in the Common Market countries.

In support of the draft treaty A. A. Roshchin, the Soviet representative, said that his country regarded the prevention of the further spread of nuclear weapons as one of the key issues of European and international security. He emphasised that the draft treaty confirmed the inalienable right of all signatories "to develop research and the production and use of nuclear energy for peaceful purposes without any discrimination" and that the potential benefits from any peaceful application of nuclear explosives should be available through appropriate international procedures to all non-nuclear weapon signatories on a non-

discriminatory basis. The text of the draft treaty laid down that the charge for nuclear explosive devices intended for peaceful purposes should be as low as possible and exclude any charge for research and development. William Foster, the United States representative, affirmed the willingness of the United States to make available nuclear explosive for peaceful purposes on a non-discriminatory basis to signatory states.

Commenting on the draft text Paul Martin, the Canadian External Affairs Secretary, expressed the hope that the nuclear weapon powers would compensate the non-nuclear weapon signatories for their renunciation of nuclear weapons by offering them reasonable security assurances. The Brazilian representative, commenting again on the issue of the peaceful uses of nuclear explosives, stated that in Brazil's view the countries that are willing to renounce nuclear weapons should not be forced into another renunciation and that "no convincing argument of a purely technical nature can be raised in favour of the imposition of restriction on the applications by national means, under effective international control, of nuclear energy in the form of explosive devices intended for peaceful purposes, such as engineering works, mining activities and other civil uses. Whatever the cost of such ventures, the foreclosing of any country's possibility to accelerate its economic development in such an important field of knowledge and thus to achieve a technological breakthrough that might be of vital significance for its industrial development would be so damaging to its future in the community of nations that no governments would feel entitled to impose such limitations on future generations". He stated that he could see no reason why Brazil should adhere to a treaty that imposes greater restrictions than the Treaty of Tlatelolco, especially since Brazil regarded these additional restrictions as unjust and unnecessary.

An Indian spokesman stated that the absence of provisions for the security of non-nuclear weapon countries and the failure to ensure progress towards nuclear disarmament or the participation of France or China made the treaty unacceptable in its present form. Most other members of the committee, however, expressed a positive attitude to the draft treaty and the main obligations contained in it, although there was much comment on the fact that the treaty effectively froze the non-nuclear weapon states in a position of inferiority and did nothing to restrain the present nuclear weapon states or, in other words, the treaty lacked balance. However, it was also argued that the nuclear weapon states could not consider arms limitations unless the non-nuclear weapon powers committed themselves to continue their present status and that the treaty, if successful, would benefit all powers in the long run. Various modifications and amendments were suggested during the discussions, and negotiations continued between the co-chairmen for an acceptable text of Article 3. Agreement was not reached before the ENDC completed its session on 14 December 1967. However, when the ENDC resumed on 18 January 1968 agreement had been reached by the co-chairmen on a draft text for Article 3 and a complete draft treaty was submitted. In effect, the control article stipulated that each non-nuclear weapon state party to the treaty should accept safeguards as set forth in an agreement with the agency concerning all their peaceful nuclear activities. Furthermore, transfers of fissile material and nuclear equipment to non-nuclear weapon states could not take place unless material and equipment were put under agency safeguards. A slightly modified form of the treaty was submitted, with the ENDC's report, to the United Nations General Assembly on 11 March 1968. The draft treaty was further discussed in the first committee and final small changes made.

On 12 June 1968 the General Assembly adopted a resolution commending the Non-proliferation Treaty and requesting the depository governments to open the treaty for signature and ratification. In the vote on this resolution 95 states voted in favour and four against, with 21 abstentions. The countries voting against were Albania, Cuba, Tanzania and

Zambia. The following abstained: Algeria, Argentina, Brazil, Burma, Burundi, Central African Republic, Congo (Brazzaville), France, Gabon, Guinea, India, Malawi, Mali, Mauritania, Niger, Portugal, Rwanda, Saudi Arabia, Sierra Leone, Spain and Uganda. Cambodia and Gambia were absent from the vote. The treaty will go into effect when it has been *ratified* by the depository governments (the Soviet Union, the United Kingdom and the United States) and 40 other states. So far only The United States, United Kingdom, Ireland, Nigeria, Canada, Mexico, Denmark, Cameroon, Finland, Norway, Mauritius and Ecuador have ratified the treaty.

Thus the actual negotiations that led up to the adoption of the treaty lasted for five years. In the first three years, agreement on a treaty was frustrated largely due to the issue of the multilateral nuclear force. During 1967 the industrialised countries realised the economic importance of the rapid expansion of nuclear energy programmes and the control arrangements of the treaty became the central issue. Additional complications arose from demands for security guarantees, the use of nuclear explosives for peaceful purposes, and positive measures of disarmament by the nuclear weapon powers. Of these issues, the ones of the most political importance were the effect of the treaty on civil nuclear energy programmes and the question of security guarantees.

On 2 December 1967 President Johnson announced that the United States was prepared to submit all American peaceful nuclear installations to the same procedures of inspection and control as would be imposed on the non-nuclear weapon states under the Non-proliferation Treaty. Two days later, a similar offer was announced in the House of Commons on behalf of the British Government. The Soviet Union has, so far, made no such offer, but argues that this gesture is unnecessary since all of its peaceful nuclear installations are "open" establishments and visited by many persons from other countries, and undesirable since the object of safeguards is the prevention of the use of fissile material, produced by peaceful nuclear installation, for military purposes, and this has no relevance in the case of a nuclear weapon state.

the non-proliferation treaty

Under Article 1 of the treaty nuclear weapon states are prohibited from transferring nuclear weapons or control over them, to any recipient, and from assisting non-nuclear weapon states in the manufacture or acquisition of such weapons. Article 2 obligates non-nuclear weapon states to undertake not to receive nuclear weapons, or control over them, from any country, and not to manufacture or acquire such weapons or to seek assistance in their manufacture. The prohibitions on both nuclear weapon and non-nuclear weapon states apply to all nuclear explosive devices. The most critical clause of the Non-proliferation Treaty is the control clause, Article 3. In fact, the future viability of the treaty largely depends upon the acceptability of the safeguard system and its successful implementation. This does not mean that the safeguard system has to be so technically accurate as to ensure completely that no fissile material is diverted for military purposes but rather that the system must be *politically* acceptable.

It seems that at present the IAEA system is adequate for this purpose. There has in the past been some political resistance to some of the activities of the IAEA, but it now appears that this is no longer the case since the agency has already signed agreements with 30 countries and is expected, in the near future, to sign several more. However, as the amounts of fissile material disseminated throughout the world increases, the safeguard system will probably remain politically acceptable only if its accuracy improves, because, as time passes, a given percentage of fissile material diverted for military purposes will represent an amount of material from which could be produced an increasing number of nuclear weapons. Whether or not the technical improvement of the safeguard system will

keep pace with the amount of material produced will depend to a large extent on whether the member states are prepared to supply the finance to allow the necessary research and development work to be performed. There is little doubt that the present resources of the IAEA are inadequate to allow it to fulfil its functions under the treaty. Some states are at present performing safeguard research projects for the purposes of national control and this activity will no doubt increase in the future. If the results are made available to the agency it would significantly assist it in performing its new functions, but even so the agency will need a very substantial increase in its budget. To fulfil its responsibility under the treaty the agency will probably need an inspection budget of about £6¼ million. In 1969 the inspection budget is £375,000. If member states do not make this money available in time, the effect on the Non-proliferation Treaty could be disastrous. It is also essential that safeguards are seen to provide equal confidence that all parties to the treaty are fulfilling their obligations. It is essential that the new emphasis on the control function of the agency should not shift attention from its basic function of promoting the peaceful uses of nuclear energy. This is of particular importance for the developing countries.

Article 4 contains an obligation on states to contribute alone, or in co-operation with other states and international organisations, to further the development of nuclear energy for peaceful purposes, especially in the non-nuclear weapon states party to the treaty. An effective safeguards system would, by increasing confidence, facilitate this co-operation. It is, however, essential that the agency is seen to remain as free as is possible from political and economic influences and that the financial resources of the agency are increased. At present, funds are available for only a fraction of the technically sound requests to the agency for assistance in nuclear programmes.

So far as the effect of Article 3 on Euratom is concerned, there seems to be no theoretical reason why the Euratom and the IAEA control systems should not co-exist. The treaty will, however, require that the IAEA verify Euratom control in those Common Market countries which sign the treaty. The treaty itself recognises that states regionally associated may jointly enter into an agreement with the IAEA for the application of safeguards. The principles and practices of the two systems are so similar that the agency should be able to verify Euratom control by statistical checking methods with as much validity as would be derived by the direct application of its own controls. One further point which will have to be settled in the verification negotiations is that Euratom controls are essentially concerned with fissile material whereas IAEA controls also cover equipment and installations. The Treaty of Rome provides for non-discrimination between its members, whereas the Non-proliferation Treaty discriminates between nuclear weapon and non-nuclear weapon states. This distinction could raise difficulties for new countries wishing to join the EEC. The main concern of the Common Market countries is that the treaty should not hamper the competitiveness of their nuclear industry; that there should be guaranteed adequate supplies of fissile material for fuelling reactors; and that there should be no risk of monopoly development.

Euratom countries will argue that IAEA control of installations should be restricted to verification of research activities, but the Non-proliferation Treaty should assist these countries by removing much of the commercial discrimination that now exists in international trade in nuclear fuel and facilities. It is not now possible, for example, to send IAEA safeguarded material to Euratom countries. The treaty should enable the IAEA to negotiate a safeguards agreement with Euratom which would satisfy Euratom's demands and which would make full use of Euratom safeguards, but the negotiation of the agreement is likely to be complex. France's unwillingness to acept IAEA safeguards on imported nuclear material will still remain a problem. Fears have been expressed that the operation of agency safeguards may lead to

industrial and commercial espionage. However, it seems that further enquiry has assured most countries that these fears were ill-founded. The fact that the United States and the United Kingdom have agreed to place their peaceful nuclear installations under similar safeguards to those adopted for non-nuclear-weapon states, although not required to do so under the treaty, could have increased confidence in the system in this respect. Article 5 of the treaty deals with the potential benefits that might be obtained from the peaceful use of nuclear explosives. If the use of nuclear explosives becomes safe, practical and economic for civil engineering projects its potential benefit for many countries is very great. Although an underground nuclear explosion has already been used in the United States to increase the output of natural gas at a location in New Mexico and a consortium consisting of the US and certain European countries has been formed to promote the peaceful application of nuclear explosives, it has not yet been proven that such applications are generally beneficial. It was, however, felt necessary to make provision in the treaty for the use of such devices and to ensure that, if they prove successful, they should be available without discrimination to all signatories of the treaty.

Under the provisions of Article 5 the signatory non-nuclear weapon states will be able to obtain the benefits from any peaceful applications of nuclear explosions, through an appropriate international body, at a charge which is as low as possible and excluding any charge for research and development. For reasons that are not entirely clear, some states, like Brazil, suggest that countries signing the treaty are making a significant sacrifice in giving up their right to develop the technology of peaceful nuclear explosives. It would appear, however, that the advantages of obtaining peaceful nuclear explosives without the very great costs of development outweigh any disadvantage to the non-nuclear weapon states in Article 5 of the treaty. The IAEA should be able effectively to perform the duties of an "appropriate international body" for providing the services required in connection with the peaceful uses of nuclear explosives. It will take several years of development work in the nuclear weapon states before nuclear explosives can be widely used for civil engineering projects and it is to be hoped that during this time the agency will make the necessary preparations for its probable role. The only safeguard which will be required is that of ensuring that the nuclear weapon country providing the explosive actually retains control of the device up to the moment of firing. As an attempt to seek a solution to the problem of providing credible and effective security guarantees for non-nuclear weapon signatory states, the Soviet Union, the United Kingdom and the United States submitted a resolution to the United Nations Security Council on security assurance and, in addition, reaffirmed the inherent right of every nation, under Article 51 of the charter, to provide individually or in alliance with others for its own self defence. The United States would make a declaration, her representative stated, to provide assistance to non-nuclear weapon signatories of the treaty in the event of a new situation created by acts or threats of nuclear aggression against them. The Soviet delegate stated that the Soviet Union would affirm its intention to seek immediate United Nations action in an emergency. These security assurances are only available to countries which sign and ratify the treaty.

They have been criticised because their operation would not be sufficiently immediate and automatic; they are also subject to the veto and do not define what "assistance" means. It is true that action under defence agreements would be more automatic but, on the other hand, such agreements impose obligations on their members which non-aligned countries would be unprepared to accept. Although the security assurances are much less than perfect, it has been argued that once the Non-proliferation Treaty comes into force it will be in the self interest of the three nuclear weapon states that have offered them to ensure their credibility. However, the most credible guarantee is a military guarantee

within an alliance. Such guarantees have contributed to the prevention of proliferation in Japan, Canada, and West Germany, although the nuclear proliferation that has taken place so far has occurred within alliances. In fact, China, France and Great Britain have probably been more influenced by their relations with their major alliance partner than by the attitude of a perceived potential adversary. In the case of India, there might be considerable credibility in a joint treaty, with explicit terms, with the Soviet Union and the United States. India would be too reluctant to jeopardise her non-alignment to accept a unilateral guarantee from either side. The credibility of the joint treaty would follow from the fact that it is unlikely that either the United States or the Soviet Union would take no action if China overran India. Recently, the two superpowers have, in fact, made some concessions in the direction of a joint guarantee to India. The major problem with all guarantees is their credibility. It has to be admitted that no guarantee can be completely credible, but it does not follow that they need be wholly incredible.

Article 6 of the treaty commits the signatories to the treaty to pursue negotiations on measures of nuclear disarmament and on a treaty of general and complete disarmament. Article 7 states that the treaty does not affect the right of any group of states to conclude regional denuclearisation treaties. Under Article 8 a review conference will be held five years after the treaty comes into force which will give an opportunity to both nuclear weapon and non-nuclear weapon states to assess whether it is achieving its purposes. Article 9 deals with signature and ratification of the treaty. Under Article 10 of the treaty a signatory can withdraw from the treaty if it decides that "extraordinary events related to the subject matter of the treaty have jeopardised the supreme interests of its country". A country has to give three months' notice of such withdrawal. A review conference will be held 25 years after the treaty's entry into force which will decide whether the treaty shall continue in force.

It is too early to judge whether or not the treaty will be successfully implemented, although to date the UK and the US have both ratified the treaty. The Soviet Union should also ratify in the near future, but 40 other ratifications are required. The EEC commission has advised its members to sign the treaty, but not to ratify it until the agreements with the IAEA are clarified. The current debate on the treaty in West Germany is connected with the elections and it is probable that the ratification process will start next year. Other near nuclear weapon countries will probably wait until the agreements with the IAEA are negotiated and this could take up to two years. It is, therefore, possible, but unlikely, that the treaty will not get off the ground.

If it does its long term viability will depend on the continuing political acceptability of the IAEA control system which in turn depends on whether the member states are prepared to supply the agency with financial and other resources it will urgently need to maintain its present standards. It will also be essential that the superpowers are seen to make progress with negotiations on curtailing their arms race. The support of many countries for the treaty is conditional on the progress made in further arms control negotiations and the rate of ratifications may depend on the rate of such negotiations. It is unlikely that the present security guarantees will be sufficient to satisfy some non-nuclear weapon states that they are adequately protected against nuclear attack or the threat of such attack. India and Japan will probably require additional guarantees if they are to give up their nuclear options.

Acceptable safeguards, further arms control measures and additional guarantees are, therefore, the probable prerequisites of a successful treaty. Assuming that these are met, the treaty should, except in extreme circumstances, provide the political means to restrain the present near-nuclear-weapon signatory powers from acquiring nuclear weapons. It cannot, however, be expected to prevent completely the acquisition of nuclear weapons by all states for all time.

5. implications of a superpower arms race

The viability of the Non-proliferation Treaty then, will depend to a large extent on whether or not the signatory nuclear weapon powers take seriously their commitment in the preamble and Article 6 of the treaty to take effective measures to achieve an early end of the nuclear arms race. In fact, it is possible to regard the treaty as a means by which the smaller powers can apply pressure on the superpowers to negotiate an arms control agreement, and some people think of this as the main value of the treaty.

the strategic forces of the superpowers

To date, the arms race between the superpowers has continued with no sign of abatement. The United States has, so far, deployed a strategic force of about 1,050 intercontinental ballistic missiles (ICBMs) in hardened underground silos and has acquired a fleet of 41 nuclear powered missile submarines, each carrying 16 Polaris missiles. The land based ICBM force consists of about 650 Minuteman I and 350 Minuteman II solid fuel missiles. It is intended eventually to replace all the Minuteman I missiles with Minuteman II, which has a two megaton warhead and a range of 8,000 miles. An improved ICBM, the Minuteman III, is being developed which will be equipped with multiple independently-targetable re-entry vehicles (MIRVs). Some of these missiles have already been tested. About 50 Titan liquid fuel ICBMs are still in service; these have a range of 9,000 miles and carry a warhead of over five megatons, but they have a slower reaction time than solid fuel missiles. It is planned to replace the Polaris missiles in 31 of the nuclear submarines with Poseidon missiles, which are equipped with MIRVs. At present, 28 of the nuclear submarines carry Polaris III missiles (range 2,800 miles, 0.7 megaton warhead) and 13 carry Polaris II missiles (range 1,700 miles, 0.7 megaton warhead). The Poseidon missile will be capable of delivering a total of nearly 1.5 megatons. The Strategic Air Command operates about 500 B-52 long range bombers, each probably capable of carrying four thermonuclear weapons, two of which are in Hound Dog air-to-surface missiles. The B-52 has a maximum range of about 12,000 miles, but is subsonic (mach number 0.95); the Hound Dog missile has a range of 700 miles. The SAC intends to bring supersonic aircraft into operation and plans to have over 200 of these by the end of 1971. However, the current controversy about the performance of the F-111 aircraft has temporarily postponed this operation. The strategic forces of the United States could, therefore, at present launch at least 4,000 thermonuclear warheads each with an average yield of over one megaton (about 1,000 in ICBMs, 656 from submarines, and over 2,000 in aircraft). In addition, there are all the thermonuclear weapons that tactical aircraft can carry and the 7,000 nuclear warheads in Europe. At ranges of about 7,000 miles strategic missiles are sufficiently accurate to fall within about a mile of their targets. For a missile with a one megaton warhead this is sufficient to ensure, with a high probability, that a targetted city would be very severely damaged.

The Soviet Union has deployed about 1,000 liquid fuel ICBMs and an increasing number of these are being installed in hardened silos. It is expected that solid fuel missiles will soon be produced and deployed. It has recently been reported by Tass that Russia has developed a vehicle launching site for solid fuel ICBMs which, so it is claimed, is impossible to detect from the air or space reconnaissance satelites. Soviet ICBMs have, in general, larger warheads than American mishiles; there are several sizes varying from one to 20 megatons. The range of these missiles varies between 5,000 and 10,000 miles. The Soviet strategic force also includes about 750 intermediate and medium range ballistic missiles, with ranges of about 1,000 miles and 2,000 miles respectively and warheads of about one megaton. It is likely that these missiles will, in the future, be suplemented by solid fuel mobile missiles. The Soviet Union is thought to have a very large missile, possibly capable of carrying a warhead of about 30 megatons, which may have an orbital capability. The test-

ing of this device would infringe the Outer Space Treaty and such a test has not taken place. It has been reported, however, that the Russians have tested a Fractional Orbital Bombardment System (FOBS) which would require a very advanced rocket as a booster. By a legalistic interpretation of the Outer Space Treaty, a FOBS does not contravene the treaty because the weapon does not make a complete orbit of the earth. The Soviet navy has a large submarine fleet including 50 nuclear powered vessels. About 45 of the submarines can fire ballistic missiles and, on average, each carries three missiles. A new type of nuclear powered ballistic missile submarine, similar to the American Polaris, is being produced at the rate of about two per year; each of these will carry 16 ballistic missiles capable of being fired while the submarines are submerged. The submarine launched missiles have warheads of about one megaton but comparatively short ranges of between 400 and 700 miles. A new submarine launched missile, capable of carrying a heavier warhead over a long range has been developed.

The Soviet Strategic Air Force has about 150 long range bombers, with maximum ranges of about 8,000 miles, and about 50 of these carry one air to surface missile. There are also about 1,000 medium range (about 3,000 miles) bombers, each capable of carrying one air to surface missile. About 200 of these are supersonic (mach number 1.9). The Soviet Union has tested ICBMs with multiple warheads.

Both superpowers are deploying, or plan to deploy, antiballistic missile (ABM) systems. The Soviet system, which began some years ago, is deployed around Moscow and possibly also Leningrad. It is based on the solid fuel Galosh missile which is believed to carry a nuclear warhead of about 1.5 megatons and to have a range of a few hundred miles. It is possible that the Griffon missile, which has a high acceleration and a short range (about 30 miles), is also used in an ABM capacity. Sentinel, the American ABM system was originally planned to consist of 15 to 20 batteries of long range Spartan missiles spaced around the United States. The preliminary estimates put the most of the system at about five billion dollars to deploy and five hundred million dollars per year to operate. About 900 million dollars were to be made available in the current fiscal year, $300 million to be used for research and development, $400 million to begin production and deployment, and $200 million to purchase land for Spartan sites; but the actual costs would have been more.

The Spartan missile, which carries a warhead of over one megaton, can intercept an incoming missile at an altitude of about 300 miles and at ranges of up to 400 miles from its location. The aim was to provide protection for the entire country against an unsophisticated attack of the type that the Chinese could mount with the first generation of their ICBMs. (It is tentatively estimated that the Chinese will have a modest force of ICBMs in the mid-1970s.) Also associated with the American ABM system is the Sprint missile, designed to intercept enemy ICBMs which escape the Spartan missiles.

Sprint has a high acceleration and is designed to intercept incoming missiles at a short range of between 20 and 30 miles. The rocket used sends the Sprint to an altitude of 12 miles in about four seconds and carries a nuclear warhead equivalent to several tens of kilotons of TNT. Whether or not Sprints are to be used in the Sentinel system is not, at present clear. If they are used it will probably only be for the defence of key elements of the ABM system itself, such as the radars and not for the defence of cities. The highly complex and expensive radar system associated with the United States ABM system includes: the Perimeter Acquisition Radar (PAR), a low frequency radar which detects the missile at a long range, tracks it and predicts its path; the Missile Site Radar (MSR), a higher frequency radar, which guides the Sprint and Spartan missiles from each battery; the Multi-function Array Radar (MAR) which is a powerful phased array radar designed to perform all the functions associated with countering a full

scale attack, that is detect the hostile targets, select the warheads from decoys, track the trajectories of the warheads and direct the interceptors; and the TACMAR radar which is a smaller version of MAR having a lower target handling capacity. The MAR system is controlled by a complex computer system and is composed of many individual separate units which can be combined into systems of different sizes.

It was planned that Sentinel should have six PAR installations along the northern boundary of the United States. An incoming missile on a minimum energy ballistic trajectory would be sighted by PAR at a distance of about 2,500 miles providing a warning time of about 10 minutes. After the incoming missile is sighted by PAR its trajectory would be tracked by MSR and this information allows the ABMs to be guided to the incoming missile using the computer system, the "brain" of Sentinel, which has a data handling and decision making capacity greater than any previously constructed system. The MAR or TACMAR systems are not designed for use with a light ABM system such as Sentinel but would be installed only if the system were extended to counter a full scale attack. In this connection it should be noted that Sentinel is designed to be of a flexible, building block nature, capable of extension into a heavier system into which the more complex radars and computers could be incorporated. Because of the strength of the opposition by the population near areas chosen for ABM sites it has been decided to modify the Sentinel system. The modified system, known as Safeguard, will use the same components designed for Sentinel, but will consist of only two ABM installations placed around remote ICBM sites in Montana and North Dakota. Safeguard will probably be expanded, possibly to 12 installations. The cost of the system is likely to be about 50 per cent more than the original Sentinel system, but the cost will be spread over a longer period.

Both quantitatively and qualitatively, there is now a rough equality between the strategic forces of the superpowers.

the strategic balance

The strategic situation created by these forces is based on mutual "deterrence" which is assumed to guarantee stability on the strategic level. Deterrence is provided by the so-called second strike assured destruction capability of each superpower. This is the capability to inflict an unacceptable degree of damage on the other side by a retaliatory strike even after absorbing an all out surprise first strike, even though the latter is aimed at strategic forces. There is, of course, a psychological element in the determination of what the adversary would regard as "unacceptable" damage; in fact, no one really knows, in a quantitative sense, what would constitute "deterrence' in any given situation.

This question involves complex philosophical and moral issues. Most men maintain that some values are to be defended even at the risk of personal survival, but whether this is also true when the survival of the society, or a large part of it, is at stake is not so simply determined and the issue becomes infinitely complex when the whole of humanity, or a large fraction of it, may be involved. It could be argued that the defence of the values of a society is only rational if the society survives in a recognisable form. On the other hand, the admission of this by one society may lead to the blackmail or subjection of it by another society. The greater the military power at the disposal of a society, the greater this dilemma becomes. In the present situation, deterrence is largely a matter of perceptions. Superpower A convinces itself that a certain degree of assured destruction in superpower B will be perceived by superpower B as a deterrent if it threatens the most vital interests of superpower A. In practice, of course, this calculation is not made in any refined sense but each superpower arms itself to a given posture, determined by a complex of reasons, and then rationalises this by "deterrence" arguments.

Bearing the perceptual nature of the subject in mind, it can be stated that because strategic stability is based on the

effectiveness of the threat of assured destruction to deter either side from launching a surprise attack, the preservation of the capability of second strike assured destruction is perceived to be of fundamental importance by the decision makers in both superpowers.

A categorisation of new weapons is possible in terms of their effect on the strategic equilibrium between the superpowers based on deterrence. New weapons which reinforce the second strike capability against enemy cities and populations can be regarded as stabilising, whereas new weapons which increase first strike capacility against the enemy's strategic forces are destabilising. This categorisation arises because the enemy's cities and populations are the hostages when deterrence is based on a balance of terror. The theory suggests that an aggressive first strike by strategic weapons would be aimed at the enemy's strategic forces, that is it would be a counterforce strike. Second strike assured destruction, and strategic balance, requires that sufficient stategic forces would remain intact after such a first strike to enable the superpower who has absorbed it to inflict a level of damage on the other side's cities and population which the superpower, who made the first strike, would regard as so high as to deter him from making the strike in the first place; a strike against cities and populations is called a countervalue strike. Thus, nuclear deterrent strategy differs from conventional strategy in that weapons aimed at populations are considered, in a sense, less dangerous than weapons directed at the enemy's strategic forces. A similar difference arises with defensive measures since those designed to preserve strategic forces are, if effective, stabilising whereas those designed to protect populations are destabilising to the extent that they reduce the effectiveness of the other side's retaliatory second strike countervalue capability. At first sight it might be thought that on this basis the United States Safeguard ABM system is stabilising. However because present ABMs are ineffective and because they are nevertheless likely to cause the opponent to increase his offensive forces this argument cannot be used. In practice, if one side deploys destabilising weapons it is likely to lead to a reinvigoration of the arms race by causing the other side to react, usually by increasing the number or performance or both, of his strategic forces in an attempt to restore the strategic deterrence balance. The perception by both superpowers that a strategic deterrence balance exists between them and the realisation by them of the damage which would be caused by a general nuclear war has entailed a policy of co-existence.

This has resulted in a growing détente between the superpowers which has allowed some progress to be made in arms control and which has produced some of the conditions necessary for a real prospect of progress towards disarmament while, at the same time, maintaining stability based on deterrence. It is not suggested that this was the result of a deliberate policy, in fact political leaders do not usually realise the political consequences of the deployment of a new weapons system until some time after the weapons have been installed, but rather that the superpowers were inevitably led to a situation of stalemate by the momentum of weapons technology. The use of the word "balance" here should not be taken too seriously since the United States seems only to perceive a "balance" if it continuously has superiority in strategic forces. Recent statements by Presiden Nixon could indicate, however, that this attitude may be changing. At a recent press conference he said, "the gap has been closed. We shall never have it again, because it will not be necessary for us. Sufficiency, as I have indicated, is all that is required." The meaning of this statement depends, of course, upon the definition of the word "sufficiency".

effect of new weapons

The development and deployment of ABM systems and MIRVs could have a profound effect on the strategic balance and indeed upon future arms control negotiations. Although present officially

announced levels of ABM deployment will not seriously impair the present strategic military balance between the superpowers, the practicability of its deployment carries with it the prospect that one or other of the superpowers might perceive a chance of attaining a dominant position in the long run. In practice, neither superpower is likely to attain a winning posture but the perception of the possibility might be sufficient to produce pressures within the superpower to attempt to attain it. The political implication of this would be to revert the relationship between the superpowers from one of co-existence to one in which they compete for world dominance. Thus, the actual or projected deployment of ABM systems, while not altering the basic strategic situation of mutual deterrence, may have produced forces which will erode the stability between the superpowers in the future. This factor is accentuated by the lack of knowledge concerning the effectiveness of ABMS. The doctrine of deterrence is most acceptable when the technical performance of strategic forces is reasonably well known to the world at large.

A development that causes doubts or uncertainties about this performance undermines confidence in the capability of strategic forces upon which the strategic balance depends. Present ABM systems are not, and are not likely to become, effective in the sense that they cannot be made adequate relative to the offence existing at the time the systems become operational. For example, there are some who seriously doubt whether the Sentinel system (both the original and modified version) would be able to cope effectively with the first generation of Chinese ICBMS.

An ABM system is an extremely complex system consisting of many components and, since none of these has been fully tested under operational conditions, it is not possible to assess the effectiveness of the system. However, it can be predicted that an ABM system can be relatively easily overcome by the use of penetration aids, such as dummy missiles, or suitable strategies.

ABM systems have resulted in a reinvigoration of the arms race. This arises because the likely response to a deployment of an ABM system by superpower A is for superpower B to increase the performance and/or numbers of her offensive weapons. This increase is likely to lead to the deployment of a heavier ABM system by superpower A in an attempt to protect against the increased strategic forces of superpower B. Superpower B would then probably respond by a further increase in offensive forces and so on. A second effect on the arms race arises from the uncertainty of the effectiveness of ABM systems. If a superpower deploys an ABM system the other superpower is likely to assume that the effectiveness of it is greater than it actually is and therefore to overact to the deployment. On the other hand, the first superpower is likely to assume that the effectiveness of his ABM system is less than it actually is and to employ a heavier system than is necessary for given defence requirements. Moreover, if one side begins the deployment of an ABM system the other will probably tend to respond, not to the level of the deployment, but to a level which this superpower calculates could be deployed by the other if it devoted a maximum effort to the deployment. It should in fairness be mentioned at this point that one serious school of thought has argued in favour of ABM systems on the grounds that if ABM systems are deployed extensively by both superpowers and if offensive forces are not increased, or better still if they are decreased, then the strategic balance between the superpowers will cease to be based on deterrence but, instead, will become based on defence. The advocates of this theory argue that, after this transition, general nuclear war would be less likely, and that nuclear disarmament much easier to negotiate. Under these circumstances, the deployment of ABMS would, of course, amount in itself to a measure of disarmament. The theory requires that the superpowers mutually agree to undergo the necessary changes in their strategic and defensive postures. There are several difficulties with this argument. The transition from deterrence to defence involves passing through a

phase of great strategic instability between the superpowers during which the chance of general nuclear war is greatly increased compared with the relatively small chance of such a war which exists with the present strategic balance. Furthermore, the amount of mutual trust which would have to exist between the superpowers to achieve the transition is unlikely to occur in the foreseeable future. If such trust between them did exist then a great deal of disarmament would, in any case, be readily negotiated since, in such a world, high levels of strategic or defensive forces would be irrelevant. Experience has shown that the most likely result of the deployment of ABMs by one side is an increase, rather than a decrease, in the quantity or quality of the offensive forces of the other side. An example of this process is that the response of the United States to the threat of a Soviet ABM deployment was the development of MIRVs.

Deployment of these MIRVs could have even more serious long term consequences than the deployment of ABM systems. If the development of these weapons continues, their accuracy will probably improve to a point at which one superpower could destroy all, or a large fraction, of the other superpower's strategic ICBMs by a first strike. MIRVs are, therefore, potentially very destabilising. Once again, it is the introduction of a factor of uncertainty which is so serious. At present, each superpower can calculate, to a fair degree of accuracy, the size of the opponent's strategic force.

The deployment of these MIRVs, however, would make such calculations extremely difficult since it would not be the number of missiles that was important, but the type of warheads each missile carried. Relatively invulnerable launching sites, such as submarines, would help to stabilise the strategic situation created by MIRV deployment and the development of more accurate MIRVs would place a high premium on missile launching submarines and undetectable mobile land-based launching sites. These are, however, very much more costly than present devices; a submarine missile, for example, is considerably more expensive to maintain than a static land-based missile. The development or deployment of MIRVs by the superpowers presents a danger that one or other superpower may perceive that it has acquired the capability of a successful pre-emptive first strike. Although such a perception is likely to be an illusion it would have a grave effect on the stability of the relations between the superpowers.

The most serious foreseeable development, if the arms race is allowed to continue, would be the deployment by both superpowers of accurate MIRVs together with an effective ABM system. At some stage during this process one of the superpowers might perceive it to be to his advantage to make a first strike, depending on the rate of improvement of defence compared with that of offence, but it is more likely that this would not happen but that both superpowers would acquire the weapons systems. If this stage in the arms race is reached it would be extremely difficult to negotiate gradual, step by step disarmament. The use of submarines does not significantly affect this argument since the deployment of extensive ABM systems, it is assumed, would eliminate the relatively few submarine based missiles. Therefore, if the weapons at present being developed and tested are deployed in significant numbers the outlook is bleak. First, the present stability of mutual deterrence will be eroded by uncertainties on both sides concerning the effectiveness of their own and the other's strategic forces. This will produce such mutual distrust that arms control and disarmament negotiations will be much more difficult than they have been so far. The fact that it took five years of hard negotiations to reach agreement on the Non-proliferation Treaty indicates how difficult such negotiations are even during a period of relative stability. In the absence of arms control measures, the continuance of the arms race will then ultimately lead the superpowers to a position from which any disarmament will be almost impossibly difficult to negotiate since neither superpower will dare reduce his forces without an absolute guarantee that the

other will simultaneously reduce his forces equally. In view of the realities of international politics it is not possible to envisage such a guarantee in the foreseeable future. The arms race is, therefore, at a threshold. At present there is a relatively stable strategic balance between the superpowers and it is realistic to expect them to be able to negotiate a significant reduction in the levels of their forces because, even after such a reduction, each superpower would retain sufficient weapons to ensure a second strike capability and, therefore, the balance of deterrence would be maintained. However, after the extensive deployment of the new weapons, a similar reduction in strategic forces would put one superpower in a position of relative inferiority with respect to the other superpower and the new strategic situation would no longer be stable. It is very unlikely that either superpower could be willing to rely on the good faith of the other and, therefore, would not risk the possible consequences of reducing his strategic posture. Indeed if such a high level of mutual confidence and trust existed between the superpowers disarmament measures would not be necessary.

effect on European countries

The extensive deployment of ABMs and MIRVs by the superpowers would have serious effects on other countries, particularly those in Europe. Moreover, these effects could have consequences for the Non-proliferation Treaty. Although there are unlikely to be any significant short term consequences of present levels of deployment, the continuation of the arms race by the superpowers will probably create strong pressures for a re-designing of the European alliances. The arguments for the development of independent nuclear forces may become irresistible. Even without the effect of the superpowers' arms race it is probable that the continued existence of the British and French nuclear forces will eventually cause significant pressures in other European countries, such as West Germany and Italy, for a national nuclear force.

There are, of course, many factors which will determine the future of European alliances, of which a continuation of the arms race is only one. It is, however, an important factor which, so far, has tended to be overlooked in debates on the alliances. European security at present depends on the strategic stability between the superpowers and any significant change in this stability affects the European situation. The main consequence of ABM deployment arises from a psychological and political factor, namely the feeling that the superpowers are protected by the defensive shield provided by their ABM systems while Europe remains undefended. This feeling is illusory and not dependent on the effectiveness of ABM systems. It is the presence of such a system that has political consequences. The insecurity it engenders produces a resentment against the superpowers and is likely to reinforce the nationalistic tendencies produced by political events such as the Soviet invasion of Czechoslovakia. It is probable that this factor will overcome the more constructive tendency toward the co-operation of non-nuclear weapon European countries. It is also possible that some governments or peoples may argue in the future that ABM systems should be extended to cover Europe, both for their own defence and to keep the alliances intact. Not only is this technically unfeasible, but it will deepen the gulf between East and West. Similar arguments apply to the suggestion that Europeans should deploy their own independent ABM systems. The ineffectiveness of present ABM systems does not, however, prevent political pressures building up for their deployment. The deployment of an ABM system in any European non-nuclear wapon state would violate the Non-proliferation Treaty because warning times would be so short that it would be impossible to retain foreign control over the use of the nuclear weapons contained in the warheads of the ABMs.

The British position is of particular interest because the question of ABM deployment has arisen at a time which coincides with the withdrawal of military forces from various overseas areas. It is

not impossible that, in the future, disaffected military personnel will apply pressure for the acquisition of the latest military weapons, including ABMs, and they may be supported by the aerospace industry. It appears that the British government intends that Britain should remain a nuclear power for the foreseeable future, even after Polaris submarines become obsolete. The question of the development of an ABM system is, therefore, likely to be raised if the superpowers continue with or extend their systems. It is noteworthy in this context that the British are apparently developing more complex multiple warheads for their submarine launched missiles.

The development of new weapons by the superpowers widens the gap between them and potential new nuclear-weapon powers. This in turn tends to prevent proliferation because a relatively small nuclear force would not deter a superpower which had deployed an ABM system. This clearly does not apply to non-nuclear weapon countries where potential enemies are either non-nuclear weapon powers or potentially only small nuclear weapon powers. It also does not necessarily apply to non-nuclear weapon powers who are interested in obtaining a minimum deterrence against a superpower which is a neighbour or near neighbour. In these cases, the non-nuclear weapon power could acquire nuclear weapons and instal them in medium or short range missiles.

An ABM system deployed against ICBMs is not suitable for use against such low flying missiles. The strategic deterrent of a small nuclear power depends on the perception that a superpower would not be willing to accept the loss of even a small number of cities if the only gain was the acquisition of the ravaged territory of the small power. A small power could, therefore, argue that it has a credible deterrent if it can produce some damage in the superpower, for a superpower, even defended by an ABM system, could not exclude all damage. These arguments are, however, based on doubtful premises and the strategic reasons that have been given to justify the acquisition of nuclear weapons by the smaller powers are not convincing. The anti-proliferation argument is, to say the least, a very weak one to support the deployment of ABM systems by the superpowers.

Judging from the long period taken so far to negotiate arms control agreements, it is not easy to be hopeful that adequate measures will be taken within the necessary time. In any case, it is not likely that a comprehensive test ban will be negotiated in the near future. This follows from the fact that the development of ABM systems requires continued underground testing of nuclear weapons to examine the success of modifications and to measure the performance of new missiles. While ABM systems are being considered, therefore, there are strong pressures for the continuation of underground tests. In fact, the continued development of ABMs will also greatly increase pressures for atmospheric tests to determine the performance of the system (including radars) under operational conditions, and, therefore, even the Partial Test Ban Treaty may be jeopardised. Moreover, it is not possible to arouse public opinion over the consequences of radioactive contamination as it was for a partial test ban. It is also claimed that underground nuclear explosions are needed to develop nuclear explosives for peaceful purposes. Further, unless the superpowers restrain the development and deployment of new weapons systems during the period that the arms control negotiations are going on, the difficulty of obtaining even a simple agreement will increase rapidly, to a very high level, because of the erosion of the strategic stability between the superpowers. Finally, if new weapon development and deployment are not restrained by the superpowers there will be secondary effects in third countries. There are likely to be growing pressures for ABM systems even though these are ineffective. This could have serious consequences for the Non-proliferation Treaty and for future European attempts for co-operation. The present smaller nuclear powers will probably be encouraged to improve the quality of their nuclear forces in an attempt to maintain their perceived credibility.

6. prospects for arms control

The present situation is complex and fluid. First, both superpowers are anxious that the Non-proliferation Treaty should be a success and know that its viability depends on them showing good faith towards their commitments under Article 6, before the treaty comes up for review five years after it enters into force. Secondly, the most likely arms control measure to be negotiated first is a simple agreement on a freeze on offensive and defensive missiles. This, however, is unlikely to satisfy many of the non-nuclear weapon powers who are looking for a more positive measure such as a comprehensive test ban or a significant reduction in numbers of offensive missiles. An assessment of the prospects for arms control in, say, the next five ar ten years is difficult. Some factors lead to feelings of optimism, others to pessimism.

Optimism is engendered because the political conditions for successful arms control negotiations may now exist. The leaders of the superpowers have both expressed a desire to start discussions on arms measures and are convinced of the necessity for the success of such negotiations. There is no reason to doubt their sincerity. In both superpowers there are urgent and serious domestic problems of which the populations are aware; this has produced strong internal pressures on the political systems demanding that energy and available resources are devoted to these problems.

There is, at present, a measure of détente between the superpowers and a perceived strategic balance between them. Recent political events have not seriously affected the nature of this détente, although there may have been a change in the détente between the superpowers and other countries, for example, between the Soviet Union and certain western European countries. Both superpowers are probably willing to accept the strategic situation which would exist after the implementation of significant reductions in their strategic forces. In fact, the equilibrium of the strategic balance would be maintained after such reductions. Both superpowers are very anxious to prevent the emergence of new nuclear weapon powers and know that this depends mainly on a halt to the arms race, followed by further positive measures of arms reductions. There is strong evidence to indicate that the superpowers control their actions in a way designed to prevent confrontation which could lead to general nuclear war. They know that the likelihood of a general nuclear war would increase during the periods of instability which will inevitably occur if the arms race continues and the weapons which have already been developed are extensively deployed. Another reason for optimism is that arms control is becoming part of the foreign policy and strategy of the major powers, particularly the superpowers. In the United States, for example, it has recently been decided that the Director of the United States Arms Control and Disarmament Agency should attend all relevant National Security Council meetings. Although this has occurred for limited periods in the past, since the second world war it has not generally been the case. Disarmament negotiations have been mainly undertaken as an issue separate from the main stream of government policy. The personnel dealing with questions of arms control have usually operated remote from policy making, and have not been allowed full access to information or integrated into the decision making process. Now, however, even the military lobbies in the superpowers appear to be beginning to regard arms control as a possible part of strategy. It is, of course, true that national security is still the primary official concern and that arms control and disarmament take second place, but the indications are that governments are beginning to realise that arms control can increase security. Some people regard the arms control successes so far achieved, particularly the Partial Test Ban and the Non-proliferation Treaty, as a reason for optimism and argue that, once begun, negotiations acquire a momentum of their own and subsequent agreement becomes progressively easier to obtain as confidence and mutual trust increase.

So far as the reasons for pessimism are concerned, a main one is the unabated

continuation of the arms race. The long time taken to negotiate arms control agreements is another. Recurrent periods of international tension, which are probably inevitable, tend to lengthen negotiating periods. The arms control agreements so far achieved have had little impact on the tempo of the arms race. The Partial Test Ban Treaty did not prevent the emergence of the fourth and fifth nuclear weapon powers, France and China, and did not significantly hinder the superpowers in the development of warheads for their missiles and anti-missiles. The Outer Space Treaty has banned the use of nuclear weapons in complete orbit but has been interpreted in such a way as to allow the development and testing of FOBS. The success of the Non-proliferation Treaty remains to be seen. Historical evidence is sometimes quoted to indicate that significant multilateral disarmament has, in the past, only occurred immediately after great wars.

The stated aims of the superpowers are not reflected in their actions and this causes serious doubt about their ability to reduce the tempo of the arms race. This is well typified by the fact that the detonation of the most powerful yet underground nuclear explosion in Nevada occurred just when the debate on the Non-proliferation Treaty began in the General Assembly. In fact, ignoring very low yield explosions, the United States has conducted, on average, at least 30 underground tests per year since the Partial Test Ban was signed and the Soviet Union has conducted an average of about ten a year; this testing can be related to the development of ABM systems. Since signing the Non-proliferation Treaty, both superpowers have tested MIRVS and the United States Senate has voted in favour of the deployment of an ABM system. There is no doubt that there are very large vested interests in the arms race and the pressures which the so-called military industrial complex can bring to bear are very great. This factor might limit the successful implementation of arms control agreements.

These considerations and the fact that, although the superpowers appear strongly to desire arms reductions, they may be unable to achieve them, even to a limited extent, raises the possibility that the main destabilising factor in international relations today may be technology itself.

effect of momentum of technology

In advanced industrial society technology acquires an inherent momentum on a very broad front and that this makes specific technological advances extremely difficult to direct and control since each part affects the whole. So it may be misleading to regard the effects of weapons technology as a separate issue, as it is regarded and studied at present. Instead of isolating the issue of arms control and disarmament, it may be more fruitful to think of the subject as part of a much wider problem and to attempt to suggest solutions on the basis of a study of this.

Little effort has been devoted to a fundamental analysis of the total consequences and effects of the technological revolutions that have occurred, and will occur, and of the means to control and direct them. Attention has, so far, been concentrated on considering the effects of each narrow technological advance separately and little consideration has been given to the way that each one interacts on the others.

To illustrate this from an example in weapons technology, the case of the United States ABM deployment can be used. Not only is the deployment of an ABM system ineffective, but it results in a reinvigoration of the arms race; has an adverse affect on the superpower détente and arms control negotiations; reduces the possibility of a comprehensive test ban treaty; and jeopardises the Partial Test Ban Treaty. Most of the arguments used in favour of the deployment of an ABM system are either based on emotional premises, such as the feeling that all defensive measures are desirable or that, because the other side has it, we must also acquire it, or are based on the types of arguments used by the more militant groups in society, such as the illusory concept that the de-

ployment of an ABM system can lead to a dominant posture in the long run. The official argument for the deployment of the "thin" system by the United States was that it would provide protection against an attack by China ; it would reduce or eliminate the possibility of catalytic war initiated by a small nuclear weapon power ; it would insure against accidental war caused by the misfiring of a missile by any one of the nuclear weapon powers ; and it would remove the credibility of small token attacks by ICBMS made for bargaining purposes in times of crisis. None of these reasons is convincing. The China argument assumes that she will behave irrationally since an attack by China on the United States would be suicidal and there is no evidence that China's actions, as opposed to her words, are either unpredictable or irrational. There is no reason why the United States should not rely on deterrence rather than defence against China, as she has against the Soviet Union. In fact, the United States' ABM system is likely to increase the credibility of the Chinese nuclear deterrent in Asia, which is just the opposite effect to that intended.

To achieve the insurances required of it the system would have to be kept fully alert continuously since warning times would be extremely short. The chance of nuclear accidents associated with the ABM system itself, operated under these conditions, is probably greater than the chance of the occurrence of the events being insured against. It follows that, on a reasonable, non-emotional assessment, the advantages of ABM systems are completely outweighed by the disadvantages, even ignoring the questions of cost and loss of resources. The only argument used by serious students of the subject in favour of ABMS is that their deployment, together with a reduction in the numbers of offensive weapons, is equivalent to a measure of disarmament. Very few authorities regard this view as at all valid. The question is, therefore, why, in spite of this, have the superpowers deployed, or planned to deploy, ABM systems? So far as the Soviet Union is concerned, it is probable that the traditional role of defence in Soviet military planning played an important part in the decision. The fact that the Soviet people suffered over 20 million casualties and huge losses of property during the second world war would make the task of those within the decision making process who favoured deployment easier, since those who attempted to resist deployment could be accused of suggesting that the country should be left undefended.

It has been suggested that the decision to approve and fund the Sentinel system in the United States was taken for political reasons and in response to political pressures. This is summed up by the statement that the Sentinel system was introduced "against the Republicans rather than the Chinese". The political advantage obtained during the Kennedy election campaign from the supposed missile gap demonstrated the dangers of appearing dilatory about strategic and defensive matters, and has made politicians sensitive to such pressures. That these pressures are strong is undeniable, coming as they mainly do from the military-industrial complex which has powerful friends in the appropriate congressional committees. These groups favour the deployment of a "thin" system as a first step towards the eventual deployment of an extended system ; when it becomes clear that the government is not prepared to concede their demands, a policy of settling for a lesser system is adopted and then, once this has been installed, pressure for a larger system is brought to bear. An ABM system is so complex that very large investments in the electronics, aerospace and other industries are concerned and these have powerful lobbies in the political system. These explanations for the fact that the decisions to deploy expensive weapons systems were taken in the absence of sound strategic reasons are not convincing as the entire story. There is a significant anti-ABM group in America and it should have been possible for the political leaders, with their support, to resist the pressures and counter the arguments put forward for deployment by pointing out to the American population the great disadvantages of, and arguments against, the deployment of ABMS ; emphasising the

spiralling costs of weapons systems; explaining that even an effective ABM system would need a shelter programme, a prospect which, as experience has shown, is very disconcerting to the American public; and pointing out how rapidly the proposed system would become obsolete and that, had the government gone ahead with the first possible ABM system, the country would now have just such an obsolete system after the expenditure of billions of dollars.

That these pressures could not be resisted despite the serious efforts made in this direction by Robert McNamara, the then Secretary of Defence, seems to indicate that the totality of the forces set in motion, once technology had made the weapons available, almost inevitably led to the decision to deploy them. It is always possible to rationalise this decision and it has, for example, been recently argued that a sufficient justification for an American ABM system is its bargaining power in the forthcoming disarmament talks with the Soviet Union. It is noteworthy that the opposition from those living near the sites chosen for Spartan deployment did not cause the decision to deploy the Sentinel system to be reversed. The ABMs are instead to be moved to protect ICBM sites. This decision introduces uncertainties into strategic calculations and threatens the equilibrium of the strategic balance. Even though these uncertainties may be minor at first, any further deployment will increase them to levels which will threaten arms control negotiations. The difficulty of reversing the decision to acquire a weapons system indicates once again, the strength of the forces involved.

Another example of the difficulties created by the momentum of technology is provided by the development of gas centrifuges for uranium separation. Because of the serious implications of these for the proliferation of nuclear weapons it would be desirable that they be not developed or, at least, put under international ownership and control. The arguments in favour of the development of centrifuges are mainly economic and commercial ones. There is no doubt that the nuclear fuel cycle will soon become a sizeable world industry. It can be predicted with confidence that the turnover in this industry is likely to be at least ten times greater by the end of the next decade than it will be during the next year and even during the latter period it should exceed £100 million. About 24 per cent of the final cost of nuclear fuel goes in the enrichment process. The governments and industry of some countries, particularly Great Britain and West Germany, believe that the talents of their societies are particularly suited to the nuclear energy industry. The industry in these countries is at present making large contributions to the domestic markets and great importance is attached to the exploitation of future opportunities in the export markets. Great Britain and West Germany are hoping to secure significant portions of the fuel cycle industry by being able to offer all aspects of the fuel cycle under single management control, since they feel that this would put them in a strong position in a highly competitive market. At present the cost of enriched uranium from the United States is lower than can be achieved by any other western country, mainly because the American gas diffusion plants are very large and cheap electric power to run them is readily available. For a country wishing to offer all the fuel cycle services the supply of enriched uranium is the weak link in the chain. The main advantages claimed for the gas centifuge method of enrichment is that it should be reasonably economic on a small scale and the plant could be expanded in stages to match the requirements of a growing power programme. Great Britain, the Netherlands and West Germany have negotiated a collaborative agreement for the development of gas centrifuges, under which two experimental plants will be built to produce enriched uranium. Although it has been decided that West Germany will participate only in an administrative way and will not build an installation of her own.

They claim that gas centrifuges are of major importance for their nuclear energy industries to provide fuel for domestic reactors and because they would

greatly benefit exports, particularly if the enriched uranium produced is competitive in price with enriched uranium from the United States. In addition, it is argued that a country's power generation should not depend on a single, foreign source for the supply of fuel. Some of these arguments are, however, open to challenge.

Fast breeder reactors are likely to become competitive by the end of the next decade and this will reduce the demand for enriched uranium. In the meantime, the IAEA, given the resources, could become a major supplier of enriched uranium. It would need to buy its stock from the nuclear weapon powers but, even so, it would represent a source of supply independent of the present sources. The argument that gas centrifuge development can be justified on economic grounds is also open to challenge. It is predicted that, in 1980, the Capenhurst plant will supply only about 30 per cent of the enriched uranium required to fuel the British nuclear power reactors installed at that time. The cost of importing from the United States the additional enrichment services then required will be about £12 million per year at present prices. The cost involved for the Common Market countries is likely to be about ten times this sum. But a gas centrifuge plant adequate for the separative work required for European countries would cost at least £500 million and would be expensive to run. The real price of the enriched uranium produced is likely to be, at best, only marginally cheaper than that of fuel imported from the United States. The main argument against the development of gas centifuges is that they could be used as a source of supply of uranium-235 for the production of nuclear weapons and also of thermonuclear weapons. Moreover, because it could be enclosed in a small area, a plant would be easy to conceal.

The major danger is that, once the technical problems of the production of centrifuges are overcome, as now seems to be the case, some country might produce and export them. Therefore any government anxious to avoid assisting proliferation would not undertake the production of gas centrifuges for what might prove to be very marginal economic reasons. If a new source of supply of enriched uranium is felt to be necessary for political reasons, then a more suitable solution would be for the IAEA to become the supplier, and if a gas centrifuge plant really proves to be a necessity, this should be owned by the agency.

The fact that Great Britain, West Germany and the Netherlands are proceeding with the proposed collaborative development in spite of their stated sincere intentions not to encourage the proliferation of nuclear weapons is difficult to explain except as the result of an almost irresistible process which began when technology made the development of gas centrifuges possible. Once this has occurred, the momentum of the process carries it on until the development has been completed. The problem is that, at an early stage, the effects of a technological advance begin to spread rapidly and to involve an ever increasing number of subsidiary industries, institutions and interests. It is the totality of the forces that can be brought to bear by these that produces the momentum of the development. An extreme example of this is the development of the automobile, the production of which now involves such a complex network of secondary concerns that the pressures which would be called into play if the production of automobiles were interfered with would be virtually irresistible. Therefore, if a development is to be controlled, it is essential that this be done soon after it is shown to be feasible, otherwise the momentum acquired inevitably carries the process along to the bitter end, in spite of reasons against it. This state of affairs has the most serious consequences in advanced societies because the scale of technology is now so large, and has so many facets, that the very existence of the political institutions in these societies is threatened, as is indicated by the social unrest in these advanced societies.

If future arms control and arms reduction negotiations are to have a reason-

able chance of success it will be necessary to find a method of influencing the momentum of weapons technology. The simplest way to achieve this would be for political leaders to intervene and stop or restrain at an early stage any development which is likely to have adverse effects on either the strategic balance between the superpowers or on the forthcoming arms control negotiations. It is, however, unlikely for several reasons that political leaders will perform this task. First, these actions are likely to be politically unpopular, at least until people are educated in the necessity for these measures, and influential lobbies have to be contended with. Secondly, the leaders do not necessarily fully understand the consequences of a given development until it has passed the stage where restraint can be easily imposed. Thirdly, the expert advisors to the leaders are often themselves involved in the relevant technology and are, therefore, not able to give objective advice. Finally, the ultimate decision may depend on a choice between alternatives which can only be made on the basis of sophisticated knowledge of more than one subject.

British policy

The probable consequences of a continuation of the superpower arms race are so serious that all states should adapt their policies in an effort to prevent this. Otherwise it is likely that the conditions necessary for arms control and disarmament negotiations will not occur again for the foreseeable future and that the strategic balance between the superpowers will be eroded and destroyed. The forthcoming disarmament talks are, therefore of extreme importance for the future of world security and it is clearly in the British interest that they should be successful; any deterioration in the détente between the superpowers has an adverse effect on Britain. If they are not successful a large general increase in the levels of arms in all states can be predicted, including the proliferation of nuclear weapons and the acquisition and dissemination of biological and chemical weapons by smaller powers.

It can be expected that it will take a long time to reach an agreement on significant arms reduction measures and it is important that Britain plays a positive role during this period. The primary aim of British policy should be to avoid extending her own nuclear forces or, better still, to reduce them and not to make easier the acquisition of nuclear weapons, or the means to obtain such weapons by other powers.

I feel that the IAEA should be given sufficient resources and support to enable it to become the body recognised as having the major responsibility for international co-operation in the development of nuclear energy. If the agency had this role, not only would the development of reactor programmes, particularly in the developing countries, be more efficiently performed, but the entire operation could be organised in a way which would minimise the probability of the spread of nuclear weapons. The agency already performs pre-investment studies on nuclear power in developing countries and there seems no good reason why the agency should not become generally responsible for advising on contracts for nuclear power reactors, acting as consultants during the installation of imported reactors, supplying the fuel for these reactors, collecting the spent fuel elements and separating and storing the plutonium. In the next decade it is expected that about 50 power reactors will be imported by less advanced countries.

If the fuel for these were to be provided free by the agency then it would own the fuel throughout its life; this would largely solve the problem of the diversion for military purposes of plutonium. stored on the territory of many states and would also ensure that non-industrial countries obtained the cheapest possible electricity since they would have no fuel costs. There are, of course, objections to this proposal, but none of them is serious compared with the dangers inherent in the dissemination throughout the world of huge quantities of plutonium. It is to be hoped that the Non-proliferation Treaty will not cause states to be lulled into a sense of false security, because this

treaty cannot be relied upon completely to prevent the proliferation of nuclear weapons, for the treaty is likely to be most effective in the cases of the present near-nuclear weapon powers, but might be relatively ineffective in preventing proliferation to some of the other countries. If just one more state acquires even primitive nuclear weapons others will probably follow the example. As a potential exporter of power reactors Britain has a clear responsibility to devise a policy which would avoid increasing the possibility of proliferation and should negotiate with the other present or likely reactor exporters (Canada, Sweden, France, Japan, West Germany, the Soviet Union and the United States) to get an agreed export policy. A possible policy would be that reactors are exported only if the receiving country agrees to obtain its fuel from the agency and to return the spent reactor elements to the agency.

The fuel could be supplied free, as suggested above, and the plutonium produced in fuel elements sold back to the country, if and when required for peaceful purposes. Britain should not supply materials of technical assistance for the construction of new plutonium separation plants. British policy should be that all separation plants and all new enrichment plants, gas diffusion or centrifuge, should be owned and controlled by the IAEA. A considerable expansion of IAEA activities must, in any case, take place if it is to fulfil its inspection functions under the Non-proliferation Treaty. British support for the strengthening of the agency will be important and every effort should be made to ensure that the necessary resources are available in time. It is important that the agency is seen to have full political support from Britain and this could be achieved by such methods as making available to the agency the results of the research on safeguards being done in this country for national control purposes, the initiation of joint research projects and concrete proposals for an expansion of the agency's activities on the lines suggested above.

After the RAF Vulcans are withdrawn from service, which will occur before 1970, the British strategic nuclear force will consist only of Polaris submarines. By 1970, the Polaris fleet of four nuclear powered missile submarines will be complete. The recent reports that the government is considering the possibility of installing MIRV warheads on the Polaris missiles are disturbing and it is hoped that they are not true. Polaris missiles already contain primitive multiple warheads, but there are not targetable. The Ministry of Defence has apparently largely solved the technical problems involved with MIRVs but it is likely that the system is still in the development stage. The deployment of MIRVs by the British would be a wrong decision, not only because it might complicate the negotiations between the superpowers but also because of the implications for British relations with European states. The French, for example, are likely to find objectionable a continued special relationship between Britain and the United States, by which Britain obtains nuclear information, and this could greatly complicate British entry into the Common Market. If Britain does not restrain future developments of her nuclear forces it could stimulate the French to improve the quality of their nuclear forces and this will produce increasing pressure for national nuclear forces in other European countries. It will, in any case, be difficult enough to prevent such pressures building up in the future in West Germany, for example, if the British and French indefinitely continue their nuclear forces even at present announced levels. The growing prosperity and the current emphasis on independence in many European countries may accentuate demands for nuclear weapons, and the British government should be aware that its actions could encourage those groups within these countries which argue in favour of a nuclear force. Some authorities argue, however, that an integrated Anglo-French nuclear force assigned to the Western European Union would reduce such pressures for independent nuclear deterrents. The most sensible British reaction to the Soviet ABM deployment is, therefore, not to respond at all. An additional argument against any further hardening of Polaris

warheads, if any further reason is necessary, is that the cost is likely to be very large.

So far as NATO is concerned, a major problem at the moment is the desire of some European countries for a greater involvement in nuclear planning and decision making. British policy on this issue ought to emphasise the opportunities for involvement in the co-ordination on nuclear issues within the Nuclear Planning Group and to attempt to ensure that this satisfies those powers who desire more participation. For the sake of the Non-proliferation Treaty and future arms control agreements it is essential that all proposals for a European nuclear force are rapidly rejected. For the present, there is a good case for leaving NATO essentially undisturbed and, as a main aim, working for cohesion within western Europe and an eventual improvement of relations with eastern Europe.

There should not, however, be significant changes in the present nuclear decision making process, although it could be argued that Britain should make definite and elaborated proposals concerning nuclear planning in order to influence such factors as the actions which should precede the contemplation of the use of nuclear weapons or the size of forces. In spite of recent statements, the best policy for NATO would be to acquire a non-nuclear option in Europe and a greater flexibility in its plans. Finally, the Nuclear Planning Group is keeping under review developments of ABM systems. It is to be hoped that the British representative will emphasise the complete undesirability of a European ABM system.

It can be concluded that the first aim of British policy should be to influence, in a positive way, the forthcoming arms control negotiations, in particular by exercising extreme restraint in her commercial nuclear practice and in the development of her nuclear forces, by giving all possible support to the IAEA, and by attempting to negotiate an agreed policy for reactor exporter countries. It is probably unrealistic to expect a reduction of British nuclear forces in the near future, but it is important that the quantity and quality of these forces should not be increased. A possible policy would be to make nuclear disarmament by Britain conditional on a significant arms reduction agreement by the superpowers.

the problem of China

The problem of China is often raised as a reason why significant disarmament measures are unlikely to be taken by the superpowers. It is not likely, however, that the Chinese will become a serious military threat to the rest of the world in the foreseeable future. Not only are the Chinese leaders preoccupied with internal problems, but they have shown theselves to be both rational and predictable in their external affairs. Contrary to the popular view, the available evidence indicates that the Chinese have a realistic view of the consequences of nuclear war, even a small one, and are anxious to avoid the outbreak of such a war.

They consider it unwise, however, to emphasise the dangers of nuclear war and argue that the best way to avoid such a war is to be militarily strong. China has, so far, expressed little interest in arms control and disarmament and appears to believe that, to show such an interest would indicate a fear of nuclear war, which would make it more likely to occur. In 1962, however, the Chinese government did propose a conference of all countries to discuss the question of the complete prohibition and destruction of nuclear weapons, although this was before China had acquired nuclear weapons, of course. The motive for acquiring nuclear weapons was almost certainly based on Chinese ambitions to attain superpower status as quickly as possible and on the argument that all great powers have nuclear weapons. Nuclear weapons are probably regarded as a method of deterring, rather than threatening, the United States (or the Soviet Union) and of increasing Chinese power within the communist system and in Asia. So far as China is concerned, therefore, there is no reason why the superpowers should

not go ahead with their arms control and arms reduction negotiations with the hope that China could be incorporated into them later. It is realistic to hope that when China has increased her strength to a point where she feels relatively secure she will then be prepared, and possibly anxious, to enter into arms control agreements. This, after all, is what has happened in the case of United States and the Soviet Union. It is significant that China is the only nuclear power to have made a pledge not to be the first to use nuclear weapons.

A no first-use agreement in which all five of the nuclear weapon powers would pledge not to utilise nuclear weapons against, or on the territory of, non-nuclear-weapon powers, may assist the fulfilment of the present need to provide the non-nuclear weapon powers with further guarantees of their security and thereby help to balance and reinforce the Non-proliferation Treaty by imposing obligations on the nuclear-weapon powers. As we have seen, the existing guarantee arrangements are probably not sufficient.

The no first use agreement would only be plausible if it were followed by reasonable arms control and arms reduction agreements. The combination of these measures would have several important advantages: it probably represents the most effective practicable guarantee to protect non-nuclear-weapon states against nuclear attack or the threat of attack; it would indicate that the nuclear-weapon powers recognise the limited value of nuclear weapons in the conduct of international affairs; it would reduce reliance on "tactical" nuclear weapons for the defence of areas like Europe; and it might lead to a future total prohibition of the use of nuclear weapons.

It is not unlikely that Great Britain, the United States and the Soviet Union would be willing seriously to consider such a no first use pledge. So far as the French are concerned, the officially announced purpose of the *force de frappe* is solely to provide a deterrent against nuclear attack and the French government should, therefore, have no objection to joining the agreement. In view of her unilateral pledge, it would be reasonable to expect China tacitly to adhere to the pledge. The problem of non-nuclear-weapon powers who have nuclear weapons on their territory but not under their control, is a complex one and, to obtain agreement, it may be necessary to exclude these from the pledge. As with all guarantees, the main objection raised to the suggestion of a no first use pledge relates to its credibility. However, solemn undertakings by states are usually not taken lightly and a no first use pledge is probably the best guarantee, short of complete nuclear disarmament, that could be hoped for in the present circumstances.

future weapon developments

If the superpowers fail to agree to restrain future weapon development new weapons are likely soon to be made available.

It can be predicted that MIRVs will be made increasingly accurate. The United States is at present developing a MIRV containing a guidance system and thruster rockets that enable it to make minor manoeuvres soon after the main booster rocket has stopped so that, at an altitude of 600 to 800 miles a number of course and speed changes occur and a warhead is ejected each time. Because of the altitude, the targets at which the warheads are aimed could be hundreds of miles apart and several degrees of longitude or latitude to either side of the missile trajectory. It is likely that a MIRV can carry up to 20 kiloton size warheads, each with its own guidance system programmed to take it to a specific target. If the accuracy of MIRVs becomes high they will be exceedingly formidable weapons.

In addition, FOBS will probably be developed to an operational level. These weapons are launched into a very low orbit around the earth about 100 miles high, and, at a point in the first orbit, a retro-rocket is fired to slow down the missile which then drops out of orbit on to the target. The orbit of FOBS would

have an almost constant altitude above the earth's surface (an ICBM would follow a true ballistic trajectory, which has much more curvature) which means that a FOBS would not be detected by ground radar until it was within a range of about 900 miles. The warning time would be only about three minutes, compared with the corresponding warning times for an ICBM of ten minutes. Also, a missile on a fraction orbit trajectory could be made to approach the opponents' radar system from a direction which would make its detection less likely.

ABM systems will almost certainly be further developed. A new high acceleration (500g) anti-missile is being developed in the United States for the point-defence of ICBM sites. Seaborn ABMS (SABMIS) are also under development. These presumably are designed to intercept enemy ICBMS in the early part of their trajectory. In addition, space based and sea bed systems, to intercept ICBMS soon after they have been fired, are no doubt under active consideration.

An ABM system could be based upon a defence screen established by exploding very large nuclear warheads in space. If this occurred inside the earth's magnetic field the charged particles released by the nuclear explosions would move along the lines of the field and might achieve a density sufficient to inactivate an incoming enemy warhead. As alternatives to a plasma of charged particles, defence screens of small pellets and gasses have been suggested. The future use of lasers for ABM systems is another possibility, although this requires the projection of large fluxes of radiation over great distances.

As far as the smaller powers are concerned, the development of chemical and biological weapons presents a grave danger to their stability. The dissemination of these weapons, which are the cheapest weapons of mass destruction, could be particular serious for some regions, such as the Middle East. There has been much discussion of the feasibility of controlling the development of chemical and biological weapons. The 1925 Geneva Protocol provides some guard against the use of these weapons, but many countries such as the United States and Japan are not parties to the protocol. Only 60 states have signed, and all states party have the right to manufacture and stockpile such weapons; and some reserve the right to use them against non-parties, or violators of the protocol and their allies. There is also doubt about its legal status. Even if all states acceded to the protocol there would still be a risk of the use of the weapons since states have the right to manufacture them and use them against those who violate it.

Moreover, the definition of chemical and biological weapons is unsatisfactory and the prohibition of their use only applies "in war". There is, therefore, ambiguity about its applicability in the case of hostilities which do not amount to war in the legal sense. In view of this, the British delegate at the ENDC has proposed that the questions of chemical and microbiological methods of warfare should be considered separately to decrease the difficulty of dealing with their control. It was proposed that a new Convention for the Prohibition of Microbiological Methods of Warfare be concluded, to supplement, but not to supersede, the 1925 protocol and, with a view to aiding consideration of further measures for controlling chemical warfare, it was proposed that the Secretary General should in fact be asked to prepare a report on chemical weapons. The reason for excluding them from the convention at this stage is that it is difficult to secure agreement on banning all chemical agents because some of these have legitimate peaceful uses in the field of riot control.

There is disagreement on whether the protocol signed in 1925 covers all chemical agents or just lethal ones. Because chemical weapons have been used in war it was felt that states might not be willing to give up the manufacture of chemical agents and the right to conduct research in this field. The convention would require that states "declare their belief that the use of microbiological methods of warfare of any kind and in any circumstances should be treated as con-

trary to international law and a crime against humanity and undertake never to engage in such methods of warfare themselves in any cirmumstances". It is envisaged that there would be a ban on the production of biological agents on a scale which was not justified for peaceful application. There is disagreement over the feasibility of effective verification of control agreements concerning biological weapons. The official British position is that strict verification is not possible and it has been suggested that a United Nations body of experts be set up to investigate allegations, made by a party to the proposed convention, which appeared to establish that another party had violated the convention. It has, however, been argued by others that a measure of verification may be possible in the production phase of biological weapons of military significance and that control over production and testing are sufficient. A final answer to this question must await further research.

A serious omission from the protocol is a formal procedure for investigating violations. Chemical weapons have been used in the Yemen and Vietnam, but no effective investigations have been performed. An urgent requirement is, therefore, the establishment of a procedure to investigate the use of chemical and biological weapons which would enable sanctions to be imposed and act as a constraint on use. So far as the control of chemical weapons is concerned, it has been suggested that even a modest production of these weapons could be detected from an analysis of a country's consumption of certain raw materials and the existence of plant and equipment. If this is so, the verification of the control of chemical weapons may be less difficult than is usually assumed.

Future steps to achieve control of chemical and biological weapons might be:

1. the improvement of the Geneva protocol to remove present ambiguities and, thereby, to attempt to obtain greater adherence to the protocol. A main requirement is international agreement on the definition of chemical warfare;

2. the supplementation of the protocol by the proposed UK Convention on the Prohibition of Microbiological Warfare, including a ban on the production and possession of biological weapons;

3. a thorough investigation of the feasibility of developing effective inspection methods to verify control agreements, particularly in the production phases of biological and chemical weapons;

4. the establishment of a sound procedure to investigate the alleged use of chemical and biological weapons.

If some powers equip themselves with chemical and biological weapons others find it necessary to develop defensive measures against these weapons. It is, for example, officially claimed that British efforts in this field are purely defensive and that Britain is not manufacturing or stockpiling chemical or biological weapons. The fact is, however, that if a defence is found for these weapons there is likely to be a further escalation of the means of attack. In this sense, the relationship between offence and defence so far as chemical and biological weapons are concerned does not differ from that for any other type of weapon.

7. the East-West détente

Alan Lee Williams MP and Geoffrey Lee Williams

The present strategic nuclear balance between the United States and the Soviet Union will probably remain a permanent feature of the international scene for as long as we can forsee, although the nature of that balance will itself change from time to time under the impact of a volatile military technology.

Strategic parity between these two superpowers will be accepted as an inescapable and desirable fact which neither country will wish seriously to challenge. Although it should be noted that the Nixon administration appears to believe that the Soviet Union is now going for a first strike capability *vis-a-vis* the United States. The supposition, however, in Robert McNamara's time as Secretary of Defence was that the Soviet Union was incapable of acquiring the ability to launch a devastating attack which could destroy America's capacity to retaliate. Yet recently in detailed testimony before the US Senate Armed Sevices Committee, Defence Secretary Melvin Laird asserted that, "the potential threat from the Soviet Union lies in the growing missile force, which could destroy a portion of our deterrent, or destroy a portion of our retaliatory force". The nature of the new threat, he explained, lay in the deployment by the Soviet Union of the SS-9, a hard-sited, liquid-fuelled Soviet ICBM capable of delivering a 25 megaton warhead, or as many as five scottershot smaller ones. He claimed that more than 200 SS-9s had been declared operational and that still more were due for deployment, which might give the Soviet Union a realistic pre-emptive strike capacity.

Later, before the same committee Deputy Secretary Packard concluded: "analysis brought us to the conclusion that the Soviet Union has the capability of being able to destroy substantially all of our land based Minuteman capability in hardened silos, if they chose to do so". Melvin Laird further declared that the Russians had embarked upon a crash nuclear missile submarine construction programme which might give them a lead over the US Polaris submarine force possibly as early as 1971. This development was made potentially more serious because the Soviets had developed a fast nuclear attack submarine designed to hunt down and destroy the Polaris submarines. Laird suggested that as a result it remained doubtful whether, after 1972 the US Polaris fleet would "remain very free from attack". However, the likelihood remains that the Soviet SS-9 ICBM is almost certainly a second strike weapon. The US does not possess a first strike capability against the Soviet Union for precisely the same reason that the Soviet Union does not possess it against the US.

Both superpowers have built up second strike capabilities to the point that a first strike capability on either side is now frankly impossible. The inescapable fact is that neither the Soviet Union nor the United States can attack the other without being destroyed in retaliation; nor can either side attain a meaningful first strike capability in the foreseeable future. The present US attitude on the question of ballistic missile defence must be seen as having relevance to the maintenance of a credible second strike retaliatory system. This can be gauged by the fact that President Nixon has decided to protect the Minuteman sites as opposed to the previous attempt under Johnson to try to protect cities as well. The Soviet government decided to deploy a ballistic missile defence system around Leningrad and Moscow and as a result provoked an American response.

Neither the appearance of President Nixon nor the Soviet invasion of Czechoslovakia can be regarded as likely to induce a greatly accelerated arms race between the two military giants. Their joint interests will dictate a realistic mutual accommodation, the extent of which depends upon the settlement of the Vietnam war and at least some kind of tacit understanding over the Middle East. None of this will be easy. South Vietnam cannot be cynically betrayed by the US nor Israel denied US displomatic and military support; the former would gravely damage America's image as the reliable superpower committed to the defence of vulnerable allies and the latter could conceivably compel Israel to go nuclear.

It is necessary to put into perspective the nature of Russo-American strategic relations since 1945 and in passing to question the intellectual foundations which seem to underlie the theory of their converging strategic interests. For it is this convergence which has produced the divergence of strategic interests within the respective alliance systems.

the rejection of isolationism

The United States, in the wake of Hitler's defeat and the sudden collapse of Japan, based its diplomatic hopes on the concept of "one world" and the rejection of isolationism. In future she would encourage the doctrine of co-operation between the great powers. This kind of thinking explains how the USA concluded that the fact that the threat to peace had been removed would now enable a war tormented world to settle down to an orderly existence based upon Russo-American co-operation and political understanding. Then the cold war intervened. The ensuing arms race, however, ended in stalemate at the strategic nuclear level within a decade, and this became virtually total by the end of the second post-war decade with the coming of second strike retaliatory systems. The Geneva Summit Conference of July 1955, through a spectacular diplomatic failure, marked the acceptance of stalemate based as it then was on the manned bomber. Again, the abortive Paris Summit Conference of May 1960 marked the reality of approaching strategic nuclear deadlock. The Soviet breaking of the nuclear test moratorium the following year, added reality to this deadlock, for she thus improved her deterrent capacity *vis-a-vis* America. Finally the liquidation of the Cuban missile crisis laid the foundations for the successful negotiations leading to the partial Nuclear Test Ban Treaty in August 1963, and five years later to the Non-proliferation Treaty. Indeed, not even the Vietnam war shattered this superpower relationship which was in some perverse way actually strengthened by their collective fear of having to back recalcitrant and intransigent allies.

China refused to sign the test ban treaty and South Vietnam at first refused to negotiate an end to the war that was causing America so much difficulty, in loss of life and treasure. This certainly made Russo-American understanding inevitable and palatable and led to renewed interest in the concept of "one world" which was now to be frankly based upon a bi-polar relationship. Now the diplomatic dialogue spoke about international security, common interest in the prevention of the spread of nuclear weapons and "crisis management". Both superpowers wished to check the anarchic tendencies of a world of sovereign nation states living in a "state of nature". The growth of such a conservative attitude was in a sense inevitable; it was not in fact entirely unexpected.

The idea of a bipolar world or "duopoly", frankly based on the hegemony of the two great powers, seemed a highly attractive prospect. The burdens of alliance-based diplomacy began to affect the US perspectives and many American academic strategists gave brilliant expression to a change of emphasis which gave birth to the hope that the realisation of a safe and less complicated world was, perhaps, just around the corner. This sort of speculation soon caused alarm to many differently placed governments both inside and outside the western alliance. Franco-German alarm at the prospect of this duopoly found an echo in the Chinese press that America and Russia, particularly over the war in Vietnam, were on collusion course, not collision course! The spectre of a superpower domination of the entire globe became the nightmare of many statesmen, aligned and non-aligned, whose thoughts turned to "spheres of interests" tightly held under the grip of a Soviet and American imperialist design.

the Soviet refusal

The Soviets have ideologically found the US interest in a possible joint power relationship an impossible idea. But in terms of power they did perceive the advantages of an understanding over so-

called spheres of influence. The Summit Conference of 1955 and Mr. Khrushchev's visit to the USA in the Autumn of 1959 confirmed the nature of the emerging balance frankly based upon irreconcilable social systems whose military might was now oriented towards stalemate and in time total nuclear deadlock.

A stabilised world order was ideologically speaking inadmissable, but the idea of joint spheres of interest led to Mr Khrushchev's definition of co-existence. This was essentially, though not entirely, pragmatic. Soviet interest in co-existence diplomacy was not entirely bogus since it was also a device to perpetuate the power dominance of the Soviet Union in an increasingly polycentric and differentiated world as well as a means of embarrassing the West. The communist world movement was threatening to fly apart and between 1960 and 1964 the process had begun to occur at a pace which highly alarmed the exuberant Khrushchev, Russian diplomacy struck a real note of accord with the growing American interest in disarmament and arms control. The meeting of the Ten Nation Disarmament Committee, though not without real moments of tragi-comedy, was a reflection of the joint power interest which both Russia and America felt about the arms race.

Furthermore even the Soviet political offensive over West Berlin carried with it strong collusive aspects which in fact led to a crisis within the western camp (Coral Bell, *The debatable alliance*, Chatham House, 1964). Of course the nuclear test ban talks were the chosen vehicle for the unfolding of the collusive intent of the two superpowers and the non-proliferation talks further evidence of this.

joint power considerations

The two superpowers were growing alarmed about the secondary nuclear arms race and as a result discovered a characteristic in common which "they could not or would not share with their respective allies: the final decision over peace or war" (C. Gasteyger: *The American Dilemma: Bipolarity or Alliance Cohesion.* ISS, 1966). Their respective alliance systems, however, were flying apart; and this tended to undermine their conjoint control of events which might lead to war. In the case of NATO the difficulties are well known. The events of 1958-1962 over Berlin led to the Franco-German alliance and the French withdrawal from NATO in 1966.

The Warsaw Pact powers were also to display fissiparous tendencies which in 1956 and 1968 took a dramatic form. The Soviet attitude to this problem is of interest because her growing interest in accommodation with her superpower adversary is in part a reflection of heightened alliance difficulties. Of course, the incidents in March 1969 over Damansky Island between Soviet and Chinese troops further strengthened the case for détente.

The Soviet government, for example, invested the Warsaw Pact with a military significance after 1961, which it singularly lacked prior to this, since, at the time of its foundation in May 1955, it was merely a political device to offset the rearmament of West Germany within the framework of the western European agreements. But the increased importance of the Warsaw Pact countries in the military defence of the Soviet Union merely increased the political disaffection of its members. Indeed, prior to the Soviet invasion of Czechoslovakia in August 1968 both Roumania and Bulgaria, the latter usually thought to be reliable, had shown a marked tendency to oppose the Soviet Union on important matters. The Soviet invasion of Czechoslovakia was seen by the Soviet military as essential if the strategy of the "flexible response" was to be fully implemented, that is, Soviet troops had to be certain of being in the right position should a NATO aggression occur.

Two features of the contemporary world scene in fact emerged clearly by the early 'sixties: neither superpower could ensure the fate of the world even though one or the other or both could destroy it several times over; and the sustained

conflict between them actually created an interdependent relationship which led to the convergence theory, or at any rate to an American interest in the apparent socio-political similarity of the mammoth Russian and American societies.

convergence

The essential prerequisite of the convergence theory was the somewhat over optimistic belief that the industrialisation of society must in time lead to a greater degree of liberalisation. Communist societies, so ran the argument, would increasingly need to reform and accept bourgeois models of political and economic behaviour. Therefore, the two superpowers were increasingly attractive suitors whose social systems were becoming progressively alike in the face of encroaching maturity. The convergence theorists argued that the Soviet Union and the United States were about to embark on a phase of "mutual discovery" in which both would discover just how complementary their societies really were.

This doctrine was fully endorsed by the late John Strachey (*The pursuit of peace,* Fabian tract 328, 1960). "Naturally the differences between them (the US and USSR) are still great. But the significant fact is that they are beginning to diminish, Apparently huge industrial, vigorous, highly organised communities such as these come to bear certain resemblances to each other, however you organise their productive and social life". The decisive factor, so this school of thought maintained, was the gradual socio-political convergence of western and Soviet society as a result of basic economic and technological advances which, though founded on different ideological grounds, were both determined by the economic basis of society. That one was thought to be "capitalist" and the other "communist", with capital owned privately in the former and publicly owned in the latter, was now discovered to be a semantic trick, a sleight of hand concocted by political theorists whose *a priori* reasoning had invented or rationalised a formidably impressive theory of conflict.

Soviet scholars rejected the new theory as a specious notion based upon a series of politically semi-literate assumptions (A Kunika: *The latest word in imperialist ideological subversion,* International Affairs (Moscow), 1965). No Marxist could publicly admit that the communist world would in time approximate to the more sophisticated open societies; the reverse had always been thought likely. China vigorously rejected the notion of convergence, but gave unexpected support to the theory that since Russia was not genuinely communist then it was inevitable that she and capitalist America would gang up on China, and present a common front against her, because she alone was genuinely revolutionary. The convergence theory seems to have little validity, and such evidence as exists, tends to point to a Russo-American military deadlock which has yet to lead to real political détente. Even if this did happen, détente does not signify a growing social and economic similarity between the two widely different social systems. It merely signifies a diminished sense of tension between them.

The convergence theory has implications far beyond the relations of the two superpowers for it is a potent cause of mischief within their respective alliance systems. The ever increasing possibility of an American-Soviet rapprochement must have the most profound impact upon America's allies and Britain in particular, consequently it is essential not to confuse the convergence theory with that of détente. But having said that, any marked degree of great power mutuality of interest, whether sociologically justified or not, must affect the respective positions of the member countries of the two alliance systems in a situation where the two superpowers have reached accommodation. That much is already clear. For example, despite Czechoslovakia, the East-West détente has, in part, reinforced the strategic dichotomy between those powers in Europe who believe western Europe must do without America by the mid-seventies and those who believe she is indispensable to the defence of Europe for, at least, the next twenty years.

Some American strategists perceived that the two superpowers, now possessed of such enormous might, had really created the conditions of *pax atomica,* which must result in a co-existence increasingly based upon the mutual interests of the two powers mostly concerned. This line of reasoning has undoubtedly much to commend it in terms of preserving international security, but is the cause of equally undoubted alarm to some of America's allies. The potency of the Gaullist theory that Europe can defend itself has increased in Europe in direct proportion to the spread of the notion that a bilateral deal was in the interest of Russia and America, for the sphere of Russo-American co-operation is seen by some commentators to be severely limited in the short term, but open ended in the long term (Ronald Steele: *The end of alliance.* New York, 1964).

International security and non-proliferation

The stability of the balance of power became the major factor in determining the whole character of the bipolar world. The beneficial aspects of that balance was the development of a common purpose which, though limited to the prevention of an untoward step towards nuclear holocaust, promised the spectre of a world in the image of the two giants but free of the dreaded fear of immediate vapourisation. In the end man would prefer the whips of tyranny to the scorpions of anarchy, and the tyranny of the two superpowers would be a mild dynasty of enlightened self interest. The overriding importance of the superpower relationship could be seen in the way in which it compelled "each giant to focus upon crises, while rendering most of them of relative inconsequence". The concept of crisis management was born (see Alastair Buchan: *Crisis management.* The Atlantic Institute, 1966).

The challenge implicit in the spread of nuclear weapons to new countries raised, according to US defence specialists, a profound threat to the stability of the bipolar world. As one writer put it, "the existence of a number of nuclear states would increase the temptation for the more virile of them to manoeuvre . . . one would be back in the 1930s with the addition of a new dimension of strength which would increase the pressure upon status quo powers to make piece-meal concessions" (Kenneth Waltz: *The stability of a bipolar world.* Daedalus, Summer 1964). Waltz advanced three basic assumptions, which were: "that the global balance is basically bipolar and stable"; that it rests on two "status quo powers", who behave more responsibly than would some of the nuclear newcomers; and that a multinuclear world is also "a multipolar one and, therefore, politically less manageable". These propositions must be examined.

stable global balance

Over the last 18 to 20 years the uncontrolled arms race has resulted in something like mutual stalemate, and this has effectively polarised the world into two huge military alliances in which the two superpowers have played a decisive and dominating role. Yet the distribution of military power was uneven, and the balance of power between these two superpowers always seemed to favour the USA.

The principal reasons for this were that the USA was essentially a maritime power with an enveloping commitment stretching half way round the globe and that the unfolding of nuclear technology favoured the USA. Being first into this field, and also possessing an experienced strategic air force, the advantage of building a diversified deterrent system in which, finally, the advent of the solid fuel rocket was to play a decisive role, meant that a strategy of "flexible response" (the deterrent theory of the stable balance of power) conferred on America a greater range of options than her major rival possessed. It could be claimed that the war in Vietnam has destroyed the validity of the flexible response because America was not prepared to escalate that conflict to the point of nuclear warfare. Yet this argument, though widely propogated, is mis-

taken, for the strategy of the flexible response is more appropriate to conflicts between powers of equal rank, and to areas such as western Europe, rather than other possible theatres of conflict. The absence from western Europe of purely conventional divisions available for "below the threshold" military operations, is perhaps a reason for doubting the validity of the flexible response strategy even in that theatre, although such a doctrine was formally introduced by NATO in 1963. The opposite of the "flexible response" strategy is massive retaliation. Because of its promise of dissuasion, this is more attractive to France, and especially to West Germany than to Britain, whose national interests dictate, should war come, a conventional/tactical nuclear conflict fought on the territory of others for as long as possible.

Though America possessed a preponderance of power it is clear that a bipolar relationship can be said to exist where two powers possess and exert enormous power in relation to other palpably lesser powers, even if the polar extremes are far from equal; and in relation to each other, the two superpowers are in fact far from equal.

However, though the balance of power cannot be said to rest on a mathematical equation, or even a rough approximation of real military strength, it can be thought of as basically stable. Again any such judgment must be qualified by the certainty that stability is indeed inherently subject to a volatile military technology. It is stable in the sense that neither side can win by simply striking first because both have the power, or capability, to retaliate. Of course it is the fear of retaliation in the face of the absence of a credible defence or interception system that constitutes deterrence.

The balance of power, though not a balance of arms, is relatively polarised and stable. Indeed, even in terms of a balance the estimate of comparative strategic strengths in early 1969 reveals that in land based intercontinental ballistic missiles (ICBMS) the USA will have 1,054 compared with between 900 and 1,000 such Soviet delivery systems. This represents a fairly dramatic change *in favour* of the Soviet Union, for the position in early 1968 was that the USA had 1,054 land based ICBMS, compared with the Soviet Union's 520. It must be remembered, however, that Polaris submarines, where the US advantage in numbers and performance is equally dramatic, probably more than compensate for the Soviet build up in land based delivery vehicles. (The USA has 656 submarine based missiles compared with 125 deployed by the Soviet Union.) But America still retains, in our view, overall superiority even if there is a growing approximation of military strength. This superiority does not consist merely in terms of gross megatonnage or indeed in the number of missile launchers available; the real test lies in the number "of separate warheads that are capable of being delivered with accuracy on individual high priority targets with sufficient power to destroy them" (see McNamara's statement to UPI editors in San Francisco on Monday 17 September 1967). In this respect there may be said to be a military balance between the superpowers, but America probably has much the most efficient delivery system, and it is this capability which matters rather than sheer weight of numbers. The superpower balance has been recently altered by the introduction of anti-ballistic missile defence systems, although the ways of overcoming the ABM, in fact, appear currently to be almost limitless for the attacker. As Robert McNamara observed in his San Francisco speech, which on the question of American defence was an exquisite exposition of deterrence theory, any ABM system "can be defeated by an enemy simply sending more offensive warheads, or dummy warheads, than there are defensive missiles capable of disposing of them". The issue of ballistic missile defence was for McNamara virtually a closed one in relation to a possible Soviet nuclear attack. This was made clear, repeatedly, in his testimony before the Senate Armed Services Committee and was maintained in the face of the views of the Chiefs of Staff and certain elements in Congress, and of the

atomic energy establishment and aerospace industry. The following dialogue makes this perfectly clear:

Senator: "You are saying that the Nike X system—even as envisaged in the 1970s—can be offset without too much trouble?"

McNamara: "In all probability, all we would accomplish would be to increase greatly both their defence expenditures and ours without any gain in real security to either side".

Wheeler: "We believe that we should go ahead now and start to deploy; one nation will probably survive best in a nuclear exchange, and the 30, 40 or 50 million American lives that could be saved are, therefore, meaningful in every sense". (Testimony before the Senate Armed Services Committee, March 1967). The latter's argument, incidentally, was echoed in *Tass* by Marshal Chuykov (Head of Soviet Civil Defence) on Moscow television in February 1967, when he said: "There exists every possibility to exclude completely or cut down considerably, losses in human life and material values in the event of nuclear attack" (quoted in *Survival*, August 1967).

Robert McNamara was clearly against trying to provide the US with an impenetrable shield against a possible Soviet nuclear attack since he was convinced on the basis of the best evidence available that such an enterprise is futile. The offence still remains supreme and for the US to spend vast sums on ABM procurement against a Soviet attack would represent a bad piece of investment which would leave America in her quest for security relatively no better off. But in McNamara's thinking there was a qualification about the uses to which ABMs might be put and he said, "We should seriously consider" in relation to the nuclear capability of China "greater protection of our strategic offensive forces" in a situation where "the Chinese are devoting very substantial resources to the development of both nuclear warheads and missile delivery systems".

The suspicion that the Chinese oriented ABM system was really the thin end of the wedge of a thick procurement *vis-a-vis* a Soviet nuclear attack became widespread. *The Times* on 18 September 1967 described the US decision as "a terrible bagatelle" and observed "there seems no readiness to accept, however, that as the Chinese missile programme expands and develops, so the American ABM defence will also have to expand and develop to the stage when it may be hard to distinguish between a system designed apparently to defend America against China and one which could perform that function very adequately against Russia as well". Indeed in McNamara's statement itself there was the suppressed promise that Russia was the real source of the ABM syndrome: "The Chinese oriented ABM deployment would enable us to add, as a concurrent benefit, a further defence of our Minuteman sites against Soviet attack, which means that at a modest cost we would in fact be adding even greater effectiveness to our offensive missile force and avoiding a much more costly expansion of that force". This interpretation must look awfully clear to Soviet military strategists who are ready enough to identify the American interest in ABM as an overt anti-Soviet move. The Russian procurement of ABM might after all be seen by them as a limited and measured response to US superiority, a posture made necessary by the need to retain a credible second strike capacity and thus ensure Soviet deterrent capability? However, the Nixon decision to deploy ballistic missile defences around Minuteman bases under the limited system called Safeguard is clearly consistent with a second strike doctrine as opposed to the Soviet objection that the McNamara deployment was consistent with a pre-emptive strike posture because American cities were to be protected against nuclear attack.

responsible status quo powers

The contention that the "two status quo powers" can be expected to behave more reasonably and responsibly than perhaps

any potential new nuclear powers, is a belief which it is difficult to sustain and which in any event rests heavily upon the supposition that the two superpowers do in fact behave responsibly. This may be difficult to prove because any judgment about the "responsible behaviour" of the superpowers can be disputed not merely by an examination of the historical record but according to whether one considers the word "responsible" a synonym for the word "cautious". It is true that by and large the superpowers have behaved cautiously towards each other, but that does not mean that they have always behaved responsibly either towards each other or towards other powers, especially those middle and small ranking powers whose interests have been in conflict with theirs.

It is the way of all great powers to consider smaller powers not merely deficient in power but deficient in political leadership as well. However, this widespread assumption is not supported by any considerable body of evidence. In fact, quite the reverse. The view that the status quo nuclear powers behave responsibly is a matter of judgment and the view that some potential nuclear powers might behave irresponsibly is a matter of speculation. Yet in a sense what is being asserted by those who believe the nuclear oligarchs to be responsible is that they have mastered or come to terms with the essentials of second strike nuclear deterrence. What, therefore, is the evidence that new or potential powers would behave more recklessly?

The supposition is, of course, that China is certainly in the category of an irresponsible nuclear power. But this may not be so, and certainly is a hypothesis of doubtful value. It is one thing to demonstrate that China has a reckless regard for the efficacy of wars of national liberation but quite another to demonstrate that she is actually willing to embark on a reckless or bellicose nuclear policy. In fact the major Chinese justification for her nuclear policy is the conventional one which applies both to British and French deterrent thinking. As one sinologist observes, "the high priority which China attaches to developing nuclear capability may be explained in terms of the Chinese desire both to deter an American nuclear attack and to wield increased influence within the communist world and within the third world of Afro-Asian-Latin American nations. The Chinese may also see their nuclear weapons as a means for establishing Chinese hegemony in Asia" (Morton H. Halperin: "China's nuclear strategy", *Diplomat*, September 1966). De Gaulle would not have dissented from the need of a similar justification for his nuclear weapons in which deterrence of Russia was to be secured by an independent French nuclear capability. China's acquisition of a credible deterrent will have a considerable impact on the present distribution of nuclear power. Its significance is comparable with that to be expected from a European deterrent system of the kind advocated by Edward Heath.

Some potential nuclear newcomers like Israel and Egypt are thought perhaps capable of reckless conduct. Recent events in the Middle East would seem to confirm the reality of this (or at least the fear of reckless nuclear sabre rattling). Yet the present Israeli-Arab tension and periodic violence can be indulged in because neither as yet fears that it will involve "unacceptable damage". Even the June war of 1967 was no real exception to this rule.

Without endorsing the facile view that the world would actually be safer if some nations now threatening the status quo became nuclear powers, it cannot be said that potential nuclear powers are inherently any more likely to behave recklessly than did America and Russia at the height of the cold war when both these powers were strongly motivated by a sense of ideological as well as great power chauvinism. At best the assumption that America and Russia conform to behavioural patterns different in kind from those expected of other potential great powers or middle powers, is a view firmly rooted in the belief that both these powers are now conservative and cautious in the light of the nuclear stalemate that exists between them.

It is certainly better not to have a vast number of small nuclear powers from an international security point of view, though it must be recognised that there is nothing in history or logic which has it that all nuclear powers must acquire second strike retaliatory systems. The fact must be faced that the Israeli situation (and perhaps that of Egypt too) is probably not amenable to second strike deterrence. Unfortunately, pre-emptive war makes perfectly good sense in this context—as long as the other side does not have nuclear weapons. Israel could build nuclear weapons; Egypt probably could not and is unlikely to get them from the Soviet Union if the nuclear Non-proliferation Treaty ever comes into operation. Israel will most probably be the next nation to explode a nuclear device. Amid the isolation of the Negev desert, on the road to the Dead Sea, a 24 megawatt reactor at Dimona symbolises the reality of Israeli nuclear potential. Once described as a "textile plant" this site received until recently French technical assistance which before June 1967 may have included separation services carried out at the plutonium plant at Marcoule, and certainly the reactor was supplied by France in the first instance. Egypt on the other hand claims to be a major producer of uranium, but she probably cannot produce enough plutonium at the "atomic city", just outside Cairo, where the two megamatt research reactor is located, to produce a nuclear device. This reactor was supplied by the Soviet Union under conditions not yet clearly established. Unless and until Egypt possesses a 20 megawatt reactor she will remain incapable of producing the necessary plutonium for nuclear status.

a multinuclear world less manageable

The third contention underpinning the notion of bipolarity is "that a multinuclear world is a multipolar one and therefore politically less manageable". This argument runs to the core of the present American dillemma. But in fact there are good grounds for doubting whether it is true. Firstly, such nuclear proliferation as has so far taken place has merely emphasised the basic bipolarity of world power. Secondly, the gap between a superpower and a second class nuclear power is still quite enormous and, if anything, the advent of the anti-ballistic missile (ABM) will further intensify this. The development of the multiple individually-targetted re-entry vehicle (MIRV) and the fractional orbital bombardment system (FOBS) will consolidate and even extend this technological gap. Thirdly, the slow spread of nuclear weapons, though posing a threat to the monopoly of the nuclear oligarchs, is unlikely to lead to a multilateral configuration in the foreseeable future. Even more arguable is the contention that a foreseeable multinuclear world which was also a multipolar one would be politically more diversified and hence more difficult to manage. But since the concept of management seems to presuppose superpower control if not close supervision of the course of international politics there may be some well merited opposition to the idea. Though in fact the long term threat to the basic bipolar world lies in the improbable development of an exclusively "European centre of deterrence". However, China represents a possible destabilising factor should she acquire a credible nuclear force. She lacks the capacity, however, to constitute in the short term a major nuclear threat to either superpower.

A great power constellation in western Europe based upon British, French, German and Italian science and technology could no doubt provide the technological basis for a sophisticated deterrent system, which, though possible and perhaps desirable, is still remote from reality.

In fact, two contradictory impulses have worked towards a veritable increase in bipolar alignments. The first impulse was the development of an independent deterrent system of the kind produced by first Britain and then France which, whatever the motivation behind this development, actually added to the bipolar nature of the world, by increasing the strategic nuclear means at the disposal of the western alliance. Even the French

deterrent has a catalytic function as ex-President de Gaulle once made clear to the Soviet Ambassador, Mr. Vinogradov, "Eh bien, Monsieur l'Ambassadeur, nous mourons ensemble". There are other arguments for the *force de frappe*. For it is seriously thought that France intends deterring America as well as the Soviet Union, but that hardly threatens to add much to Soviet retaliatory capacity *vis-a-vis* America! There is the possibility that Russia and China will mend their fences and agree on a mutual understanding. Should this happen Chinese nuclear capacity may be regarded as complementing Soviet nuclear power in the same way as the British deterrent gave added credibility to western deterrent forces, largely based upon American capability, in the period from 1957 to the Nassau Agreement of December, 1962.

The second impulse which was initially hostile to the bipolar alignment related to the corrosive influence that, in principle, nuclear proliferation was expected to have on the western alliance (that is, the belief that the independent deterrent would reduce the need for American nuclear protection) which in fact developed in such a way as actually to increase American readiness to meet her European obligations (the McNamara thesis) and to an increase in American power so as to fulfil her obligations. The result was a slight intensification of the arms race and a further bipolarisation of power. America became stronger and the necessary readjustments made by Russia, the nuclear tests of 1961 being a case in point, further increased the essential nature of bipolarity.

It can further be contended that if western Europe should become a nuclear power in its own right, or if the Anglo-French deterrent did become actual, this new accretion of power would merely complement, and perhaps reinforce, the American deterrent system and not supplant it or necessarily rival it. This can be reckoned to be so where a potential and actual Soviet threat to dominate Europe remains constant. A "great power" complex in western Europe may transform *politically* the present bipolar relationship into a multipolar relationship and we may see this before 1980, but the mere acquisition of nuclear weapons need not be seen as inevitably leading to this situation. A multinuclear world might lead to a multipolar one but there is nothing determinant about this and no inevitable trend towards such a development needs come from a wider distribution of nuclear power. The development of a western European deterrent seems likely to make East-West European co-operation more difficult.

Although such an event might actually lead to a panic Russo-American agreement to manage their relations at the expense of western Europe. It can be said that a European deterrent both weakens and strengthens the impulse towards superpower détente.

The paradox is, of course, that the more America and Russia emphasise the need for a manipulated bipolar world the more likely it is that they will release forces which will tend to undermine it. But the problem for America in particular under its new president is whether to give top priority to the development of the East-West détente or whether to promote cohesion within the western alliance. The nature of the dilemma, however is not what it is conventionally thought to be.

break up of NATO

The present incipient break up of NATO is attributable to the growing suspicion that member states have that their interests are about to be cynically sacrificed. The Soviet invasion of Czechoslovakia has in some curious way perhaps emphasised the danger since in some European eyes America reacted less to this violation of a country's independence than, say, Great Britain or West Germany, who were outraged by this example of treachery and ruthlessness. For the position of West Germany, in particular, is greatly affected by, and conditioned to, the East-West conflict which, if the nature of that conflict

should change, one way or the other, inevitably raises doubts about specific German interests and any American guarantee of those interests. West Germany is both exposed to the possible effects of an expanded Russo-American détente (which must by definition throw doubt on the priority that the US attaches to German reunification) and to any show of militancy by the Soviet Union along her Warsaw Pact frontiers, which threatens her tenuous security.

There can be perhaps no clear answer as to whether there can be any kind of German reunification without East-West détente. But it would be foolish to ignore the possibility that German reunification might in any event be, in principle as well as in practice, abandoned in some superpower deal which allows a modicum of liberalisation in eastern Europe in return for a permanently divided Germany within the framework of a European security pact. The conditions in which this might be achieved must, however, be such as to be generally acceptable to the German people, as a whole, and this is unlikely to be the case where the Germans feel themselves to have been betrayed to their enemies. If, therefore, Germany is to remain divided one way or the other, then America should be cautious about seeming to disregard the legitimate national interests of West Germany, which are likely to be sacrificed in a Russo-American accommodation. Moreover, Britain is now seeking to establish a new relationship with West Germany, involving, among other things, some understanding about the joint development of an advanced combat aircraft as well as the peaceful development of nuclear energy, and will increasingly line up with the Germans on diplomatic issues, unless a threatened collapse of the international monetary system forces an Anglo-French understanding, which most certainly will be at the expense of West Germany.

Therefore Britain is unlikely to abandon the idea of German reunification for the time being, but her long term commitment to it, like so much else, may change.

France has rejected the strategy of "the flexible response" which she has falsely equated with subservience to America within NATO: this with an insistence that her natural dominance of the European Economic Community remains unchallenged by British membership compounds the nature of the present crisis of confidence within the western alliance system as a whole. With both flanks in some disarray, and with the prospect in the mid-seventies of the northern Scandinavian members opting for neutrality, and the southern Mediterranean members falling out in violent disagreement, the scene can be said to be set for a period of acute crisis within the western alliance.

In fact with a diminution of the East-West conflict and the resultant feeling that the immediate military threat to western Europe has declined below a point where it is a credible threat, the old unity of the western alliance has evaporated. Even the presence of the Red Army in Czechoslovakia straddled along her Bavarian borders was hardly enough to compel prosperous West Germany to spend more than a modest extra fraction of its GNP on defence or to help finance on more generous terms BOAR's expensive stay in Rhine-Westphalia.

Clear thinking on the subject of NATO has always been obscured by the widespread acceptance of two powerful legends. These are the legend of alliance cohesion and the legend that all member states of NATO are equal and sovereign (Philip Windsor "Recent developments in NATO", *The World Today*, June 1966). Be that as it may, the contemporary difficulties within NATO, at any rate, stem in part from the diverging nature of the interests of its 15 member states. The differing interests can, however, be reconciled even if the notion that it is "in some manner illegitimate for countries, that belong to a common alliance but have different geographical positions and degrees of power, to have different interests" is an erroneous one (*ibid*). But the real question is whether the apparent dilemma in US policy between bilateralism and alliance cohesion is really the problem that it appears to

be. It rests perhaps on a double misconception: "the failure to distinguish between the effects of a mainly military Soviet-American bipolarity and a politically more differentiated international system" has been combined with "a wrong idea about where the actual causes of East-West détente lie" (Curt Gasteyger: *Adelphi Paper* no 24, ISS, London, 1966). Professor Kissinger, however, appears to appreciate this point and Nixon's foreign policy has already exhibited a greater perception of reality than that of his predecessor.

the present east-west détente

There seems little doubt that the present East-West détente is strictly limited in character and has come about because of the enormous military power both superpowers possess. The military deadlock at the strategic nuclear level has prevented what the political situation seemed likely to induce—a major war. The East-West détente was therefore severely circumscribed and does not involve more than "a vital aim of preventing war" (*ibid*). Now in the post-Czechoslovakian period, the question of how best to transform military deadlock into political agreement can be described as the critical one in Nixon's "era of negotiation".

Some American commentators saw in the horrific nature of nuclear war the emergence of an overwhelming conviction that we must start from the proposition that "war is no longer an inherent necessity of the social process, but rather an absurd monstrosity." A rather more modest interpretation of the impact of nuclear technology was advanced in which Soviet behaviour was seen as veering between policies under the pressure of extremist or moderate elements and that something similar was occurring in the US (Louis J. Halle: "War in Gestation", *New Republic*, November 1961).

It is clear that the current military détente between the United States and the Soviet Union must be seen as one development and the, as yet, unrealised political détente as another. The former has shallow foundations and is essentially negative. The US military together with their Soviet colleagues, according to Professor Seymour Melman in his memorandum to President Kennedy in December 1960, can "no longer advise their governments how to win a major war" and this fact explains the nature of the détente which slowly emerged as the balance of power became more and more stable. The military détente is a frank and realistic recognition of a position of total strategic nuclear stalemate. Within its perimeters both the Vietnam and the third Arab-Israeli wars have been fought and contained.

The present military détente has, therefore, made the world safe for limited conflicts between the major powers. Major war would devastate them beyond endurance. This fear sustains the necessity of détente. Russo-American understanding is sustained by conflict that cannot reach the stage of open war on a large scale without threatening their joint existence. They live in awe of each other in the posture of gladiators. Neither willingly able to fight the other. War, should it come between them, will spring from untoward design or plain folly. Neither prospect can be dismissed. Russia, however, has been much better led since the death of Stalin, despite Czechoslovakia. Likewise America, despite Vietnam, is more responsibly led in international politics than its colossal power might have otherwise led one to expect. That both powers abuse their power is hardly surprising, but that they abuse it so little is truly remarkable. Russian and American imperialism, insofar as it exists, though no more attractive than the British variety, is not entirely without reason or merit.

The strictly military character of the détente must be recognised and this carries the important corollary that we must, however, avoid the false conclusion that a ready sword is an adequate substitute for politics. And, of course, the military might of both superpowers insofar as it has induced détente might be regarded as an end in itself, were it not for the fact that the omnipresent bipolar con-

frontation provides neither power with the means to assure peace and order throughout the globe, as successive Middle East crises clearly indicate. Conflicts in the third world, or outside the areas of overt Soviet-American confrontation, still remain impervious to great power diplomacy. The great power formula for a Middle East settlement, guaranteed by "the four big powers", is a diplomatic gambit of an earlier age which is now totally irrelevant. Israel cannot be coerced into accepting the November 1967 resolution of the UN security council by its permanent members.

The impression both America and Russia often convey is that when it comes to alliance diplomacy within their respective spheres of interest no change must be allowed to occur which weakens the bipolar relationship in any significant way. However, there is no absolute conflict between inevitable and desirable changes within the alliance systems, and an East-West détente essentially based on a tacit Russo-American understanding. The salvation of the world does not lie in a consciously manipulated condominium of the superpowers with sham military alliances frozen into the posture of ageing cold war warriors. And obviously the present military détente will in time become an entente when all the European powers both East and West acquire a vested interest in it.

the way ahead

Either détente or alliance cohesion has definite limitation (Curt Gasteyger: *Adelphi Paper* no 24, ISS, 1966). Détente has resulted in the Partial Nuclear Test Ban Treaty, the hot line, and the more recent Non-proliferation Treaty. The bilateral relationship upon which the above agreements were erected was gravely shattered by the Soviet invasion of Czechoslovakia. The failure so far to agree on a ballistic missile defence moratorium, with President Johnson's decision in the autumn of 1967 to go ahead with anti-ballistic missile defence and President Nixon's adaptation of the Sentinel system, indicates its essentially modest nature. But even the modest achievement of the Non-Proliferation Treaty has seriously shaken the confidence of the West German government in US intentions. And it would therefore be imprudent for President Nixon to give undue emphasis in declaratory policy to the need to mend his fences with Moscow at the expense of West Germany, or for that matter, of the western alliance as a whole. For one thing the options that President Nixon has to choose from should not be based on the erroneous assumption that détente or alliance cohesion are self contained alternatives. They are not. To assume, as do many American senators, including Fullbright, that such clear cut alternatives exist, is to disregard completely the complexity of international politics.

Détente and perhaps, in time, entente, will be soundly based if America has ensured to the greatest degree possible the preservation of the national interests of those powers most affected. Those powers are easily identified: West Germany particularly, but also Japan, Taiwan and Korea, as far as America is concerned; Poland, Czechoslovakia and East Germany as far as the Soviet Union is concerned. Within western Europe a greatly extended Russo-American understanding will have enormous implications.

The existing impulse towards the construction of a European deterrent would be greatly strengthened by a clumsy American diplomatic manoeuvre to get agreement with the Soviet Union in order to avoid the complexities of alliance diplomacy and to preserve the essentials of a bipolar world. Perhaps the European deterrent will inevitably emerge anyway as a concomitant of the growth of the European economic institutions, but its appearance and, in particular, the reason for its appearance, will depend upon what kind of agreement is reached by the two superpowers. After all America must know that even the appearance of a European deterrent, which the strategic situation might make necessary, need not be a menace to peace or against specific American or Soviet interests. Indeed a European nuclear deterrent could

prove to be a great cohesive factor within the western alliance and could remove anxieties about the security of those states whose present opposition to an extension of the détente is currently so crucial and embarrassing to the United States.

Of course a European deterrent would initially depend upon British warhead and guidance experience and growing French experience in the field of solid fuel rocketry. By the early 1970s Britain and France will have a total of nine ballistic submarines in service and they would be capable of delivering about 150 megaton warheads (in the order of about 100 million tons of TNT or its equivalent) on Soviet cities. But for it to become a truly European deterrent, or second centre of deterrence, a land based mobile strategic rocket echelon would be mandatory (see Neville Brown *"Arms without empire"*, Penguin Special, 1968). The military rationale of such a force would probably need to be one of maximising destruction in a manner strikingly similar to the more absolutist notions of deterrence current in the fifties. Such a doctrine may, however, appear unattractive and dangerous as well as unacceptable to the Americans but, again, as Professor Kissinger has repeatedly asserted in the past, the case for European deterrents, or indeed a European deterrent, rests on the consideration that the deterrence of the Soviet Union, whose strategic doctrine includes the belief that European cities must be obliterated early on in a nuclear exchange, is best accomplished by those West European powers whose national interests are directly at stake.

The central power balance lies in Europe and is the product of the tensions that divide this area. It cannot be altered or weakened without inevitably involving the countries of both East and West Europe whose lands are directly menaced by either military bloc. The détente between East and West was the direct result of a recognition by both sides that the line dividing Europe was likely to be permanent or likely to remain unchanged for a long time to come. War was recognised to be the only way of changing this fact and this policy was rejected by the two superpowers as unrealistic.

In 1948 Stalin may have contemplated the use of force to change the status quo just as the Soviet Union actually used force in 1956 in Hungary and Czechoslovakia in 1968 in order to preserve it. The West was reluctant to use force in 1948 over the Berlin airlift but was prepared to fight in 1961 if Khrushchev annexed West Berlin. However, in 1956 and in the 1968 the West, though in principle in favour of a change in the status quo in eastern Europe, was not willing to intervene to assist Hungary or Czechoslovakia gain her independence under a social democracy. This much we know. But the question yet to be answered is whether the growing détente between the two superpowers—if carried considerably further—will allow both halves of Europe to develop in a way of their own choosing and whether a greater measure of independence of the two superpowers can be achieved which will enable Europe to develop in peace and prosperity. And whether the relationship of both superpowers to a "European security system" that will become feasible in the 'seventies and 'eighties can be clearly defined and widely accepted as a necessary and desirable feature of Europe's long term security. This question of a European security system is a vexed one and has in the past been plagued by propagandist attempts, particularly by the Soviet Union, to suggest that such a system must be anti-German oriented. However, its real purpose must be to avoid a great power collision in Europe between two heavily armed military alliances whose mutual antagonism has but slowly diminished.

Some day a security system in Europe will emerge and nobody today can foresee its actual shape and character, but its essential features can be generally stated. Both NATO, or its successor, and the Warsaw Pact powers, will probably elect to maintain much the same kind of military structure, but military effort will need to be geared to joint requirements: surveillance, inspection of zones where phased withdrawal or "disengagement"

of forces has been agreed to, radar cover against rapid troop movements, and where appropriate, mixed teams of observers engaged in supervising the operation of the security system insofar as its implementation depends upon inspection and control. Obviously, such a system cannot give absolute security, only relative security, yet given a permanent East-West détente it might enable both the US army and Red Army to withdraw from their present positions. Provided this system is underpinned by the superpowers and freely negotiated with the full support of their respective allies, the thing will work. Yet it will depend upon a continued American participation in the defence of Europe as well as genuine confidence amongst the western powers; the Soviet government must also have guaranteed legitimate security interests in eastern Europe as well as a more stable internal relationship with small communist powers whose regimes will inevitably be distinctly liberal and western oriented without being pro-capitalist or hostile to the Soviet Union. However, the time for a general European security system is not yet and it has, of course, been retarded by the violent Soviet reaction to the Czech bid for a more civilised and democratic regime.

conclusion

Some would assert that the balance of power at the present time is inherently unstable, with the built in instability provided by the ballistic missile preventing a stable military balance arising. In fact the present Soviet-American military balance at the strategic level is relatively stable and relatively free from quick changes of fortune. However, it is worth noting that since the Soviet invasion of Czechoslovakia, the local military balance at the conventional level has moved against the West. In a period of 13 hours more than 20 Warsaw Pact divisions with about 250,000 men, weapons and supplies invaded Czechoslovakia from three exposed flanks and advanced as far as the border with West Germany, which hitherto had been occupied solely by Czechoslovakian troops. Thus last year, as Summer passed into Autumn, a significantly larger number of Soviet troops were in a state of readiness and tactically deployed for action in the Soviet Imperium than at any time since the formation of NATO.

Western Europe felt exposed, so the slight but definite recredescence of the cold war was inevitable. But in the years ahead the local balance in Europe will be less susceptible to the vagaries of Russo-American politics, especially since neither superpower need feel quite so strategically dependent upon Europe in an age of global defensive/offensive missilery. So the chance of genuine détente must be reckoned to be good.

A wise and forward looking policy must make allowances for the yearnings for freedom now evident in eastern Europe without alarming the Soviet Union; arrangements also in relation to western Europe should allow for orderly and progressive change without causing America to feel that she must break with her allies out of fear that her liabilities are open ended.

A superpower Europe, or a United States of Europe, can have no place in the type of security arrangements we envisage as practicable and desirable over the next two decades. However, the best policy for the West in the meantime is that of patient negotiation with the Soviet Union in the search for genuine détente as well as a determination to maintain a credible defence structure based upon existing arrangements. Détente and alliance fidelity are the twins of good fortune.

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