UNITED NATIONS
GENERAL ASSEMBLY

PREPARATORY COMMITTEE FOR THE SPECIAL SESSION OF THE GENERAL ASSEMBLY DEVOTED TO DISARMAMENT


Working paper prepared by the Secretariat

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INTRODUCTION

1. By resolution 31/189 B of 21 December 1976, the General Assembly decided to convene a special session devoted to disarmament, to be held in New York in May/June 1978. It further decided to establish a Preparatory Committee for the Special Session of the General Assembly devoted to Disarmament, composed of 54 Member States appointed by the President of the Assembly on the basis of equitable geographical distribution, with the mandate of examining all relevant questions relating to the special session, including its agenda, and to submit to the Assembly at its thirty-second session appropriate recommendations thereon.

2. The General Assembly also requested the Secretary-General, inter alia, to render the Preparatory Committee all necessary assistance, including the provision of essential background information, relevant documents and summary records.

3. At its fourteenth meeting on 20 May 1977, the Preparatory Committee requested the Secretariat to prepare certain working papers. Included among them was "An analytical summary of the United Nations studies describing the effects of the possible use of nuclear weapons, chemical weapons, bacteriological (biological) weapons and napalm and other incendiary weapons, as well as those dealing with the reduction of military budgets, with the economic and social consequences of the arms race and disarmament and with the relationship between development and disarmament".

4. In response to the request of the Preparatory Committee, the Secretariat has prepared this working paper, in which summaries of the following studies have been included:

(a) Effects of the Possible Use of Nuclear Weapons and the Security and Economic Implications for States of the Acquisition and Further Development of These Weapons A/6858.

(b) Chemical and Bacteriological (Biological) Weapons and the Effects of Their Possible Use A/7575/Rev.1, S/9292/Rev.1.

(c) Napalm and Other Incendiary Weapons and All Aspects of Their Possible Use A/8803/Rev.1.

(d) Reduction of the Military Budgets of States Permanent Members of the Security Council by 10 per cent and Utilization of Part of the Funds Thus Saved to Provide Assistance to Developing Countries A/9770/Rev.1.
2.

(e) Reduction of Military Budgets, Measurement and International Reporting of Military Expenditures
A/31/222/Rev.1

(f) Economic and Social Consequences of the Arms Race and of Military Expenditures
A/8469/Rev.1.

(g) Economic and Social Consequences of Disarmament
E/3593/Rev.1

(h) Disarmament and Development
ST/UNA/174

5. Some comments are necessary in order to assess the scope of the working paper. In fulfilling the mandate given by the Preparatory Committee, the Secretariat has included all studies prepared by expert groups appointed by the Secretary-General, in pursuance of various resolutions of the General Assembly. While the working paper presents summaries of each of the studies, the original wording has been maintained for most of the texts, with a view to reflect properly the findings and opinions of the experts.

6. The abovementioned studies cover various aspects relating to arms and disarmament questions. It should be noted, however, that they were requested by the General Assembly in each particular case, in accordance with its assessment of the specific problem brought to its attention, rather than as elements of a comprehensive approach for the consideration of all relevant aspects pertaining to arms and disarmament questions. Only recently the updating of some of these studies, such as those dealing with the reduction of military budgets and the economic and social consequences of the arms race and of military expenditures, has become a matter of continuous concern for the General Assembly.

7. Some of the studies refer to military technology and weapons effects, but mainly with respect to weapons of mass destruction: nuclear, chemical and bacteriological (biological) weapons. One of them is concerned with napalm and other incendiary weapons, which have been a matter of special attention by the General Assembly. However, there have been no studies prepared regarding other conventional weapons or new weapon-systems, either of mass destruction or conventional.

8. In any evaluation of these summaries, it should be borne in mind that time elapsed since the original reports were prepared. The study on nuclear weapons was submitted to the Secretary-General on 6 October 1967, while the one dealing with chemical and bacteriological (biological) weapons was completed on 30 June 1969. The most recent study, dealing with napalm and other incendiary weapons, dates from 22 September 1972. Therefore, subsequent technological advances as a result of research and development efforts devoted to these weapon-systems are not considered. A similar problem arises in connexion with the data given in the studies concerning costs for development, production and stockpiling of such weapons. These figures might require substantial revision and updating if precise information on present costs were needed. As regards the study on nuclear weapons, it should be noted that a new and significant development took place with the
3.

conclusion of the Treaty on the Non-Proliferation of Nuclear Weapons,\(^1\) which entered into force on 5 March 1970. After the submission of the report on chemical and bacteriological (biological) weapons, the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction,\(^2\) the first multilateral agreement of actual disarmament, entered into force on 26 March 1975.

9. As stated previously, the studies on nuclear, chemical, bacteriological (biological), napalm and other incendiary weapons are concerned with their technology and effects. They provide background information for a better understanding of such weapons and the consequences of their use, but they are not intended to tackle specific problems that may arise in disarmament negotiations.

10. As indicated in paragraph 6 above, the studies on the reduction of military budgets reflect a recent interest of the General Assembly in this question following the adoption of resolutions 3093 A and B (XXVIII). The second of the two reports on the subject, concluded in 1976, is being followed up in 1977 by the same group of experts. The question of the reduction of military budgets is closely related to the level of world military expenditures. This matter is touched upon in some of the other studies, such as those on the economic and social consequences of the arms race and of military expenditures and on disarmament and development. The Secretariat is also preparing a working paper for the Preparatory Committee on a comparative study of global military expenditures and development assistance since 1945, as stated in available official and unofficial documents. But there is no in-depth study prepared by the United Nations on the level of such expenditures.

11. With respect to the study on the economic and social consequences of the arms race and of military expenditures, it is being updated by a group of experts appointed by the Secretary-General and will be considered by the General Assembly at its thirty-second session. References are made in the first report to the characteristics and other consequences of the arms race.

12. The study on the economic and social consequences of disarmament was concluded approximately fifteen years ago. It was followed by the report on disarmament and development in 1972. Since the 1972 report is also related to the study on the economic and social consequences of the arms race and of military expenditures submitted in 1971, it cannot be strictly considered as updating the 1962 report. Differences in approach are also evident in both studies.

13. The question of international peace and security and its relationship with disarmament is discussed in the studies summarized in this working paper, in some cases with more detail than in others depending on their scope and purposes.


EFFECTS OF THE POSSIBLE USE OF NUCLEAR WEAPONS
AND THE SECURITY AND ECONOMIC IMPLICATIONS FOR STATES
OF THE ACQUISITION AND FURTHER DEVELOPMENT OF THESE WEAPONS

(A/6858)

I. EFFECTS OF THE POSSIBLE USE
OF NUCLEAR WEAPONS

INTRODUCTION

1. The enormity of the shadow which is cast over mankind by the possibility of nuclear war makes it essential that its effects be clearly and widely understood. Nuclear armouries which are in being already contain large megaton weapons every one of which has a destructive power greater than that of all the conventional explosive that has ever been used in warfare since the day gunpowder was discovered. Were such weapons ever to be used in numbers, hundreds of millions of people might be killed, and civilization as we know it, as well as organized community life, would inevitably come to an end in the countries involved in the conflict. Many of those who survived the immediate destruction, as well as others in countries outside the area of conflict, would be exposed to widely-spreading radio-active contamination, and would suffer from long-term effects of irradiation and transmit, to their offspring, a genetic burden which would become manifest in the Disabilities of later generations.

HIROSHIMA AND NAGASAKI

Physical effects

2. The first atomic bomb to be used in warfare had a yield of nearly twenty kilotons, that is to say it had an explosive force equivalent to nearly 20,000 tons of conventional chemical explosive (e.g. TNT). It was detonated at approximately 550 metres above Hiroshima on 6 August 1945. On 9 August a second atomic device, with a similar yield, was detonated at about the same height over Nagasaki. In Hiroshima, destruction was concentric around the centre of a spreading city whose population was about 300,000. Within seconds, a rapidly growing fire-ball developed into a mushroom-like cloud, supported, as it were, on a column of black smoke, and the heat radiating from the fire-ball caused thousands of fires.

3. By comparison with Hiroshima, Nagasaki was a narrow city surrounded by hills and open to the sea in only one direction, with a population of about 87,000 people living within three kilometres from the centre. The immediate effects of the explosion were the same, but the area of destruction and fire differed in accordance with the different layout of the cities. In both cases the heat of the explosion was so intense that, up to a distance of about a half kilometre from the centre of the disaster, the surface of domestic ceramic roof tiles melted and firing of domestic wooden houses, by direct radiation, was observed up to one and a half kilometres.
4. There are varying estimates of the casualties in Hiroshima and Nagasaki and it has proved difficult to estimate the exact numbers of exposed people who may have died after escaping from the city. Available estimates are that 78,000 were killed and 84,000 injured in Hiroshima, and that 27,000 were killed and 41,000 injured in Nagasaki. In addition, there were thousands missing in both towns. In Hiroshima 60,000 houses were completely or partially destroyed. Wooden houses within two and a half kilometres radius were carried away, while brick buildings were turned into heaps of rubble. Severe damage to houses occurred as far out as eight kilometres.

5. No exact information is available concerning the relative importance of blast, burns and nuclear radiation as the causes of fatalities in these bombings. Burn injuries constituted the major problem in medical care. People exposed in the open had been severely burned, injuries from direct radiation being incurred as far out as about two kilometres from the centre of the zone of destruction. From the day after the bombing, burns accounted for about one half of all the deaths.

6. The explosion over Hiroshima rapidly led to a firestorm which lasted for about six hours and which burned out an area of twelve square kilometres of the town. Seventy per cent of the fire-fighting machines in Fire Brigade stations were rendered unusable, and 80 per cent of the fire-fighting personnel were unable to respond to the emergency. The loss of water pressure through the breaking of pipes contributed greatly to the additional destruction by fire. But even if men and machines had survived the blast, many fires would have been inaccessible within one and a half kilometres from ground-zero.

7. About 45,000 of the fatal casualties in Hiroshima died on the day of the explosion, and some 20,000 during the following four months, as a result of traumatic wounds, burns and radiation effects. Difficulties were aggravated by shortage of supplies and equipment, and by the extraordinary demands made on crippled medical staffs. Next to immediate medical problems, the most serious challenge to those who had survived the direct effects of the explosion, were problems of water supply, housing and food. Electrical distribution systems suffered severely. To people who were not immediate casualties these difficulties compounded the profound psychological effects of the disaster of which they were part.

Long-term radiation effects

8. Apart from the effects which ionizing radiation had on the immediate victims of the explosions, the survivors were also exposed to the hazards of the radiation both in terms of latent disease occurring in the individual (somatic effects) and of changes in hereditary material (genetic effects). It had been suspected for some time that exposure to repeated moderate doses of nuclear radiation is conducive to leukaemia. A study of the survivors of the two nuclear explosions, over Hiroshima and Nagasaki, shows that the disease can undoubtedly result from a large single (acute) dose of radiation. The incidence of leukaemia in the survivors of Hiroshima and Nagasaki was observed to be increasing in 1948. It reached a peak in 1950-1952.
9. A continuing study of the survivors of the two Japanese disasters has also suggested an increased incidence for other kinds of malignant cancer, particularly cancer of the thyroid, and not just leukaemia, which has a much shorter latent interval. The indications are stronger that a significantly high proportion of the babies born to women who were pregnant when exposed to the explosion, and who survived, had heads smaller than average size, and that some of these suffered severe mental retardation.

10. Insufficient time has passed since these two nuclear disasters to determine what genetic changes, if any, were induced in the survivors.

THE SIGNIFICANCE OF THE POSSIBLE USE OF NUCLEAR WEAPONS IN FUTURE WARS

11. The obliteration of the distinction between the "front" or the "rear" of a war zone, which came about as a result of the air offensives of the Second World War, has now been compounded by the advent of nuclear weapons. Some present-day military theorists who write about nuclear war speak of attacks on cities taking place simultaneously with, or even before, attacks on armed forces and specific military targets.

12. It is therefore necessary to build up a picture of what would happen if a large city were attacked not with kiloton weapons of the kind used on the two Japanese cities but with the much more powerful hydrogen bombs or fusion bombs which are available now and whose yield is usually expressed in megatons, i.e., unit yields equivalent to one million tons of chemical explosive.

13. Since every city has its own individuality, its own pattern of services, communications and food supplies, a realistic picture of what would happen cannot be derived unless one considers a real city. One such study was made of a city, with a population of just over one million people, which extended in all directions for about eight to ten kilometres (i.e., with a surface area of some 250 sq. km.) and attacked, it was assumed, with a single one-megaton nuclear weapon, burst at ground level. Using the experience of Hiroshima and Nagasaki, and estimating also on the basis of the results of carefully designed weapons effects experiments, the following figures of casualties emerged:

- Killed by blast and fire: 270,000
- Killed by radio-active fall-out: 90,000
- Injured (of whom 15,000 were in the area of fall-out and thus exposed to the effects of radiation): 90,000
- Uninjured (of whom 715,000 were in the area of fall-out): 710,000
14. One third of a million dead is approximately the same number of civilians who were killed by air raids both in Germany and in Japan during the whole of the Second World War. Practically all the inhabitants of the central area of the city, an area of about six by five kilometres, would have been killed, mainly as a result of the destruction caused by blast and fire. Any who were not immediately killed in the central area would have died from nuclear radiation. Most of the 90,000 of the city's population who would have suffered non-lethal injuries would have been serious casualties, and, for 15 to 20 per cent of these, rescue operations would have been greatly impeded by radio-active fall-out.

15. The scale of the physical destruction which would be associated with casualties of this order of magnitude is so great that there is no basis of experience which could serve to help describe the instantaneous transformation of a vast living city into a sea of blazing rubble. Every house or building would be damaged; about one third would be completely wrecked, i.e., with damage ranging from utter and complete obliteration, to buildings with more than half their walls down; another one third would be severely damaged, i.e., wrecked for all practical purposes, but perhaps providing some temporary shelter if nothing else were available. Only about one third of the original houses would be in any way serviceable, although they would have lost a great part of their roofs, doors and windows. In many areas, water and gas mains, sewers, and power supplies would have been destroyed. Not a single area would have retained all its essential services. Roads would have been erased and even the lightly damaged peripheral areas would very likely be deprived of their water supplies and sources of food supply.

16. In hostile circumstances of the kind we are assuming, it would be unrealistic to suppose that only one city would be struck. With many in the same desperate plight, there could be no question of any substantial help being brought to the survivors from outside. In brief, a big city of the size that has been described would for all practical purposes be eliminated by a single one-megaton weapon ground-burst near its centre. One-megaton bombs are small units in the megaton spectrum; larger weapons, much larger ones, are now stockpiled.

Radio-active contamination

17. Close to the explosion the lethal effects of radiation would be instantaneous. But nuclear weapon explosions also give rise to radio-active fission products and, in the case of a ground-burst, these become mixed with earth particles sucked into the atmosphere. The heavier particles of soil and weapon debris fall back to the ground and settle in the vicinity of the explosion, giving rise to delayed radiation hazards. These particles constitute local radio-active fall-out. For a ground-burst of the type assumed in the foregoing paragraphs, the area of intense fall-out could cover hundreds of square kilometres. Within such an area, people
who were not adequately sheltered and who did not remain under cover until the radio-activity of the fall-out had decayed substantially would be exposed to intensities of radiation sufficient to produce very serious hazards to health.

18. For a ten-megaton explosion over a hypothetical city with a population of one million people, the area of complete or serious destruction would cover between 300 and 500 sq. km., that is to say the area of the entire city. Moreover, the effects of blast and direct radiation would extend well beyond its boundaries, with heat and forest fires raging up to twenty kilometres from the ground-zero of the explosion. Half of the entire population over an area of radius of some twenty-five kilometres could be expected to die within the first few days as a result of radio-active contamination, even after allowing for some shelter provision.

19. In the case of an air-burst of a twenty-megaton bomb the heat which would result would be intense enough to start fires as far as thirty kilometres from a point of detonation, depending on how clear the atmosphere was at the time, and could endanger the lives of people in an area with a radius of nearly 60 kilometres. It has been estimated that such a device, if exploded over Manhattan, would, in the absence of shelter or evacuation programmes, probably kill 6 million out of New York City's 8 million inhabitants, and lead to an additional one million deaths beyond the city limits. The surface explosion of a twenty-megaton bomb would result in the formation of a crater 75-90 metres deep and 800 metres in diameter.

**ESTIMATE OF EFFECTS OF A NUCLEAR ATTACK ON A REGION OF A COUNTRY**

20. A study was made of the likely results of a nuclear attack on a hypothetical industrial region, consisting of nine cities each with populations of over 50,000 inhabitants (some well over), and also containing 140 smaller towns of fewer than 50,000 inhabitants (about sixty of which contained elements of key industry). Assuming that a one-megaton bomb burst at ground level in each of the nine cities, the study showed that cumulative estimates of casualties provided a very inadequate measure of the over-all effects of the attack. The estimates showed that 20 per cent of the total population, or 30 per cent of the urban population, or 35 per cent of the key-industrial population would be killed. The houses destroyed would be 30 per cent of total, or 40 per cent of urban, or 50 per cent of those occupied by key-industrial population. But cities are not isolated entities; they are linked in a variety of functional ways. Taking the interaction of effects into account, the study showed that the percentage of key industry in the whole region (i.e., industry with more than local significance) which would be brought to a stop would be between 70 per cent and 90 per cent of the whole.
21. A Swedish study of the consequences of nuclear attacks against Swedish cities showed that an attack carried out with about 200 weapons, ranging from 20 kilotons to 200 kilotons in yield, would result in 2 to 3 million casualties, i.e., 30 to 40 per cent of the total population of about 7 million people. It also showed that between 30 to 70 per cent of Swedish industry would be destroyed, and that about two thirds of the industrial workers would receive fatal or severe injuries.

**EFFECTS ARISING FROM THE USE OF NUCLEAR WEAPONS IN FIELD WARFARE**

22. Carefully conducted and dispassionate theoretical studies of the use of nuclear weapons in field warfare, including analyses of an extensive series of "war games" relating to the European theatre, have lead to the clear conclusion that this doctrine could lead to the use of hundreds, and not of tens, of so-called tactical nuclear weapons in the battlefield area, given that both sides resort to their use. Were nuclear weapons to be used in this way, they could lead to the devastation of the whole battle zone. Almost everything would be destroyed; forests would be razed to the ground and only the strongest buildings would escape total destruction. Fires would be raging everywhere. Circumstances such as these would be incompatible with the continued conduct of military operations within the zones of devastation.

23. An offensive on the scale to which all these studies point, over a land battle area with a front of, say, 250 km. and 50 km. deep, would render hundreds of thousands, even millions, homeless. Such a level of destruction could be achieved with only 100 small nuclear weapons in a European battle area chosen because it did not contain any large towns. With 400 weapons, which is not an unreasonably large number if both sides used nuclear weapons in a battle zone, the physical damage caused would correspond to something like six times that caused by all the bombing of the Second World War.

24. The destruction and disruption which would result from so-called tactical nuclear war would hardly differ from the effects of strategic war in the area concerned. The concept of escalation from tactical to strategic nuclear war could have no possible meaning in an area within which field warfare was being waged with nuclear weapons. This picture is not altered if one postulates so-called "clean" nuclear weapons, in place of those which formed the basis of the foregoing studies. Claims have been made about the possibilities of providing, for battlefield use, low yield weapons (say 1 to 10 kilotons) which would release an abnormally high proportion of their energy in blast and nuclear radiation, while producing virtually no radio-active fall-out. "Clean", in this context, is a matter of degree. These suggested weapons would basically rely on a fission reaction so that radio-active fall-out could never be completely avoided. In any case, the resulting chaos in the battlefield area referred to above was brought about, not by fall-out, but primarily through blast effects.
Interdiction targets

25. Were such weapons ever to be used in a war, it is also quite certain that they would not be restricted to the battle zone itself. It is part of the concept of tactical nuclear warfare that in a purely military campaign they would also be used outside the area of contact in order to impede the movement of enemy forces, the operation of air forces and so on. The objectives which would be attacked in order to achieve these effects are generally called interdiction targets. Theoretical studies of operations of this kind provide a picture of "deep" nuclear strikes whose effects would be hardly distinguishable from a strategic nuclear exchange in which both sides set out from the start to destroy each other's major centres of population.

DETERRENCE OF WAR

26. Nuclear weapons constitute one of the dominant facts of modern world politics. They are at present deployed in thousands by the nuclear weapon Powers, with warheads ranging from kilotons to megatons. We have already witnessed the experimental explosion of a fifty to sixty-megaton bomb, i.e., of a weapon with about 3,000 times the power of the bomb used in 1945 against Japan. Hundred-megaton devices, weapons about 5,000 times the size of those used in 1945, are no more difficult to devise. They could be exploded just outside the atmosphere of any country, in order utterly to destroy hundreds, even thousands, of square kilometres by means of blast and spreading fire.

27. The effects of all-out nuclear war, regardless of where it started, could not be confined to the Powers engaged in that war. They themselves would have to suffer the immediate kind of destruction and the immediate and more enduring lethal fall-out whose effects have already been described. But neighbouring countries, and even countries in parts of the world remote from the actual conflict, could soon become exposed to the hazards of radioactive fall-out precipitated at great distances from the explosion, after moving through the atmosphere as a vast cloud. The extent and nature of the hazard would depend upon the numbers and type of bombs exploded. Given a sufficient number, no part of the world would escape exposure to biologically significant levels of radiation. To a greater or lesser degree, a legacy of genetic damage could be incurred by the world's population.

28. It is to be expected that no major nuclear Power could attack another without provoking a nuclear counter-attack. It is even possible that an aggressor could suffer more in retaliation than the nuclear Power it first attacked. In this lies the concept of deterrence by the threat of nuclear destruction. Far from an all-out nuclear exchange being a rational action which could ever be justified by any set of conceivable political gains, it may be that no country would risk the resultant chaos which would leave in doubt a government's ability to remain in control of its people. But the fact that a state of mutual nuclear deterrence prevails between the Super Powers does not, as we know all too well, prevent
the outbreak of wars with conventional weapons involving both nuclear and non-nuclear weapon nations; the risk of nuclear war remains as long as there are nuclear weapons.

II. ECONOMIC IMPLICATIONS OF THE ACQUISITION AND FURTHER DEVELOPMENT OF NUCLEAR WEAPONS

GENERAL CONSIDERATIONS

29. Any given size of effort to develop nuclear weapons will have economic implications which differ according to the nuclear and industrial base from which the programme starts. Moreover, a penalty of the arms race is that no size of programme ever satisfies. Even if it became possible to set a limit to an arsenal of nuclear warheads, their delivery systems and the defence of their bases can absorb effort indefinitely.

30. The magnitude and timing of any programme depends on the base of the country's scientific, technical and industrial capability. Scientific and technical capability determines the country's ability to undertake the problems of:

   a) Production of fissile and other material to meet the necessary strict specifications;

   b) Warhead assembly and testing;

   c) Development and control of the delivery vehicles, whether missile or aircraft units in an effective operating system.

It involves personnel represented by physicists, chemists, metallurgists, mathematicians, engineers, skilled machine tool operators, electricians, pipefitters, welders, sheet-metal workers, furnace and chemical plant operators, instrument makers and fabricators.

31. Industrial capability is measured by the country's established experience in fields of advanced technology, such as nuclear energy, aviation, electronics and space technology.

32. In arriving at the cost figures presented below, countries possessing the above capabilities have been used as a basis, and it is therefore to be expected that costs would be considerably higher for countries which are less developed and have to devote major efforts to establishing these basic prerequisites.
33. The estimated costs, supported by some actual figures, for a first generation of simple nuclear warheads together with an unsophisticated delivery-vehicle system indicate that the acquisition of such a system may be within the reach of a number of nations. These cost figures, however, bear hardly any credibility as representing a limit lasting for any significant time, even for an industrialized country. The reasoning is that the need to develop less vulnerable and more sophisticated delivery systems seems certain to be felt in order to secure the military and political objectives of the force. It thus seems that the total costs of acquiring a nuclear weapons system over, say, ten years are liable under certain circumstances to be closer to the costs given for the French and United Kingdom systems up to 1969, namely, $8,000 million to $9,000 million than to the $1,700 million to $2,000 million derived below for an unsophisticated system. The cost of producing the weapons can probably be estimated with fair accuracy, at least in countries with developed peaceful nuclear activities. However, experience has shown that the major part of the cost of a nuclear force is that of the delivery systems and, in particular, of the missiles, and these are liable to very large overruns and continuing costly development.

**BASIC COSTS OF NUCLEAR WARHEADS**

34. The three fissile materials suitable for use as nuclear explosives are uranium-235, plutonium-239 and uranium-233. Uranium-233 is still rare, so its cost has not been considered here. A kilogramme of natural uranium contains seven grammes of uranium-235, while the main component is uranium-238. For use as a nuclear explosive the uranium-235 has to be separated and concentrated or "enriched" to 90-95 per cent of total uranium. The five nuclear weapons Powers have each established a capacity for producing highly enriched uranium-235. So far as is known only one process for uranium-235 isotope separation has been put into large-scale use. It is known as the gaseous diffusion process. This process requires large and costly plants based on an advanced technology which has not been fully disclosed. The total cost of the three United States plants was around $2,300 million, and the annual operating costs were estimated at from $500 million to $600 million. Some twenty-five kilogrammes of this material would be required for the production of one nuclear warhead with a yield in the twenty-kiloton range. Uranium-235 is preferred over plutonium for the production of thermonuclear weapons (H-bombs).

35. Plutonium-239 results from exposing uranium-238 to neutrons in a nuclear reactor. It is estimated that some eight kilogrammes of 95 per cent plutonium-239 would be needed for a nuclear warhead yielding a twenty-kiloton explosion. A complete plutonium-239 production complex would require plants for concentrating uranium ore, refining the uranium to high purity, and probably reducing it to metal ingot, and for fabricating reactor fuel, a nuclear reactor, a chemical plant for plutonium extraction and one for reducing plutonium to metal, together with numerous service facilities. For production complexes with capacities in the range of 8-160 kilogrammes of
weapons-grade plutonium per year, the capital costs would be in the range of $22-$37 million, and the annual operating costs $5-$10 million.

36. Considering the high cost of the gaseous diffusion plant for uranium-235, it would seem that a country planning to make only a small number of nuclear warheads per year would go to the plutonium type. This is particularly so if it has an established activity in the peaceful uses of nuclear energy, since plutonium is produced as a by-product in most nuclear reactors.

DESIGNING, MANUFACTURING AND TESTING

37. The amount of published information relating to warhead assembly and testing is severely limited by military secrecy. The capital investments in a factory for assembling 10 warheads per year would be about $8 million and annual operating costs about $1 million. The total costs of testing one twenty-kiloton device underground would amount to $12 million, and the costs of testing four such devices would amount to $15 million.

COSTS FOR VARIOUS WARHEAD PRODUCTION PROGRAMMES

Plutonium warheads production programme

38. Based on the estimated cost figures given for plutonium production and warhead design, manufacturing and testing, the total estimated costs of a small programme and a moderate programme are shown below in table 1.

TABLE 1. ESTIMATED COSTS FOR VARIOUS PLUTONIUM-BASED WARHEAD PRODUCTION PROGRAMMES
(In $US millions)

<table>
<thead>
<tr>
<th></th>
<th>Small programme (10X20-kiloton devices over ten years)</th>
<th>Moderate programme (100X20-kiloton devices over ten years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fissile material</td>
<td>70.0</td>
<td>151.0</td>
</tr>
<tr>
<td>Design and manufacture</td>
<td>18.0</td>
<td>18.0</td>
</tr>
<tr>
<td>Testing</td>
<td>12.0</td>
<td>15.0</td>
</tr>
<tr>
<td>Storage, maintenance</td>
<td>4.0</td>
<td>14.0</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>104.0</strong></td>
<td><strong>168.0</strong></td>
</tr>
<tr>
<td>Annual average</td>
<td>11.0</td>
<td>19.0</td>
</tr>
<tr>
<td>Cost per warhead</td>
<td>11.0</td>
<td>1.9</td>
</tr>
</tbody>
</table>
Production programme including thermonuclear warheads

39. The escalation of the total warheads production costs resulting from the construction and operation of a diffusion plant for enriching uranium-235 and the development and testing of thermonuclear weapons is well demonstrated by the French example shown in table 2. The gaseous diffusion plant was built after 1960.

**TABLE 2.** **COSTS OF TOTAL FRENCH NUCLEAR WARHEADS PROGRAMME**

(In $US millions)

<table>
<thead>
<tr>
<th></th>
<th>Fission material production</th>
<th>Design and manufacture</th>
<th>Testing</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>To 1960.........</td>
<td>160</td>
<td>40</td>
<td>40</td>
<td>240</td>
</tr>
<tr>
<td>1960-1964.......</td>
<td>860</td>
<td>160</td>
<td>300</td>
<td>1,680</td>
</tr>
<tr>
<td>1965-1970.......</td>
<td></td>
<td></td>
<td></td>
<td>3,180</td>
</tr>
<tr>
<td><strong>GRAND TOTAL</strong></td>
<td>1,040</td>
<td>500</td>
<td>380</td>
<td>5,060</td>
</tr>
</tbody>
</table>

40. The total delivery vehicle costs in most circumstances will be greater than the nuclear weapons costs. The accuracy with which delivery vehicle costs were predicted has been notoriously poor. Heavy overruns of expenditures have been the rule rather than the exception and have been concurrent with lengthy delays in the projected time-tables. The time needed to develop a delivery system depends on the existing industrial base and related experience and would, in most cases, take at least ten years for reasonably industrialized nations. Monetary costs do not, by themselves, give a realistic picture of the necessary effort in terms of overall resources. A sizable technological base is needed to create and maintain a force of delivery vehicles. Even if major components can be purchased abroad, the delivery system must be integrated into a workable whole, and this process requires the skills of a number of qualified persons, which may even exceed the number needed for warhead production.

**PROCUREMENT COSTS SUMMARY**

41. It will be assumed that a modest but significant nuclear armament would be represented by a force of from thirty to fifty jet bomber aircraft together with fifty-medium-range missiles of the 3,000-kilometre range in soft emplacements and 100 plutonium warheads. The sum of the costs estimated above for such a system acquired and deployed over ten years would be at least $1,700 million averaging $170 million per year.
A hypothetical programme comprising two stages each of five years' duration has been envisaged. By the end of the first stage (1968-1972) a nuclear force of from ten to fifteen bombers and from fifteen to twenty nuclear weapons would be established, and during the second stage (1973-1977) the force would be extended to include from twenty to thirty thermonuclear weapons, 100 intermediate range missiles and two missile-launching nuclear submarines. The total costs of such a programme based on domestic industry and resources would amount to $5,600 million, corresponding to an average annual cost of $560 million for ten years. This hypothetical programme could be considered as a scaled-down version of the French programme. The cost estimate is considerably lower than the expenditures in France and the United Kingdom.

43. The actual annual costs of the nuclear forces in some countries are shown in Table 3. The costs are also given relative to the annual defence budgets and the gross national product (GNP).

<table>
<thead>
<tr>
<th>Country</th>
<th>Period of time</th>
<th>Total costs (in $US millions)</th>
<th>Annual costs as percentage of</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Military budget</td>
</tr>
<tr>
<td>France</td>
<td>1960-1964</td>
<td>2,100</td>
<td>13.0</td>
</tr>
<tr>
<td></td>
<td>1965-1970</td>
<td>5,200</td>
<td>18.0</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>1962-1963</td>
<td>480</td>
<td>10.0</td>
</tr>
<tr>
<td></td>
<td>1965-1966</td>
<td>350</td>
<td>6.0</td>
</tr>
<tr>
<td></td>
<td>1966-1967</td>
<td>300</td>
<td>5.0</td>
</tr>
<tr>
<td>USA</td>
<td>1962</td>
<td>13,200</td>
<td>26.4</td>
</tr>
<tr>
<td></td>
<td>1963</td>
<td>12,100</td>
<td>23.3</td>
</tr>
<tr>
<td></td>
<td>1964</td>
<td>11,200</td>
<td>21.1</td>
</tr>
<tr>
<td></td>
<td>1965</td>
<td>8,200</td>
<td>16.8</td>
</tr>
<tr>
<td></td>
<td>1966</td>
<td>8,200</td>
<td>14.6</td>
</tr>
<tr>
<td></td>
<td>1967</td>
<td>8,400</td>
<td>12.1</td>
</tr>
</tbody>
</table>
ECONOMIC IMPLICATIONS

44. What has been defined as a modest nuclear armament requires not only a ten-year programme costing the equivalent of $US 170 million per year but resources of special kinds and quality. The basic ingredients would be raw materials, a corps of approximately 1,300 engineers and 500 scientists and a modern industrial base. Sophisticated delivery systems are equally demanding of high-quality materials and skills. For production of the intermediate-range ballistic missiles, estimates suggest that manpower requirements for technical and skilled personnel would rise higher than those for nuclear weapons. To produce over ten years and deploy fifty such 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. The suggested fleet of fifty bombers would require a minimum of from 1 to 2 million man-hours of skilled and unskilled labour just to assemble. The design and development stage would absorb an additional 2 million or more engineering man-hours.

IMPLICATIONS OF EXPECTED GROWTH OF PLUTONIUM RESOURCES

45. There are two observations that we can make. First, that the cost of development of simple nuclear warheads is progressively decreasing as the technology involved is increasingly becoming public knowledge, and a new country can avoid the unprofitable directions which the countries that pioneered had to discover through costly experience. Second, that the large-scale development of nuclear power projects, resulting from a breakthrough in capital as well as operating costs, compared to conventional power stations, will make available a very large capacity of potential producers of weapons-grade plutonium. It is estimated that by 1980 there would be in the world more than 3 X 10^5 megawatts of nuclear power production. This would involve the production of plutonium sufficient for thousands of bombs each year.

III. SECURITY IMPLICATIONS OF THE ACQUISITION AND FURTHER DEVELOPMENT OF NUCLEAR WEAPONS

46. The effort to maintain a state of nuclear deterrence has demanded the expenditure of vast resources and, paradoxically, far from increasing the sense of security, has at times engendered a sense of insecurity. The opposing sides have taken, and continue to take, major steps to assure themselves that their nuclear warheads and delivery vehicles are proof against whatever countermeasures might be undertaken by the other side. These counter measures are essentially designed to increase the chances of a nuclear armoury surviving a pre-emptive nuclear assault by the other side and of nuclear weapons being able to penetrate whatever defences the other might deploy. The reciprocal technological development and sophistication of nuclear warheads and their associated weapons systems which thus results constitute a spiralling nuclear arms race.
THE CURRENT PROSPECT

47. So far as international security is concerned, it is highly probable that any further increase in the number of nuclear weapons States or any further elaboration of existing nuclear arsenals would lead to greater tension and greater instability in the world at large. Additional nuclear Powers accentuating regional tensions could only add to the complexity of the problem of assuring peace. Furthermore, it is impossible to deny the proposition that the danger of nuclear war breaking out through accident or miscalculation becomes greater, the larger the number of countries which deploy such weapons and the larger the stockpiles and the more diversified the weapons they hold.

48. The possibility of an increase in the number of countries acquiring a nuclear arsenal is attributable to different sets of motives. In some quarters the fact that the existing nuclear weapons Powers have so far failed to reach agreement either about stopping the further development or of freezing or reducing their own nuclear arsenals is regarded as an argument for the acquisition of nuclear weapons by other nations. In searching for greater security, some may also believe that if a state of mutual deterrence has been generated between the existing nuclear weapons Powers, a corresponding situation could be created between any other Powers who already possess the industrial and technological background necessary to make bombs. But against such views, it is worth noting that nowhere has the development of nuclear weapons made it possible to dispense either with troops on the ground or with conventional arms. Thus, the burden of an arms race with conventional weapons is compounded as soon as a nation embarks upon the path of acquiring nuclear weapons. Moreover, the insecurity which would be brought about by entering the nuclear arms race would make it imperative to improve continuously the sophistication of the nuclear weapons and their delivery systems, as well as measures for providing an early warning of an impending attack. The nuclear arms race demands immense technological and other resources and, of itself, creates conditions under which the economic progress of a nation could stagnate. Again, the acquisition by any nation of nuclear weapons could also trigger a change in its international relations. Non-nuclear neighbours could be tempted to acquire nuclear weapons, or they might perhaps undertake immediate preventive military action. Similarly, the existing nuclear Powers might react by countermeasures and/or attempts to strengthen their own position in the region and thereby intensify their own arms race. Nuclear weapons nations are also faced with the problems of establishing systems of control of nuclear weapons within their own borders. Not only must there be protection against misuse; the tensions which would exist if serious civil strife were to occur in a nation that possessed nuclear weapons would be greatly intensified. If these problems are not adequately solved, there are added risks to the security of that nation and to the world as a whole.

49. Clearly any arms race absorbs resources which might otherwise be used to improve standards of living. The struggle to improve living conditions is most effectively pursued when advanced technological products are freely exchanged between countries. This process is hindered by the mutual fears and suspicions associated with an arms race.
THE ISSUE OF TACTICAL WEAPONS

50. A second motive additional to the search for "security through deterrence" which might encourage proliferation is the view that nuclear weapons constitute a form of armament superior to conventional weapons in field warfare. However, it is hardly likely that a non-nuclear-weapons country, living in a state of hostility with a neighbour, could start to furnish itself with a nuclear arsenal without either driving its neighbour to do the same or to seek protection in some form or other, explicit or implicit, from an existing nuclear weapons Power or Powers. Equally, if in the pursuit of its political objectives, one of two sides, both of which possessed and deployed nuclear weapons, were to have the will to initiate the use of its weapons, it is difficult to see how a nuclear engagement could be stopped once it had started. From what has been said in section I of the report, it is clear that, given that both sides to a conflict deploy nuclear weapons, it is highly debatable whether there are any circumstances of land warfare in which such weapons could be used as battlefield weapons or, if they were so used, would confer any military advantage to either side in the zone of contact. Whatever significance can be attributed to tactical nuclear weapons is to be found essentially in the concept of deterrence.

NUCLEAR WEAPONS IN THE POLITICAL CONTEXT

51. The third argument which is sometimes advanced in favour of the acquisition of nuclear weapons is that doing so promotes political independence, enhances national prestige and thus a country's influence on the international scene. A contrary view is that the influence of certain Powers in international affairs would be the same whether or not they possessed nuclear weapons. The issue of prestige is equally debatable. Undoubtedly, there may for a short time be some imponderable element of prestige in the manifestation of the technological prowess which is implied by the development of nuclear weapons. But this prestige is a mixed blessing and could rapidly generate those deleterious reactions on the part of neighbouring States to which reference has been made in a preceding paragraph.

52. When one asks whether or not the acquisition and further development of nuclear weapons increases security, one thus ends up with two very simple questions. The first is what, in fact, have nuclear weapons contributed so far to military power? In so far as this question can be answered, the reply can only be that while the state of mutual deterrence which prevails between the two super Powers has helped to avert any head-on conflict between them, it has not made it possible for either to reduce its military expenditures in general or to neglect the effectiveness of its conventional armoury in particular. In a smaller way, the same conclusion applied to both the United Kingdom and France.

53. At the same time, profound limitations clearly exist in the possible use of these weapons. The consequences of their employment either in all-out war or in field warfare would be so disastrous to both sides that it is very difficult to conceive of circumstances in which they could be used. Where two sides possess such weapons, it is totally unrealistic to suppose that one
could use them in a military conflict without provoking retaliation by the other. Once retaliation had occurred, it is also difficult to suppose that a nuclear conflict would not escalate in intensity. The situation might, of course, be totally different if only one side to a localized conflict possessed nuclear weapons. But since the end of the Second World War, no nuclear weapons State has been able to derive any immediate military advantage from the possession of nuclear weapons, let alone use them to gain an easy victory. In fact, the possession of nuclear forces does not necessarily prevent a decline in political influence. Were the acquisition and maintenance of a nuclear arsenal to impose a major economic and technological burden on a country, it is possible that possession of such an arsenal would be associated with a reduction, and not with an increase, in both the national security and political influence of the country concerned.

CONCLUSION

54. The solution of the problem of ensuring security cannot be found in an increase in the number of States possessing nuclear weapons or, indeed, in the retention of nuclear weapons by the Powers currently possessing them. An agreement to prevent the spread of nuclear weapons as recommended by the United Nations, freely negotiated and genuinely observed, would therefore be a powerful step in the right direction, as would also an agreement on the reduction of existing nuclear arsenals.

55. A comprehensive test ban treaty, prohibiting the underground testing of nuclear devices, would also contribute to the objectives of non-proliferation and would clearly help to slow down the nuclear arms race. So would effective measures safeguarding the security of non-nuclear countries. Nuclear-weapon-free zones additional to those of Antarctic and Latin America would equally be of major assistance. These measures are mentioned neither to argue the case for them nor to set them in any order of priority. Any one of them, or any combination of them could help inhibit the further multiplication of nuclear weapons Powers or the further elaboration of existing nuclear arsenals and so help to ensure national and world security. But it must be realized that these measures of arms limitation, however desirable, cannot of themselves eliminate the threat of nuclear conflict. They should be regarded not as ends sufficient in themselves but only as measures which could lead to the reduction of the level of nuclear armaments and the lessening of tension in the world and the eventual elimination of nuclear armaments. All countries have a clear interest in the evolution of a world which allows of peaceful and stable coexistence. Non-nuclear weapon countries, as well as those which possess nuclear weapons, need to work in concert, creating conditions in which there should be free access to materials, equipment and information for achieving all the peaceful benefits of atomic energy, and for promoting international security.

56. International agreement against the further proliferation of nuclear weapons and agreements on measures of arms control and disarmament will promote the security of all countries. The United Nations has the overriding responsibility in this field. The more effective it becomes in action, the more powerful its authority, the greater becomes the assurance for man's future.
20.

CHEMICAL AND BACTERIOLOGICAL (BIOLOGICAL) WEAPONS
AND THE EFFECTS OF THEIR POSSIBLE USE

(A/7575/Rev.1, S/9292/Rev.1)

INTRODUCTION

1. In accordance with General Assembly resolution 2454 A (XXIII) the Secretary-General was asked to prepare, with the assistance of qualified consultant experts, a report on chemical and bacteriological (biological) weapons and on the effects of their possible use.

2. No form of warfare has been more condemned than has the use of this category of weapons. The fear today is that the scientific and technological advances of the past few decades have increased the potential of chemical and bacteriological (biological) weapons to such an extent that one can conceive of their use causing casualties on a scale greater than one would associate with conventional warfare. At the moment most of our knowledge concerning the use of chemical weapons is based upon the experience of the First World War. According to official reports gas casualties numbered about 1,300,000 of which about 100,000 were fatal. The agents used in that war were much less toxic than those, in particular nerve agents, which could be used today, and they were dispersed by means of relatively primitive equipment as compared with what is now available.

3. It is true that a considerable effort has also been made to develop chemical agents which have as their purpose not to kill but to reduce a man's capacity to fight. Such agents are used by civil authorities of a number of countries in order to suppress disorders and to control riots, but when used in warfare they would inevitably be employed as an adjunct to other forms of attack, and their over-all effect might be lethal.

4. Since the Second World War, bacteriological (biological) weapons have also become an increasing possibility. But because there is no clear evidence that these agents have ever been used as modern military weapons, discussions of their characteristics and potential threat have to draw heavily upon experimental field and laboratory data and on studies of naturally occurring outbreaks and epidemics of infectious disease, rather than on direct battlefield experience.

5. The greater threat posed by chemical weapons today derives from the discovery and manufacture of new, more toxic compounds. On the other hand, bacteriological (biological) agents already exist in nature and can be selected for use in warfare. Some of these agents have been known for several decades, but there is a vast number of other possible agents, especially viruses, which have been discovered only recently. Increases in potency of these various types of agent have been made possible by scientific and technological advances in microbial genetics, experimental pathology and aerobiology.
6. As is well known, the use of toxic gases in the First World War generated so powerful a sense of outrage that countries were encouraged to adopt measures prohibiting both chemical and bacteriological (biological) weapons. The result was the Geneva Protocol of 17 June 1925, which prohibits the use in war of asphyxiating, poisonous or other gases and of all analogous liquids, materials or devices, as well as bacteriological methods of warfare. This established a custom and hence a standard of international law, and in practice most States have adhered to the principle that no one should resort to the use of such weapons.

7. It is simple to appreciate the resurgence of interest in the problems of chemical and bacteriological (biological) warfare. Advances in chemical and biological science, while contributing to the good of mankind, have also opened up the possibility of exploiting the idea of chemical and bacteriological (biological) warfare weapons and the situation will remain threatening so long as a number of States proceed with their development, production and stockpiling.

8. As the present report shows, the outstanding characteristics of this class of weapons, particularly bacteriological (biological) weapons, is the variability, amounting under some circumstances to unpredictability, of their effects. Depending on environmental and meteorological conditions, and depending on the particular agent used, the effects might be devastating or negligible. They might bear not only on those attacked but on those who initiated their use, whether or not the attacked military forces retaliated in kind. Civilians would be even more vulnerable than the military. The development, acquisition and deployment of chemical and bacteriological (biological) weapons constitutes a real economic burden which varies in extent for different countries. Above all, their acquisition could not possibly obviate the need for other weapons.

9. It would be enormously costly in resources, and administratively all but impossible, to organize adequate protection for a civilian population against the range of possible chemical agents. Even military personnel would be unlikely to escape the wider-spread and longer-term effects on their country at large.

10. To appreciate the risks that bacteriological (biological) warfare could entail, one has only to remember how a natural epidemic may persist unpredictably, and spread far beyond the initial area of incidence, even when the most up-to-date medical resources are used to suppress the outbreak. The difficulties would be considerably increased were deliberate efforts made, for military reasons, to propagate pathogenic organisms. Mass disease, following an attack, especially of civilian population, could be expected not only because of the lack of timely warning of the danger but because effective measures of protection or treatment simply do not exist or cannot be provided on an adequate scale.
11. Once the door was opened to this kind of warfare, escalation would in all likelihood occur, and no one could say where the process would end. Thus the report concludes that the existence of chemical and bacteriological (biological) weapons contributes to international tension and that their further development spurs the arms race without contributing to the security of any nation.

Chapter I

THE BASIC CHARACTERISTICS OF CHEMICAL AND BACTERIOLOGICAL (BIOLOGICAL) MEANS OF WARFARE

12. Since World War I, the variety and potency of chemical and bacteriological (biological) weapons has grown steadily, and there has been a corresponding increase in the capacity to deliver them to a target area. The most significant result of these technical developments is the great variety of injurious effect which these agents can induce and the consequent increase in the number and types of situation in which there might be a temptation to use them for military purposes.

A. Characteristics of chemical and bacteriological (biological) weapons

13. For the purposes of this report, chemical agents of warfare are taken to be chemical substances, whether gaseous, liquid or solid, which might be employed because of their direct toxic effects on man, animals and plants. Bacteriological (biological) agents of warfare are living organisms, whatever their nature, or infective material derived from them, which are intended to cause disease or death in man, animals or plants, and which depend for their effects on their ability to multiply in the person, animal or plant attacked.

14. Various living organisms (e.g. rickettsiae, viruses and fungi), as well as bacteria, can be used as weapons. In the context of warfare all these are generally recognized as "bacteriological weapons". But in order to eliminate any possible ambiguity, the phrase "bacteriological (biological) weapons" has been used throughout to comprehend all forms of biological warfare.

15. All biological processes depend upon chemical or physico-chemical reactions, and what may be regarded today as a biological agent could, tomorrow, as knowledge advances, be treated as chemical. Because they themselves do not multiply, toxins, which are produced by living organisms, are treated in this report as chemical substances. We also recognize that there is a dividing line between chemical agents of warfare, in the sense in which we use the terms, and incendiary substances, such as napalm and smoke, which exercise their effects through fire, temporary deprivation of air or reduced visibility.
16. Finally, we recognize that both chemical and bacteriological (biological) agents are designated either as lethal agents, that is to say, agents which are intended to kill, or as incapacitating agents, that is to say, agents which are intended to cause disability. These terms are not absolute but imply statistical probabilities of response which are more uncertain with bacteriological (biological) than with chemical agents. Not all individuals will die from an attack with a given lethal agent, whereas some, for example, infants and people weakened by malnutrition, disease or old age might succumb to an attack with incapacitating chemical or bacteriological (biological) agents. With a few chemical agents, notably some tear gases (lachrymators), there is a negligible probability of any fatal outcome, and these have been used to quell riots and civil disorders (riot-control agents), as well as in warfare as harassing agents, in order to enhance the effectiveness of conventional weapons or to facilitate the capture of enemy personnel.

1. DIFFERENCES BETWEEN CHEMICAL AND BACTERIOLOGICAL (BIOLOGICAL) WARFARE

17. Although there are some similarities between chemical and bacteriological (biological) agents regarded as weapons of war, they differ in certain important respects. These differences are related to:

Potential toxicity

18. Although more toxic than most well-known industrial chemicals, chemical warfare agents are far less potent on a weight-for-weight basis than are bacteriological (biological) agents. This difference reflects the fact that bacteriological (biological) agents, being alive, can multiply. For the same reason, they also are very much more susceptible to sunlight, temperature and other environmental factors than are chemical agents. A bacteriological (biological) agent disseminated into a given environment may retain its viability while losing its virulence.

Speed of action

19. As a class, chemical agents produce their injurious effects in man, animals or plants more rapidly than do bacteriological (biological) agents. The time between exposure and significant effect may be minutes, or even seconds, for highly toxic gases or irritating vapours. On the other hand, a bacteriological (biological) agent must multiply in the body of the victim before disease (or injury) supervenes; this is the familiar "incubation period" of a disease.

Duration of effect

20. The effects of most chemical agents which do not kill quickly do not last long, except in the case of some agents, such as phosgene and mustard, where they might continue for some weeks, months or longer. On the other hand, bacteriological (biological) agents which are not quickly lethal cause illness lasting days or even weeks and, on occasion, involve periods of prolonged convalescence.
Specificity

21. Although both classes of agents can be used to attack man, animals or plants, individual biological agents, in general have a much greater degree of host specificity. Influenza, for example, is essentially a disease of man and rice blast is a disease confined to rice only. Chemical agents are much less specific: nerve agents can affect mammals, birds and invertebrates.

Controllability

22. By controllability is meant the ability to predict the extent and nature of the damage which chemical and bacteriological (biological) agents can cause. The most likely means of delivering chemical and bacteriological (biological) agents is by discharge into the atmosphere. Control is thus possible only to the extent that the meteorological situation can be predicted.

23. Because they infect living organisms, some bacteriological (biological) agents can be carried by travellers, migratory birds or animals to localities far from the area originally attacked. The possibility of this kind of spread does not apply to chemical agents. But control of contamination by persistent chemical agents could be very difficult. Should large quantities of chemical agents penetrate the soil and reach underground waters, or should they contaminate reservoirs, they might spread hundreds of kilometres from the area of attack.

Residual effects

24. In circumstances which favour their persistence herbicides, defoliants and perhaps some other chemical agents might linger for months, stunting the growth of surviving or subsequent plant life. The risk of residual effects with some bacteriological (biological) agents is potentially greater, mainly because they could lead to disease, which might become epidemic.

2. TECHNOLOGY OF CHEMICAL AND BACTERIOLOGICAL (BIOLOGICAL) WARFARE

25. The technological problems associated with chemical and bacteriological (biological) warfare are of two kinds: (a) those associated with the production of the agents and the weapons needed for their dissemination and (b) those which concern the provision of the protective equipment and defences necessary to protect military forces and civilian populations. Any nation whose chemical, pharmaceutical and fermentation industries are well advanced could produce chemical and bacteriological (biological) agents on a scale commensurate with its other military capabilities. The problems which relate to defence are far more difficult, for as with most weapons, effective defence calls for much more stringent training and demands far more manpower and monetary resources than does the offence.
3. CHEMICAL AND BACTERIOLOGICAL (BIOLOGICAL) WEAPON SYSTEMS

26. The use in warfare, and the possible military effectiveness, of chemical and bacteriological (biological) agents need to be considered in the context of the weapon systems of which they would be part. A weapon system comprises all the equipment and personnel, as well as the organizational structure, required to maintain and operate a military device. Artillery shells filled with mustard gas or nerve agents and guns to fire them, or an aircraft with a spray tank filled with a bacteriological (biological) agent, are not by themselves weapon systems. Many complex technological problems have to be overcome in transforming a chemical or bacteriological (biological) "agent" into a "weapon system". A "weapon" is of little military value if it is not dependable and if it cannot be delivered to a target with certainty.

27. In addition, considerations affecting defence need to be taken into account. Masks, protective clothing, detection alarms, special medical supplies, augmented logistic facilities and, above all, thoroughly trained military and civilian personnel are necessary parts of chemical and bacteriological (biological) weapon systems. Although chemical and bacteriological (biological) weapon systems are cheaper and more readily attained than nuclear weapons, they are highly complex systems which call for sizable resources and considerable expertise for their development and operation. But the possibility always exists that by choosing a single agent and a simple means of delivery a nation could equip itself relatively cheaply to attack a limited area with a reasonable chance of success.

B. Concepts of the use of chemical and bacteriological (biological) weapons in war

1. CHEMICAL WEAPONS

26. Chemical weapons could be used within the zone of contact of opposing forces or against military targets, or against targets which have no immediate connexion with military operations, such as centres of population, farm land and water supplies. The circumstances in which they could be used within a zone of contact are many and varied. Whether or not in the battle-area, civilians might become casualties. The risk of civilian casualties would obviously be greater if chemical attacks were made on military targets well in the rear of the zone of contact and would be very serious in the case of attacks on centres of population.

2. BACTERIOLOGICAL (BIOLOGICAL) WEAPONS

29. There is no military experience of the use of bacteriological (biological) agents as weapons of war, and the feasibility of using them as such has often been questioned. Some recent investigations under field conditions throw light on this point. In one field trial, a harmless powder was disseminated from a ship travelling 16 kilometres off shore.
The resulting aerosol travelled at least 750 kilometre and covered an area of over 75,000 square kilometres. This observation provides an indication of the size of area which might be covered by a windborne aerosol, but it does not tell whether the bacteriological (biological) agents which might be spread in an aerosol would still retain their virulence.

30. However, some idea of the relative size of areas which can be covered by bacteriological (biological) and chemical aerosols can be gained from this same experiment. Depending on the bacterial or viral agent and its degree of hardiness, areas of from 5,000 to 20,000 km² could have been effectively attacked, infecting a high proportion of unprotected people in the area. If the same means are applied to a hypothetical chemical attack using the most toxic chemical nerve agent, the downwind hazard from this would not have extended more than one kilometre, and probably less, unless meteorological conditions were extremely favourable. The area covered by such a chemical attack might thus have been from 50 to 150 km².

31. For purposes of sabotage or covert (secret, as in sabotage actions behind enemy lines) operations, small aerosol generators for bacteriological (biological) agents could be built, for example, into fountain pens or cigarette lighters.

C. Chemical and bacteriological (biological) agents

1. CHEMICAL AGENTS

32. Chemical agents are usually described in terms of their physiological effects and are characterized as follows:

Agents affecting man and animals

33. Nerve agents are colourless, odourless, tasteless chemicals of the same family as organophosphorus insecticides. They poison the nervous system and disrupt vital body functions. They constitute the most modern war chemicals known; they kill quickly and are more potent than are any other chemical agents (except toxins).

34. Blister agents (vesicants) are oily liquids which, in the main, burn and blister the skin within hours after exposure. But they also have general toxic effects. Blister agents caused more casualties than any other chemical agent used in the First World War.

35. Choking agents are highly volatile liquids which, when breathed as gases, irritate and severely injure the lungs, causing death from choking. They were introduced in the First World War and are of much lower potency than the nerve agents.
36. Blood agents are also intended to enter the body through the respiratory tract. They produce death by interfering with the utilization of oxygen by the tissues. They, too, are much less toxic than nerve agents.

37. Toxins are biologically produced chemical substances which are very highly toxic and may act by ingestion or inhalation.

38. Tear and harassing gases are sensory irritants which cause a temporary flow of tears, irritation of the skin and respiratory tract and, occasionally, nausea and vomiting. They have been widely used as riot-control agents and also in war.

39. Psycho-chemicals are drug-like chemicals intended to cause temporary mental disturbances.

**Agents affecting plants**

40. Herbicides (defoliants) are agricultural chemicals which poison or desiccate the leaves of plants, causing them to lose their leaves or die. Some herbicides, particularly those containing organic arsenic, are also toxic for man and animals.

**Methods of delivery**

41. Chemical munitions are designed to fulfil three objectives: (a) to provide a container for the agent so that the agent/munition combination can be delivered to its target; (b) to attain an effective distribution of agent over the target area; and (c) to release the agent in active form. In the case of incapacitating and riot-control agents, it is necessary that the munition itself should not cause injury or death and that it should not start fires. The munitions to be used would depend on the method of delivery, the shape and size of the target area and other variables. Ground-to-ground munitions include grenades, shells, rockets and missile war-heads; air-to-ground munitions include large bombs, dispensers, spray tanks and rockets; emplaced munitions include generators and mines.

2. BACTERIOLOGICAL (BIOLOGICAL) AGENTS

42. Like chemical agents, bacteriological (biological) agents may also be classified in terms of their intended use, whether designed to incapacitate or kill human beings, to incapacitate or kill food and draught animals or to destroy food plants and industrial crops.

43. Bacteria, viruses, fungi and a group of microbes known as rickettsiae are by far the most potent agents which could be incorporated into weapon systems.
The selection of agents for use in warfare

44. The bacteriological (biological) agents which could potentially be used in warfare are far fewer than those which cause naturally occurring disease. To be effective for this purpose they should:

(a) be able to be produced in quantity;
(b) be capable of ready dissemination in the face of adverse environmental factors;
(c) be effective regardless of medical counter-measures;
(d) be able to cause a large number of casualties.

Agents affecting man

45. All the diseases under consideration occur naturally, and the causative organisms, with few exceptions, are known to scientists throughout the world. Incapacitating agents are those which, in natural outbreaks, cause illness but rarely death. If the natural disease has an applicable mortality, the agent is regarded as a lethal one. Different populations have varying degrees of resistance to the diseases produced by bacteriological (biological) agents. An infectious disease which might be only mildly incapacitating in one population might prove disastrous to another, for example, as a result of malnutrition. Conversely, a weapon which was intended to spread a lethal disease might only cause occasional mild illness in people who had been given a protective vaccine or who had become immune as a result of natural infection.

46. Viruses are the smallest forms of life. Most of them can be seen only with the electron microscope and must be grown on living tissue (tissue cultures, fertile eggs, etc.).

47. Rickettsiae are intermediate between the viruses and bacteria. Like the viruses, they grow only in living tissue.

48. Bacteria are larger than viruses and can be easily grown on a large scale employing equipment and processes similar to those used in the fermentation industry; but special skills and experience would be needed to grow them in quantity in the particular state in which they readily cause disease.

49. Fungi also produce a number of diseases in man, but very few species appear to have any potential in bacteriological (biological) warfare.

Agents affecting animals

50. Bacteriological (biological) anti-animal agents, such as foot-and-mouth disease and anthrax, would be used primarily to destroy domestic
animals, thereby indirectly affecting man by reducing his food supply. Outbreaks of contagious disease in animal populations, known as epizootics, may spread much more readily than do epidemics among human beings. Most of the bacterial diseases of animals which could probably be used in warfare are also transmissible to man.

**Agents affecting plants**

51. The natural occurrence of devastating plant diseases has suggested that plant pathogens might be used for military purposes.

**Methods of delivery**

52. Bacteriological (biological) agents can, in principle, be loaded into the same type of munitions as can chemical agents. Other than for convert or "special-purpose missions", bacteriological (biological) weapons, if developed for military purposes, would in all probability be delivered by aircraft or by large ballistic missiles.

53. If bacteriological (biological) warfare ever occurred, the aerosol technique would be the one most likely to be used, simply because the respiratory tract is normally susceptible to infection by many microorganisms, because of the wide target area which could be covered in a single attack and because ordinary hygienic measures are ineffective in preventing the airborne route of attack.

**D. Defence of man against chemical and bacteriological (biological) agents**

54. A comprehensive defensive system against attacks by chemical or bacteriological (biological) agents would necessitate a very effective organization manned by well-trained personnel. Although military units and small groups of people could be equipped and trained to protect themselves to a significant extent, it would be impracticable for most (if not all) countries to provide comprehensive protection for their entire civil population.

**1. MEDICAL PROTECTION**

**Chemical attacks**

55. No general prophylactic treatment exists which could protect against chemical attacks.

**Bacteriological (biological) attacks**

56. Vaccination is the only useful means available for prophylaxis against bacteriological (biological) attacks. It is probable, however, that even those existing vaccines which are effective in preventing natural infectious diseases might afford only limited protection against respiratory infection by an agent disseminated into the air in large
amounts by a bacteriological (biological) weapon. Moreover, whole populations could not be vaccinated against all possible diseases.

2. DETECTION AND WARNING

57. The requirement is to detect a cloud of a chemical or a bacteriological (biological) agent in the air sufficiently quickly for masks and protective clothing to be donned before the attack can be effective. There are also requirements for the detection of ground contamination with chemical agents and for detection equipment to enable those under attack to decide when it would be safe to remove their protective equipment.

Chemical attacks

58. In the First World War it was possible to rely upon odour and colour as the primary means of alerting personnel that a chemical attack had been launched. The newer, more toxic chemical agents cannot be detected in this way. On the other hand, presumptive evidence that such weapons had been used would be of value as warning. Once an enemy had used chemical weapons, each subsequent attack would necessarily have to be presumed to be a possible chemical attack. Individuals would have to mask whenever any bombardment occurred. Because of the uncertainty, however, it would be clearly desirable to devise and provide a system of instruments which could detect the presence of toxic chemicals and give timely and accurate warning of a chemical attack. It must be recognized that in spite of instrumental warning systems, personnel near the point of dissemination of a chemical agent might still not have sufficient time to take protective action.

Bacteriological (biological) attacks

59. Unlike chemical weapons, bacteriological (biological) weapons cannot readily be distinguished from the biological "background" of the environment by specific chemical or physical reactions, and much lower aerosol concentrations of bacteriological (biological) agents are more dangerous than of chemical agents. The problem of early detection and warning is thus even more difficult than for chemical weapons.

3. PHYSICAL PROTECTION

60. The primary objective is to establish a physical barrier between the body and the chemical and bacteriological (biological) agents and, especially, to protect the skin and the respiratory tract. Without this no warning system, however effective, has the slightest value.

Individual protection

61. Protective masks are the first line of defence against all chemical and bacteriological (biological) agents. Since mustard gases and the nerve agents of low or intermediate volatility can penetrate the
unbroken skin, even through normal clothing, the whole body surface must be protected by some form of special clothing. Together with a mask, protective clothing, properly worn and in good condition, will afford excellent protection against known chemical and bacteriological (biological) agents.

Collective or communal protection

62. Collective protection takes the form of fixed or mobile shelters capable of accommodating groups of people and has been devised not only for civilians but for special groups of military personnel (e.g., command posts, field hospitals). Collective protection is the most effective physical means of protection against all forms of attack.

63. Once a bacteriological (biological) attack had been suspected or detected, it would be necessary to identify the specific agents involved so that proper protective measures could be taken and treatment planned. At present the only means of identifying specific micro-organisms is by normal laboratory procedures. However, laboratory identification of biological agents is still a complicated and unsatisfactory process.

4. DECONTAMINATION

Chemical agents

64. Prolonged exposure to weather and sunlight reduces or eliminates the danger of most chemical agents. But in general, it would be essential to resort to decontamination immediately after an attack. Unless food had been stored in metal cans or other containers which were impermeable to chemical agents, it would have to be destroyed. Decontamination of complex equipment and vehicles is a difficult and time-consuming procedure. Decontamination might even need to be extended to roads and selected areas. This would involve the removal of contaminated soil by bulldozing or by covering it with earth, using explosives to spread a powdered decontaminant over a wide area.

Bacteriological (biological) agents

65. Decontamination procedures for biological agents are similar to those used for toxic chemical agents.

E. Protection of domestic animals and plants against chemical and bacteriological (biological) attacks

66. The widespread protection of domestic animals and plants from chemical attack would be impracticable.

Animals

67. Animals or flocks could be protected by collective shelters although the cost would be great and, in the absence of automatic warning devices, it would be impossible to assure that the creatures would be sheltered at the time of attack. The ideal means of protection for animals would be vaccination.
Plants

68. The only hopeful approach would be to breed disease-resistant plants. But unless the exact identity of the bacteriological (biological) agent which might be used were known well in advance (possibly years), it would not be feasible to apply this principle to provide protection to crops against this kind of attack.

Chapter II

THE PROBABLE EFFECTS OF CHEMICAL AND BACTERIOLOGICAL (BIOLOGICAL) WEAPONS ON MILITARY AND CIVILIAN PERSONNEL, BOTH PROTECTED AND UNPROTECTED

A. The effects of chemical agents on individuals and populations

69. The effects of chemical warfare agents on humans, animals and plants depend on the toxic properties of the agent, the dose absorbed, the rate of absorption and the route by which the agent enters the organism. Toxic agents may enter the body through the skin, the eyes, the lungs or the gastro-intestinal tract (as a result of eating contaminated food or drinking contaminated liquids). Protective masks, protective clothing, and shelters and, to a certain extent, decontamination when applicable, give substantial protection against all chemical warfare agents. But, as already emphasized, the mere possession of a means of protection by no means constitutes an absolute safeguard against contamination by poisons. Since protective measures are most effective when performed by trained personnel working in units, military personnel are more likely to be provided with adequate protection than a civilian population. In any event, the civilian population in most countries is simply not provided with protection against chemical warfare.

70. The effects of the more lethal modern chemical weapons have not been studied under conditions of actual warfare. Furthermore, no complete and systematic field studies of the use of defoliants, herbicides and riot-control agents are available. The following descriptions of the probable effects of chemical weapons, based both on evidence and on technical judgement, must therefore be regarded as somewhat conjectural.

1. EFFECTS OF LETHAL CHEMICAL AGENTS ON INDIVIDUALS

71. Lethal chemical agents kill in relatively small doses, and as a rule the amount that causes death is only slightly greater than that which causes incapacitation. Death may occasionally be caused by high doses of presumed incapacitating agents, and, conversely, minor effects could be caused by low doses of lethal agents.

Nerve agents

72. These lethal compounds are readily absorbed through the lungs,
eyes, skin and intestinal tract without producing local irritation, and they interfere with the action of an enzyme (cholinesterase) essential to the functioning of the nervous system. The nerve-agent casualty who has been exposed to a lethal dose will die of asphyxiation within a few minutes if he is not treated swiftly by means of artificial respiration and drugs, such as atropine or oximes. Otherwise recovery is generally rapid and complete. It is estimated that the most toxic nerve gases may cause death at a dosage of about 10 mg min/m³. A dosage of one mg min/m³ consists of an exposure for one minute to gas at a concentration of one milligramme per cubic metre. Less toxic ones are lethal at dosages of up to 400 mg min/m³.

**Blister agents**

73. Mustard is a typical blister agent which, like other members of this class, also has general toxic effects. Blistering with mustard is comparable to second-degree burns. More severe lesions, comparable to third-degree burns, may last for a couple of months. Blindness may be caused.

**Other lethal agents**

74. Phosgene and compounds with similar physiological effects were used in the First World War. Death results from damage to the lungs.

75. Hydrogen cyanide in lethal doses causes almost immediate death by inhibiting cell respiration.

76. Most of the so-called blood agents contain cyanide, and all act rapidly. The casualty would either die before therapy could begin or recover soon after breathing fresh air.

77. Botulimum toxin is one of the most powerful natural poisons known and could be used as a chemical warfare agent. The bacteria do not grow or reproduce in the body, and poisoning is due entirely to the toxin ingested. Respiratory paralysis is the usual cause of death.

## EFFECTS OF LETHAL AGENTS ON POPULATIONS

78. As already indicated, the possible effects of an attack on populations with lethal chemical warfare agents would depend upon the agent used, upon the intensity of the attack, whether the population was mainly under cover or in the open, on the availability of protective facilities, on the physiological state of the individuals affected and on the meteorological conditions, which might differ from what had been predicted and alter during the course of an attack.

**Effects of nerve gas on protected troops in combat**

79. To counter a heavy attack with air-burst munitions, protective measures of a very high order of efficiency, including protective masks,
light protective clothing, means for decontamination, detection systems, antidotes and medical care, would have to be available. Protective clothing and rapid utilization of gas masks would give a certain measure of protection. But in this case, subsequent decontamination and medical care would be necessary to avoid heavy lethal losses.

**Effects of nerve gas on a military target in the rear**

80. After an attack in which tons of Sarin were used against an area of one square kilometre, the impact area and the area immediately downwind from it would be highly lethal to all unprotected personnel. The distance between the impact area and the area of lowest effective dosage would rarely exceed a few tens of kilometres. Personnel provided only with gas masks, but not wearing them at the moment of the attack, would suffer substantial losses in and close to the impact area. Further downwind, masks would give essentially complete protection if warning were provided reasonably quickly.

**Effects of a nerve gas attack on a town**

81. Given a town with a total population of 80,000, a surprise attack with nerve gas could cause 40,000 casualties, half of them fatal, whereas under ideal circumstances for the defence, fatalities might number no more than 2,000. It is inconceivable, however, that the ideal would ever be attained.

3. **EFFECTS OF INCAPACITATING CHEMICAL AGENTS**

82. Incapacitating chemicals, like tear gases and certain psychochemicals, produce in normal healthy people a temporary, reversible disability with few, if any, permanent effects. In young children, old people and those with impaired health, the effects may sometimes be aggravated.

**Tear and harassing gases**

83. Either as vapour or in aerosol, tear and harassing gases rapidly produce irritation, smarting and tears. These symptoms disappear quickly after exposure ceases. The entire respiratory tract may also be irritated, resulting in a running nose and pain in the nose and throat. The toxicity of these gases varies in different animal species and in different environmental conditions.

**Toxins**

Staphylococcus toxin occurs naturally in outbreaks of food poisoning, which is the only medical experience with this toxin. The time from ingestion of the toxin to the onset of symptoms is usually two to four hours, although it may be as short as half an hour. Most people recover in 24-48 hours, and death is rare.
Psychochemicals

85. These substances have been suggested for use in war as agents, which could cause temporary disability by disrupting normal patterns of behaviour. The idea cannot be accepted in its simple form, inasmuch as these substances may lead to more permanent changes, particularly in individuals who are mentally unbalanced or in the early stages of a nervous or mental disease. Moreover, very high doses, which would be difficult to exclude during use in war, can cause irreversible damage to the central nervous system or even death. Psychochemicals could also have particularly severe effects on children.

86. It is extremely difficult to predict the effects which an attack with psychochemical agents would produce in a large population. Apart from the complication of the varying reaction of exposed individuals, there could be strange interactions within groups. Inasmuch as the probability of fatal casualties resulting directly from exposure is low, some normal group activity might be sustained.
4. OTHER EFFECTS OF CHEMICAL AGENTS

Effects on animals

87. The effects of lethal chemical agents on higher animals are, in general, similar to those on man.

Effects on plants

88. A variety of chemicals kill plants, but little is known about their long-term effects. The duration of effect usually lasts weeks or months. Some chemicals kill all plants indiscriminately; others are selective.

B. The effects of bacteriological (biological) agents on individuals and populations

89. As stated previously, mankind has been spared any experience of modern bacteriological (biological) warfare, so that any discussion of its possible nature has to be based on extrapolation from epidemiological knowledge and laboratory experiment.

1. EFFECTS ON INDIVIDUALS

90. Bacteriological (biological) agents could be used with the intention of killing people or of incapacitating them either for a short or a long period. The agents, however, cannot be rigidly defined as either lethal or incapacitating, inasmuch as their effects are dependent upon many factors relating not only to themselves but to the individuals they attack. Any disease-producing agent intended to incapacitate may, under certain conditions, bring about a fatal disease. Similarly, attacks which might be intended to provoke lethal effects might fail to do so.

91. The effects of some forms of bacteriological (biological) warfare can be mitigated by chemotherapeutic, chemoprophylactic and immunization measures (for protection see Chapter I). Specific chemotherapeutic measures are effective against certain diseases but not against those caused by viruses. However, it may not always be possible to apply such measures, and they might not always be successful. For example, with some diseases early therapy with antibiotics is usually successful but relapses may occur. Moreover, resistance against antibiotics may develop in almost all groups of micro-organisms, and resistant strains may retain full virulence for man as well as for animals.

Possible bacteriological (biological) agents

92. Victims of an attack by bacteriological (biological) weapons would, in effect, have contracted an infectious disease. The diseases would probably be known, but their symptoms might be clinically modified. For example, apart from the deliberate genetic modification of the organism, the portals of infection might be different from the natural routes, and the disease might be foreign to the geographical area in which it was deliberately spread. Possible bacteriological (biological) agents representing diseases caused by the main groups of relevant micro-organisms are the following:
93. Anthrax. Under natural conditions, anthrax is a disease of animals, the main source of infection for man being cattle and sheep. The lung or respiratory form of transmission is most severe, and unless early treatment with antibiotics is resorted to, death ensues within two or three days in nearly every case. Antibiotic prophylaxis is possible but would have to be prolonged for weeks. The anthrax bacillus forms very resistant spores, which live for many years in contaminated areas and constitute the most dangerous risk the disease presents. Heavy concentrations of resistant anthrax spore aerosols could result in a high proportion of deaths in a heavily exposed population. Immunization could not be expected to protect against a heavy aerosol attack.

94. Coccidioidomycosis. This disease, which is also called desert fever, is caused by a fungus found in the soil of deserts in the United States, South America and the USSR. The spores of the fungus are very stable and can easily be disseminated as an aerosol. Treatment presents great difficulties.

95. Plague. Under natural conditions, small rodents, from which the disease is transmitted by fleas, are the main source of human infection with plague. This is how "bubonic" plague develops. If the plague microbes are inhaled, pneumonic plague develops after a three-to-five-day incubation period. The patient suffers from severe general symptoms and, if untreated, normally dies within two to three days. A patient with pneumonic plague is extremely contagious to contacts. Preventive vaccination is moderately effective against bubonic, but not pneumonic, plague. If administered early, streptomycin treatment may be successful.

96. Q-fever. Under natural conditions, Q-fever is a disease of animals, the main sources of infection to man being sheep, goats and cattle. In untreated cases, the illness lasts from two to three weeks; the patient feels exhausted and is unable to do normal work for several weeks. But the disease can be successfully treated with broad-spectrum antibiotics (tetracyclines). The agent causing the disease is a rickettsia and is extremely infectious for man. A Q-fever aerosol could produce an incapacitating effect in a large proportion of the population of an attacked area. The infective agent could persist in the environment for months.

97. Tularaemia. Under natural conditions, tularaemia is a disease of wild animals, the source of human infection being rodents, especially rabbits and hares. The pulmonary form (airborne infection) is the more serious. In Europe and Japan mortality due to this form of the disease was never higher than 1 per cent, even before antibiotics became available. American tularaemia strains, on the other hand, are much more dangerous; some epidemics have been associated with a mortality rate as high as 20 per cent, despite antibiotic treatment. Usually treatment with streptomycin or tetracyclines is highly effective. A tularaemia vaccine developed in the USSR is also highly effective. The agent causing the disease is a microbe which is very sensitive to common disinfectants but is able to survive for as long as a few weeks in contaminated dust, water etc. The disease is not transferred from man to man, but long-lasting natural foci might be created.
98. **Venezuelan equine encephalitis virus (VEE).** In nature, VEE is an infection of animals (equines, rodents, birds) transmitted to man through mosquitoes which have fed on infected animals. The mortality rate is very low, and recovery is usually rapid after a week, with residual weakness often persisting for three weeks. No specific therapy is available. The vaccine is still in the experimental stage. Concentrated aerosols could be expected to incapacitate a very high percentage of the population exposed. In some areas, persistent endemic infection in wild animals would be established.

99. **Yellow fever.** In nature, yellow fever is primarily a virus disease of monkeys, transmitted to man by a variety of mosquitoes. The very severe forms end in black vomitus and death. In a non-immune population, mortality rates for yellow fever may be as high as 30–40 per cent. There is no specific treatment, but prophylactic vaccination, being highly effective, is widely used in yellow fever endemic areas.

### 2. EFFECTS ON POPULATIONS

100. Other than for sabotage, the use of aerosol clouds of an agent is the most likely form of attack in bacteriological (biological) warfare. The effects of bacteriological (biological) attacks obviously would vary according to circumstances. Military personnel equipped with adequate protective measures, well trained in their use and provided with good medical services could, if warned of an attack, be able to protect themselves to a considerable degree. But effective early warning and detection systems do not yet exist. On the other hand, attacks on civil populations are likely to be covert and by surprise, and, at present, no civilian populations are protected. Unprotected military or civilian personnel would be at complete risk, and panic and irrational behaviour would complicate the effects of the attack. The heavy burden that would be imposed on the medical services of the attacked region would compound disorganization, and there would be a major risk of the total disruption of all administrative services.

101. In view of the extensive antipersonnel effects associated with agents of the kind with which this report is concerned, it is useful to view them against the area of effect of a one-megaton nuclear explosion.
### Comparative Estimates of Disabling Effects of Hypothetical Attacks on Totally Unprotected Populations Using a Nuclear Chemical or Bacteriological (Biological) Weapon That Could Be Carried by a Single Strategic Bomber

<table>
<thead>
<tr>
<th>Type of weapon</th>
<th>Nuclear (one megaton)</th>
<th>Chemical (15 tons of nerve agent)</th>
<th>Bacteriological (biological)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Criterion for estimate</strong></td>
<td>Up to 300 km²</td>
<td>Up to 60 km²</td>
<td>Up to 100,000 km²</td>
</tr>
<tr>
<td><strong>Area affected</strong></td>
<td>Seconds</td>
<td>Minutes</td>
<td>Days</td>
</tr>
<tr>
<td><strong>Time delay before onset of effect</strong></td>
<td>Destruction over an area of 100 km²</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td><strong>Damage to structures</strong></td>
<td>Radioactive contamination in an area of 2,500 km² for 3-6 months</td>
<td>Contamination by persistence of agent from a few days to weeks</td>
<td>Possible epidemic or establishment of new endemic foci of disease</td>
</tr>
<tr>
<td><strong>Other effects</strong></td>
<td>3-6 months after attack</td>
<td>Limited during period of contamination</td>
<td>After end of incubation period or subsidence of epidemic</td>
</tr>
<tr>
<td><strong>Possibility of later normal use of affected area after attack</strong></td>
<td>90 per cent deaths</td>
<td>50 per cent deaths</td>
<td>50 per cent morbidity; 25 per cent deaths if no medical intervention</td>
</tr>
</tbody>
</table>
40.

| Multiyear investment in substantial research and development production capability | $5,000-10,000 million | $1,000-5,000 million | $1,000-5,000 million |

- It is assumed that mortality from the disease caused by the agent would be 50 per cent if no medical treatment were available.
- It is assumed that indicated cumulative investments in research and development and production plants have been made to achieve a substantial independent capability. Individual weapons could be fabricated without making this total investment.

3. EFFECTS ON ANIMALS

102. The way bacteriological (biological) weapons might be used against stocks of domestic animals would probably be the same as that used in attacks against man. Viral infections probably cause the most important diseases of domestic animals and could have more devastating effects than diseases produced by other types of pathogens. Since many of the organisms that cause infectious diseases in domestic animals are also pathogenic for man, such attacks might also affect the human population directly.

103. Covert bacteriological (biological) attack during peacetime directed against domestic animals could give rise to serious political and economic repercussions if large numbers of stock were affected.

104. Isolated attacks against stocks of domestic animals during wartime would have only a nuisance value. However, if a highly infectious agent (e.g., foot-and-mouth disease) were used, even a local attack could have very widespread effects because of spread by the normal commercial movement of animals.

105. The possibilities of protecting domestic animal stocks against bacteriological (biological) attacks are so remote that they are not worth discussing.

4. EFFECTS ON PLANTS

106/107. Living micro-organisms could also be used to generate diseases in crops which are economically important either as food or as raw material (e.g., cotton and rubber). Significant food crops in this respect include potatoes, sugar-beet, garden vegetables, soya beans, sorghum, rice, corn, wheat and other cereals and fruits.
108. In theory there are measures which could protect crops against bacteriological (biological) attacks; but at present their potential cost rules them out in practice. There is no essential difference between the measures which would have to be introduced to counter bacteriological (biological) weapons and those employed normally to control plant diseases in peacetime. But the use of bacteriological (biological) weapons to destroy crops on a large scale would imply that the attacker would choose agents capable of overcoming any known, economical method of protection.

5. FACTORS INFLUENCING THE EFFECTS OF BACTERIOLOGICAL (BIOLOGICAL) ATTACKS

Exotic diseases

109. Any country that resorted to bacteriological (biological) warfare would presumably try to infect, with a single blow, a large proportion of an enemy population with an exotic agent to which they had not become immune through previous exposures. In addition, a disease which had been controlled or eradicated from an area might be reintroduced as a result of bacteriological (biological) warfare.

Altered or new diseases

110. Deliberate genetic steps might also be taken to change the properties of infectious agents, especially in antigenic composition and drug resistance. Apart from genetic changes that could be induced in known organisms, it is to be expected that new infectious diseases will appear naturally from time to time and that their causative agents might be used in war.

Epidemic spread

111. As already emphasized, a wide variety of agents can infect by the inhalation route, so that in a bacteriological (biological) attack a large number of persons could be infected within a short time. From the epidemiological point of view, the consequences would differ, depending on whether the resultant disease was or was not transmissible from man to man. In the latter case the result would be a once-for-all disaster, varying in scale and lethality according to the nature of the organism used and the numbers of people affected.
Susceptibility of population

112. A very important factor in the effectiveness of an aerosol attack is the state of immunity of the target population. Where the population is completely lacking in specific immunity to the agent which is disseminated, the incidence and severity of disease are likely to be exceptionally high. Naturally occurring examples of very severe epidemics in virgin populations are well known (e.g., measles in Fiji, poliomyelitis and influenza in the Arctic).

Populations of increased vulnerability

113. The Food and Agriculture Organization (FAO), the World Health Organization (WHO) and the United Nations Children’s Fund (UNICEF) have pointed out that in developing countries a shortage of nutritious food is a major factor in the high mortality rate due to infectious diseases, particularly in children.

114. Primitive housing and inadequate clothing would lead to an increased vulnerability to bacteriological (biological) weapons and, more particularly, chemical weapons. Other conditions which characterize poor populations have a definite influence on the spread of infections. Inadequate housing, lack of potable water and, in general, bad sanitation, a low educational level, numerous vectors of infectious disease and, of course, a lack of medical services are factors which also favour the spread of disease.

Social effects and public health measures

115. A basic factor which influences the risk of epidemic situation during every war is a rapid impairment of standards of hygiene, produced by widespread destruction of housing and of sanitary facilities, the inevitable decline in personal hygiene and other difficulties.
Chapter III

ENVIRONMENTAL FACTORS AFFECTING THE USE OF CHEMICAL AND
BACTERIOLOGICAL (BIOLOGICAL) WEAPONS

A. General considerations

116. Environmental factors influence the behaviour of chemical and bacteriological (biological) weapons to a far greater extent than they do any other kind of armament.

117. Chemical attacks would usually take effect simultaneously in two forms:

(a) Contamination of the ground at, and in the immediate vicinity of the target by direct deposition of the agent at the time of dispersion and by subsequent settling of large particles;

(b) Formation of a toxic cloud consisting of fine particles, or droplets, of aerosol and possibly of vapour.

118. Most bacteriological (biological) attacks would be designed primarily to create an infectious aerosol as an inhalation hazard. Some ground contamination, however, might also result when infectious particles settled on the ground. Both ground contamination and toxic or infectious clouds would be immediately subject to the physical action of the atmosphere.

B. The influence of atmospheric factors on clouds of aerosols or vapours

119. The movement of a toxic or infectious cloud after its formation depends chiefly on the combined effects of wind and atmospheric conditions. The cloud is carried a longer or shorter distance by the wind; at the same time it is dispersed and diluted at a faster or slower rate by turbulence of the atmosphere and by local disturbances of mechanical origin resulting from the roughness of the ground. The cloud may rise rapidly in the atmosphere or remain in the immediate vicinity of the ground, thus retaining its destructive power for a greater or lesser time, depending on whether the air layer in which it is released is in a stable or unstable state.

1. STATE OF THE ATMOSPHERE

120. The state of the atmosphere plays such an important role in the behaviour of aerosol clouds that one might almost say that it is the predominant factor in determining the outcome of an attack, the effect of which could be considerably reduced, or almost nullified, if the atmosphere was very unstable, or very serious if it was in a state of pronounced and prolonged stability. This condition has characterized all the disasters caused by
industrial pollution; for example, the smog which claimed 4,000 victims in London in 1952 took its toll during a period of atmospheric stability which lasted for seven days.

2. URBAN AREAS

121. The case of urban built-up areas is more complex, and it may even be said that each one possesses its own microclimate, depending on its geographical situation, its topography and the layout and nature of its buildings. Fog is more frequent over towns than over open country (+30 per cent in summer and +100 per cent in winter). The process of fog formation is accelerated by the particles, dust and smoke which form a dome over the town. Fog will obviously have a concentrating effect on particles originating in toxic clouds.

3. EFFECT OF WIND AND TOPOGRAPHY

122. The wind carries and spreads the toxic or infectious cloud, which is simultaneously diluted by turbulence. The distance which the cloud travels before its concentration has fallen to a level below which it is no longer harmful depends on the velocity of the wind and the state of the atmosphere. Inasmuch as topography also produces changes in the normal wind pattern, it, too, plays an important part in determining the direction of travel of toxic clouds, sometimes focusing their effects in individual areas.

123. A stable or neutral atmosphere in equilibrium might cause a toxic cloud produced by a chemical or bacteriological (biological) attack to persist for hours after it had exercised its military effect, which could generally be expected to materialize in the first few minutes following the attack. These conditions could obtain not only at night but during long winter periods over vast continental expanses. If a neutral atmosphere in equilibrium were associated with a light wind, irregular in direction, then the area affected could be relatively large, and, assuming an adequately heavy initial attack, the concentrations would be high.

4. SPECIAL FEATURES OF BACTERIOLOGICAL (BIOLOGICAL) AEROSOLS

124. So far as physical phenomena are concerned, bacteriological (biological) aerosols would be generally affected in the same way as chemical clouds of aerosol and vapour, but not necessarily to the same extent. But inasmuch as the effective minimum doses for bacteriological (biological) agents are considerably smaller than for chemical agents, bacteriological (biological) aerosols could contaminate much larger areas than could chemical clouds.

125. There would be no limit to the horizontal transport of microorganisms, if there were none to the capacity of the organisms to survive in the atmosphere. The agents whether alive or dead, might remain suspended and travel very considerable distances. Even if bacteriological (biological) clouds were to move only nearest the ground, they could cover very large areas.
126. On the other hand, most pathogenic agents are highly vulnerable when outside the organism in which they normally reproduce and are liable to biological inactivation, which is sometimes rapid, in the aerosol state.

C. Influence of atmospheric factors

127. Atmospheric factors, such as temperature, humidity, precipitation and solar radiation, may also influence the results of an attack with aerosol. Bacteriological (biological) agents would be more susceptible to environmental influences than chemical agents.

128. Physico-chemical atmospheric factors have a destructive effect on aerosol-borne micro-organisms. Their viability decreases gradually over a period of hours or days at a progressively diminishing rate. This apparent vulnerability of micro-organism in aerosols might cast some doubt on the possible effectiveness of bacteriological (biological) attacks. However, there are various means by which the rate of decay in the aerosol can be considerably reduced; for example, the use of very high concentrations of agent; the use of suitably "modelled" pathogenic strains; or the protection of aerosol particles by encapsulating them in certain organic compounds.

Chapter IV

POSSIBLE LONG-TERM EFFECTS OF CHEMICAL AND BACTERIOLOGICAL (BIOLOGICAL) WARFARE ON HUMAN HEALTH AND ECOLOGY

A. General

129. So far this report has dealt essentially with the potential short-term effects of chemical and bacteriological (biological) warfare. The possible long-term effects of the agents concerned need to be considered against the background of the trends whereby man's environment is being constantly modified, as it becomes transformed to meet his ever-increasing needs.

130. Man has his special ecological problems. His numbers are multiplying fast, and increasing population requires commensurate increases in food production. But although the use of fertilizers, herbicides and pesticides has brought about a massive increase in food production, it has also added to the pollution of soil and water and, as a result, has altered our ecological environment in an enduring way. So, too, have other features of our industrial civilization. Every new advance on our technological civilization helps to transform the ecological framework within which we evolved. From this point of view, the existence and possible use of chemical and bacteriological (biological) agents in warfare have to be regarded as an additional threat, and as a threat which might have enduring consequences, to our already changing environment.

B. Consequences to man of upsetting the ecological equilibrium

131. The chemical industry doubled its output between 1953 to 1960, and it is still growing fast; the useful results of its continued development are of the utmost importance to man's future. The good effects on food production of the use of artificial fertilizers alone far outweigh any secondary
deleterious consequences of their use. The beneficial effect of the utilization of modern chemical pesticides also does not need spelling out. What has to be realized about modern agricultural practices is that without them the increases in the output of food which the world needs could never be achieved.

132. But as already indicated, the great increase in the use of fertilizers, pesticides and herbicides does have deleterious side effects that cannot but help transform – for all we know adversely – the environment in which living matter, including fish, otherwise thrive. The dangers of the side effects of modern pesticides are also beginning to be appreciated and are already beginning to be guarded against in advanced countries. It is theoretically possible that in some situations in which non-selective chemical pesticides are used disruption of the ecological equilibrium could lead to the long-term suppression of useful animals and plants. Detergents are another modern chemical development whose use has had to be regulated, inasmuch as they have a direct short-term effect on certain types of natural food, such as daphniae and the algae which are eaten by fish.

133. Towns and cities are growing all over the world and in the developed countries conurbations (fusion of cities with loss of suburbs) have reached population levels approaching 50 million. The use of chemical or bacteriological (biological) weapons against cities would undoubtedly have an exceptionally severe disorganizing effect, and the full re-establishment of the services necessary for health, efficient government and the smooth operation of industry might take a very long time.

C. Possible long-term effects of chemical and bacteriological (biological) means of warfare on man and his environment

134. Chemical weapons, in addition to their highly toxic short-term effects, may also have a long-term effect on the environment in which they are disseminated. If used in very high concentration they might cause damage by polluting the air and water supplies and by poisoning the soil. Bacteriological (biological) weapons could be directed against man's sources of food through the spread of persistent plant diseases or of infectious animal diseases. There is also the possibility that new epidemic diseases could be introduced, or old ones reintroduced, which could result in deaths on the scale which characterized the mediaeval plagues.

1. CHEMICAL WEAPONS

135. There is no evidence that the chemical agents used in the First World War – chlorine, mustard, phosgene and tear-gas – had any untoward ecological consequences. The regions affected have long since returned to normal and fully productive use.

136. The organophosphorous, or nerve, agents have never been used in war. But inasmuch as these agents are toxic to all forms of animal life, it is to be expected that if high concentrations were disseminated over large areas,
and if certain species were virtually exterminated, the dynamic ecological equilibrium of the region might be changed.

137. In high rainfall areas, deforestation by the use of herbicides may lead to serious erosion, and so to considerable agricultural losses. Deserts have been created in this way.

2. BACTERIOLOGICAL (BIОLOGICAL) WEAPONS

Against man

138. New natural foci, in which infection may persist for many years, may be established after an aerosol or other type of bacteriological (biological) attack. The spread of rabies in Europe following the Second World War, as a consequence of the disorganization caused by war, shows how an epidemiologically complicated and medically dangerous situation can emerge even with an infection which had long been successfully controlled. Bringing the situation under control demanded extraordinary and prolonged efforts. None the less, the disease has not yet been stamped out. Natural foci cannot be eliminated without organized and long-term international co-operation. Large-scale use of bacteriological (biological) weapons might reduce populations of susceptible wild species below the level at which they could continue to exist. The elimination of a species or group of species from an area might seriously disturb its ecological equilibrium and eventually lead to the establishment of a natural focus of disease.

139. The gravity of these risks would depend on the extent to which the community of species in the country attacked contained animals which were not only susceptible to the infection but were living in so close a relationship to each other that the infection could become established. For example, a natural focus of yellow fever is very unlikely to become established in any area lacking an adequate population of mosquitoes suitable as vectors.

140. Endemics or enzootics of diseases (i.e., infections spreading at a low rate, but indefinitely, in a human or animal population) could conceivably follow a large-scale attack, or might be started by a small-scale sabotage attack, for which purpose the range of possible agents would be much wider and might even include such chronic infections as malaria.

141. Another consideration is the possible introduction of a new species to an area to cause either long-term disease or economic problems. Certain mosquito species have naturally spread to many areas of the world from their original home in Africa and have been responsible for serious disease problems in the areas that have been invaded. It is conceivable that in the war the introduction of such insects on a small scale might be tried for offensive purposes.
Against domestic animals

142. Foot-and-mouth disease is a highly infectious but largely non-fatal disease of cattle, swine and other cloven-footed animals. It is rarely transmitted from a diseased animal to man. The milk yield of diseased cows decreases sharply and does not reach its normal yield even after complete recovery. It is obvious that a large epizootic could constitute a very serious economic burden, for example, by bringing about a serious reduction in the supply of milk.

143. Brucellosis is an example of chronic disease which could possibly result from bacteriological (biological) weapon attacks. There are three forms known and any of these may be transmitted to man, in whom it causes a debilitating but rarely fatal disease lasting for four to six months or even longer.

144. If large quantities of anthrax spores were disseminated in bacteriological (biological) weapons, thus contaminating the soil of large regions, danger to domestic animals and man might persist for a very long time. There is no known way by which areas could be rendered safe.

Against crops

145. The rust fungus is one of the most damaging of natural pathogens which affect wheat crops. It is estimated that the annual total world loss of wheat from rust is equivalent to about $500 million. Rust epiphytotics might have a very serious effect in densely populated developing countries, where the food supply might be reduced to such an extent that a human population already suffering from malnutrition might be driven to starvation.

3. GENETIC AND CARCINOGENIC CHANGES

146. The possibility also exists that chemical and bacteriological (biological) weapons might cause genetic changes. Some chemicals are known to do this. LSD, for example, is known to cause genetic changes in human cells. Such genetic changes might conceivably have a bearing on the development of cancer. A significantly increased incidence of cancer in the respiratory tract (mainly lung) has been reported recently among workers employed in the manufacture of mustard gas during the Second World War.

Chapter V

ECONOMIC AND SECURITY IMPLICATIONS OF THE DEVELOPMENT, ACQUISITION AND POSSIBLE USE OF CHEMICAL AND BACTEROLOGICAL (BIOLOGICAL) WEAPONS AND SYSTEMS OF THEIR DELIVERY

A. General

147. Previous chapters have revealed the extent to which scientific developments have magnified the potential risks associated with the concept
of chemical or bacteriological (biological) warfare. The doubt that an attack could be restricted to a given area means that casualties could occur well outside the target zone. Were these weapons used to blanket large areas and cities, they would cause massive loss of human life, affecting non-combatants in the same way as combatants, and, in this respect, they must clearly be classified as weapons of mass destruction.

B. Production

1. CHEMICAL WEAPONS

148. With the rapid development of the industry since the First World War, there has been an enormous growth in the potential capacity to produce chemical agents. The scale, nature and cost of any programme for producing chemical weapons, and the time needed to implement it, would clearly be largely dependent on the scientific, technical and industrial potential of the country concerned. It would depend not only on the nature of the chemical industry itself and the availability of suitably trained engineers and chemists but on the level of development of the chemical engineering industry and of the means of automating chemical processes, especially where the production of highly toxic chemical compounds is involved. Whatever the cost of developing a chemical or bacteriological (biological) capability, it needs to be realized that it would be a cost additional to, and not a substitute for, that of acquiring an armoury of conventional weapons.

149. Today a large number of industrialized countries have the potential to produce a variety of chemical agents. Many of the intermediates required in their manufacture, and in some cases even the agents themselves, are widely used in peacetime. Such substances include, for example, phosgene, which some highly developed countries produce at the rate of more than 100,000 tons a year and which is commonly used as an intermediate in the manufacture of synthetic plastics, herbicides, insecticides, paints and pharmaceuticals. The world production of ethylene-oxide and propylene-oxide is now well in excess of 2 million tons per year. Two hundred and fifty thousand tons of ethylene-oxide would yield about 500,000 tons of mustard gas.

150. The production of highly toxic nerve agents, including organophosphorus compounds, presents problems which, because they are relatively difficult, could be very costly to overcome. The approximate cost of acquiring one plant complex to produce munitions containing up to 10,000 tons of Sarin a year would be about $150 million. The cost, of course, would be considerably less if existing munitions could be charged with chemical agents.

151. A country which possessed a well-developed chemical industry could clearly adapt it to produce chemical agents. But were it to embark on such a step, it would be only the beginning. The establishment of a comprehensive chemical warfare capability would also involve special research centres, experimental test grounds, bases, storage depots and arsenals. The development of sophisticated and comprehensive weapon systems would be a very costly part of the whole process.
2. BACTERIOLOGICAL (BIOLOGICAL) WEAPONS

152. The microbiological expertise necessary to grow agents of bacteriological (biological) warfare exists to a large extent in many countries, inasmuch as the requirements are similar to those of a vaccine industry and, to a lesser extent, a fermentation industry. Apart from the combination of the highly developed technologies of these two industries, there remains only a need for some specialized knowledge, expertise and equipment to permit the safe handling of large quantities of bacteriological (biological) agents. But the technological complexities of producing bacteriological (biological) agents in dry powder form are very much greater than for wet spray systems. Moreover, it would be desirable to provide an effective vaccine with which to protect production staff. The technical difficulties would increase with the scale and complexity of the weapon systems that were being developed.

153. Despite the fact that the development and acquisition of a sophisticated armoury of chemical and bacteriological (biological) weapon system would prove very costly, any developing country could acquire a limited capability in this type of warfare. Hence, the danger of the proliferation of this class of weapons applies as much to developing as it does to developed countries.

C. Delivery systems

154. Practically all types of explosive munitions (artillery shells, mines, guided and unguided rockets, serial bombs, landmines, grenades, etc.) can be adapted for the delivery of chemical agents. A modern bomber, for example, can carry about fifteen tons of toxic chemical agents, and it is estimated that only 250 tons of V-gas, an amount which could be delivered by no more than fifteen or sixteen aircraft, is enough to contaminate a great city with an area of 1,000 square kilometres and a population of from 7 to 10 million. Were such a population mainly in the open and unprotected, fatal casualties might reach the level of 50 per cent.

155. Existing armaments which (with some modification) could be used to deliver agents in order to generate local outbreaks of disease could also contaminate large areas with pathogens. For example, a single aircraft could cover with a bacteriological (biological) agent an area of up to 100,000 square kilometres, although the area of effective dosage might be much smaller due to loss of the infectivity of the airborne agent.

D. Protection

156. The measures which would be required to protect a population, its livestock and plants against chemical or bacteriological (biological) attack are immensely costly and complex (chapter I). Even if protective measures were provided against known agents, it is conceivable that new ones might be developed whose physical or chemical properties would dictate a need for new individual and communal protective equipment. This could constitute an even greater economic burden.
157. Defensive measures, especially against chemical agents, would also have to include the extremely laborious and expensive task of decontaminating large numbers of people, as well as equipment, weapons and other materials.

158. A very important part of a defense system against chemical or bacteriological (biological) weapons would be the means of very rapidly detecting an attack and identifying the specific agent used. Methods for doing this rapidly and accurately are still inadequate.

159. It would be extremely difficult to arrange for the medical treatment of a civilian population which had been attacked with chemical or bacteriological (biological) weapons. Mobile groups of specialists in infectious disease, of microbiologists and of well-trained epidemiologists would have to be organized to provide for early diagnosis and treatment, and a network of reserve hospitals and a massive supply of drugs would have to be prepared in advance. The maintenance of a stockpile of medical supplies is extremely costly.

E. Cost to society

160. The extent to which the acquisition, storage, transport and testing of chemical and bacteriological (biological) munitions would constitute an economic burden would depend on the level of a country's industrial and military capability, although compared to nuclear weapons and advanced weapon systems in general, it might not seem excessive. But the task of organizing delivery systems and deployment on a large or sophisticated scale could well be economically disastrous for many countries.

161. Chemical and bacteriological (biological) attacks could be particularly dangerous in towns and densely populated areas. The consequences might also be particularly serious in regions with a warm, moist climate, in low-lying areas and in areas with poorly developed medical facilities.

162. The technical and organizational complexity and the great financial cost of providing adequate protection for a population against attack by chemical and bacteriological (biological) agents have already been emphasized. Total costs of civil defence against chemical and bacteriological (biological) agents would be greater than $15,000-$25,000 million for a developed country of 100-200 million people. But even if such a programme were ever planned and implemented, there could be no assurance that full protection could be achieved.

163. It is almost impossible to conceive of the complexity of the arrangements which would be necessary to control the consequences of a large-scale bacteriological (biological) attack. Even in peacetime, the development of an epidemic of a highly contagious disease started by a few individual cases necessitates enormous material expenditure and the diversion of large numbers of medical personnel. Large-scale bacteriological (biological) attacks could have a serious impact on the entire economy of the target country and, depending on the type of agent used, the disease might well spread to neighbouring countries.
164. Whatever might be done to try to save human beings, nothing significant could be done to protect crops, livestock, fodder and foodstuffs from a chemical and bacteriological (biological) weapons attack. Water in open reservoirs could be polluted as a result of deliberate attack, or perhaps accidentally, with chemical or bacteriological (biological) weapons. Enormous damage could be done to the economy of a country whose agricultural crops were attacked with herbicides. For most practical purposes, it would be impossible to prevent the destruction of cultivated plants on which herbicides have been used, and, depending on a country's circumstances, widespread famine might follow.

165. Over and above all these possible effects of chemical and bacteriological (biological) warfare on farm animals and crops is the possibility discussed in the previous chapter, of widespread ecological changes due to deleterious changes brought about in wild fauna and flora.

F. The relevance of chemical and bacteriological (biological) weapons to military and civil security

166. Chemical weapons could be more effective than equivalent weights of high explosive when directed against densely populated targets. Similarly, so far as mass casualties are concerned, bacteriological (biological) weapons could, in some circumstances, have far more devastating effects than chemical weapons, and effects which might extend well beyond the zone of military operations.

167. From the military point of view, one essential difference between antipersonnel chemical and bacteriological (biological) weapons, on the one hand, and a conventional high-explosive weapon, on the other (including small arms and the whole range of projectiles), is that the area of the effects of the latter is more predictable. Neither the effectiveness nor the effects of chemical and bacteriological (biological) weapons can be predicted with assurance. In fact, they could open the door to hostilities which could become less controlled, and less controllable, than any war in the past. Uncontrollable hostilities cannot be reconciled with the concept of military security.

168. Since some chemical and bacteriological (biological) weapons constitute a major threat to civilian populations and their food and water supplies, their use cannot be reconciled with general national and international security. Their very existence contributes to international tension without compensating military advantages. They generate a sense of insecurity not only in countries which might be potentially belligerent but in those which are not. Neutral countries could be involved through the use of chemical and bacteriological (biological) weapons, especially those whose territories bordered on countries involved in a conflict.

169. Obviously, any extensive use of chemical weapons would be known to the country attacked. The source of the attack would probably also be known. On the other hand, it would be extremely difficult to detect isolated acts of sabotage in which bacteriological (biological) weapons were used, especially if the causative organism were already present in the attacked country. Because of the suspicions they would generate, acts of sabotage could thus provoke a conflict involving the widespread use of chemical and bacteriological (biological) weapons.
CONCLUSION

170. All weapons of war are destructive of human life, but chemical and bacteriological (biological) weapons stand in a class of their own as armaments which exercise their effects solely on living matter. The fact that certain chemical and bacteriological (biological) agents are potentially unconfinned in their effects, both in space and time, and that their large-scale use could conceivably have deleterious and irreversible effects on the balance of nature adds to the sense of insecurity and tension which the existence of this class of weapons engenders.

171. The potential for developing an armoury of chemical and bacteriological (biological) weapons has grown considerably in recent years, not only in terms of the number of agents but in their toxicity and in the diversity of their effects.

172. Moreover, chemical and bacteriological (biological) weapons are not a cheap substitute for other kinds of weapons. They represent an additional drain on the national resources of those countries by which they are developed, produced and stockpiled. The cost, of course, cannot be estimated with precision. To some the cost might be tolerable, to others it would be crippling, particularly when account is taken of the resources which would have to be diverted to the development of testing and delivery systems. And no system of defence, even for the richest countries in the world, and whatever its cost, could be completely secure.

173. Because chemical and bacteriological (biological) weapons are unpredictable, in varying degree, and because no certain defence can be planned against them, their universal elimination would not detract from any nation's security. The development of a chemical or bacteriological (biological) armoury, and a defence, implies an economic burden without necessarily imparting any proportionate compensatory advantage to security. And, at the same time, it imposes a new and continuing threat to future international security.

174. The general conclusion of the report can thus be summed up in a few lines. Were these weapons ever to be used on a large scale in war, no one could predict how enduring the effects would be and how they would affect the structure of society and the environment in which we live. This overriding danger would apply as much to the country which initiated the use of these weapons as to the one which had been attacked, regardless of what protective measures it might have taken in parallel with its development of an offensive capability. A particular danger also derives from the fact that any country could develop or acquire, in one way or another, a capability in this type of warfare, despite the fact that this could prove costly. The danger of the proliferation of this class of weapons applies as much to the developing as it does to developed countries.

175. The momentum of the arms race would clearly decrease if the production of these weapons were effectively and unconditionally banned. Their use, which could cause an enormous loss of human life, has already been condemned and prohibited by international agreements, in particular the Geneva Protocol of 1925. The prospects for general and complete disarmament under effective international control would brighten significantly if the development, production and stockpiling of chemical and bacteriological (biological) agents intended for purposes of war were to end and if they were eliminated from all military arsenals.
NAPALM AND OTHER INCENDIARY WEAPONS AND
ALL ASPECTS OF THEIR POSSIBLE USE
A/8803/Rev.1

INTRODUCTION

1. In accordance with General Assembly resolution 2852 (XXVI), the Secretary-General was asked to prepare as soon as possible, with the help of qualified governmental consultant experts, a report on napalm and other incendiary weapons and all aspects of their possible use. It was envisaged that a report by the Secretary-General "on the question of napalm ... could facilitate subsequent action by the United Nations with a view to curtail- ing or abolishing such uses of the weapons in question as might be established as inhumane" (A/8052, para. 126).

2. The request for this report is not a single or isolated action. The International Conference on Human Rights, held under United Nations auspices at Teheran in 1968, adopted resolution XXIII entitled "Human rights in armed conflicts". It was noted in this resolution that "the use of chemical and biological means of warfare, including napalm bombing erode human rights and engender counter-brutality". In the same resolution, napalm bombing was mentioned as an example of the widespread violence and brutality of our times. It is also appropriate to mention in this context the Conference of Government Experts on the Reaffirmation and Development of International Humanitarian Law Applicable in Armed Conflicts organized by the International Committee of the Red Cross. Among the experts consulted by the ICRC, a number declared themselves in favour of the prohibition of napalm.

3. Incendiary weapons may be defined, for the purposes of the present report, as weapons which depend for their effects on the action of incendiary agents. These in turn may be defined as substances which affect their targets primarily through the action of flame and/or heat derived from self-supporting and/or self-propagating exothermic chemical reactions; these reactions, for all practical purposes, are combustion reactions.

1/ Final Act of the International Conference on Human Rights (United Nations publication, Sales No.: E.68.XIV.2), p. 18.
4. Of particular significance today are weapons based on napalm. "Napalm" was a term originally coined to designate a special type of thickening agent that was capable of converting gasoline into a particularly destructive type of incendiary agent. Nowadays the term has acquired a wider meaning and is used in this report to designate all types of incendiary agents made from gasoline, or from other light petroleum distillates, to which thickening agents have been added. Napalms are often exceptionally simple to make, requiring raw materials that are widely available in many parts of the world.

5. The report presents a series of conclusions. The tenor of these is as follows: incendiary weapons are cruel weapons that cause great human suffering. Their use is often indiscriminate as regards their targets. Because of this there is a need to consider measures for the clear-cut prohibition of incendiary weapons.

Chapter I

INCENDIARY AGENTS AND WEAPONS

DEFINITIONS AND SCOPE

6. Napalm and other incendiary weapons are designed to inflict damage on an enemy, his possessions or his environment primarily through the action of heat and flame. Other categories of weapons may also have an incendiary action - as, for example, in the case of nuclear weapons - but this report is concerned only with those where incendiary effects are the ones primarily sought. Incendiary weapons may, however, have other damaging effects. Some incendiary agents are poisons and some produce toxic or asphyxiating effects when they burn.

7. Incendiary-weapon systems have three principal components: an incendiary agent; munitions for dispensing and igniting the incendiary agent in the target area; and a delivery system for conveying the munitions to the target. Munitions containing incendiary agents have been developed for most of the weapon delivery systems possessed by present-day armed services, including aircraft, artillery, naval ordnance, armoured fighting vehicles and the individual soldier.

INCENDIARY AGENTS

8. An incendiary agent is a chemical, or a mixture of chemicals, which can be triggered into undergoing a chemical reaction that liberates a large and sustained quantity of heat. Almost invariably the reaction is that of combustion, namely, reaction of a fuel with oxygen. The oxygen may either be incorporated in the incendiary agent in the form of an oxidizing agent, or it may be drawn from the air.

9. Targets vary in their vulnerability towards heat. The human body, for example, and inflammable materials such as wood or dry vegetation, are more vulnerable than structures composed predominantly of concrete or metal.
For this and other reasons, a range of different incendiary agents has been developed. These can be grouped into four broad categories, namely metal incendiaries, pyrotechnic incendiaries, pyrophoric incendiaries and oil-based incendiaries. Napalm is an oil-based incendiary.

10. An incendiary agent may also be classified either as an "intensive" type or as a "scatter" type. The intensive-type agents are designed for use against materials and buildings of low combustibility and include the metal and the pyrotechnic incendiaries. The scatter-type agents are designed for use against readily combustible targets, or as direct casualty agents against people. Such targets do not necessitate intense point-sources of fire and heat. They can be damaged if relatively small quantities of burning incendiary agent are scattered over their surfaces. Pyrophoric and oil-based incendiaries are scatter-type agents. Their destructiveness is greatest when they are sufficiently adhesive to cling to surfaces while burning, and adhesion-improving additives have been developed for them.

METAL INCENDIARIES

11. Many metals react readily with oxygen or air, much heat being generated in the process. When heated to a high enough temperature, some react so violently that they incandesce and burst into flame. Because they are dense materials, they may therefore make efficient intensive-type incendiaries.

12. Magnesium is the best known metal incendiary, and is the one that has been the most extensively used in war. It is not a particularly cheap material, but it is a widely used industrial commodity in many parts of the world. Certain other metals have a higher heat of combustion, but they are either too expensive or too difficult to ignite. Magnesium melts as it burns, and the molten burning metal may spread over an appreciable area.

13. Hot magnesium reacts with water to generate hydrogen gas, which itself may then ignite. This may complicate the problems of fire-fighting. In order to increase the difficulties of fire-fighting, explosive charges are sometimes included in the bomb casings.

PYROTECHNIC INCENDIARIES

14. Pyrotechnic incendiaries are ignitable mixtures comprising a fuel and an oxidizing agent. They therefore differ from the other categories of incendiary in that they incorporate their own source of oxygen and do not rely on the surrounding air for combustion.

15. Thermite is the prime example of a pyrotechnic incendiary. It was the most widely used incendiary agent of the First World War, and continues in use to the present day. When ignited, this composition burns with great rapidity and violence, the burning temperature exceeding that of magnesium. Molten iron is released in the process; this may flow or be spattered over surrounding surfaces.
16. Despite its alarming appearance when ignited, thermite burns so rapidly that much of the heat generated may be wasted, and it does so without producing a flame. For these reasons, thermite is often modified by including other materials within its formulation. One such mixture is known as thermate. Thermates are easier to ignite than thermite and usually generate large flames. They are used today in incendiary hand grenades and in aircraft bomblets.

PYROPHORIC INCENDIARIES

17. Pyrophoric incendiaries are materials which ignite spontaneously when exposed to air.

18. White phosphorus is a widely used pyrophoric incendiary. When exposed to air, it soon bursts into flame, generating oxides of phosphorus which, under the influence of atmospheric moisture, turn into a dense cloud of white smoke. White phosphorus is generally capable of setting fire only to the most readily combustible materials. It is a scatter-type incendiary. It is usually distributed over its target by an explosive burst. Particles of the agent adhere readily to surfaces while they burn.

19. Lumps of burning white phosphorus are difficult to extinguish with water, and even if water is effective, the lumps reignite when they are dry. Phosphorus fires are best controlled with sand or earth. One particular hazard of fighting phosphorus fires is the ease with which lumps of burning phosphorus stick to the boots and other clothing of fire-fighters. Solutions of white phosphorus in carbon disulphide have been used for incendiary projectiles, bombs and hand-grenades. They have also been dispensed from aircraft spray-tanks. White phosphorus is commonly used as an igniter for oil-based incendiaries charged into projectiles or bombs. Like magnesium, white phosphorus is not a particularly cheap material. However, there is a substantial chemical industry that is based upon it, and its annual world production, which is growing, exceeds a million tons. About 15 countries in the world possess white phosphorus manufacturing facilities.

20. Of the many other pyrophoric materials that are known, triethyl aluminium is one which has recently come into use as an incendiary agent. This substance takes fire, sometimes with explosive violence, in contact with air or water. When used with a thickening agent, it can be scattered in burning gobbets that produce severe skin burns, ignite combustible materials and are extremely difficult to extinguish.

NAPALM AND OTHER OIL-BASED INCENDIARIES

21. Hydrocarbons derived from petroleum oil are inflammable liquids that possess a high heat of combustion and produce a large flame. Because they are cheap (the current market price of crude oil is around $20 per metric ton) and widely available, they have long been studied and used as incendiary agents. Moreover, hydrocarbons burning in quantity frequently generate large amounts of carbon monoxide, which is a highly poisonous gas that may significantly add to the aggressive properties of oil-based incendiaries. Petroleum
hydrocarbons have heats of combustion considerably greater than that of magnesium or white phosphorus. Gasoline is mixed with certain additives when used as an incendiary agent. These greatly increase its destructiveness. They modify its flow properties into a form more suited to weapons use, and make it sufficiently adhesive and cohesive to stick to surfaces in burning gobbets. They may also prolong its burning time and increase its burning temperature.

22. At the outset of the Second World War, the most common additive was rubber. As this became a critical raw material, much work was done on developing substitutes. In 1942, it was discovered that an aluminium soap obtained from a mixture of coconut acid, naphthenic acid and oleic acid provided a particularly effective thickener. This substance came to be known as napalm. Nowadays the meaning of the word "napalm" has broadened to include all types of thickened hydrocarbons used as incendiary agents. In the present report, "napalm" signifies any gelled-hydrocarbon incendiary. In many, but not all, respects, gasoline thickened with napalm soap proved superior as an incendiary agent to previous gasoline gels. It combines a prolonged burning time with great adhesiveness and certain other advantageous physical properties. Important among these are its stability as a gel, and its visco-elasticity.

23. The napalm soap of the Second World War continues in use today, but during the intervening years research and development programmes have produced - and continue to produce - still more effective thickeners. One of the most extensively employed of the new napalms comprises gasoline mixed with an equal quantity of benzene, the mixture being thickened with an equal quantity of polystyrene. It has a greater adhesiveness than earlier napalms, greater storage stability, and lends itself better to large-scale production.

INCENDIARY WEAPONS

24. A wide range of different incendiary weapons has been developed. A distinction is adopted in the following description between incendiary weapons intended for use against population centres, on the one hand, and those for use against battlefield targets, on the other.

INCENDIARY WEAPONS FOR USE AGAINST POPULATION CENTRES

25. Incendiary air attacks against population centres have been conducted in past wars by dispensing great quantities of bombs over the target area with the aim of initiating a large number of primary fires that subsequently spread of their own accord, developing into a conflagration. Against buildings that are made predominantly of brick, stone, concrete or metal, bombs containing intensive-type incendiary agents have chiefly been used. The bombs are made heavy and strong enough to penetrate through roofs. Upon

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2/ The word "napalm" is a contraction of "naphthenate" and "palmitate". It was at first supposed that it was the palmitic acid contained in the coconut acid which was responsible for the efficacy of napalm, rather than the lauric acid, as later transpired.
detonation, they spatter their contents over the inflammable interiors of the buildings. Small magnesium or thermate weapons have generally been dropped in clusters containing a hundred or more. The cluster units open above the target to distribute their bomblets over the target area. Many small fires may then be created in close proximity to one another, and this has proved particularly favourable to the development of a conflagration.

26. Incendiary bomb-loads dropped on urban areas have generally contained a proportion of high explosive weapons. These are intended to shatter windows or break down walls, thereby increasing the inflammability of the target area. They are also intended to rupture watermains and destroy other public utilities, thereby impeding fire-fighting activities.

AIR WEAPONS FOR USE AGAINST BATTLEFIELD TARGETS

27. Tactical aircraft supporting ground operations have frequently used incendiary weapons. Against fixed installations, they may employ the same weapons as those described above. Another weapon, the "fire-bomb", has been extensively used by ground-support aircraft against installations and vehicles. It is also a potent casualty weapon when used against populated area targets. A current version holds about 400 litres of napalm. When it strikes the ground, the agent is spattered over an elliptical area about 120 metres long and 25 metres wide. Another aircraft incendiary weapon is the white phosphorus rocket. Rocket launchers are common armaments for ground-support aircraft.

GROUND WEAPONS FOR USE AGAINST BATTLEFIELD TARGETS

28. Although napalm was developed during the Second World War primarily for use in air raids on cities, its properties made it particularly suited for use in flamethrowers. Indeed, but for the development of napalm, the flamethrower would probably not have acquired its present status. There are two principal types: the portable, which a soldier can carry on his back, and the mechanized flamethrower, used either as an auxiliary or as a main armament on armoured fighting vehicles. Incendiary rockets fired from portable rocket launchers are beginning to replace portable flamethrowers in some of their tactical roles. Larger rockets of this type are being developed for use from armoured fighting vehicles.

29. Other ground weapons dispensing incendiary agents include landmines charged with napalm or white phosphorus; artillery projectiles, mortar bombs or small rockets (i.e., up to 125 millimetre calibre) charged with white phosphorus; and hand- or rifle-grenades charged with white phosphorus or thermate.

OTHER INCENDIARY WEAPONS

30. Incendiary weapons have also been developed to meet certain specialized requirements that do not fall within the preceding categories. Noteworthy among them are the devices that have been designed for firing vegetation and crop cultivations, although efforts to develop them have not been notably successful.
Chapter II

ACTION OF INCENDIARY WEAPONS AND THEIR NON-MEDICAL EFFECTS

31. Incendiary weapons may damage or destroy most types of material. They may initiate fires that subsequently take hold and spread through their surroundings. Four matters of particular significance emerge from the present chapter:

    (a) Incendiary weapons may severely damage structures, machinery and other items of equipment even where such targets are made predominantly from non-combustible materials. To take a battlefield example, napalm is capable of immobilizing armoured vehicles and putting other heavy weapons out of action.

    (b) If a fire takes hold and spreads, it may soon become uncontrollable, bringing indiscriminate destruction to almost everything in its path.

    (c) In built-up areas, the spread of fire depends largely on the density and nature of buildings in the area. Densely built-up zones where wood is the predominant building material are particularly vulnerable to spreading fires.

    (d) In rural areas, the probability of fire spread is largely determined by the climate, the topography and the prevailing weather conditions. The additional long-term ecological consequences, which could be severe, are largely unpredictable.

HOW INCENDIARIES START FIRES

32. Intensive-type incendiaries, because of their high burning temperature and compactness, are powerful emitters of radiation, which is one of the main reasons why they may be effective against poorly combustible targets. Heat transfer by convection, in the form of hot air currents or flames, is also important. Scatter-type incendiaries operate more by convection than radiation, and are therefore most destructive when the burning agent sticks to vertical surfaces. An explosive charge in the weapon distributes gobbets of burning agent (e.g., white phosphorus or napalm) which may then stick to walls, floors, ceilings, furniture, and so forth, creating numerous foci of fire.

SPREAD AND DURATION OF FIRES

General Features

33. Whether a fire takes hold and spreads through an area is a complex matter that depends on the interaction of many factors. Among them are the characteristics and distribution of the different types of material...
in the area, the prevailing weather conditions, and the local topography. In many situations, the wind velocity and the dryness or dampness of the target materials are particularly important. The behaviour of the fire also depends on the number and distribution of the foci from which it springs: to take an illustration from the Second World War, the scattering of large numbers of small incendiary bombs over a town was often more likely to burn it down than the same tonnage of larger bombs.

34. An incendiary attack on a city is usually designed to create what is called a mass-fire. This occurs when the fires spreading from several foci merge into a single conflagration. This may then build up to an enormous and uncontrollable pitch of violence, only subsiding when virtually nothing combustible remains. Mass-fires may be of two kinds. In one, the fire-front is moving, often with great rapidity, in the direction of prevailing winds. In the other, the fire is stationary, with very fast currents of air being sucked into it from all directions by the intense updraught created by the conflagration. Virtually everything combustible in the area is consumed. Mass-fires of the second kind are known as fire-storms, and are even more destructive than the first kind. They are not known in wildland, only in urban areas, and even there they occur only under rare circumstances.

Wildland fires

35. The spread of fire through wildland is largely determined by the velocity of the wind and by the size, disposition and moisture-content of dead and living vegetation in the area. Wildland fires can become very large. The cooling period of a fire can be very long. Forest fires have even been known to smoulder on all winter under a blanket of snow, becoming active again the following summer when the fuels dry out.

Urban fires

36. Concerning the start of urban fires, it is fairly well established that the moisture content of the fine fuels in the interior of buildings is a determining factor, and that fuel dryness depends upon the humidity of the air in the building. Generally speaking, the initiation of urban fires is less weather-dependent than the initiation of wildland fires.

37. There are several factors that determine how fires spread inside rooms, from room to room and from building to building. The initial phase of the fire is critical for its further development and determines whether extensive damage will result. It is therefore at this phase – during the initial spread of fire away from the burning incendiaries – that counter-measures are best directed. A few minutes only may elapse before the combined heat production of the incendiary and of the materials it has ignited leads to a "flash-over" characterized by the sudden ignition of all combustible materials in the room.

38. Once one room in a building is burning in this manner, the fire soon spreads from room to room. The time taken for this to happen depends on the design and construction of the building. A wooden frame house may
be enveloped by flames in less than half an hour; a brick building may still be saved from complete destruction even after one hour. Fire tends to spread upwards and horizontally through a building. Downward spread, which is slower than upward spread, generally requires that a floor be burned through, burning fragments then dropping to the floor below. It follows that incendiary bombs tend to be more destructive if they succeed in penetrating through several floors of a building before igniting.

39. The spread of fire from one building to another usually follows the ignition of exterior surfaces, particularly roofs. This occurs most easily between adjoining buildings, but even where there is a gap of several tens of metres, a neighbouring house can be set on fire by thermal radiation. Once flames from burning houses begin to project into the open air, the subsequent spread of fire is largely wind-controlled. It is generally accepted that surface wind-speed is the most important weather factor influencing the spread of small urban fires. During the fire-raids on cities during the Second World War, wet weather and precipitation seem to have had little effect on over-all fire-raid damage.

40. Urban mass-fires may occasionally take the form of fire-storms. In a fire-storm, the induced inrush wind-velocity exceeds that of the prevailing wind, thus preventing any significant spread outside the periphery of the fire, and causing it to burn more intensely. The temperature in a fire-storm area may be around 1500°C, and the fire-storm may continue for three to four hours. Fire-storms are considerably more destructive than other urban fires and cause a much greater loss of human life. They rarely, if ever, occur naturally, and even during massive incendiary air raids they have proved uncommon. In Germany, scores of cities were subjected to fire-raids during the Second World War, but fire-storms occurred in no more than five of them.

41. Fire-fighting in a city subjected to incendiary attack is a very difficult undertaking and in some cases its results may be marginal at best. It is essential that the fire-fighting process be started as early as possible. The extinguishing of burning magnesium bombs using sand or earth, for example, is not difficult, but as soon as the fire begins to take hold in the city the fire-fighting problems will rapidly become insurmountable. Once a mass-fire has started, fire-fighting efforts may be successful but only at the fringes of the fire zone. Within the fire zones, the safety of the inhabitants can, of course, be best assured by evacuation. If this is not possible, shelters may have to be relied upon, but to be effective these need to be elaborate and, in most cases, specially constructed. Shelters like this usually do not exist in cities.

GENERAL EFFECTS OF FIRE

42. The mass-fire environment is a complex and changing one. Above all, it is intensely hot. All the damage that it causes in buildings and material, and much of the damage it does to life, will be due to heat. Temperatures in excess of 1100°C can be expected within, immediately above, and downwind of strongly burning structures. Hot fires generate powerful air currents which may appear as strong ground-winds of varying velocity. In a fire-storm, the currents may be strong enough to sweep people off their feet and suck them into the blaze.
43. A large, strongly burning fire consumes oxygen in vast quantities. Particularly inside buildings, or in places where ventilation is at all restricted, this may deplete the local air to the point where human or animal life may be endangered. As oxygen levels fall during the fire, increasing concentrations of carbon monoxide build up. A toxic hazard is therefore created, and this may become acute over wide areas, particularly in confined spaces. A substantial proportion of the air-raid victims of the Second World War died from carbon monoxide; on some occasions this led observers to suppose that chemical warfare agents had been employed. Other toxic gases, vapours or smokes may appear depending upon what is burning.

SPECIFIC EFFECTS OF FIRE ON MATERIEL

44. The heat generated by incendiary agents, or during conflagrations, is capable of bringing about profound physical and chemical changes in most materials. The resultant damage is not confined to materials that are combustible. Metal construction materials such as steel, cast iron and aluminium alloys do not generally take fire, mainly because there is usually insufficient oxygen present. Chemical changes may occur, such as oxidation, but they are confined to outer surfaces. The main effect of heat on metals is to cause softening and loss of mechanical strength.

45. Few, if any, buildings are immune to damage by fire. Whatever they are made from they invariably contain combustible furniture and fittings. If these catch fire, and the fire then spreads, even the most fire-resistant materials may not escape damage from the resultant heat.

46. Vehicles are particularly vulnerable to fire. Their upholstery, for example, is often highly combustible, and fire may soon spread to the petrol tank. Even military vehicles, which are generally better protected than civilian vehicles, may be destroyed or immobilized by fire. Armour-piercing weapons may inject incendiary materials into the vulnerable interior of armoured vehicles.

47. Machinery and other equipment may likewise suffer severe damage from fire. Electrical equipment is especially likely to break down. The consequences of damage of these types may range from the destruction of individual weapons or factory tools up to the breakdown of public utilities or the dislocation of great communication networks.

SPECIFIC EFFECTS OF FIRE ON THE NATURAL ENVIRONMENT

48. Fires may propagate themselves rapidly across wide tracts of countryside under certain climatic conditions and in certain types of vegetation. Wholesale destruction of crop cultivations and of other means of subsistence may result from this. Large-scale fires may also have longer-term ecological consequences. The soil may no longer be able to acquire or retain its nutrients, and its quality may deteriorate, while in some areas there may be a serious risk of erosion of the topsoil, either by wind or by
water. Previously fertile areas may thus be rendered barren. The elimination of a plant species from an area through the action of fire may be succeeded by invasion of the area by a different species. Similar effects may be observed in the fauna of areas affected by fire. One common characteristic of burnt-out forest areas is their rapid colonization by different insect species. These may constrain further regeneration of plant life and may, under some circumstances, lead to the establishment of new foci of human or animal disease.

49. The extensive use of incendiary weapons in rural areas, whether or not it is intentionally directed against cultivations or similar targets, may well produce wide-ranging destruction. In the short term, harvests may be lost on which the livelihood of large numbers of non-combatants depends. In the long term, depending upon the largely unpredictable outcome of the resultant ecological changes, irreversible damage may occur which has little or no bearing on the objectives for which the weapons were used in the first place.

Chapter III

MEDICAL EFFECTS OF INCENDIARY WEAPONS ON
ON INDIVIDUALS AND POPULATION

50. The main features of this chapter may be summarized as follows:

(a) Burn injuries differ from the wounds commonly caused by conventional weapons in the exceptional difficulty of their medical treatment.

(b) Although published information is scanty, napalm weapons appears to produce an exceptionally high proportion of deaths among their casualties compared with other weapons. Whether mortal or not, napalm injuries, like other burns, may be intensely painful.

(c) Recovery from burn injuries is slow, and during most of the period the patient remains in great pain. Napalm and white phosphorus burns are likely to leave him deeply scarred and disfigured for the rest of his life.

DIRECT EFFECT OF INCENDIARIES ON INDIVIDUALS

Type of burn injury

51. Skin is easily damaged by heat, the degree of damage depending upon the amount of heat. In medical practice, different categories of burn are distinguished according to their depth, their extent and their cause. The classification of a burn injury into a particular category - "first degree", "second degree", and "third degree" - indicates the depth of the burn and this together with its extent determines the type of medical treatment which is required. Third degree burns destroy the full thickness of the skin, including the hair follicles and sweat glands. Blisters rarely form. The sensory nerve endings are destroyed, so that there is no sense of touch. There is often attendant coagulation of fat, muscle and other deep tissue, which may later result in severe scar contractures and deformities. In peace-time practice, surgeons find it sufficient to use the above classification of burns. The use of napalm in war, however, has led to an increase
in the number of deep burns and experience in treating them. In the process of triage of such burns, doctors have established the special category of fourth-degree and even fifth-degree burns. These relate to burns that completely char the skin and extend into the deep tissue of the body, damaging the musculature and reaching to the bones and internal organs.

52. The threat to life of second- and third-degree burns for the injured depends on the extent, depth and localization of the burns and on a number of other factors, the principal one being the quality of, and accessibility to, medical aid. People with 40 per cent burns have a chance of survival if they are given all possible medical aid in specialized burn hospitals, but if more than 60 per cent of the surface is burned they usually die.

53. Third-degree burns, and deep second-degree burns that cover more than 10 to 15 per cent of the body surface, have a profound effect on the entire body, not merely on the afflicted areas of the skin. The victim is likely to go into a state of shock characterized by a grave and sometimes mortal derangement of the circulation. Toxic effects are likely to develop as poisons generated in the burnt area are carried around in the blood circulation. Moreover, there is always a severe risk of infection of the burned tissue. Because of his injuries, the victim may be unable to eat, and even if he can, he will probably not wish to, through lack of appetite. People exposed to flames and heat may also suffer respiratory burns.

Effects of napalm and related incendiaries

54. Napalm may burn, asphyxiate or poison its victims. Its stickiness, high burning temperature and prolonged burning time lead to deep burns. The asphyxiating and toxic effects, when they occur, stem from the combustion of oxygen in the local air, from the heat of the combustion products, and from the large amounts of carbon monoxide that are generated in the process.

55. It must be stated that, despite the large quantities of napalm that have been employed in war, the medical literature so far contains rather little information on the direct effects of napalm and its combustion products on the human body. One team of surgeons serving in a civilian hospital in an active conflict area in South Viet-Nam in 1966 and 1967 concluded, because of the infrequency with which they saw napalm burns, that its victims were more likely to be killed than to require medical aid. Another field observation suggests that about a third of the casualties are likely to die within half an hour. If this is so, napalm must be one of the most lethal weapons in existence today.

56. The principal characteristic of napalm burns is their combination of depth and multiplicity. In the manner in which the agent is commonly employed, it is scattered over its target in large gobbets. This means that people occupying the target area, if they are hit at all by the agent, are likely to be hit by a substantial mass of it. Moreover, what also tends to happen is that when they try to remove the napalm from their skin, or strip off their burning clothes, they spread it over other parts of their bodies, particularly their hands.
57. Napalm burns are particularly likely to induce a state of shock. In severe cases of shock, the supply of oxygen reaching such organs as the brain, heart, liver and kidneys may drop below life-sustaining levels. There are different types of shock. "Neurogenic" shock may succeed pain, fright or other sudden emotional distress. "Hypovolemic" shock is caused by a lowered blood volume due, for example, to loss of blood or plasma from a wound or burn. Napalm victims exhibit both these types of shock, this probably being the major cause of death among those who die quickly.

58. In addition to shock, carbon monoxide poisoning may be a second contributory factor in the high and rapid mortality among napalm victims. Even small quantities of inhaled carbon monoxide can deprive the body of the oxygen it needs for survival, thereby provoking death in a matter of minutes. Sublethal exposures to the gas can result in permanent injury to the central nervous system and the heart.

59. In addition to shock and carbon monoxide poisoning, respiratory burns are the third major contributory cause of death from napalm. Napalm victims are likely to inhale large quantities of hot air and combustion products and may then be asphyxiated.

60. A further factor contributes to the high mortality rate among napalm casualties is the difficulty and complexity of the medical treatment which burn injuries require. In countries where medical resources are limited, napalm casualties may have little chance of receiving medical attention in time.

61. The burns of napalm casualties who do not die rapidly are likely to become heavily infected. The damaged tissue provides a culture medium that is particularly favourable to the growth of bacteria. The casualties are also likely to develop severe anaemias through destruction of red blood cells in the burn sites.

62. If he stays alive through the first day, a badly burned napalm victim will remain in a critical state for the next 30 to 40 days. During this period, the other complications referred to above will often result in death despite intensive medical care. Less than 20 per cent of such casualties are likely to last through to the period of convalescence. They will then have to come to terms with their deformities and disabilities and the grave emotional consequences that these will inevitably have for them.

Effects of white phosphorus

63. White phosphorus, like napalm, commonly produces deep burns that may sometimes be very extensive. The agent is usually scattered as a mass of sticky particles, and each of these may adhere to a person's skin, continuing to burn until isolated from air or fully burnt out. Phosphorus burns of the hand, wrists or feet, for example, may (like other deep burns) result in partial or total disablement of these extremities after healing.

63a. Phosphorus lodged in the tissue may produce systemic poisoning after entering the circulation. It is a powerful protoplasmic poison, and as such it may damage all vital cells that it reaches. This can have many consequences, several of them potentially lethal, notably the damage to the liver, heart, kidneys and the organs that generate blood cells. Whether these toxic effects are manifested, however, depends on the extent to which white phosphorus is absorbed into the circulation from surface wounds.

Effects of other incendiaries

64. Thermite and thermate incendiaries, when they burn, scatter droplets of molten iron. People in their immediate vicinity are therefore likely to
experience a multiplicity of small deep burns, with particles of iron lodged in the skin. Similar effects are produced by magnesium incendiaries.

**EFFECTS OF CONFLAGRATIONS ON POPULATIONS**

66. People may die or suffer injury during incendiary attacks both from the direct effects of incendiary agents that have just been described, and from the indirect effects that result from the fires which the incendiaries initiate. Additional hazards to human life develop in the course of such fires, but in the main their effects do not differ in kind from the direct effects of incendiary agents.

**Physical effects**

67. From the point of view of the effects on the human body, an extremely high environmental temperature is the principal characteristic of mass-fire. This will lead to a large number of deaths from asphyxiation, caused by thermal damage to the respiratory tract. It will also lead to burns that range in intensity from those of the first degree among people on the periphery of the blaze, up to the grisly phenomenon of the charred and shrivelled corpses that were found in large numbers after some of the Second World War fire raids.

68. Air raid shelters commonly failed to provide the inhabitants of cities with protection against massive fires caused by incendiary attacks during the Second World War. Insufficient thermal insulation often meant that the shelters became lethally hot. People who did not enter air raid shelters often had a better chance of remaining alive than people who did, for the flames raging in the surrounding areas tended to suck the air out of the shelter, replacing it with a lethal mixture of carbon monoxide, smoke and other combustion products. Some of the large-scale incendiary bomb attacks on cities conducted during the Second World War proved as destructive as the atomic bombs dropped on Hiroshima and Nagasaki. On average, there were 20,000-30,000 casualties in each German city subjected to major air raids. Sixty per cent of these casualties remained alive and in need of medical aid. The consequences of an incendiary attack on a population centre may therefore be catastrophic.

**Psychological effects**

69. Most human beings seem to have an inbred fear of fire, and the psychological effects of incendiary weapons are commonly listed among their military attractions. The use of agents such as napalm or white phosphorus, which cling to surfaces and to fleeing people while burning, cannot fail to increase the over-all psychological impact. Coupled with a general breakdown of communications and public utilities and services, the result could well be mass panic, with all its consequences for survival procedures that might otherwise be effective.
MEDICAL COUNTERMEASURES AGAINST INCENDIARY ATTACK

70. The proportion of burn casualties among the victims of war has been rising steeply. During the nineteenth century, burns probably accounted for no more than one per cent of battlefield injuries. The figure was not much higher during the First World War. During the Second World War, the proportion increased, due mostly to the petrol burns that were an inevitable consequence of mechanized warfare. The Second World War also brought with it a sharp increase in the proportion of non-combatant casualties among the victims of war, a trend which has not been reversed in subsequent conflicts. In part this is because of an increasing reliance upon area weapons, which, by their indiscriminateness, are especially likely to harm non-combatants living around their targets. Incendiaries have proved to be one of the most destructive and widely used weapons in the attack on urban targets. They have also become increasingly relied upon in recent conflicts as battlefield area weapons, particularly fire-bombs containing napalm.

71. There are six distinct phases in the medical treatment of a burn casualty. The following description relates primarily to napalm victims, but much the same applies for casualties of mass conflagrations or of other incendiary weapons. In the case of white phosphorus burns, the process is more complicated: special efforts have to be made to remove phosphorus particles that are still burning from the flesh.

72. The first phase is the transport of the victim to a medical aid post. A man in a state of shock, as he might be even from mild napalm burns, may be helpless and too weak or fearful to move.

73. The pain, which is in part responsible for the initial (neurogenic) state of shock, must be relieved by analgesic agents, such as morphine. The secondary (hypovolemic) shock must then be controlled, together with the consequences of the toxic products of burnt tissue that enter the blood circulation. For a weak or more, therefore, continuous transfusions of blood plasma, whole blood, and other fluids, will have to be made into the patient's veins. Respiratory support will also be needed.

74. While this is continuing, stringent measures need to be taken to prevent the burns from becoming infected. Amputations may have to be performed if extensive charring has occurred and infection cannot be checked.

75. Meanwhile the patient will require careful metabolic support. The loss of protein at burn sites must be compensated with special nutritional supplements.

76. The fifth phase in the treatment is that of late reconstruction and rehabilitation. This involves the use of surgery to release flexion contractures in the skin, and to restore function to extremities and other organs. This phase is a prolonged and painful one.

77. Finally the patient must be given emotional support to sustain him through the long period of pain and isolation, and above all, to assist his psychological adjustment to extensive scarring and other deformities.
78. It may be estimated that the requirements for treating a thousand wartime casualties having 30 per cent burns would include 8,000 litres of plasma, 6,000 litres of blood, 16,000 litres of Ringer's lactate solution (a balanced salt solution), 250 trained surgeons and physicians, and around 1,500 skilled attendants. Each patient would require a hospital bed for anything up to four or five months. The degree to which these requirements can be fulfilled determines the proportion of the casualties that could be expected to survive.

Chapter IV

INCENDIARY WARFARE AND ITS CONSEQUENCES

INCENDIARY WARFARE BEFORE THE SECOND WORLD WAR

79. The development of incendiary weapons, like that of most other modern armaments, has been progressing for many centuries. Fire is an ancient accompaniment of warfare, and has regularly been used to lay waste enemy habitations, possessions and cultivations. There is a difference, however, between fire as an instrument of depredation or of scorched-earth tactics, and fire as a weapon. The documented history of incendiary warfare stretches back for some three millennia. Assyrian bas-reliefs have been found, for example, which show the defenders of a city besieged in the ninth century B.C. repelling siege engines by throwing burning liquid over them. The rise of artillery that followed the introduction of gunpowder brought with it certain new types of incendiary projectiles, thus continuing a line of development that stretches back to the fire arrow. These new incendiary devices were soon eclipsed by explosive artillery shells, however, and it was not until the latter part of the eighteenth century that their use again became at all widespread.

80. As in so many other areas of military technology, rapid developments in incendiary weapons were made during the First World War. The most portentous of the techniques was the use of airships and aeroplanes to drop incendiary bombs on targets deep in the enemy rear or in the enemy homeland. Operations were relatively small in view of the limited capacity of contemporary aircraft. Early in the War, the German Army introduced the flamethrower, which it had been developing during the pre-war years. Incendiary projectiles fired from artillery or trench-mortars were employed widely. They were used in attempts to set fire to opposing trench systems or support facilities. They were also used as anti-personnel weapons: time fuses were fitted so that they detonated in the air, raining down a shower of burning phosphorus particles or molten iron.

81. In the course of the Italo-Ethiopian War and the Spanish Civil War, portable and tank-mounted flamethrowers were used. So were incendiary bombs in attacks on population centres. Similar techniques were employed in the Sino-Japanese conflict. These events stimulated wide military interest, and incendiary warfare development programmes were initiated or accelerated by all the major military Powers.
INCENDIARY WARFARE AGAINST POPULATION CENTRES
AND RELATED TARGETS

82. This section describes the use of incendiary weapons during and since the Second World War against civilians, against their natural environment and against their means of production and subsistence.

Incendiary air raids on cities

83. During the first year of the Second World War, the use of incendiary weapons was largely confined to the battlefield. However, in September 1940, an air attack on London that included the use of incendiary bombs began a process of escalation that was to establish the incendiary air attack as the most devastating instrument of mass-destruction yet employed in warfare. Around 100,000 tons of bombs were dropped on 60 Japanese towns and cities, practically all of them incendiaries. The air raids killed 260,000 people and injured another 412,000. Nearly two and a quarter million homes were destroyed and 9.2 million people left homeless. In Germany, 1.35 million tons of bombs were dropped on population centres, 49 towns and cities being singled out for large-scale attack. Although less than a quarter of the bombs were incendiaries, more than three quarters of the resultant civilian casualties were due to fire. There are estimated to have been 1.4 million civilian air-raid casualties in Germany, of whom 600,000 died. Civilian air-raid casualties in the United Kingdom amounted to 147,000, including 61,000 dead.

84. The air raids that caused the greatest devastation in Germany during the Second World War were those directed against Hamburg in the summer of 1943 and against Dresden in February 1945. Both of them involved huge tonnages of incendiary weapons, and both succeeded in creating fire-storms. The number of dead was enormous, but in neither case are reliable statistics available. Around 135,000 people are believed to have been killed during the attack on Dresden. The intensity and co-ordination of the attack on Hamburg were sufficient to build up a huge conflagration that in turn developed into a cyclone-like fire-storm. The asphalt of the streets burned. About half of the town-dwellings were totally destroyed. Probably 43,000 or more people were killed, and it took more than two months to dig their corpses out of the debris.

85. The attack on Tokyo on the night of 9-10 March 1945 was conducted entirely with incendiaries. In terms of the number of dead, it exceeded in destructiveness either of the subsequent nuclear attacks on Hiroshima and Nagasaki. It is estimated that 83,800 people died and 41,000 more were injured. More than a million were left homeless.

86. Since the Second World War, incendiary air attacks against population centres have continued to be practised. One major example occurred during the Korean war, when a large part of the city of Pyongyang was destroyed by incendiaries in January 1951.
Use of incendiary weapons against environmental targets

87. Since the time of the First World War, there has been recurrent military interest in the use of incendiary weapons to harm the enemy through destruction of his agriculture or rural environment. Harvests and crop cultivations have been one objective, in strategies of attrition or food denial. Tracts of natural vegetation have been another, the aim being to facilitate aerial reconnaissance or target acquisition.

INCENDIARY WARFARE ON THE BATTLEFIELD

88. Outside the Pacific theatre, battlefield incendiary weapons did not become prominent during the Second World War. Emplaced flamethrowers were sometimes incorporated into fortified defensive positions, for example around Moscow and the southeast coast of England. Both portable and mechanized flamethrowers of various types and sizes were available to the belligerent armies but were used only occasionally. In the Pacific campaigns, however, incendiary weapons came to be used extensively on the battlefield after they had been found especially well suited to the nature of the ground fighting and the terrain over which it was conducted.

89. Compared with conventional ground weapons, the tonnage of napalm weapons used during the Second World War was small. This situation changed during the Korean war, when napalm began to acquire its present reputation as a militarily effective weapon. Several armed services around the world subsequently adopted napalm, and it has apparently been employed almost as a matter of course in a number of recent conflicts. Its widest use has been in Viet-Nam where seven months of fire-bombing during 1966 spread as much napalm as had been used during the entire Korean war.

Battlefield use of napalm ground weapons

90. In the hands of ground forces, napalm has on occasion been used effectively in defensive operations, but it is primarily a special-purpose assault weapon for the destruction of enemy soldiers holding positions that are protected against explosives, bullets or shrapnel. Flamethrowers, both portable and mechanized, are the principal weapons.

91. When napalm is effective, its effectiveness may stem both from its fierce casualty-producing properties and from its psychological impact. In the view of a current military manual or napalm weapons, the latter may often be the more important. Man seems to have an intense inbred fear of fire, and napalm weapons may unnerve him to an extent which other forms of attack may not.

Battlefield use of napalm air weapons

92. The fire-bomb is the principal napalm air-support weapon. A thousand or more square metres of ground around its point of impact become splattered with blazing napalm, which creates a huge wall of rolling fire that burns for several minutes, the flames often reaching high above tree-top level. The fire-bomb originally gained much of its reputation among field commanders as an anti-materiel weapon, particularly against tanks and heavily dug-in emplacements. It continues to be used in these roles, and also against such targets as convoys of supply vehicles, structures
containing command posts, and anti-aircraft missile emplacements. The area of effectiveness of a fire-bomb is often greater than that of a high-explosive weapon of the same size, and direct hits may therefore be less necessary. The fire-bomb is also an anti-personnel weapon, and because of its area-effectiveness, it has proved an exceedingly efficient one. People caught in the open by an aircraft coming in low and fast with fire-bombs have little chance of escape. Natural cover may not offer much protection.

SOCIAL AND ECONOMIC CONSEQUENCES OF INCENDIARY WARFARE

93. The experience of the past has demonstrated that incendiaries are among the most powerful means of destruction and devastation. This is most evident in cases where they are massively employed against urban targets. Except for nuclear weapons, and perhaps also certain biological and chemical weapons, no other armament places such destructive power in the hands of military commanders. The element of control which can be exercised over the effects of such weapons as high explosive bombs, is lacking in the case of most incendiary weapons, and like all area weapons they are essentially indiscriminate.

94. Incendiary weapons, when used in massive raids against urban targets, demonstrate the total quality of war; its savage and cruel consequences for all society. This characteristic is shared with other weapons that are adaptable to mass destruction, but incendiaries have, in certain circumstances, proved particularly destructive. Any attempt to reduce the catastrophic social and economic consequences of total war should therefore have as a major objective the prevention of the massive use of incendiaries.

95. The use of incendiary weapons on the scale of the major incendiary air raids of the Second World War is, in economic terms, an extremely costly undertaking. The poorer nations of the world are therefore more likely to be the recipients of such attacks than the executors, and may suffer irremediable economic hardship from their consequences.

96. Concerning other modes of incendiary warfare, the economic perspective may be rather different. In conflict situations where the objectives are less ambitious, or where the air defences are weaker or non-existent, relatively small numbers of less sophisticated aircraft may provide an effective delivery means. Some incendiary agents, napalm in particular, are exceptionally cheap and easily produced, even in the less developed countries. It is thus possible to conceive of situations in which incendiary weapons could permit warring countries that do not possess substantial military or economic resources to inflict exceptionally severe damage upon one another.

97. The tactical employment of air-delivered fire-bombs is an important aspect of the use of napalm in particular. It is a tactic, however, that often demonstrates the indiscriminate nature of incendiary warfare against a society. Because of the considerable area covered by each napalm bomb and often great inaccuracy of its delivery, fire-bombs may cause severe damage in the civilian sector even when, ostensibly, the targets of attack are military.
98/99. It is important to recognize that the care and treatment of burn casualties represents a more difficult problem for hospitals than the treatment of most other kinds of casualty. It is clear that it would be next to impossible even for a highly developed country to mobilize the necessary resources to treat the casualties caused by massive use of incendiaries. Conditions would be even more difficult in less developed countries, resulting in a situation where large numbers of people suffering from severe pain would have to be left without care.

100/101. The possibilities of providing protection for the civilian population against the effects of incendiaries are not very promising, especially when the effects of mass fire in urban areas are considered. Although it is possible to conceive of a shelter programme of sufficient quality to enable a city population to survive a conflagration or even a fire-storm, such a programme would be very expensive, both economically and in terms of changes in the society, and would take many years to establish. Few if any countries have undertaken such a programme. The indiscriminate nature of the effects of incendiary weapons is thus further underlined by the difficulties of providing adequate protection for the civilian population.
102. There exists today a broad range of incendiary weapons designed for use both on the battle field and against population centres and other vital targets. Many of these weapons are extremely simple to manufacture, and the necessary raw materials are readily available the world over. This is particularly true of napalm weapons, which are already a part of the arsenals of a number of countries. The development continues towards incendiary weapons of still greater destructiveness, and there may also follow a proliferation of these weapons throughout an increasing number of States. The situation is therefore gradually deteriorating and this underlines the urgent need for international consideration of effective measures of disarmament concerning incendiary weapons.

103. Massive use of incendiary weapons creates fires that may merge and grow into widespread conflagrations and fire-storms. Such mass-fires are largely uncontrollable and usually present insurmountable difficulties for the protection of civilians and the environment in which they live. It follows from this, and from past wartime experience, that incendiaries are among the most powerful means of destruction in existence. Any attempt to constrain the conduct of total war should therefore include the elimination of the use of incendiaries on a massive scale.

104. The massive spread of fire is largely indiscriminate in its effects. When there is a difference between the susceptibility to fire of military and civilian targets, it is commonly to the detriment of the latter.

105. Burn injuries, whether sustained directly from the action of incendiaries or as a result of fires initiated by them, are intensely painful and, compared with the injuries caused by most other categories of weapon, require exceptional resources for their medical treatment. Under war conditions only a few of the people exposed to more extensive napalm burns survive to the period of real convalescence, which is long and difficult. Permanent loss of function, disfigurements and severe scarring are frequent. Disabilities, impairment of sight or hearing, and grave emotional disorders are often the consequences of this. Plastic repair and reconstruction of the damage is very difficult and painful, and may have only limited effect. When judged against what is required to put a soldier out of military action, much of the injury caused by incendiary weapons is therefore likely to be superfluous. In terms of damage to the civilian population, incendiaries are particularly cruel in their effects.

106. Napalm and other incendiary weapons owe their effect not only to heat and flame, but also to the toxic effects of carbon monoxide and other combustion products. Asphyxiating effects may also be important, particularly in connexion with the massive use of incendiaries.

107. Attempts have been made to use incendiaries to damage crops, forests and other features of the rural environment. Although there is a lack of knowledge of the effects of widespread fire in these circumstances, such attempts may lead to irreversible ecological changes having grave long-term consequences.
108. The rapid increase in the military use of incendiary weapons, especially napalm, during the past 30 years is but one aspect of the more general phenomenon of the increasing mobilization of science and technology for war purposes. The long upheld principle of the immunity of the non-combatant appears to be receding from the military consciousness. It is therefore essential that the principle of restraint in the conduct of military operations, and in the selection and use of weapons, be reasserted with vigour. Incendiary weapons, in particular napalm, are a fitting subject for renewed efforts of this type.

109. The law of armed conflict is the formal expression of the principle of restraint. There exist well-established juridical norms that have a bearing on incendiary warfare in view of the properties of incendiary weapons. These provisions require close study with a view to further improvement.

110. Most of the norms referred to in the previous paragraph are embodied in The Hague Regulations of 1907, particularly articles 22 3/ and 23(e)4/ which, according to many experts, have become part of customary international law. The principle of a distinction between military targets and civilian population also occurs in the body of international customary law. Attention may be drawn, for example, to the 1923 draft rules relating to aerial warfare.5/ The principle of the immunity of the non-combatant has been reaffirmed since then, notably by the United Nations General Assembly (resolutions 2444 (XXIII) and 2675 (XXV)) and by an International Conference of the Red Cross (XX International Conference, Vienna, 1965, resolution XXVIII). The principle is also to be embodied in the draft Additional Protocol(s) to the Geneva Conventions of 1949 being prepared by the International Committee of the Red Cross. Also requiring consideration in view of the toxic and asphyxiating effects of many incendiaries is the 1925 Geneva Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare.

111. It is not the purpose of this report to assess the use of incendiary weapons in the light of legal and humanitarian principles. Nevertheless, in view of the facts presented in the report, the group of consultant experts wishes to bring to the attention of the General Assembly the necessity of working out measures for the prohibition of the use, production, development and stockpiling of napalm and other incendiary weapons.

3/ Article 22 states: "The right of belligerents to adopt means of injuring the enemy is not unlimited".
4/ Article 23 (e) states that it is forbidden "to employ arms, projectiles, or material calculated to cause unnecessary suffering".
5/ Article 22 states: "Air bombardment for the purpose of terrorizing the civil population, of destroying or damaging private property not of military character or of injuring non-combatants is prohibited".
REDUCTION OF THE MILITARY BUDGETS OF STATES PERMANENT MEMBERS OF THE SECURITY COUNCIL BY 10 PER CENT AND UTILIZATION OF PART OF THE FUNDS THUS SAVED TO PROVIDE ASSISTANCE TO DEVELOPING COUNTRIES

A/9770/Rev.1

I. INTRODUCTION

1. The origin of this particular study is to be found in an initiative of the Union of Soviet Socialist Republics specifically linking disarmament and development. On 25 September 1973, the Union of Soviet Socialist Republics proposed to the General Assembly, at its twenty-eighth session, that it should include in its agenda, as an important and urgent question, an item entitled "Reduction of the military budgets of States permanent members of the Security Council by 10 per cent and utilization of part of the funds thus saved to provide assistance to developing countries" and it included in the proposal a draft resolution.1/ In the course of the debate certain differences of opinion emerged concerning the Soviet proposal. In order to preserve the impetus provided by this proposal, the representative of Mexico proposed a second resolution of a procedural nature. The General Assembly, at its 2194th plenary meeting, on 7 December 1973, adopted simultaneously resolutions 3093 A and B (XXVIII) initiated by the USSR and Mexico respectively and bearing the same title as the item.

2. By resolution 3093 A (XXVIII), the General Assembly recommended that all States permanent members of the Security Council should reduce their military budgets by 10 per cent from the 1973 level during the next financial year; appealed to those States to allot 10 per cent of the funds so released for the provision of assistance to developing countries; expressed the desire that other States, particularly those with a major economic and military potential, should act similarly; and established the Special Committee on the Distribution of the Funds Released as a Result of the Reduction of Military Budgets to distribute the funds released, for the provision of assistance to developing countries.

3. By resolution 3093 B (XXVIII), the General Assembly, "conscious that the United Nations has been unable to study this important question with the required depth and care" requested the Secretary-General to prepare, with the assistance of qualified consultant experts appointed by him, a report on the reduction of the military budgets of the permanent members of the Security Council, which should cover also other States with a major economic and military potential, and on the utilization of a part of the funds thus saved to provide international assistance to developing countries; called upon all Governments to extend their full co-operation to the Secretary-General to ensure that the study was carried out in the most effective way; and invited the Secretary-General to transmit the report to the General Assembly for its consideration at the twenty-ninth session.

4. Pursuant to this resolution, the Secretary-General appointed the Group of Experts. We have considered the mandate for our work as that set forth in resolution 3093 B (XXVIII); at the same time we have taken into special con-
sideration the specific recommendations made in resolution 3093 A (XXVIII) and have also taken into account the discussions of the General Assembly at its twenty-eighth session.

II. MILITARY EXPENDITURE AND DEVELOPMENT AIDS

5. The only figures of total world military expenditure that are available are unofficial estimates, and we have followed the practice of previous reports in using the figures collected by the United States Arms Control and Disarmament Agency (ACDA) and the Stockholm International Peace Research Institute (SIPRI). In the previous reports, the estimate given for the year 1970, at 1970 prices, was around $200 thousand million. From 1970 to 1973, there has been a further small rise in real terms; one source shows this as a 5 per cent rise in volume, the other as a 1 per cent rise. In addition, however, there has been a very substantial rise in prices, particularly in the market economies. As a consequence, the latest available estimate of world military expenditure, for 1973, is $205-$235 thousand million at constant (1970) prices, and it is $240-$275 thousand million at current (1973) prices. This figure is larger than the combined estimated product of the developing countries of South Asia, the Far East and Africa combined, and much larger than that of Latin America.

6. The basic pattern of world military expenditure in the post-war period has tended to rise strongly in periods of crisis and war, as at the time of the Korean War or the Viet-Nam War. It has then levelled off for a number of years, but without falling much. Once a new and higher level of military expenditure has been established it tends to be maintained. We have taken as the long-term trend the average rise from 1961 to 1973. This shows a volume rise of 3 per cent a year. At present-day prices, this is equivalent to an annual addition of the order of $7 to $8 thousand million to the world total.

7. The NATO and Warsaw Pact countries in the early 1960s accounted for some 90 per cent of the total; now the figure is nearer 80 per cent. The developing countries, whose share of the total of world military expenditure was 5.5 per cent in the early 1960s, now account for about 11 per cent.

8. The dynamics behind this long-term rising trend in world military expenditure are complex: there is not a simple, single "world arms race", but, rather, different forces are at work in different areas. Among the major military Powers, for example, the form it takes is primarily technological. The share of the major military budgets devoted to research and development (R and D) reached 10-15 per cent in the early 1950s and has stayed at that level since. World spending on military research and development is now of the order of $20 thousand million annually, and it occupies the time of some 400,000 scientists and engineers around the world.3/ This technological arms

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2/ This chapter is concerned with military expenditure, rather than military budgets, since there are no aggregate figures for world military budgets.

race in the developed world has continued in spite of a marked relaxation in tension in recent years.

9. The forces behind the intense development and exploitation of technology for military purposes cannot then simply be explained as an "action/reaction" process in a world of increasing tension. One explanation is that modern weapons have now a very long gestation period or lead-time. It may take 10 years from the initial design to the final deployment of a new fighter. Consequently, military authorities tend to focus their attention, not on what the other side has already produced, but on possible future developments. Then again, technical and industrial teams are built up to design and develop types of military equipment. When one project is completed, another project is found for them. There are also economic and bureaucratic forces at work. Firms who derive a major portion of their sales from the manufacture of armaments and bureaucracies are concerned to maintain their positions.

10. In the developing countries, where the rise in military spending in recent years has been relatively rapid, the forces are of a rather different kind. Some new States are building up their armed forces from a low base. In other cases, there are active conflicts. Countries in the developing world are, in general, dependent on the industrialized nations for the more advanced and complex weapons; and they are acquiring them, by gift or purchase, to an increasing extent. Some countries within this group are beginning to establish their own military production facilities.

11. There are thus strong world-wide forces behind the long-term upward trend in world budgetary expenditures for military purposes. The same, unfortunately, cannot be said for aid to developing countries. There is a marked contrast, both in the size and in the trend of these two budgetary items. In total, the developed countries appropriations for military purposes are some 20 times their appropriations for development aid. Comparing the present day with the early 1960s, the share of output which these countries devote to military purposes has fallen a little (see table below). Unfortunately, the share going to aid -- apart from being so much smaller -- has also fallen, even more rapidly.
III. REDUCTION OF MILITARY BUDGETS

A. OBJECTIVES: THE ECONOMIC AND SOCIAL CONSEQUENCES OF MILITARY BUDGET REDUCTIONS

12. The objectives of a reduction in military budgets are clear. The first is that, as a measure of arms control and disarmament, it should be a step along the road to a more peaceful world. The second objective is to release resources for economic and social welfare; and these released resources should be used both for the benefit of the State making the reduction and, through international assistance, for the benefit of developing countries - a view which the Group emphatically endorses.

13. If military budgets were reduced, this would help to improve the general international climate. The arms limitation agreements so far reached are evidence of this. They have been important, not only in their own right, but also because they have helped to strengthen international confidence.

14. The economic benefits which could be derived from military budget reductions are equally indisputable. We would like to single out one point whose saliency has increased in the last three years. During these years, there has been a marked increase in world-wide concern about the longer-term adequacy of the world's natural resources; there is a greater recognition that some resources are indeed finite, and less easy assurance that adequate substitutes will be developed and produced in time. To take one example: it is widely argued that by the end of this century, formidable new civil technological advances will be needed if the world is to provide a tolerable standard...
of living for its inhabitants. In this light, the employment of nearly half a million scientists and technologists on developing weapons of war seems even more of a waste than it did before.

15. The alternative potential uses of the resources freed from military expenditure are myriad. Certainly there would be transition problems. None the less, we are still prepared generally to endorse the conclusions of the report on the economics of disarmament\(^4\) that the problems of transition can be met.

16. Developed countries reducing military budgets would understandably employ a substantial part of the resources released for their own use. There is indeed a danger in the present world climate of opinion that countries would pre-empt the whole of the released resources for their own use. If this were to happen, the consequence would be that the relative gap in the standard of living between the developed and developing world would widen even further. Hence the importance of the provision in the resolution which provides our mandate — that a portion of the funds and resources saved should be devoted to international assistance to developing countries. If the major military Powers were to channel approximately 1 per cent of the resources currently devoted to military expenditure to development aid, the addition to the flow of aid would probably be of the order of $2 thousand million, at 1973 prices. This would increase that flow by no less than 20 per cent.

B. REDUCTION OF MILITARY BUDGETS IN ACCORDANCE WITH GENERAL ASSEMBLY RESOLUTION 3093 A (XXVIII)

17. The proposal for reductions in military budgets was addressed in the first instance to the permanent members of the Security Council; it seemed reasonable that the first steps should be taken by those countries — all nuclear Powers whose military expenditure was highest. However, the resolution expressed the desire that other States — particularly those with a "major economic and military potential" — should also join in. This would have the advantage that cuts in the military budget of permanent members of the Security Council would not be offset by increases in the budgets of their allies in military blocs.

18. The proposed reduction in military budgets is a single-stage measure — a cut of 10 per cent in the published military budget for the 1973 financial year. The measure was envisaged by the sponsor as five concurrent unilateral reductions; in this way it was hoped to avoid the complex problems that would arise with a formal agreement. The resolution also proposed a quantitative link between the reduction in the use of resources for military purposes and the increase in aid; that 10 per cent of the cut should be devoted to international assistance for developing countries.

\(^4\) Economic and Social Consequences of Disarmament (United Nations publication, Sales No. 62.IX.1).
C. MILITARY BUDGET REDUCTIONS: CONSIDERATION OF ALTERNATIVE OPTIONS

19. The Soviet proposal is one way to reduce military budgets; it concerns the total only, for a single year, and involves a reduction by a specific percentage. Here we also consider certain other options. Such options could, for example, cover some particular component of the total - such as research and development (R and D). Then again the form of the limitation proposed can be a percentage, it could also be a ceiling, or the reduction might be prescribed in absolute terms. The reductions proposed can obviously be large or small, and can be for a single year or for longer periods. One of the interesting variations examined is an expenditure cut which is linked with a limitation on some component of military force; it might be linked, for example, with some limit on the number of men under arms. The mode of agreement can vary - from mutual example to formal agreement.

IV. MEANING AND MEASUREMENT OF MILITARY EXPENDITURE

A. SCOPE AND CONTENT OF MILITARY BUDGETS

20. A prerequisite for negotiating the reduction of military budgets in two or more countries is agreement on what is and what is not to be included in military budgets. The problem of defining the scope and content of a complex aggregate is encountered in many international comparisons - e.g., of health or education - but it is critical where a State's decision on allocations to national security and international development assistance will depend directly on the measure of comparative military budget levels. Unfortunately, there is no accepted conceptual standard of the definition and coverage of the military sector. Moreover, the great variation in the range of activities included in military budgets prevents reliable quantitative comparisons without extensive adjustment of the basic data. To name but three examples of such divergences, some countries include the payment of military pensions in their military budget and others do not. Civil defence is sometimes included and sometimes excluded; indeed, in some countries private citizens are required to incur expenditure under this heading. In some countries, the cost of the development of atomic weapons has been borne by agencies other than the Ministry of Defence. Therefore, in the hope of providing a more precise yardstick with which military budgets can be compared, the following analysis focuses on States' expenditure for military purposes - in brief, military expenditure irrespective of either classification in State financial accounts or method of financing, within or without the government budget. The Group notes that there seems to be general agreement that military expenditure customarily includes outlays on the following: pay and allowances of military personnel; pay of civilian personnel; operations and maintenance; procurement of weapon systems; military research and development; military construction; military aspects of atomic energy and space; and stockpiles of military equipment and materials. There are also other expenditures which, under certain circumstances, could be treated as military expenditure - for example, outlays on civil defence, para-military forces and military aid.
21. For most agreements to reduce military expenditure, it may be necessary not only to delimit the totals but also to define component categories. Military expenditure may be classified by type of "input" (military wage costs, operations and maintenance, procurement of weapons, etc.) and also by functions (for example, strategic forces, general purpose forces, communications, command, etc.).

B. VALUATION OF RESOURCES IN THE MILITARY SECTOR

22. Negotiators attempting to agree on equivalent reductions in military budgets will be concerned to ensure, as far as possible, that these cuts do represent equivalent reductions in military power. It cannot automatically be assumed that this will be so. First of all, the military power of a country does not, of course, depend on the military expenditure of just one year; it depends on the total stock of military "capital" (weapons, bases, accumulated technical knowledge, and so on). Military expenditure in any particular year just maintains and adds to the pre-existing stock. So negotiators will have to have confidence, first in the reliability of the estimates and, then, in the acceptability of the initial levels of military capital.

23. Another reason why it would be difficult to forecast the effect on military power of a given cut is the difficulty of developing a set of relative prices for military goods and services which reflects their comparative usefulness in producing military power as perceived by national decision-makers.

24. Especially for agreements extending beyond a single year, there is the problem that rates of price increase differ considerably from country to country - particularly in recent years. Allowance would have to be made for differential price change to avoid inequitable effects on an agreement to reduce military expenditures. The construction of price indices to "deflate" military expenditure encounters not only the standard "index-number problems" but also the difficulties of defining the output whose price change is to be measured. Rapid technological change makes the problem of separating price and quality changes more formidable for military than for civil goods. For example, it is difficult to disentangle that part of the sharply increased cost of a fighter aircraft which is due to pure price change from that part which reflects an increase in performance.

25. The comparisons of military expenditure among countries are analogous to comparisons within one country over time. For international comparisons, special rates for translating the military expenditure of different countries into a common currency - corresponding conceptually to the price indices used within one country - should be calculated and multiple answers are again unavoidable.

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5/ The "index-number" problem refers to the awkward situation where the measurement of the average price change between two periods produces two possible answers depending on whether one uses quantities of the first or second period as weights in developing an aggregate average. Both solutions are equally valid.
V. REDUCTION OF MILITARY EXPENDITURE AS A DISARMAMENT MEASURE

A. SOME SPECIAL FEATURES OF AGREEMENTS TO REDUCE MILITARY EXPENDITURE

26. The interest in the reduction of military expenditure as a disarmament measure is connected with certain characteristic differences between such reductions and agreements limiting specific forces in physical units. Because they are couched in terms of money, agreements to reduce military expenditure can cover the whole spectrum of military activities, including such activities as research and development. Research and development is one of the most difficult of military activities to control in physical terms alone.

27. Agreements to reduce total military expenditure allow very considerable latitude to reallocate expenditure within the constrained total, thus putting fewer restrictions on the internal decision-making of the participant States.

28. Among the problems that often in the past have hindered the conclusion of formal agreements to reduce military expenditure has been the problem of verification, since such an agreement deals with economic aggregates rather than observable physical entities. But over the past half century there has been a very considerable change in the amount and quality of economic information available in many countries. To the extent that this change has taken place among States which might be participant to such an agreement, this factor may have helped to increase contemporary interest in the use of expenditure-reduction agreements.

B. EFFECTS OF MILITARY EXPENDITURE REDUCTIONS ON INTERNATIONAL SECURITY

29. We turn to the question of the effect of cuts in military expenditure on security - a matter which negotiators would obviously have very much in mind. This will clearly vary with different types of reduction. Here we consider three: first, an agreement to cut military expenditure in total only; secondly, such an agreement together with a subsidiary agreement to limit some particular expenditure component, such as outlays on strategic forces; and thirdly, a reduction of total military expenditure together with some limitations in physical terms - say, on the number of men under arms.

30. If the limitation were on the total of military expenditure alone, countries, in distributing the cuts among different categories of expenditure, would presumably try to maximize their security position and would assume that other signatories to the agreement would do the same. They might favour strategic forces rather than general purpose forces, for example.

31. Reallocations of expenditure under constrained totals might be stabilizing or destabilizing. A country's ability to reallocate expenditure
84.

in a destabilizing way could be limited - but certainly not wholly prevented - if to the general cut in expenditure there were added some other limitations, for example, an additional limitation on spending on strategic forces. However, there is a clear dilemma: the more extensive the limitations, the less likely any disruption in the military balance - but the more onerous the limitations would be.

3. An increase in the flow of information might be a substitute for these additional limitations. If countries knew how others were reallocating their expenditure and were free to react themselves, the changes on the various sides would probably cancel out.

C. VERIFICATION OF A FORMAL AGREEMENT TO REDUCE MILITARY EXPENDITURE

33. The fourth and final question to be considered in this chapter is that of verification. Verification of an agreement is simply a procedure for obtaining and evaluating information about changes in a participating State's military expenditure. This may or may not require an exchange of information. If there were complete and absolute trust among States - so that each State were convinced that under no circumstances whatever, now or in the future, would other States attack it - then little if any information would be needed to support an agreement. Conversely, if two States totally and completely distrust one another, then even an enormous amount of information might not be sufficient for any agreement to be reached. Because information requirements vary with the degree of trust among States, it would obviously be wrong to attempt to lay down that certain types of agreement must, under all circumstances, need certain types of information.

34. For verifying an agreement to reduce military expenditure, it would be mainly economic and financial data which would be needed; some have already been described - such as the data necessary to compare budgets prepared on different accounting systems, and appropriate domestic price indices. In addition, material would be needed to enable a check to be kept on a number of financial and physical flows in the economic system.

35. Effective verification seriously conflicts with a country's desire to keep the nature of its military preparations secret. We can envisage a kind of information-disclosure ladder. Among the lower rungs in the phase of confidence building, military accounts might be published in expanded form with explanatory material. Successive rungs could be reached with increasing amounts and different types of economic and financial information, possibly up to and including the auditing of unit records through sample inspection.

36. The various technical issues involved in an agreement to reduce military expenditures are sufficiently complex to suggest that it might be reasonable to make a step-by-step approach.
VI. USE OF RELEASED RESOURCES FOR INTERNATIONAL DEVELOPMENT ASSISTANCE

A. SCOPE AND BACKGROUND

37. For purposes of our report, we do not need to establish a link between disarmament and development; our mandate does this for us. The Strategy of the Second United Nations Development Decade is to aim for a 6 per cent rate of growth for the developing countries. For the majority of developing countries, the achievement of this objective will call both for the full mobilization of domestic resources and for the enlisting of substantially increased foreign aid.

38. In this report, we are concerned with transfers of resources from Government military budgets; clearly, therefore, these transfers would be used to supplement official development assistance. Consequently, in this chapter we concentrate on the data for this total - official development assistance - rather than on data on flows from private sources. The mid-Decade target for this official flow of aid - a target which not all donor countries have accepted - has been set at a minimum net amount of 0.7 per cent of the gross national product at market prices of economically advanced countries. We have noted that the share of national product devoted to aid has been moving away from the target, instead of towards it - falling from around 0.4 per cent of national product in the early 1960s to 0.26 per cent in the early 1970s, so that it is now much less than half what would be required to meet the target figure.

B. TRANSFER OF RESOURCES TO AID

39. The proposals which we are discussing here could be a very important move towards arresting and reversing this downward movement in the share of aid in national product. One possible option - in which, as indicated earlier, the main military Powers transfer 1 per cent of their military budgets to aid - would produce a figure of the order of $2 thousand million, which would be a 20 per cent addition to the world's official aid flow. Different options for military budget cuts would, of course, release different amounts and categories of resources. It is clearly important that the new flow discussed here should be a net addition to aid and that donor countries which give some undertaking to transfer military resources to aid should not reduce their other aid programmes. It is generally agreed that aid is very much less effective if it is sporadic than if it is continuous. Most development projects - such as dams, or road or railway construction - take a long time to complete. Therefore, it is those reductions in military expenditure giving rise to a continuing flow of aid which best serve the interests of developing countries.

40. It is generally true that the very rapid rate of inflation at the moment is tending so to erode the sums set aside for official development assistance that there is very little rise in real terms. The aid commitment for the future which might be made should be drawn up with provisions for appropriate adjustments to compensate for the rise in prices in donor countries. This would be a radical change in present practice.
C. NATURE AND CHARACTERISTICS OF THE ADDITIONAL AID FLOWS

41. First of all, in the past, aid has on occasions been used for the objectives of the donor country — political, military, or commercial — and as a consequence it has often not been deployed in the most effective way for the economic welfare of the recipient countries. We consider it, therefore, most important that donor countries should not be in a position to impose conditions on this flow of aid. This is not to say that the aid should be absolutely without conditions: certainly there should be conditions and criteria, some of what we suggest later. But they should be reached by international agreement, not imposed unilaterally by individual donor countries.

42. Secondly, there should be a high and growing concessionary element in this new flow of aid — that is, a high proportion of it should consist of grants or loans at low interest rates and easy repayment terms. A high concessionary element means that aid flows will be effectively "net" and will not have substantial delayed effects in reverse flows of interest and debt repayments.

43. The cost of servicing external debt in developing countries has been growing fast. The reverse flow of interest and capital repayments has been offsetting an increasing proportion of the gross inflow of public and private financial resources. If we take the figures for 81 developing countries, debt service was equal to 40 per cent of the gross inflow from developed countries in 1965; by 1971 the figure was 52 per cent. The rising cost of debt means that net transfers — that is, the gross inflow minus capital amortization and interest payments — has been going up very slowly. Indeed, in real terms, net transfers to these 81 countries hardly rose at all from 1965 to 1971.

44. We do not know the exact proportion of official development assistance which is tied (that is, tied to purchases from the donor country). We know, however, that 80 per cent of official development assistance in countries members of the Development Assistance Committee of the Organization for Economic Co-operation and Development is bilateral — although this percentage has fallen a little in recent years — and there are reasons to assume that virtually all of this bilateral aid is tied. Tied aid has all the potential inefficiencies of bilateral trade and it makes it easier for the donor country to impose political or military conditions. It would be desirable for the new flow of aid which we envisage to be untied as far as possible — or at least to be granted in the framework of a policy designed to untie it gradually and completely. Further, this new aid should be used to reinforce the trend towards channelling aid through multilateral institutions. It would also be desirable that contributions be made as far as possible in convertible currencies.

5/ The figures cover inflows from countries which are members of the Development Assistance Committee. If they were extended to cover all donor countries, the conclusion would probably be reinforced.
45. The General Assembly, in resolution 3093 A (XXVIII), also laid down that the distribution of the development funds envisaged under that resolution should be carried out with due regard to the following principle: distribution on an equitable basis, consideration being taken of the most urgent needs and requirements of the recipient countries, without discrimination of any kind.

46. The sponsor of the resolution (the Union of Soviet Socialist Republics) suggested that such assistance should in the first instance be rendered to those countries of Asia, Africa and Latin America which have suffered most from drought, floods, crop failure and other recent national disasters.

47. It was at about the time that this resolution was passed that the situation of those developing countries which possess no substantial mineral resources began to worsen considerably with the rise in commodity prices—particularly that of oil. In paragraph 2 of section X of resolution 3202 (S-VI) of 1 May 1974, the General Assembly requested the Secretary-General to "launch an emergency operation to provide timely relief to the most seriously affected developing countries". If resources from reductions in military budgets were to be forthcoming in time, they could usefully supplement the funds which have been made available for this purpose.

48. The problem of the criteria for aid is not an easy one. We note that three criteria have been canvassed in the literature on this subject: that aid should be given to the neediest; or to those countries which obtain the best returns; or to those countries which make the greatest national effort. In addition, from time to time regional and country analyses of aid flows have been made showing patterns for which it is difficult to find justification. All these criteria have something to be said for them; we consider that once the new flow of aid is established, the General Assembly should give guidance to the organ responsible for the distribution on the principles to be adopted. We consider that we should add one more criterion— or condition—for this particular flow of aid. Measures should be taken to ensure, as far as possible, that this aid should not be used by the recipient countries to increase their own military expenditure.

49. In view of the urgent needs of the developing countries, the greatest effort should be made to convert into international assistance without delay a proportion of the resources obtained from any future agreement on the reduction of military expenditure.
I. INTRODUCTION

A. Origin and background

1. Pursuant to resolution 3093 B (XXVIII) of 7 December 1973, the Secretary-General, after consultation with Member States, appointed a Group of Consultant Experts which prepared the report entitled Reduction of the Military budgets of States Permanent Members of the Security Council by 10 per cent and utilization of part of the funds thus saved to provide assistance to developing countries. Hereafter this will be referred to as the "1974" report.

2. At its thirtieth session, the General Assembly adopted resolution 3463 (XXX) on 11 December 1975 in which it, inter alia, requested the Secretary-General, assisted by a group of qualified experts appointed by him after consultations with Member States, to prepare a report containing an in-depth analysis and examination in concrete terms of four issues:

"(a) The definition and scope of the military sector and of military expenditures, as well as the classification and structuring of expenditures within the military budgets, with the over-all aim of achieving generally acceptable and universally applicable delimitations and definitions and a standardized accounting system, so as to permit effective comparisons of the military budgets;

"(b) The valuation of resources in the military sector, considering different economic systems and different structures of production within the military sector, with the purpose of examining methods concerning the relationships between resources and military output;

"(c) The deflation for price change in military production in different countries, with the aim of examining methods of measuring real expenditure trends over a period of time, taking into account differences between countries in the rate of price change;

"(d) The international value comparison and exchange rates relevant to military production, with the purpose of examining methods for accurate currency comparison of military expenditures".

B. Disarmament and development

3. Since the adoption of resolution 3093 B (XXVIII) in 1973, two objectives have been singled out by the General Assembly. One has been to

1/ A/9770/Rev.1.
secure some degree of arms control and disarmament, and the other to release resources for alternative purposes, i.e. social and economic development, particularly in the developing countries.

4. The continuing global expansion of arms and forces, both nuclear and conventional, attests to the need for effective arms control. As indicated in the introduction to the report of the Secretary-General on the work of the Organization in August 1975, it has been estimated that the size of military programmes throughout the world has more than trebled during the post-war period, to a current level on the order of $300 billion.2/ From an arms control viewpoint, the rapid and accelerating advances observed in the field of military technology are particularly disquieting. In this connexion, expenditure limitations may have the advantage not only of encompassing research and development outlays but, also, by virtue of the comprehensive scope of such limitations, of possibly constraining qualitative improvements in military forces.

5. A reallocation of resources from military to civil purposes would provide possibilities for an increase in the rate of world economic growth. Some of the savings achieved by reduction of military expenditure could help augment the presently inadequate levels of assistance to developing countries. Compared to world military programmes with a magnitude of around $300 billion, official development assistance flows to the developing countries in 1975 amounted only to about $17 billion or roughly 6 per cent.

C. Objectives of the report

6. The present study follows the 1974 report in identifying and defining the object to be reduced - or, more generally, limited - as a participant State's expenditure for military purposes. In resolution 3463 (XXX) the General Assembly affirmed the need for a fresh effort to achieve "generally acceptable and universally applicable" definitions and measures as a prerequisite for international agreement to halt the growth of military expenditure. The central purpose of this study is to furnish the major components of a system of concepts, definitions and measurement procedures, along with a corresponding reporting structure, based on the requirements deduced from the logic of expenditure limitation.

7. In resolution 3463 (XXX), the General Assembly urged that an effort be made to develop definitions and procedures that would be "generally acceptable". If we are to make progress towards the goal of expenditure limitations, the condition of general acceptability must be satisfied by establishing definitions and a reporting system which are seen both to constitute concrete progress toward the goals established in resolution 3463 (XXX) and also to protect the vital national interests of the States concerned.

8. Therefore, the following criteria were applied to the development of solutions for the main issues of our mandate:

90.

9. Although the Group of Experts has attempted to deal with the major issues that arise under the heading of measurement, it could not provide all the elements for a complete solution. Implementation of the international reporting system, which is the major recommendation of this report, would not resolve all the arms control problems of expenditure limitations. The Group of Experts reaffirms the view expressed in the 1974 report that solution of the measurement problem is only the first—although a very positive first—step towards realization of expenditure limitations. Particularly critical for successful negotiation of an expenditure limitation agreement is to solve the complex problems of verifying compliance with the agreed restraints.

10. A viable reduction of military expenditures presupposes a substantial flow of information—first, as a reference for negotiations, and second, in order to verify the fulfilment of reductions. However, it should be noticed that the prerequisites for increased exchange of information have improved with more efficient methods of collecting, processing and evaluating information. Creating mutual confidence among States, and thereby stimulating détente, depends to a great extent on improving the flow of military information. Where information is lacking, there is no clear answer to the question of how much military strength is enough. Uncertainty in military planning may lead to a preference for too much rather than too little.

11. Given the nature of the task of the Group of Experts, its approach to the weighty issues set before it has been technical and analytic. The Group is conscious of the real-world problems that must inevitably be encountered in putting any such analysis to practical effect. Implementation may have to proceed pragmatically with methods and procedures developed gradually and improved step by step as information exchange and experience increases.

II. DEFINITION AND ACCOUNTING OF MILITARY EXPENDITURES

A. Introduction

12. The ability to compare military expenditures may serve a number of different purposes: (a) to measure the domestic economic impact of changes in levels of national military outlays; (b) to trace the effects of changes in military expenditures, particularly international arms sales, on international trade flows and national payments balances; (c) to measure differences in the "burden of defence" on the national economy; or (d) to devise constraints on military expenditures in order to achieve a measure of arms control.
13. It is important to distinguish among these various purposes because delimitation of the military sector and the scope and content of military expenditures will vary significantly according to the objective sought. If one is concerned about the international arms trade, the important elements of military expenditures to be examined are those most closely related to international transfer of military goods and services; accordingly, domestic transactions would assume lesser importance. On the other hand, if the goal is arms control and eventual disarmament, attention will focus on current and future military capabilities. For reasons indicated in section I, progress towards the achievement of expenditure limitations requires that the arms control purpose be central to the definition of military expenditure. In particular, the acceptability of such limitations will depend upon each State's perception that its military security will not be impaired by entering into the constraints envisaged.

14. The purpose of this study is to measure military expenditures so as to obtain a reasonably clear reflection of military capability. However, it is recognized that military expenditure is not all-encompassing. Not everything that affects military capability can be expressed in monetary terms. There are imponderables of the society and of military organization which are difficult or impossible to quantify. It will always be necessary to take additional, albeit qualitative, account of the relationships existing between the military and the society in different countries. These factors, too, represent an important element in the evaluation of military capabilities.

B. Definition and scope of the military sector

15. The extent of the military sector may be understood in broader or narrower terms, depending on the political-military conditions and the time interval considered. In wartime the military sector encompasses functionally the whole of society that must be mobilized for success in combat or, indeed, for national survival. In peacetime, the military sector is of course functionally and legally more limited, with a scope possibly related to the degree of international tension. As for the time dimension, it is evident that, in the very short run, only mobilized forces with existing equipment and material stocks can be relied on for military capability. In the very long run, most of total national output and some portion of the national capital stock not initially earmarked for military use could be reallocated to the military sector. It would be extremely difficult to quantify the costs involved in this concept of the military sector. For example, activities will frequently have economic and social as well as military benefits, and there is probably no way of apportioning the costs of a particular measure and the various considerations that motivated it. Evidently, our definition must be based on some intermediate time-frame and a less than total mobilization of the social and political structure.

16. Definitions of military expenditures sometimes include the current costs of past military activities, such as pensions to retired servicemen and families of deceased military personnel, or even payments on the national debt, accumulated largely in the prosecution of past conflicts. As was indicated earlier, the definitions of military sector and military expenditures developed here are geared to arms control through military expenditure limitation. With this objective, our concern is restricted to current and future force potential.
Hence, the definitions must exclude activities related only to past military involvement.

17. As the 1974 report suggests, the military activities of a State may be viewed as intended ultimately for the protection of "national security", of which "military security" is the element directly related to the national military activities. That aspect of national security which seems to correspond most directly to national military activities and the capability to affect events through military policy was called "force potential" in the 1974 report. We may therefore follow the 1974 report in defining the military sector as "that group of activities whose object is the research, development, provision, assembly, maintenance and deployment of current and future force potential intended for application mainly against external forces".

18. The activities of the military sector may also be viewed in terms of:

(a) Employment of military and civilian personnel; including reserves;
(b) Procurement of equipment;
(c) Operations and maintenance;
(d) Construction of military facilities;
(e) Research and development.

In each category listed above, reference is not just to conventional arms but also to nuclear weapons; military applications of space technology are also included.

19. The delimitation of the military sector is complicated by the existence of more or less close substitutes for some of the activities mentioned above. Important substitutes which seem worth examining are:

Paramilitary forces

20. The concept of paramilitary forces is difficult to define. Several different types are identified under this general rubric in the annual entitled The Military Balance issued by the International Institute for Strategic Studies. It seems reasonable to include in the military sector those groups which, having received organized military training, could, if equipped with appropriate weapons, be used as substitutes for regular military forces.

Civil defence

21. It is apparent that passive or civil defence against air attack may be a substitute for active air defence of urban areas. Therefore, in principle civil defence should be included in the military sector, although the application of the principle requires further study.

"Strategic" stockpiling other than armaments

22. The difficulty of "determining the defence-motivated portion of national
inventories" makes it impractical to attempt to include this activity in the military sector.

"Mothballed" or reserve arms production facilities

23. Such facilities represent, in effect, a stockpiling of future production capacity. Their acquisition and maintenance should therefore be included in the military sector as procurement of equipment and be viewed as an element of the core itself, because such reserve facilities constitute future force potential.

Military assistance

24. Military assistance to allies or non-allies should also be included in the military sector. The implicit and perhaps justifiable assumption is that military aid to some extent always strengthens the military position of the donor country.

C. Definition and scope of military expenditures

25. Such activities as training military units, equipping them with weaponry and facilities, and deploying the units for various missions depend on flows of goods and services in the form of personnel, materials, equipment, etc., which are obtained from outside the military sector. Military expenditures are measured as the value of flows of final goods and services into the military sector, valued at factor cost. Given the obvious convenience of adhering to the time span commonly used in national and international accounting, the time unit of definition to be used here is a full year. Part of such flows of goods and services may sometimes be financed by the private sector. The scope and content of military expenditure may be clarified in terms of costs of the activities identified in subsection B.

Compensation of military and civilian personnel, including reserves

26. In accordance with previous discussion of sector limits, pensions and allowances to retired personnel, and to families of deceased personnel, are excluded.

Procurement of equipment

27. Procurement is defined to cover all equipment, not just major classes, and as in the sectoral definition, includes major modifications of equipment on hand. For practical reasons, acquisition of all ammunition and ordnance is classified as procurement. In many countries various forms of government assistance may be extended to military industry. Examples are investment in tools for production of specific weapon systems or grants and loans for current operations or investment purposes. Such assistance is treated here as a subsidy which must be added to product price.
Operations and maintenance

28. Outlays on operations and maintenance include the following:

(a) Purchases of food, clothing, petroleum products, training materials, medical materials, office supplies and other materials for current use, including stockpiling and additions to inventories.

(b) Travelling expenses, postal charges, printing expenses and payment for other current services;

(c) Contract services for repair and maintenance of equipment and facilities;

(d) Purchases of parts, materials and tools for repair and maintenance of equipment and facilities;

(e) Real estate rents.

Construction of military facilities

29. Construction embraces acquisition of land and facilities as well as construction per se.

Research and development

30. Research and development should be subdivided into (a) basic and applied research, outlays on which present a most difficult verification problem; and (b) development, testing and evaluation, for which verification seems more manageable.

31. A difficult problem of military expenditure classification is presented by civilian activities carried out by the armed forces or the Ministry of Defence. Military forces sometimes perform such exclusively civilian activities as construction, farming assistance, medical services, education, hydrographic services or the operation of such institutions as naval observatories. Such activities should be excluded from military expenditures. However, the excluded outlays must be strictly limited to those with a purely civilian effect, such as the cost of construction materials for certain clearly civilian projects.

D. Structuring and classification of military expenditures: a proposed international reporting system

32. We now propose a framework for standardized international accounting and reporting of military expenditures. Agreement on a common accounting table and a common set of accounting principles would facilitate international comparison of military expenditures. The purpose here is to propose an aggregated accounting table that could be used as soon as practically possible by States in reporting their military expenditures.

33. The use of a standard accounting format for military expenditures will probably first fulfil its function as a confidence-building tool. The improved
information available through published budgets reduces the fear of underestimating military forces of other States and the tendency to overcompensate.

34. The minimum possible presentation of military expenditures is to give the total amount, using specified accounting and pricing standards. Negotiations on limitations or reductions of military expenditures, defined so crudely, are likely to be in vain. More information is necessary on such major components as "ground combat forces", "air defence" and "strategic forces". Specifying the military forces on this level of disaggregation makes possible a rough assessment of what military balance would result from a proposed mutual change.

35. Having broadly defined the boundaries of the military sector and the scope of military expenditures, we may now proceed to present a detailed structuring of military expenditures. This will be done both in terms of resource cost elements and in terms of military missions or programmes. A scheme of the general accounting structure to be used for reporting by participant States is set out in the accompanying table A.
### TABLE A

Recommended format for international reporting of military expenditures

<table>
<thead>
<tr>
<th>Resource costs</th>
<th>Force groups</th>
<th>Strategic forces</th>
<th>General purpose forces</th>
<th>Central support, administration and command</th>
<th>Paramilitary forces</th>
<th>Civil defence</th>
<th>Military assistance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(1)</td>
<td>(2) (3)</td>
<td>(4) (5)</td>
<td>(6) (7)</td>
<td>(8)</td>
<td>(9) (10) (11)</td>
</tr>
</tbody>
</table>

#### I. Operating costs

1. Personnel
   - (a) Civilian
   - (b) Conscripts
   - (c) Other military

2. Operations and maintenance
   - (a) Materials for current use
     - (purchases of food, clothing, petroleum products, training materials, medical materials, office supplies and the like)
   - (b) Maintenance and repair
     - (i) Contract services for repair and maintenance of equipment and facilities
     - (ii) Purchases of parts, materials and tools for repair and maintenance of equipment and facilities
   - (c) Travel expenses, postal charges, printing expenses and payment for other current services
   - (d) Real estate rents

#### II. Procurement and construction

1. Procurement*
   - (a) Aircraft and engines
   - (b) Missiles, including conventional warheads
   - (c) Nuclear warheads and bombs
   - (d) Ships and boats

**Subdivision of general purpose forces**

Cols. (2) Land forces
Cols. (3) Naval forces
Cols. (4) Air forces
Cols. (5) Other combat forces

**Subdivision of central support, administration and command**

Cols. (6) Central support (supply, maintenance construction, training, medical, etc.)
Cols. (7) Central administration and command, including intelligence and communications

**Subdivision of military assistance**

Cols. (10) Contributions to allied forces and infrastructure
Cols. (11) Military assistance to allies and non-allies
II. (continued)

(e) Tanks, armoured personnel carriers and other armoured equipment
(f) Artillery
(g) Other ground force weapons
(h) Ordnance and ammunition**
(i) Electronics and communications
(j) Vehicles
(k) Other

2. Construction

(a) Airbases, airfields
(b) Missile sites
(c) Naval bases and facilities
(d) Electronics, communications and related structures and facilities
(e) Personnel facilities
(f) Medical facilities
(g) Warehouses, depots, repair and maintenance facilities
(h) Command and administration facilities
(i) Fortifications
(j) Shelters
(k) Other

III. Research and development

1. Basic and applied research
2. Development, testing and evaluation

* Subdivide by
  Domestically produced vs. imported.
  Allocation to forces vs. stockpiled.

** Excluding elements in (b) and (c) above.
36. The structure of table A bears similarities to military expenditure accounting used by some countries but differs from any particular national system, since it is developed specifically for the purposes of the study. Also, military expenditures are to be recorded independent of the type of financing, channel of expenditure and type of budget accounting used in any particular national system.

37. The table, while comprehensive in its coverage of expenditures as defined in this report, cannot take into account the value of the current services of military capital, nor does it allow for the recording of stocks of capital and their net and gross changes. Since military balances in the short run are dominated by inherited stocks, it would be desirable in the future to supplement expenditure values with data in physical terms for a number of resource categories.

38. Standardized reporting in the form recommended will require considerable effort. Since it is impossible to know in advance what kind of data States are able and willing to report, more information is requested in table A than can reasonably be expected from all States at the outset. A pragmatic approach and a step-by-step implementation will help overcome the difficulties encountered.

39. In conclusion, we would like to underline our belief in the utility of expenditure limitations as an approach to effective arms control. Reporting military expenditures on an international basis under the aegis of the United Nations is the keystone to that approach, and the Group of Experts believes that this study suggests a valuable instrument for that purpose.

III. VALUATION OF RESOURCES IN THE MILITARY SECTOR

A. Introduction

40. The accounting of military expenditures must determine not only what and how to count - for example, whether civil defence should be included or excluded; whether ammunition purchases should be recorded under procurement or operations and maintenance - but also how to value. What kinds of prices shall be used to weigh physical quantities of goods and services so that the resulting aggregates correspond to the objectives of the measurement?

B. Military expenditure and military utility

41. Given the fundamental arms control purpose of military expenditure limitations and reductions stipulated in this report, it would be desirable to establish valuation criteria that would generate expenditure measures corresponding to measures of military utility. In that case, changes in measured military expenditures could be expected to parallel the changes in real military capability which are to be constrained under the expenditure limitation. An attempt to establish the basis for such a measure of military expenditures uses a conceptual model which postulates that each State's political-military authorities maximize national military security derived from the combination of military goods and services, subject to a budget constraint. In this model, military expenditures may be interpreted in terms of the military utilities
derived directly from the consumption of military goods and services, or indirectly through their combination in output-defined programme packages. The assumptions of this concept are, however, stringent, with no discernible application to the real world, and it appears necessary to reject the military utility model as a basis for a valuation criterion.

C. Military expenditure and production potential

42. The alternative approach to the valuation of military activities suggested in the 1974 report is that of opportunity costing. Resources used in the military sector would be priced at the value of the civilian opportunities foregone because of allocation to military use. Opportunity costing of military activities therefore is a measurement of the civilian production potential that is embodied in the resources in military use, as contrasted with the military utilities that are supposed to be measured by military expenditure. For that reason, opportunity cost valuation yields expenditure values that are second-best measure for arms control purposes, and for reasons indicated in subsection B above, we have no choice but to use a second-best solution for the valuation of military expenditure. The discussion below suggests a variant of opportunity costing as a basic valuation criterion for military expenditure. Such expenditure would then be interpreted in terms of potential to produce military goods and services, in an analogue to the production potential interpretation of national income flows and in distinction from the counterpart welfare-utility interpretations.

43. The 1974 report states the main principles of opportunity costing. It also notes that opportunity costing requires a correspondence of relative prices and relative real costs, that the correspondence is "far from perfect" in the real world, and that the nature and degree of the shortfall will vary because of differences in international price systems. In pure form, factor cost measurements presuppose efficient production, that an economy fully exploits and fully employs the technical possibilities and resources available to it. But distortions of relative prices are found in all real economies, resulting largely from government action on behalf of one or another public policy interest. However, there also are salient international differences in relative prices that reflect the significant differences between different price systems.

44. If we are to succeed in defining a valuation framework of such a nature that military expenditure will be even crudely indicative of an economy's potential to produce military goods and services, it will be necessary to take these and other pricing problems, in both centrally planned economies and market economies, into account. One theoretical apparatus that succeeds in doing so is the Adjusted Factor Cost standard of pricing devised by Professor Abram Bergson, who eases the requirements of the traditional factor cost standard by recognizing that any economy may be operating short of its real production frontier, on a "feasibility locus".

45. To summarize briefly the cost implications of these standards, it may be noted that commodity prices are viewed as composed of charges for factors of production. Wages are the same for any given occupation, with inter-

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2/ By the same token, however, such values are directly relevant for a measurement of the burden of defence.
occupational differences corresponding to the average difference for the economy as a whole in the disutility of employment and marginal productivity. A net charge for capital is accounted for either as a cost (interest) or as residual income (profits) but at a uniform rate for all production based on the average productivity of capital generally. In addition, cost includes depreciation. Land rent allows for differential return to superior land. Where actual costs diverge from the standards indicated, adjustment of expenditures would be required.

46. A modified factor cost standard of this type is a viable solution to the problem of developing a consistent and feasible set of rules for international valuation of military expenditure in domestic currencies. Moreover, it is of general applicability, since the presumption of less than fully efficient operation applies to all economies and encompasses all the major price distortions responsible for shortfalls from the theoretical norm.

47. It will be understood that such a theoretical framework requires judicious application and will necessarily have to bend to the realities of data availability. It cannot be expected that real world measurements can be precisely tailored to fit neatly defined theoretical categories. The criteria suggested here, of course, represent only one possible approach to the valuation problem, although we believe the approach is useful.

IV. PRICE AND VOLUME MEASURES OF MILITARY EXPENDITURES

A. Introduction

48. An increase in military expenditure by a State which has concluded an agreement to limit or reduce military spending is not in itself evidence of a broken agreement. It is quite possible that an increase in expenditure is necessary to purchase the same basket of military goods and services because of an autonomous rise in their prices. Therefore, it is essential to distinguish between nominal and real changes in military expenditures. The usual procedure is to revalue physical quantities at the prices of a single year, and so eliminate the distorting effects of pure price changes. Unfortunately, there is no single source and no systematic collection and processing of information concerning changes in military expenditures at constant prices.

B. Conceptual problems in intertemporal and international comparisons

49. In view of close correspondence between the theory of intertemporal and international price and volume comparisons, it seems useful to set forth at this point a number of the basic common ideas. There are complex conceptual problems involved in constructing measures of the change in volume of production or real expenditures over a period of time and between countries. This is particularly true in areas where it is difficult to develop a concept of output or quantity to which a constant price can be attached. It has already been pointed out that the concept of output of the military sector is somewhat elusive and in sections II and III it has been acknowledged that the concept of military security or even force potential cannot be easily specified and
measured. In view of these difficulties, the alternative chosen in section III was to measure changes in the flows of final military goods and services into the military sector. These flows are valued at factor cost defined in average cost terms. Therefore, the task of deflating for price change within one country or for price differences between countries at a point in time is to construct intertemporal or international price indexes in factor cost terms.

50. We envisage that those responsible for the construction of military price deflators will require information and data from different countries, at different levels of aggregation, and according to different definitions. The usual problems associated with the index number construction may appear in a more extreme form for the military sector. For comparisons over a period of time, military outputs may be weighted in terms of base year or given year prices, corresponding to the familiar Laspeyres and Paasche index number formulae. There are, therefore, two possible indexes for price change of military output. The counterpart in international comparisons reflects the use of the price weights of one country or another. This is the so-called index number problem, made more severe by rapidly changing military structures. For this reason, the Group of Experts recommends a deflation procedure using both types of index referred to above.

C. Technical problems in constructing military price indexes

51. For such cost categories as personnel, materials and standard equipment, the construction of price deflators is fairly routine. More difficult problems arise in the case of military hardware, especially advanced and technically sophisticated weapons systems, where quality change is rapid and difficult to measure, and the distinction between an improved product and a new product is often hard to make. With respect to quality change, experience gained in adjusting civilian price indexes will be helpful for standard items with counterparts in the civilian sector; experimental work could be necessary for more complex items of military equipment.

52. In some cases the data needed to construct military price indexes will not be available; then surrogate indexes drawn from the civilian economy could possibly be used. Their appropriateness in each case will need to be carefully considered.

D. Specific proposals for the construction of price deflators for military expenditures

53. The task of constructing price indexes that closely mirror the actual changes in prices of military goods and services is both technical and political. Technically, the problem is to establish procedures that will yield accurate measures of price change. Politically, it is important to guard against self-serving statistics in the price deflating system. Hence, it would be of doubtful value to use indexes constructed and measured by military agencies without the opportunity of cross-checking against data developed from other sources. Deflation of military expenditure by programme categories does not seem possible because of the large number of price changes that may take place within programmes, comprising very varied elements or components. Therefore a necessary starting point for the deflation procedure is the allocation of military expenditure into resource cost categories, such as those shown in the accounting matrix of table A, each of which could be deflated by an appropriate price index.
Personnel costs

54. The further breakdown of personnel costs should accord with the levels of skill, educational attainment, etc. It may be desirable to distinguish between military and civilian personnel costs and deflate them separately. The difficulty of measuring the rate of growth of productivity of personnel in military activities, as in services generally, makes it useful to adapt price indexes of comparable grades and categories of labour from the civilian economy.

Procurement of equipment

55. To the extent that change in performance or specification of particular products can be measured at all, it is preferable to determine the level of price change at the point at which equipment enters the military sector. To acquire the necessary data, prices must be found for projects in different years which in various senses are equivalent. An assessment based on producers' or purchasers' prices would take into account changes in productivity and adjustments to changed factor prices. The major weakness of this method is the difficulty of making appropriate adjustments for changes in quality.

56. The object of deflation is to achieve a measure of real change in prices of military goods and services so that military expenditure will, in fact, reflect real changes in volume over a period of time. Thus the type of deflator to be used and the extent to which surrogates may be applicable depend on an estimate of the distortion that would result, taking account of what is feasible and practicable and the information available.

Construction

57. Construction (buildings, fortifications, airfields, etc.) is a category of goods and services where price indexes are rarely based on prices of the finished product itself. In many countries there is a variety of cost indexes for construction, but the indexes measure only the price changes for specified units of production resources, e.g. labour, concrete, bricks and so on, without consideration of effects on the price of the finished product from changes in productivity. The difficulties of developing end-product price indexes for construction make it necessary, at least in the short run, to rely on the closest substitute for a comprehensive construction price index: the construction cost indexes prepared primarily for the civil economy which are now available in most States.

Imports

58. Import items must be identified and valued at the same level of aggregation as in the procurement of military hardware. It seems likely that most States importing military equipment will have records of financial flows and price changes.
Research and Development

59. Here the breakdown can be by categories of personnel, materials and equipment which can be treated in the ways designated above for these categories.

Miscellaneous

60. With respect to goods consisting largely of standard items and commodities which bear strong physical resemblance to civilian counterparts, it would seem appropriate to use wholesale price indexes, assuming that they are appropriately constructed.

V. INTERNATIONAL VALUE COMPARISONS FOR MILITARY EXPENDITURES

A. Introduction

61. Any proposal for reduction or limitation of military expenditures may require a generally acceptable means of comparison in absolute value terms. Very little empirical work has been done in the field of international comparisons of military spending. But since the very beginnings of modern economics, considerable interest has been shown in simple comparisons of real income and expenditure, productivity and relative prices between countries.

B. International comparisons using exchange rates

62. An increasing number of leading economists consider that international comparisons which convert national products or some component of national products, estimated in terms of the national currency, into a common currency unit by means of prevailing or adjusted exchange rates are of doubtful value. The existence of different rates for different trade transactions in many countries makes it very difficult to determine the official exchange rate; and although it may be possible to derive a weighted average exchange rate, this requires detailed information on foreign transactions which is often hard to obtain. But even if average official rates of exchange could be computed, their use for the conversion of values to a common currency is open to question. To produce the right results the relationship of internal prices in two or more countries, i.e. the relative purchasing power of currencies must be the same as the exchange rates used to make value comparisons. This equivalence is extremely unlikely. With respect to internationally traded goods it would require that exchange rates reflect the long-run equilibrium rate of exchange, and this would only be possible in the absence of restraints to trade such as tariffs, export subsidies, quotas and licences, and exchange controls.

63. These objections to the use of exchange rates in international comparisons of national products apply with even greater force to military products. There simply are no official exchange rates for military products.
C. Purchasing power parties for the military sector

64. The reliability of estimates of purchasing power parities for final military goods and services will depend upon the availability and quality of the data provided by individual States. Serious consideration of military sectors, and the derivation of reliable internal purchasing power parities for military output, will require detailed price and quantity information. Some conceptual problems involved in international comparisons have already been discussed in section IV above. For the purpose of reductions and limitations of military expenditures, it has been suggested in previous sections that flows of final military goods and services used should be measured. Expenditures on resources on an adjusted factor cost basis would be deflated, where possible, by both a Laspeyres index and a Paasche index. These are the price indexes necessary for the compilation of purchasing power parities.

VI. SUGGESTIONS FOR IMPLEMENTATION

A. Introduction

65. The Group of Experts believes that, while the recommendations in sections II to V concerning the complex problems posed in our mandate are not necessarily exhaustive, they are viable and constitute an analytical step forward towards the goal of expenditure limitations and reductions. There are several technical issues which have been left unresolved, largely because the possible choices required a level of technical detail and specialization which could be supplied only by professionals in the narrow subfields involved. For this reason, there is clearly a need to translate the concepts and procedures developed in this study into practical ways and means that can be utilized on a regular basis by the United Nations and its Member States.

66. The Group has previously expressed the view that the international reporting instrument developed in section II (table A) must be operationalized, tested and refined. These are three distinct phases of what might be called "operational development", which constitutes a prerequisite for more general application of the accounting matrix as a regular instrument for reporting the military expenditure of the States Members of the United Nations.

B. Operational development of the reporting instrument

67. The three phases of operational development may be briefly described as follows: By operationalization is meant the precise definition and specification of expenditure categories and their content in such detail as to constitute concrete guidance to States that will be supplying the required data. In the next phase, testing, the instrument and its accompanying instructions are transmitted to the participant States for completion with the required data. In this phase, the adequacy of the operationalization is examined and assessed. The correction and improvement of the matrix, as well as the accompanying instructions, based on the experience obtained in the testing phase, may be called refinement.

68. In the implementation of operational development, the General Assembly may wish to keep the process under its general supervision. However, the Group of Experts recommends that the technical responsibility for the concrete tasks
of operationalizing, testing and refining should be delegated to an ad hoc panel of experienced practitioners in the field of military budgeting, under the aegis of the United Nations system.

69. In testing the validity of the reporting system proposed in the present report, the General Assembly may opt for a universalistic approach, on the grounds that all Member States should be given an opportunity to participate on a voluntary basis from the outset. In the interest of economy and time, however, the General Assembly may wish to consider, if feasible, that at the initial stage a selected group of States would suffice, providing it is representative.

C. Suggestions for further action

70. If the operational development of the standardized reporting instrument is successfully completed, the instrument should be ready for adoption and institutionalization by the United Nations for regular reporting. At this further stage the international community should be ready for discussion of the other major technical issues of expenditure limitation and especially of the problems of verification. At the appropriate time, further consideration should be given to utilizing part of the resources released from the reduction of military expenditures for social and economic development, particularly that of the developing countries.
INTRODUCTION

1. The discussions and negotiations which have been pursued in the United Nations and elsewhere in order to achieve the basic goal of the maintenance of peace and the elimination of war have led to some initial steps in the field of arms limitation and disarmament. Nonetheless they have not succeeded in halting, let alone reversing, an arms race that has grown ever more perilous over the years, and ever more wasteful of human and other resources. The trend to produce and accumulate ever more sophisticated and ever greater numbers of costly and deadly weapons continues uninterruptedly. More and more States, including a growing number of smaller or developing countries have found themselves impelled along this path.

2. Nuclear weapons constitute the most fearful category of armaments to which military expenditures are devoted, and these pose the greatest threat which mankind now faces.

3. Chemical and bacteriological (biological) weapons have consumed only an insignificant part of total expenditures on arms, but the ominous shadow they cast over the world is totally disproportionate to their cost. The United Nations considers chemical and bacteriological (biological) weapons as belonging to the category of weapons of mass destruction, and has insistently called for their elimination.

4. By far the largest part of the total of military expenditures which is devoted to equipment is, however, consumed in the development, production and purchase of conventional weapons such as aircraft, tanks and guns, the weapons which have been used in the wars which have marred this last decade. This generalization applies as much to the nuclear Powers as to the non-nuclear States.

I. QUALITATIVE ASPECTS OF THE ARMS RACE

5. The decade of the 1960s was marked by a greater spread and by a more extensive technological elaboration of armaments than any which preceded it. During the period, there were no developments comparable to the emergence of radio or radar, jet engines or rockets, nuclear weapons or electronic computers. Yet the decade will be remembered because supersonic flight became commonplace, because of the diversification of nuclear weapons in the armouries of a few major Powers, and because their multiplication meant the accumulation of destructive power, only a fraction of which would be enough to eliminate life on earth; because the development of ballistic missiles, and the sophistication of their guidance and control systems, made any point on earth open to precise attack by nuclear warheads; and because space technology added a new dimension to the field of military communications and surveillance.
6. The make-up of military budgets varies from country to country, but it can safely be said that in the major arms-producing countries on average about half goes to personnel costs and the rest to a combination of research and development, purchase of equipment, construction and operations. The estimated total for world military expenditures over the period 1961 to 1970 is $1,870 billion (at 1970 prices) (see section II, table 1, below), of which it can be reckoned that about $600 billion was devoted to the purchase of equipment. By far the larger proportion of this sum was spent on conventional arms. The outlays on nuclear arms which the nuclear Powers have made over the years, and which are also included in this sum, have resulted in the stockpiling of weapons with a potential destructive power infinitely greater than that of all other armaments put together. The weapon-systems associated with nuclear armaments are not only extremely costly to produce, but their vast "over-hitting" power makes them, in no conceivable sense, a substitute for conventional arms. The same general conclusion applies to chemical and bacteriological (biological) weapons.

7. Of the total of $1,870 billion which went to military expenditures over the period 1961 to 1970, an estimated 10 per cent - somewhat less than $200 billion - was devoted to military research and development. This work was highly concentrated in the six countries which now account for more than four-fifths of total military expenditure. Although only a minor part of the total, it is this outlay for research and development that determines the main feature of the modern arms race - the qualitative changes in armaments. The people who design improvements in weapons are themselves the ones who as a rule envisage the further steps they feel should be taken. They do not wait for a potential enemy to react before they react against their own creations.

8. These features of the arms race show up very clearly in the field of long-range nuclear weapons. First there was a rapid change in the means of delivery, starting with the switch from manned bombers to liquid-fuelled ballistic missiles, beginning with intermediate and moving on to rockets of intercontinental range. Solid-fuelled missiles soon followed, deployed in concrete silos, in order to protect them from attack. In parallel, submarine-launched ballistic missiles were developed and deployed.

9. With the introduction of ever more sophisticated and less vulnerable means for the long-range delivery of nuclear warheads, nations turned their efforts in military research and development to the problem of detecting and intercepting ballistic missiles. Simultaneously, efforts were directed to the devising of missiles with multiple warheads (MLRVs) capable of being aimed at a number of targets from a single launch, and so, theoretically, of overwhelming anti-ballistic missile (ABM) defences.

10. The research and development effort devoted to nuclear armaments during the 1960s has been enormous. Military satellite communications, supplementing more conventional methods of communication, have also been deployed, as have also space surveillance systems.

1/ The United States, the Soviet Union, the People's Republic of China, France, the United Kingdom and the Federal Republic of Germany.
11. Vast technological developments have occurred in weapons and weapon-systems designed for air, land and sea warfare. The development and deployment of supersonic aircraft has greatly increased the cost and complexity of what are still regarded as conventional fighter aircraft. A modern fighter-bomber costs ten times the aircraft of 10 years ago which it replaced.

12. The familiar chain of new weapon, counter-weapon and counter-counter-weapon has also characterized the sphere of land warfare. The dependence of armies on armoured vehicles has intensified, the response to this change being the continued elaboration of sophisticated anti-tank weapons. Helicopters have been brought into greater use, in the effort to increase the mobility of land forces.

13. In the naval sphere nuclear and gas turbine propulsion have added new dimensions to the design of ships' machinery. The increasing vulnerability of surface vessels to air attack has been countered by the development and installation of anti-aircraft missiles. Counter-measures have followed, such as the stand-off bomb, which can be launched from beyond the range of the ship-borne missile.

14. Some figures are available which reflect these various qualitative changes. At the outset of the decade, hardly any intercontinental ballistic missiles (ICBMs) had yet been deployed. By the end of the decade the estimated numbers were 2,150. In 1960 the deployment of submarine-launched ballistic missiles was negligible. By the end of the decade, some 55 nuclear-missile submarines were operational, comprising about 800 missiles, capable of delivering about 1,700 warheads.

15. From 1960 to 1968 the world stock of fighting vessels is estimated to have increased from 4,550 to 4,900. At 1968 prices, the value of the stock in 1960 was about $34 billion, as compared with $60 billion in 1968, a 75 percent rise.

16. A much more striking change occurred over the period in the world stock of supersonic fighters. At the opening of the decade their estimated number was 6,000. By the end it had doubled.

17. This brief sketch of the qualitative changes in armaments that have taken place over the decade shows that while the cost of the arms race in terms of the resources which it consumes is highly alarming, the mounting sophistication and destructiveness of the weapons which result from it are even more so.

II. THE ARMS RACE IN TERMS OF RESOURCES

18. As already noted, military expenditures for the world as a whole added up to an estimated total of $1,070 billion (at 1970 values) over the period 1961 to 1970 inclusive. During the 10 years from the beginning of the decade, annual expenditures have increased by more than $50 billion to reach
their present level of about $200 billion.\textsuperscript{1} Military expenditures are in fact now running at two and a half times what all Governments are spending on health, one and a half times what they spend on education, and 30 times more than the total of all official economic aid granted by developed to developing countries.\textsuperscript{2}

Table 1. World Military Expenditures and GNP

1960-1970\textsuperscript{a}
(Amounts in billions of constant 1970 dollars)

<table>
<thead>
<tr>
<th>Year</th>
<th>World military expenditures</th>
<th>World GNP</th>
<th>Military expenditures as percentage of GNP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960</td>
<td>150.5</td>
<td>2,023.5</td>
<td>7.4</td>
</tr>
<tr>
<td>1961</td>
<td>156.1</td>
<td>2,116.6</td>
<td>7.4</td>
</tr>
<tr>
<td>1962</td>
<td>167.6</td>
<td>2,213.7</td>
<td>7.6</td>
</tr>
<tr>
<td>1963</td>
<td>174.2</td>
<td>2,313.7</td>
<td>7.5</td>
</tr>
<tr>
<td>1964</td>
<td>174.0</td>
<td>2,462.4</td>
<td>7.1</td>
</tr>
<tr>
<td>1965</td>
<td>174.9</td>
<td>2,589.8</td>
<td>6.8</td>
</tr>
<tr>
<td>1966</td>
<td>190.5</td>
<td>2,732.0</td>
<td>7.0</td>
</tr>
<tr>
<td>1967</td>
<td>206.5</td>
<td>2,842.8</td>
<td>7.3</td>
</tr>
<tr>
<td>1968</td>
<td>209.9</td>
<td>2,963.9</td>
<td>7.1</td>
</tr>
<tr>
<td>1969</td>
<td>209.6</td>
<td>3,096.0</td>
<td>6.8</td>
</tr>
<tr>
<td>1970</td>
<td>202.6</td>
<td>3,204.1</td>
<td>6.3</td>
</tr>
</tbody>
</table>

\textsuperscript{a} Estimates prepared by the United States Arms Control and Disarmament Agency. World totals are based on national data adjusted to uniform definitions of military expenditures and GNP, in so far as available information permits.

\textsuperscript{1} The statistical study of world military expenditures is still in its infancy and comparatively little research into the question has been encouraged. This is mainly because of the issue of secrecy. The margin of error in the figure of $200 billion for annual world military expenditures at the end of 1960s is not known, and any figure for total expenditures between $170 and $250 billion would be plausible. There is a much smaller margin of error in the calculation of trends.

\textsuperscript{2} It should be noted, however, that in many countries a large proportion of spending on health and education is private.
19. In a period in which no major nations have been at all-out war with each other, it is a new departure for the world to devote so large a proportion of its resources to military uses. Compared with previous periods in which the more highly industrialized countries were not at war with each other, there have been two major changes. First, the world's standing armies are much larger than they used to be. Second and more important, the qualitative changes in weaponry described in the previous chapter mean that the weapons with which these armies are equipped have grown immensely in lethal power, in cost and in complexity. The relative share of world output devoted to military uses in the years since 1949 has been at least double what it was in 1913, when there had already been three years of competitive rearming between the great Powers. It is a highly disturbing fact that the world has increased the volume of resources which it is devoting to military uses at least twenty-fold during the course of this century.

20. Over the past 20 years, the rise, though rapid, has been irregular. It has tended to go up sharply in periods of crisis or war, and then level off for a number of years, but without returning to the pre-crisis figure.

21. During the period 1960-1970, the movement of military expenditures, as well as of their share in GNP, was irregular. Their level increased considerably in real terms, but their share in GNP decreased somewhat by the end of the 1960s. People might suppose that were the calculated percentage of the national product devoted to military expenditure by rival States to remain steady, they would not be engaged in an arms race. Equally, a falling percentage of national product could be taken to imply that an arms race was "going into reverse". Neither of these inferences would necessarily be true. Indeed, a steady percentage of a constantly rising world output would imply an unending arms race, at the same time as a falling percentage could conceal an absolute increase in military expenditures. Economic evidence alone, therefore, cannot demonstrate that the arms race is abating.

22. World military expenditure is highly concentrated in a few large countries. Six countries out of 120 3/ alone accounted for more than four-fifths of the world total for the decade of the sixties. Developing countries play a lesser role in the global arms race. With nearly half of the world's population, they account for only about 6 per cent of world military spending, and their influence on the world trend in expenditure, and on the technological arms race, is consequently minimal. Further, they devote a smaller share of their resources to military purposes than do the major industrialized countries. Although military spending in developing countries is very low in relation to that of the advanced countries, it is significant that in the decade of the sixties the rate of growth of military expenditures was appreciably faster in the developing countries than the world average - in contrast to what has happened in the six nations which are the major military spenders. Against a world rise of about 3 to 4 per cent a year, military spending in the developing countries has been increasing at a rate of some 7 per cent a year. When the

3/ The 120 countries cover all the countries in the world with any significant military expenditure. The six major countries are: the United States, the Soviet Union, the People's Republic of China, France, the United Kingdom and the Federal Republic of Germany.
needs of economic development are so pressing, it is a disturbing thought that these countries should have found it necessary to increase their military spending so speedily.

23. The rapid rate of increase in military spending in developing countries should, however, be interpreted with caution. The arms race in the third world can be directly related to the wars in which it has been engaged. But as is fully recognized, some conflicts have not been conducted independently of the great Powers, which have provided considerable supplies of weapons and of finance. In other regions a number of new States have been building up their armed forces virtually from nothing.

24. It has been estimated that about 50 million people are engaged directly or indirectly for military purposes throughout the world. The available information does not permit a more precise figure. Fairly accurate figures for the armed forces alone are available, but they are not a good substitute for expenditure estimates — partly because the armed forces have become increasingly capital-intensive. Not only is the ratio of equipment costs to total expenditure rising, but in a number of countries the armed forces have been employing an increasing number of civilians to do work which was previously done by servicemen.

25. It is worth noting, however, that the figure for the personnel in the world's armed forces as a whole reached a total of 23 to 24 million by 1970, and that it had been rising at a rate of about 2 per cent a year during the decade of the sixties. Virtually all of the increase in military man-power occurred in the developing countries, whose share of the over-all total for the world's armed forces is now about 37 per cent, in contrast to a 6 per cent share in military expenditure. Over the past decade the numbers in their armed forces have been rising by 4 per cent a year.
III. THE DYNAMICS OF MILITARY RESEARCH AND DEVELOPMENT

26. The extent to which military expenditures affect other fields of public and private spending becomes clearer when the dynamics of the race, as reflected in the continuing elaboration of armaments, are understood. Obviously the scale of the resources which are provided for the maintenance of armed forces and for the acquisition of armaments is determined by political decision. It does not necessarily follow that the process of action and reaction which characterizes the arms race, certainly the arms race in sophisticated weapons, means that security is increased as more is spent on armaments. Indeed in the field of nuclear weaponry the reverse appears to be the case. Furthermore, every new generation of weapons and weapon systems inevitably demands more and more resources which could be used for different economic and social purposes. By providing resources for basic fields of science which might bear upon the development of sophisticated weapons, the arms race also inevitably affects the direction and tempo of a country’s scientific and technological development.

27. It is the most powerful industrial nations which are the pace-setters of the arms race. They too are the ones which have also had a considerable impact on the development of science-based industries in the civil field which are complementary to those which provide military matériel, for example aircraft. The arms race of the major Powers is now a competition to achieve an advantage not just in quantity but even more in quality -- in the speed of aircraft, in the range and accuracy of ballistic missiles, in the manoeuvrability of tanks, in the efficiency of radar systems, and so on. The arms race has in fact become essentially a technological race, the achievements of one side spurring the other to improve on the technological advances which it might have made itself. The arms race becomes based on the "hypothesis of the worst case", that is to say, one of two sides designs its programme of development on the assumption that its rival could, if it so decided, be the stronger.

28. That is one aspect of the force behind the race. There is another. Before a new weapon is completed, the military designer is as a rule already designing a more effective model which -- he hopes -- will not only be more effective in performance, but also less vulnerable to defences which the other side might introduce in response to a new threat. Obsolescence thus also becomes a characteristic of the technological arms race. Over the period of the 1960s, the effect of the increasing sophistication of military equipment was far greater than would be implied merely by a numerical statement of the economic resources involved. The process was inevitably associated with a very focused research and development effort, which depended on the services of a disproportionate number of professional scientific and engineering personnel. Probably at least a quarter of the world total of scientists and engineers who are engaged in research and development are in fact still employed on military work, and military research and development probably absorbs some "25 billion of an estimated world total research and development expenditure of some $60 billion.4/  It is usual to find that in countries with developed military

industries, the proportion of the labour force of the engineering industry which is absorbed in the production of military equipment is far greater than the percentage of GNP which goes to military expenditures, and that the percentage of all qualified scientists and engineers employed on military research and development is even higher.

29. Qualitative changes in armaments also generate quantitative and qualitative changes in manpower within the armed services. The numbers of skilled technicians required for the maintenance of ever more sophisticated equipment have to increase, and higher standards of skill and training on the part of operating personnel also become essential. As complex armaments began to spread to the developing countries during the past decade, those countries have also been diverting more of their scarce technical manpower to military purposes, paying for them to be trained abroad, or employing foreign technicians, all to the detriment of a more fruitful use of national resources.

30. The record of advanced weapons programmes in the sixties provided many illustrations of the abandonment of costly projects before their completion, and after hundreds of millions of dollars had been poured into them. Sometimes the work was stopped because of the impossibility of overcoming a technological or scientific hurdle. Sometimes it came to an end because the conception on which it was based changed owing to a new military appreciation of the "need", or because of development in a potential enemy's armoury. More usually, projects have been abandoned because they have run up against a barrier set by the absolute size of the economy of the country concerned. Since abandoned projects are likely to be replaced by other projects, the process of abandonment increases the economic waste caused by the arms race.

31. Because of their inherent tendency to rise, research and development expenditures always stand to consume more and more of any defence budget. It is not only that new technology always costs more to achieve than the "state of the art" which it succeeds, or that, once it has been developed, a generation of weapons, designed to replace another, inevitably turns out to be much more costly to manufacture. New weapon-systems continuously require more highly qualified personnel, and therefore personnel costs tend to rise faster than in the civil side of the economy.

32. The economic implication of the rising tendency of research and development costs, together with the rise in personnel costs, is that more and more countries are compelled to opt out of some sectors of the technological arms race. As a consequence, richer countries are enabled to continue longer in the technological arms race, as they can export modern weapons and so produce them on a larger scale, with reduced unit costs.

33. The arms race is thus a hindrance to development both because it draws heavily on available material and human resources, and because it adds to the threat to peace. In its essence, it is incompatible with normal economic and social development.
IV. THE NATIONAL CONSEQUENCES OF THE ARMS RACE AND MILITARY EXPENDITURES

34. The resources which are allocated for military purposes are a broad indication of what is denied other avenues of public and private expenditure. If countries had not expended their means for military purposes, they could obviously have put the resources so consumed to many other uses.

35. Poverty and slums exist even in the richest countries. Housing is still an unsatisfied demand. Housing investment, together with slum clearance and urban renewal, represents only about 3 to 3.5 per cent of the world's total national product. But in the world as a whole far fewer resources were devoted to new housing during the sixties than to military expenditures. This is particularly true of the major countries.

36. Health services, like education, constitute a major demand which is less than adequately satisfied, even in the richest countries; and in the poorer countries there is a crying need for more resources. The comparison of world expenditure on health and military expenditure is a difficult one, since health services in some countries are entirely publicly financed, and in others are mainly privately financed. But, as already noted, for the world as a whole, military expenditure is about two and a half times the estimated total of publicly financed health expenditure. A rough calculation suggests that all medical research in the world consumes only about $4 billion. This compares with some $25 billion which it is estimated is now spent on military research and development.

37. Then there is the major problem of protecting the environment, which is only now beginning to be understood. Military operations can bring about major environmental devastation. The vast destruction which is associated with modern war is the extreme case. Nuclear tests are an isolated illustration of the environmental damage that can be caused by armaments. There is also the diversion to military purposes of the resources required for the major task of repairing the environmental ravages of the past, and of preventing the further depredations which could become increasingly urgent as population multiplies.

38. Another important aspect of military expenditures is their effect upon economic growth. To the extent that the arms race inhibits growth, this economic effect reinforces all that has been said about its impact upon consumption.

39. A fast rate of economic expansion is, of course, one of the central economic objectives of most countries. The social factors involved are usually treated under the heading "investment in man" -- investment in order to increase the health, well-being, education and physical and organizational potentialities of a country's citizens. Needless to say, many of these types of social investment are ends in themselves. But they are obviously also very potent factors in the rate of economic growth. Military expenditures undoubtedly absorb resources which are substantial enough to make a considerable difference both in the level of investment for civil purposes and in the volume of resources which can be devoted to improving man's lot through social and other services.

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40. There is no doubt that a transfer of resources from military to civil uses would provide further possibilities for an increase in the rate of economic growth. It is certain that there would be a once-and-for-all increase in the amount of goods available for civil purposes and that from then on the economy would grow at permanently higher levels.

41. It is entirely reasonable to compare fixed investment with military expenditure, and to see whether a reduction in military expenditure could make a significant difference to the investment level. For the world as a whole, military expenditure -- at 6 to 6.5 per cent of world national product -- is about a third as large as fixed capital formation -- 20 per cent of world national product. Clearly, therefore, given a conscious decision to this effect, the investment level could be given a significant upward shift. There is no lack of investment opportunities in the world. Most countries have waiting lists of investment projects, particularly in the public sector, which they are unable to start through lack of resources.

42. Many developing countries do not have an industrial sector capable of arms production, and so import most of their arms from abroad. A reduction in their arms spending would free foreign exchange resources which could be used for the import of more investment goods, thus facilitating a higher rate of growth. For these countries, the need for adequate investment is particularly acute. At their present level of investment the gap between their standard of living and that of the industrialized countries is not likely to be satisfactorily narrowed for years to come. One of the basic problems of growth in many developing countries is to find the resources for the creation of new productive sectors which are now more or less entirely lacking and for a massive expansion of infrastructure. Yet one of the largest items in current public expenditure in many of these countries is military expenditure. What all this means in terms of the denial of alternative opportunities is revealed clearly in an economic study of 44 developing countries over the period 1951 to 1965.1/ This indicated that the part of their military expenditures which went to procurement diverted domestic and foreign resources equivalent to about 4 per cent of their gross capital formation.

43. "Research and development" has been institutionalized in modern industrial societies, so that innovation is no longer so haphazard a process as it was in the period of the isolated inventor. In consequence, research and development's share in the national product of industrial countries has risen fast. As was said in the previous chapter, the arms race has been associated with a sharply focused research and development effort and has absorbed a high proportion of the total professional manpower and the limited resources which the countries involved have available for all research and development. Concentration of research and development outlays on production exclusively for civil purposes would lead to an improvement in the efficiency with which capital and other resources are utilized and hence would accelerate the rate of growth.

44. In most countries more is still devoted to military purposes than is spent on education generally, and overwhelmingly more than goes to research and development for the civil sector of the economy. But, as has already been pointed out, at least as important is the fact that the armed forces in industrialized countries absorb a disproportionately large share of the available technically skilled personnel.

45. Private consumption, as well as provision for such social services as education, health, housing and transportation, together with the cost of protecting our physical environment, is clearly in direct competition with military expenditures. Rising standards of living -- in the context of the world in which we now live -- mean more expenditure on all these things. Were military expenditures to fall it would assuredly be expected in some, if not all countries, that more resources would be released for personal spending.

46. Military expenditures also tend to disturb and destabilize the course of the economy in general, particularly when they fluctuate sharply. The rest of the economy has only too often had to be adjusted, to fit in with military exigencies and with the time-cycle of military developments. Apart from general destabilizing effects on the economy, the disturbing effects of the fluctuations which so often characterize military programmes tend to be concentrated in the particular regions and particular industries where military procurement takes place.

47. In terms of balance of payments, it is usually the developing countries which stand to lose most from their military expenditures. If a developing country wishes to acquire sophisticated weapons, and if none of the countries manufacturing them wishes to provide them by way of military aid, the developing country could incur a considerable balance-of-payments cost in acquiring either the weapons or the background technology (or both).

48. Military expenditures have also had the effect of increasing the disequilibrium in countries' balance of payments -- and that is both a national and international consequence of military expenditure. Such disequilibria in world payments undoubtedly have slowed, and at times even threatened to reverse, world progress towards further relaxation of restrictions on trade and payments.

49. Against the long catalogue of harmful effects of the arms race and military expenditure, one benefit which has been claimed is the spur given to technological progress. Obviously, if there is such a benefit, if war is the mother of invention, the cost in human lives and misery has been far too high a price to pay for it.

50. During the Second World War certain scientific and technological advances were accelerated, such as the development of atomic power, of computer, of air transport and radar, and of electronics in general. This has undoubtedly left its mark on all advanced technologically based industry today. But, if countries are prepared to set the right priorities and if the right motivation is generated, they ought to be able to achieve even more rapid technological progress without war or an arms race.
Particularly important is the fact that military and space technology appears to be becoming more and more specialized, and less and less adaptable to civilian use. Moreover, military secrecy always retards the pace at which civil benefits can be extracted from military developments.

More important than this, the specialized features which have been imparted by military demands to the pattern of research and development were clearly no designed to solve the world's present social and economic problems, and far less those which population growth and environmental protection pose for tomorrow. If even a fraction of what has gone into military research and development were provided for a frontal attack on some of the main economic and social problems of the world, one ought to expect much larger benefits in the peaceful uses of science than have come from the spin-off of military research and development.

Whereas it is possible to consider the economic consequences of the arms race and of military expenditures in quantitative terms, their social consequences can only be discussed qualitatively. It stands to reason that military expenditures also have profound social consequences, and the shadow of possible disaster which modern armaments cast over the world is clearly the most ominous. Against the background of the Second World War, the fear engendered by the nuclear arms race was one of the factors which stimulated the post-war disillusion of the youth in many countries, whatever the level of their military spending. Every child learned that he lived in a world in which violence had become commonplace, and which was now stocked with sufficient lethal power to wipe out all human life. There can be no question that the continuing arms race and the growth of violence in the world add to the disaffection of millions of people.

The arms race also tends to change traditional relationships between the civilian and military sectors of the economy. The military sector means more than the military forces themselves. It includes the firms and industries which serve them, the scientific institutions where their research is done, and the political establishments and ministries that owe their power to the arms race -- a combination which has come to be called the "military-industrial complex". The military-industrial complexes everywhere become concerned to preserve themselves, and consequently to maintain the circumstances which gave birth to them. That is a further social consequence of the arms race.

Yet another is the threat to democratic processes which can arise. The spirit of militarism is opposed to the spirit of democracy and peaceful progress in the world.

Whatever the varied and numerous considerations which keep the arms race alive, they therefore not only entail heavy economic sacrifices, but also weaken those processes of social evolution which provide our only real hope for the future of the human species.

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8/ An OECD report has commented that "the technological requirements of defence and space are diverging from those of civilian industry, which means that the possibility of such direct transfer will tend to diminish". "The effects of military and space research on civilian technology", Government and Technical Innovation (Paris, OECD, 1966), p. 31.
V. THE INTERNATIONAL CONSEQUENCES OF THE ARMS RACE AND MILITARY EXPENDITURES

57. The purposes which military expenditures are meant to serve are by definition international in character. Periods of international tension are usually associated with an acceleration in the arms race; and in turn a speeding-up of the race exacerbates international tension. The massing of armaments and the continued development of new weapon-systems cannot but generate more suspicion and greater tension than exists at the start, and by so doing provoke hostile reactions on the part of those who feel threatened. This applies to all armaments, whether they come into the category called conventional, or that designated "weapons of mass destruction". The competition in nuclear weapons obviously overshadows all other aspects of the arms race, since a nuclear war would put the future of the entire world at risk.

58. Regional arms races in conventional weapons, which are sustained by supplies of arms from arms-producing Powers, are also immensely important in the exacerbation of international tensions. Moreover, the rate of obsolescence in modern armaments is such that considerable quantities of surplus war material become available each year. There is consequently a strong economic motive to search for markets for such material. Quite apart from the severe sacrifices in life and resources which conflicts in the developing areas of the world entail, these at the same time carry the risk that they might spread to neighbouring countries, and inevitably they imply the additional danger that the military forces of some other countries, especially major Powers, could become directly involved.

59. The arms race inevitably exacerbates international tensions and inevitably undermines the purposes and principles of the United Nations Charter. The foregoing considerations underline the necessity for all States to pursue their efforts toward disarmament, in particular nuclear disarmament.

60. International suspicions and fears, however, do far more than poison relations in the political sphere. They also damage the economic and social well-being of the world by impeding exchanges between peoples whether these be of trade and the flow of capital, or of knowledge and technological "know-how". Military considerations have limited trade in so-called strategic commodities and have led to the creation of rival trade groupings involving, inter alia, restrictions on trade in some of the products of advanced technology. The same strategic considerations also inhibit technological and scientific exchanges between countries. This can be regarded as an extension of the strategic embargo on international trade.

61. Stockpiling of raw materials as a consequence of the arms race is also a factor which in the past has distorted world trade. The tendency towards stockpiling seems to be declining, but there is still the possibility that the reduction of stockpiles can create market distortions.

62. Trade between the centrally planned and the developed market economies has clearly been affected by the arms race and by the tensions between the two systems. Even if the latter did not exist, there would still be problems in increasing trade between countries with basically different economic systems. But, in a disarmed world, trade between market and centrally planned economies could hardly fail to rise.
63. The developing countries, in which more than two-thirds of the world's population live, which account for about 15 per cent of the world output and whose share of world exports was about 18 per cent in 1969 (down from about 27 per cent in 1953), would also benefit immediately from a cessation of the arms race. As was pointed out in section IV, the arms they import lead to distortions in their trade.

64. In a world free of tensions, and increasingly disarmed, the level of trade could well be higher simply because world output might have reached a higher level. In the past the general experience has been that, for every 1 per cent added to world output, about 2 per cent is added to the volume of world trade.

65. An increase in world output clearly could also have a powerful impact on the volume of aid provided by the richer to the poorer countries. One major effect of the arms race and military expenditure has been to reduce the priority given to aid in the policies of donor countries. Furthermore, some aid becomes viewed not exclusively or even primarily in terms of a solution of the problems of the third world, but as a means of acquiring influence in a particular region, or of denying influence to some other country.

66. As already noted, total world military expenditures are some 30 times the level of official development assistance, which now added up to some $7 billion. The sum has fallen steadily throughout the 1960s not only in relation to the gross national product of the donor countries, but also to that of the developing countries; in 1970 such assistance was equivalent to only one-third of 1 per cent of the combined GNP of the donor countries. Funds of this kind contribute to the volume of investment in the developing countries. A slowing of the arms race would make more such funds available.

67. The General Assembly has set targets both for the total flow of capital - which it is proposed should reach 1 per cent of the gross national product of the developed countries by 1975 - and for the flow of official development assistance alone, which should reach 0.7 per cent of gross national product.21 While a number of countries have made progress towards these targets in recent years, the over-all tendency has been for the share of aid in the gross national product of the developed countries to fall rather than rise.

68. It would take only a 5 per cent shift of current expenditures on arms to development to make it possible to approach the official targets for aid. The volume of fixed investment in the developing countries is estimated to have been around $65 billion in 1969. A shift of 10 per cent from world military expenditure to investment would provide enough resources to raise the figure by almost a third.

69. Obviously, if the "disarmament dividend" were to become a reality, there would be many other claimants besides aid for the resources freed in developed countries. None the less, any wise assessment of world problems could not fail to give additional aid a very high priority.

21 See General Assembly resolution 2626 (XXV), paras. 42 and 43.
70. Given a "disarmament dividend", there are reasons for being optimistic that developed countries would be prepared to budget for some increase in aid. Lower levels of military expenditure would remove an important obstacle to the expansion of aid. In 1953, in General Assembly resolution 724 A (VIII), Member Governments were urged: "when sufficient progress has been made in internationally supervised world-wide disarmament, to devote a portion of the savings achieved through such disarmament to an international fund, within the framework of the United Nations, to assist development and reconstruction in underdeveloped countries". The complementary objectives of the Disarmament Decade and the Second United Nations Development Decade illustrate the same point.

71. The way the resources made available for aid are utilized makes all the difference to the effectiveness of their impact on the growth of the developing countries. Priorities have to be set, problems properly explored, and the best available measures used for their solution.

VI. CONCLUSIONS

72. From time immemorial States have relied on military forces to further their interests and to enhance their security. Today is no exception. But with the acceleration of technological change, the perils have become so acute that it is no exaggeration to say that the arms race has finally provided man with the means of putting and end to his species. Political wisdom has so far averted his final disaster. It cannot, however, insure against military miscalculation or against human or technical error, both of which could lead to the same fearful end.

73. The arms race makes more acute the very international strains to which it relates. Political differences become sharpened by the fear and suspicion which the amassing of armaments generates. International trade is slowed, particularly in the products of advanced technological industry. Military expenditures contribute to acute imbalances in the international payments. Cultural exchanges stagnate. In short, armaments, which are supposed to provide security, provoke the very political differences which nations may assume they will help dissipate.

74. The cost of the arms race is enormous, and because of it, resources have been denied almost every other field of social activity. In total, it consumed nearly $1,900 billion from 1961 to 1970. If annual military expenditures continue to absorb their present percentage of world GNP, they could well reach the level of $300-350 billion (at 1970 prices) by the end of the decade, with a total outlay for the decade of some $750 billion more than was spent from 1961 to 1970.

75. The military expenditures which cast the greatest shadow over the world are those of the major Powers, which between them account for the bulk of all such spending. Arms race between the developing countries are, however, no less dangerous. There is the risk of conflicts spilling over to third countries, or indeed to the major Powers. The military expenditures of these countries deplete the resources which could otherwise be used for development.
76. This report has considered the opportunities lost as a result of the arms race. Economic aid has suffered. Enormous social problems lie ahead for all countries. Public services, health, education, housing, and now the protection of the environment, all need the resources which the arms race consumes.

77. The Second World War began at a climactic moment in the development of modern science. New scientific knowledge was only too ready for exploitation in the prosecution of war. Whatever "spillover" effects there may have been from the resulting military technology, they could have been generated without the competitive challenge of militarism.

78. As was stated in the preamble to General Assembly resolution 2667 (XXV), a halt in the arms race would contribute effectively to the improvement of international relations and the maintenance of world peace and security. Every effort to retard the race would help, for any retardation would make it possible to release resources for peaceful uses, including aid. We share both the conviction and the hope that increased aid to developing countries would be a natural consequence of substantially reduced military expenditures.

79. The enormous cost of the arms race in human and other resources will become even clearer than it is today when the pace of the race is slackened as a result of concerted international political decision.

80. It is our unanimous conclusion that:

(1) A substantial reduction in the military expenditures of all countries, particularly of those whose military expenditures are highest, should be brought about as soon as possible. The sooner concrete measures of disarmament, particularly of nuclear disarmament, are achieved, and the arms race is thereby halted and reversed, the faster will be the progress towards the goal of general and complete disarmament.

(2) Regardless of their size or their stage of development, all countries share the responsibility of taking steps which will help achieve this goal.

(3) A halt in the arms race and a significant reduction in military expenditures would help the social and economic development of all countries and would increase the possibilities of providing additional aid to developing countries.

(4) In order to draw the attention of the Governments and peoples of the world to the direction the arms race is taking, the Secretary-General should keep the facts under periodic review.
INTRODUCTION

1. This Consultative Group on the economic and social consequences of disarmament has dealt with the subject on the assumption that disarmament, once agreed upon, would be general and complete and also rapid. It has done so in the belief that this was the intention of the General Assembly resolution under which it was appointed, and also because this interpretation gives the clearest form to both the benefits and the difficulties, thereby minimizing the risk that the latter will be under-estimated. The report represents the unanimous findings of the Consultative Group.

I. RESOURCES DEVOTED TO MILITARY PURPOSES

2. The most fundamental way in which disarmament affects economic life is through the liberation of the resources devoted to military use and their re-employment for peaceful purposes. This shift in the composition of the aggregate demand for goods and services is simply a large-scale manifestation of a phenomenon that is constantly taking place in all economies as the demand for certain goods and services shrinks while the demand for other goods and services expands; thus disarmament in its economic aspects should not be considered as a unique phenomenon.

3. To assess the transitional problems that may arise and to determine that the peaceful uses to which the resources released may be put, it is necessary to ascertain in some detail the volume and composition of resources so released. On the basis of available data there appears to be general agreement that the world is spending roughly $120 billion annually on military account at the present time. This figure is equivalent to about 8-9 per cent of the world's annual output of all goods and services; it is at least two-thirds of the entire national income of all the under-developed countries.

4. The world's armed forces now number about 20 million persons. This figure does not include all those currently employed in supplying goods or services directly or indirectly to the armed forces. The total of all persons in the armed forces and in all productive activities resulting from military expenditure may amount to well over 50 million.

5. The available data do not, however, make it possible to assess with the desired degree of accuracy the volume of resources that disarmament would actually release. For one thing, the existing estimates may not be comprehensive; some categories of military expenditure may be excluded. Further, there may be considerable inconsistency in the pricing of military output compared with the pricing of other production, as also in the relationship between the pay of the armed forces and civilian wages and salaries. Although the data provide an inadequate basis for precise comparisons of the military burdens

among countries, it can be safely asserted that within most countries military expenditure accounts for a very significant proportion of total output.

6. The great bulk of the world's military expenditure is highly concentrated in a handful of countries. Available indications are that about 85 per cent of the world's military outlays is accounted for by seven countries - Canada, the Federal Republic of Germany, France, the People's Republic of China, the Union of Soviet Socialist Republics, the United Kingdom of Great Britain and Northern Ireland and the United States of America.

7. In order to formulate economic and social policies so as to take full advantage of the opportunities afforded by disarmament, it is necessary for the countries concerned to know in detail the possible alternative uses for the resources released. To prepare a list of the resources absorbed by armaments, it is desirable that each country should, at the appropriate time, determine the composition of military expenditure and estimate the productive resources that it absorbs. The latter calculation is straightforward with respect to certain components of military expenditure. The members of the armed forces, for example, constitute a labour supply that would otherwise be available for peaceful purposes. Similarly, those research facilities employed for military purposes which are adaptable to civilian research are readily identified. Other productive resources, however, are devoted to military use only in an indirect manner which may not be apparent at first glance. While it is clear, for example, that the labour and capacity in ordnance production are employed solely for military purposes, it is impossible to state, without careful analysis, what proportion of the manpower and other resources devoted to, say, coal mining are so employed. The degree of elaboration with which statistics should be compiled and economic analysis performed varies from country to country according to the complexity and size of the national economy. Analogous considerations apply to the determination of the amount of resources required directly and indirectly to satisfy alternative peacetime needs.

8. Data made available by a number of countries show that military production is highly concentrated in a few industry groups, notably munitions, electrical machinery, instruments and related products, and transportation equipment, including airplanes and missiles. There is a similar concentration in the same industries of the employment resulting from military expenditure. In most other industries military outlays account for a relatively small proportion of total demand. Industries dependent on military expenditure also have a high degree of concentration in certain regions and cities. While this pattern of concentration of output and employment is not necessarily characteristic of all countries, it appears to apply generally to the major military powers.

9. The situation is rather different in those countries that rely upon imports for their supplies of military goods or in which the major part of military expenditure is for the pay and subsistence of the armed forces,
rather than for their equipment. In such cases, the resources devoted to military purposes consist essentially of manpower and foreign exchange.

II. THE PEACEFUL USE OF RELEASED RESOURCES

10. There are so many competing claims for usefully employing the resources released by disarmament that the real problem is to establish a scale of priorities. The most urgent of these claims would undoubtedly already have been largely satisfied were it not for the armaments race.

11. The resources liberated by disarmament within any country could be employed in part to promote economic and social progress at home and in part to expand foreign aid. The main civilian purposes for which the freed resources, whether domestic or foreign in origin, could be applied, may be classified as follows:

- Raising standards of personal consumption of goods and services;
- Expanding or modernizing productive capacity through investment in new plant and equipment;
- Promoting housing construction, urban renewal, including slum clearance, and rural development;
- Improving and expanding facilities for education, health, welfare, social security, cultural development, scientific research, etc.

12. The various claims upon resources listed above are, of course, closely interlinked. A rise in personal consumption may necessitate new investment in industry or agriculture or both. Enlarged aid from the industrial to the underdeveloped countries may involve expanding capacity for the production of the goods that the latter countries need, notably capital equipment. As regards the under-developed countries themselves, if additional aid is to bring the greatest benefits, a larger volume of investment out of domestic resources is likely to be required; this would be facilitated by the release of internal resources through disarmament.

13. Since it can be assumed that the economy as a whole is highly flexible in the long run, the resources freed by disarmament could ultimately be used for any one or more of the purposes listed above, and in any combination. In the long run, there should be little difficulty in adapting resources to needs.

14. In the very short run, by contrast, the range of choice may be somewhat more limited. It takes time to turn swords into ploughshares or to make an office clerk or factory worker out of a soldier. Studies in some industrial countries have shown that the productive capacities released from military use would be much more immediately adaptable to the increased output of consumer durables and industrial equipment than to the production of houses, food, clothing or educational facilities. It should, however, be borne in mind that some of the major military powers now have fairly comfortable margins of productive capacity available to them. In these cases it is unlikely that disarmament would generate many new demands that could not fairly readily be satisfied from available resources.
Personal consumption and productive investment

15. Among the alternative uses of resources released by disarmament, increased personal consumption might well absorb a large share. It is fair to suppose that even in the developed countries there would be strong pressure on Governments to raise the level of living. Disarmament would, in particular, offer an important opportunity to raise incomes of low income sections of the population and to facilitate equalizing the rates of pay for men and women. In most countries, however, not all the resources freed by disarmament would be allocated directly to consumption, no matter what the level of income might be. A substantial portion of the released resources would be used for expansion of productive capacities because only such expansion can provide a firm basis for further increases in consumption.

Social Investment

16. Social investment is an important alternative both to private consumption and to industrial and agricultural investment. Its claims rest partly upon the clear urgency of the direct need for improved social amenities, and partly upon the fact that growth of industrial and agricultural productivity is dependent upon developments in education, housing, health, and other fields. Since social investment has had to compete with military claims for state funds, it (like aid to underdeveloped countries) has probably been particularly affected by the armaments race.

17. The rural and urban environments in many countries are both deteriorating, mainly under the impact of urban growth. The social and physical symptoms of this deterioration are bad housing, poor community services and delinquency, the paralysis of city traffic, and in many of the less developed countries an absence of sanitation accompanied by a high incidence of communicable disease. In many metropolitan cities of such less developed countries "squatters' settlements" already contain a considerable part of the population.

18. The magnitude of the resources required for dealing with the problem of urbanization is very large. According to rough estimates by the United Nations Bureau of Social Affairs, as many as 150 million families in the less developed countries are in need of adequate homes. These immense requirements are contributing in many under-developed countries to the maintenance of a level of spending on housing and urban development such that the pressing claims of directly productive sectors have to be curtailed.

19. Another field in which the supply of social capital is deficient in many countries is road and air transportation. The rapid increase in the stock of automobiles and the lag in road facilities in these countries during the post-war years have been accompanied by extraordinary congestion and numbers of accidents. Airports and other air facilities are also deficient in many underdeveloped areas as well as in some more advanced economies, and investment in civil aviation will claim a share of the resources freed by disarmament.

20. The development and conservation of natural resources provides another important field for increased outlays in the event of disarmament. In the United States it has been estimated that Federal expenditure requirements up to 1980 in the field of water resource development alone total almost $55 billion, while $173 billion will be needed for non-Federal programmes. The Soviet Union could advance the preparation and implementation of a number of important nature-transforming projects in various parts of the country in order to improve living and working conditions for the people.
Investment in health, education and social services

21. Another major use of the resources released from disarmament is investment to raise standards of health, education and social services. There is an urgent need for improvement in health services throughout the world. In many countries the ratio of doctors, dentists and other medical personnel to the population is inadequate and even falling, and there are also great deficiencies in the supply of hospitals and hospital beds as well as of other basic health facilities.

22. In most developed countries educational needs are rising and are bound to expand even more rapidly; with the ever wider spread of technical progress there will be a rising premium on a higher educational background, on better scientific and technological skills and on a broader range of knowledge. At the same time greater efforts will be directed towards reducing the drop-out rate of the less talented and towards ensuring that an increasing proportion of the highly talented reach upper levels. In the under-developed countries, the magnitude of the educational problem may be seen from the fact that most of them still have illiteracy rates of well over 50 per cent of the population aged fifteen years and over.

23. Apart from needs in the fields of health and education, there are urgent requirements for expansion in social services. Even in the most advanced countries, there are pronounced shortcomings in the provision of child welfare services, vocational rehabilitation agencies, community centres and other special services.

24. It is thus clear that, so far as social investment is concerned, there is already a heavy backlog of urgent need, and the recent acceleration of population growth and of technical change make it certain that the need, and the demand, will grow. Social investment therefore is likely to claim an increasing volume of resources, to which disarmament would make a welcome contribution.

Scientific research for peaceful purposes

25. The release of scientific and technical manpower would be one of the important consequences of disarmament. Amongst the major powers a significant part of the national research and development effort currently serves military purposes. The total elimination of military spending would bring about a sizable release of resources for civilian research and development.

26. Not all of the needs described above can be satisfied by single nations acting alone. In some instances their satisfaction will require international co-operation. Serious gaps exist in the permanent world-wide network of meteorological observing stations and in the corresponding telecommunication facilities. Telecommunications are important to developing economies and there is need to pursue a number of objectives in this field, including the development of networks. There is also considerable scope for international co-operation in developing the world's air transport facilities. In addition, joint projects to assist the development of under-developed countries as well as programmes of co-operation in the social and economic fields could be undertaken.
27. It is evident from the foregoing illustrative discussion of the magnitude of current and impending needs that the resources freed by disarmament would not be large enough for the many claims upon them. Though it would take active decisions by Governments in the light of national and international needs to set in motion the necessary programmes for employing the released resources, it seems abundantly clear that no country need fear a lack of useful employment opportunities for the resources that would become available to it through disarmament.

III. THE IMPACT OF DISARMAMENT ON NATIONAL PRODUCTION AND EMPLOYMENT

28. Disarmament would raise both general problems of maintaining the over-all level of economic activity and employment and specific problems in so far as manpower or productive capacity might require adaptation to non-military needs. Structural problems of conversion of the latter type will be discussed in chapter 4.

29. In the economic life of all countries, shifts in the pattern of demand and in the allocation of productive resources are continually occurring in response to changes in technology, foreign trade, consumer tastes, per capita income, the age distribution of the population, migration, and many other factors. The reallocation of productive resources which would accompany disarmament is in many respects merely a special case of the phenomenon of economic growth. There are, however, some aspects of the process of disarmament which would raise problems significantly different from those that have been experienced in the usual process of economic growth. While many of the continuous changes in the composition of demand work themselves out only over a long period of time, it seems reasonable to assume that disarmament, once decided upon, would occur more rapidly -- over a period of only a few years. The reallocation of resources attendant upon disarmament would therefore pose some special problems. The more rapid the rate of growth of an economy, however, the easier it would be to bring about the economic changes disarmament might require.

30. The conversion of resources that would be required as a result of disarmament at the present time would be far smaller, in the aggregate, than that which took place at the end of the Second World War. Thus an examination of the early post-war conversion may help to give perspective to the present problem.

The post-war conversion

31. The post-war conversion was a much larger one and involved a more rapid transfer of resources than total disarmament would require at present. During the last years of the war, the world devoted about one half of its resources to destruction. The real military expenditure and the number of people in uniform were about four times as high as today. The extent of devastation in the areas overrun by armies or bombed from the air was immense. The usual network of trade both within and between countries was thoroughly disrupted. Despite these difficulties, huge armies were quickly demobilized without a significant rise in unemployment in most countries, and the pace of recovery, particularly of industrial output, was impressively rapid.
32. During the post-war conversion, the major concern of economic policy was to restrain, rather than to maintain, over-all demand. This period was characterized by intense pressure of excess demand for both consumption and investment. Most commodities were in short supply. The wartime accumulation of liquid savings in the hands of the population guaranteed a high level of continued effective demand. As plant and equipment were released from war production or repaired or replaced, they were immediately turned to producing goods for which demand had remained unsatisfied or deferred in some countries during nearly fifteen years of the Great Depression and the war. Most of the demobilized manpower found employment in civilian occupations, while the total labour force declined, reflecting a voluntary withdrawal of some women, minors and veterans from the labour market. As supply conditions improved, price and distribution controls were progressively eased.

33. There were large arrears not only of consumption but also of investment. The capital stock had in many countries been run down by destruction, obsolescence and lack of maintenance. Technological progress had continued and in fact sharply accelerated in some fields during the war years. But much of it had remained unincorporated in plant and equipment -- during the depression because of lack of effective demand, and during the war because of diversion of resources to wartime needs. Residential construction had undergone successive postponement in some countries. These factors led to an upsurge in business and residential investment after the war.

34. In the United States, by the end of the Second World War, the military budget had accounted for over 40 per cent of the gross national product. Between 1945 and 1946, expenditure on national security was reduced by 80 per cent. The decline in military expenditure was equal to one-third of the gross national product and nearly two-thirds of personal consumption in 1944. By way of comparison it may be said that the military budget in the United States in recent years has been somewhat less than 10 per cent of the gross national product and about 15 per cent of personal consumption. The decline in total real demand was less than half the drop in military spending because of the advance in all other sectors of demand. The small decline in national output was perhaps no more than could have been expected as a result of voluntary withdrawals from the labour force and from the shortening of working hours.

35. Between August 1945 and June 1946, the size of the United States armed forces was reduced by over 9 million men. There was a small reduction in the labour force as women and minors returned to home and school, and veterans continued their interrupted education. As a result of this, and of the cutting back of overtime, unemployment in 1946 remained below 4 per cent of the labour force, despite the very extensive and rapid demobilization.

36. While the large backlog of demand of private business and consumers was responsible for much of the ease with which the post-war adjustment was made, effective government policies also helped. Taxes were reduced. There was a very great increase in transfer payments, principally veterans' cash benefits and payments related to the veterans' training and education programme. As a result, despite the massive decline in military spending, disposable income fell hardly at all.
37. In western Europe the conversion process took somewhat longer than in the United States because of the damage or destruction to productive facilities and the fact that the total output had in many cases fallen below pre-war levels. Inflationary pressures were severe. Confidence in currencies was shaken. Many key products, notably coal, steel, certain imported materials, and foodstuffs were in short supply.

38. Despite these difficulties the conversion was relatively rapid. Eighteen months after the cessation of hostilities, industrial output had recovered its pre-war level nearly everywhere except in the Federal Republic of Germany and in Italy. The demobilized armed forces were rather quickly absorbed in employment in civilian occupations. Except in the two countries just mentioned, unemployment declined well below pre-war levels. The recovery of western Europe was assisted by a considerable amount of external aid.

39. In some of the under-developed countries, the post-war recovery presented special problems. This was partly because agriculture, which formed a much larger proportion of the output of the under-developed than of the developed countries, was generally slower to recover than was industry. For some time after the war, too, delivery of equipment was delayed by conversion and re-equipment needs in the industrial countries. There is, however, no reason to believe that any future disarmament would be attended, in the under-developed countries, by the same types of problem as prevailed after the Second World War. As indicated previously, the main question in these countries would be whether development programmes could be enlarged and stepped up significantly - and in sufficiently good time - to permit the absorption of the demobilized armed forces and other resources into productive employment.

40. In the Soviet Union, experience of conversion immediately following the Second World War was significantly different from that in other countries, because of the much greater destruction and devastation which had taken place during the war. However, by 1948 industrial production was already nearly one-fifth above the 1940 level. The circumstances of any future disarmament would be much more favourable to a smooth conversion process than those at the end of the Second World War.

Experience in the centrally planned economies

41. The experience of the centrally planned economies in reducing the armed forces is also of interest. In the Soviet Union, the armed forces were reduced from 5.8 million men in 1955 to 3.6 million men in 1958. There were also reductions in military forces in other centrally planned economies during that period. No significant problems were created by the demobilization in these countries since the demand for labour was continually increasing.

Impact on national production and employment

42. National experience with general economic policies during previous conversion periods will unquestionably be valuable for policy makers in the future. In adopting a programme of general and complete disarmament, Governments would certainly wish to assess very carefully the probable impact of disarmament on national production and employment, and to examine their economic policies to ensure that these were as well thought out as possible. It would be important to maintain a high general level of domestic demand for goods and services and thereby to support satisfactory levels of output and employment.
The economic measures needed to maintain over-all effective demand are different in the private enterprise economies from those in the centrally planned economies. In the latter, economic decision-making is centralized. Most of the productive capacity is government-owned. The national economic plans are directed toward the achievement of a set rate of growth and higher levels of living. In the private enterprise economies, on the other hand, where the private sectors are much larger than the government sectors, the power to make economic decisions is diffused. Governments must therefore rely heavily, in influencing economic decision-making in the private consumption and investment sectors, on relatively indirect means such as fiscal and monetary policies. In general, the governments of underdeveloped countries cannot count as readily as those of the more developed countries on an expansion of private investment. Greater attention needs therefore to be given to undertaking whatever volume of expenditure may prove necessary in the government-owned sector in the underdeveloped countries.

The instruments of adjustment in the industrialized private enterprise economies are more highly developed, easier to bring into operation, and may be expected to work more effectively in some countries than in others. Bearing in mind, however, that a substantial part of military expenditure would probably be replaced by other government expenditure in most countries it may be concluded that the maintenance of effective demand in the face of disarmament should not prove difficult. Indeed, it should be practicable not merely to maintain the level of demand during the transition period, but to move forward to the more rapid growth in total real income that a transfer of resources from military use to productive investment would render physically possible.

For many under-developed countries, the effect of disarmament upon the industrial countries' demands for primary products, and thus on the export earnings of the primary producing countries, would be of great importance. So would the methods of dealing with the liquidation of strategic stockpiles. These problems are discussed in chapter 5. It is necessary to add here that the industrial countries' success in maintaining effective demand during the immediate period of disarmament would be of great concern to all primary producing countries. The significance of disarmament for an expansion of aid to underdeveloped countries is dealt with in chapter 6.

In the centrally planned economies, the maintenance of effective demand while reducing military expenditure would be simply a matter of efficiency of planning techniques. Since decisions concerning the production of military output as well as of investment and consumer goods are co-ordinated through the national economic plan, the substitution of one type of expenditure for another does not raise any basic problems for the maintenance of effective demand.

IV. STRUCTURAL PROBLEMS OF CONVERSION

Even with the successful maintenance of total effective demand during a period of disarmament, significant problems of adjustment would remain in specific sectors and areas of the economy. Part of the personnel released by the armed forces and the armaments industry would have to be trained or retrained so as to permit absorption into peacetime occupations. Some plant and equipment would have to be converted. Productive capacity might contract in some industries, and might have to be expanded in others. Where the manufacture of armaments has been concentrated in particular regions, it would be necessary either to shift resources out of those regions to other areas of growing demand,
or alternatively to undertake schemes of redevelopment. The necessary steps would have to be taken to modify the direction of research and of technological development.

48. It has already been suggested that the broad problem of re-adaptation of industry and manpower resulting from disarmament is not basically dissimilar from that experienced in the normal process of economic growth. The higher the rate of growth of the economy, the easier the process of adaptation. In the longer run, disarmament would allow each country to raise the rate of investment and to adapt productive capacity more adequately to the needs of the population and to the requirements of economic growth, both in private enterprise and the centrally planned economies. In the shorter run, the smoothness of the transition would largely depend on the ability of Governments to anticipate the types of problem that might arise, and on the adequacy of preparations.

49. The resources now supplying military requirements could be adapted to peacetime needs partly by shifts within industries and plants, and partly by shifts between industries.

(a) Shifts within industries and plants. In a large number of cases, it may be possible for a given plant to shift the nature of the end-product from military equipment to durable consumer goods and investment goods while using the same productive equipment and manpower. For instance, there might be a shift from tanks to tractors, from military to civilian aircraft, from naval vessels to merchant ships, or from electronic equipment for military purposes to television sets. This might be a relatively easy procedure.

(b) Shifts between industries. Other cases, however, might call for a more complex form of conversion requiring the output of some industries to be completely stopped or sharply curtailed and that of others to be correspondingly expanded. Many ordnance factories might cease to produce altogether. In some countries, the total output of aircraft, ships and boats would have to be reduced since civilian demand for such products would not fully offset the fall in military demand. On the other hand, a considerable expansion of output in the cement, brick, glass and building industries might be required should there be a shift in expenditure in favour of civilian construction. Shifts of this type cannot be accommodated within the same plant but require instead a movement of resources from one industry to another. Shifts between industries would take a somewhat longer time to accomplish than shifts within industries, the length of time depending on how major or far-removed were the shifts.

50. The extent to which the conversion would involve shifts within industries and plants as opposed to shifts between industries can be judged from studies made in a number of countries.

The problem of inter-industry shifts

51. Professor Leontief has prepared a hypothetical study of the inter-industrial ramifications of conversion in the United States on the assumption that military expenditure is replaced wholly by increases in
expenditure on other kinds of goods and services in proportion to their shares in total demand in 1958. Such a reallocation of military expenditure would release 1,320,000 employees from the contracting industries for employment elsewhere. Over four-fifths of the decline in employment would be in four industries - aircraft and parts (which includes missiles), radio, ordnance, and ships and boats. In addition to the 1,320,000 employees released from contracting industries, the 2,530,000 members of the armed forces and about 790,000 civilian employees of military agencies would become available for alternative employment. Thus, about 4.5 million persons — some 6 or 7 per cent of the total labour force in employment in 1958 — would, on these assumptions, have to change their employment from one industry group to another or find civilian instead of military employment.

52. Professor Leontief estimates the number absorbed into expanding sectors to be some 600,000 less than that released from the military establishment and the contracting industries. This difference, taken literally, would imply that an increase of about 1 per cent in total government and private expenditure, spread over the duration of the disarmament process, would be required to preserve the general level of employment. It is, however, a residual figure which should be treated with reserve, since it is less than the margin of error of this hypothetical calculation.

53. This indicates the numbers who would have to move from one industry to another (or out of direct military employment) in the event of very rapid disarmament. If the operation were to extend over a number of years, the change per annum would be only a fraction of the total.

54. Under-developed countries generally have been meeting their requirements for military goods and services by imports, so that their disarmament would release foreign exchange rather than industrial workers. Disarmament would also free members of the forces with many useful skills and training.

55. In the centrally planned economies, as indicated previously, productive capacity is usually fully utilized. Thus it would be necessary to convert plants producing military equipment to production of durable consumer goods and of such investment goods as can be produced in them with only minor retooling. Such conversion could be achieved rapidly. In the longer run, disarmament would make possible substantial increases of investment, so that the more adequate adaptation of productive capacity to the needs of the population and to the requirements of economic growth could proceed fairly rapidly. The Governments of the centrally planned economies state that there will be no difficulty in absorbing released manpower.

Special problems

56. The preceding analysis of the changes resulting from the process of reallocation of military expenditure to other purposes suggests that the net shifts in employment and output would be relatively small. As already indicated, however, special problems would arise from a concentration of the military effort in certain industries or areas. These problems may be broadly classified as follows:

(i) Adaptation of skills to peace-time requirements.

(ii) Problems of assistance to particular enterprises, industries and localities, heavily oriented to military use.

(iii) Reorientation of research and technological development.

57. In some instances, the skills that are essential for service in the armed forces or in some of the major industries producing military goods may not be readily adaptable to the requirements of civilian employment. Consequently, there would arise a necessity to retrain part of the skilled manpower and to train some of the unskilled.

58. (a) Armed personnel and employees in the Ministry of Defence. Most of the officers in modern armed forces have received training that would fit them easily for technical, engineering, medical and similar posts in civilian life. The demobilization of the non-professional members of the armed forces would involve a much larger number of persons. But most of these men have been drawn from civilian life where they were previously engaged in non-military occupations. In many cases, they have acquired new technical skills while in military service. In most of the under-developed countries, the regular armed forces possess a much higher level of industrial and technical skills than the civilian population; this would tend to give them a relatively greater chance of being absorbed into civilian employment.

59. (b) Industries producing military goods. As pointed out above, the problem of conversion in the industrial countries is likely to be a short-term one for most industries. In industries depending heavily on military orders, many of the employees possess a level of skill that should find gainful employment in other branches of production, so long as over-all effective demand is rising. Moreover, where some form of retraining or additional training would be needed for employment, it could be acquired through the facilities for apprenticeship and on-the-job training often provided by individual firms or plans for their new labour force.

60. In this age of automation the demand for highly skilled labour is rising faster than the demand for semi-skilled and unskilled. Therefore a significant number of those who would be released in the latter categories might be faced with difficult problems, particularly if they were of an advanced age. Governments should stand ready to assist the reabsorption of such workers into productive employment.

3/ Owing to virtual absence of major military goods industries in the under-developed countries, this question has relatively limited relevance for them.
(ii) Particular enterprises and localities

61. Owing to the concentration of military output in a few industries, termination of military contracts would bear specially upon the activities of particular enterprises. These would have a choice of three courses of action; complete shut-down, the adaptation of existing plant and equipment to the production of other goods through major retooling, and investment in entirely new plants. Similar problems on a much larger scale were faced at the end of the last war and tackled with a considerable degree of success.

62. The geographical distribution of the activity based on military expenditure is very uneven in many countries. The readjustments necessitated by disarmament would therefore impinge particularly heavily on certain areas and localities. Various forms of public and other assistance would thus prove necessary to facilitate readjustment. Measures of three types would be required. First, attempts should be made to diversify the structure of employment by developing new industries where possible. Secondly, adequate relocation allowances should be provided to facilitate the movement of those who are mobile to areas where the labour market is expanding. Thirdly, adequate relief should be granted to those whose attachment to the locality is too deep or whose age is too advanced to contemplate moving to other areas. The costs of the necessary measures would be very small in relation to the resources that disarmament would release.

(iii) Reorientation of research and technological development

63. In the centrally planned economies Governments have always played a major role in promoting research and development. In the private enterprise economies also, this role has expanded everywhere in recent years, particularly through the growth of research for military purposes. No reduction in the actual employment of scientific and technical personnel need be feared, however, because the demand for civilian research would increase rapidly. Indeed, one of the main reasons why scientific research is still far from adequately applied in many civilian fields is the fact that highly qualified personnel have been scarce, and have been pre-empted by military demands.

V. THE IMPACT OF DISARMAMENT ON INTERNATIONAL ECONOMIC RELATIONS

64. Disarmament would be bound to have favourable effects on the development of international economic relations. The political detente that would accompany an international disarmament programme would in itself imply that nations were willing to reconsider their economic relations with one another. The consequent relaxation of international tensions would provide a sound basis for reduction of trade barriers and for modification of existing trade agreements and trading practices. In the long run this would encourage an expansion of international trade, a more rational international division of labour and a more effective use of the world's resources. In the short term it might help conversion by generating new demand for exports from existing sources of supply that could be satisfied fairly easily from existing capacities.

65. The relaxation of international tension would benefit trade through the elimination of the concern with national defence as a factor affecting national trade policies. The needs of national defence have long been accepted as a legitimate reason for the pursuit of discriminatory and protectionist policies.
66. Disarmament would bring about a change in the composition and rate of growth of output and thus affect the structure and rate of expansion of world trade. In so far as increased investment and greater economic aid would accelerate the rate of economic growth in developed and under-developed countries, a more rapid expansion of world trade could be anticipated. However, there are more immediate effects that might follow the shift in demand; these hinge on the difference between the import content of military expenditure and the import content of the increments to consumption, investment and foreign aid that disarmament would facilitate.

67. Some exports of primary products, such as petroleum, rubber and most metallic ores depend significantly at present on direct and indirect demand generated by military purchases. Some 15-16 per cent of world copper output has served, directly and indirectly, military purposes. For tin, nickel, lead and zinc the corresponding figure is over 9 per cent; for petroleum, between 8 and 9 per cent. In view of the well-known sensitivity of the prices of these products to changes in demand, the elimination of all armament expenditure, if there were no offsetting rise in civilian demand, could have a seriously adverse effect on the income of those under-developed countries whose exports consist largely of such raw materials. However, the demand for these raw materials would be reduced only fractionally - by less than 2 per cent - if the elimination of military expenditure were accompanied by a corresponding increase in private and public non-military expenditure.

68. Since disarmament may be expected to result in an acceleration of economic growth, it should stimulate the growth of demand for primary production in general. Coupled with the fact that disarmament should be associated with a tendency for the advanced countries to open their markets more widely to foodstuffs, for instance, this would make for a substantial growth of primary commodity trade. Accelerated economic growth would be still more powerful in increasing total demand for manufactures. The tendency to reduce trade barriers should be particularly important in enabling developing countries to increase their exports of manufactures to the more highly developed.

69. Both private enterprise and centrally planned economies should also be prepared to open their markets more widely to under-developed countries once the trade restrictions imposed for security reasons are lifted. There might, however, be instances in which declines in demand for particular commodities would cause appreciable difficulties. In these cases consideration should be given to special aid for the countries concerned, in the same way as for particular industries or areas within the principal disarming countries.

70. The immediate impact of disarmament on international economic relations during the conversion period is a matter that needs to be given careful study along with the other conversion problems already discussed in chapters 3 and 4. Changes in the level of aggregate economic activity associated with disarmament in the major industrial countries would be a major determinant of the level of international trade during the conversion period.

71. If appropriate steps are taken it should be possible even in the short run to avoid any significant reductions in the general level of primary product prices, but it needs nevertheless to be realized that any failure to achieve this goal could have serious consequences. For many of the countries mainly dependent on the export of primary commodities, a percentage decline in their export earnings which might appear small arithmetically could cause grave damage.
72. A more widespread problem relates to particular countries that are largely dependent on the export of those commodities for which world demand might suffer a temporary decline. In conjunction with the formulation of any disarmament programme, therefore, it is highly desirable that a detailed study be undertaken on the changes in demand for the various primary commodities which would result from disarmament. No country should be allowed to suffer a disruption to its economic life, even temporarily, as a result of disarmament.

VI. THE EFFECTS OF DISARMAMENT ON THE VOLUME AND FRAMEWORK OF AID FOR ECONOMIC DEVELOPMENT

73. The promotion of economic and social development in under-developed countries is one of the most important ways in which the resources released by disarmament could be put to use. National efforts and international cooperation in the development of the under-developed countries have so far not brought about the desired acceleration of economic growth. An acceleration of the rate of growth of under-developed countries depends upon many factors, including the adoption of appropriate national development programmes and, in many cases, social and institutional reforms. Among these programmes an important role must be assigned to encouragement of productive investment both from domestic and foreign resources. To this end world disarmament could make a major contribution. Despite the inadequacies of the available statistics, it appears that the world's military expenditures far exceed the combined gross investment expenditures of the less developed areas; they are probably at least five times as large and may be much greater. A much larger volume of resources could thus be allocated to investment for productive development in these countries even if only a fraction of the resources currently devoted to military purposes were used in this way.

74. Disarmament could bring about a marked increase in the rate of growth of real income in the poorer parts of the world. This conclusion is reinforced by a comparison of the volume of resources now being devoted to military use with the various estimates made in recent years of the external financial needs of the under-developed countries. The total amount of foreign capital required by the under-developed areas, over and above their domestic resources devoted to investment, is estimated to range from $6 billion to $10 billion annually. These figures are based on conservative assumptions. After allowing for the present flow of foreign capital through existing institutions and arrangements, it is believed that there is a deficiency of about $3 billion a year that needs to be made good in order to achieve the modest annual rate of growth in income of 2 per cent per capita.

75. In the longer run, productive capacities can be adapted to any changed patterns of demand, and provided that the needs of under-developed countries are known in sufficient detail, no serious problems should arise in matching resources to uses. Even in the short run, however, it seems probable that a significantly large proportion of the resources absorbed for military use would indeed prove to be of a type useful for investment in under-developed countries. An important proportion of military expenditure absorbs the output of heavy industry and of the engineering and construction industries. The output of these industrial sectors could undoubtedly make a valuable contribution to the industrialization
of the less developed areas and to their accumulation of social capital. Transportation and communication equipment, for example, is an important component of military expenditure and is urgently required by under-developed countries.

76. Disarmament would also release personnel, such as scientific research workers and engineers, who could be utilized for other purposes. In the event of disarmament, it should prove possible for the industrialized countries to provide greater technical assistance and thereby help remove one of the serious limitations to development efforts in these countries.

77. With respect to the impact of disarmament on the framework and structure of aid to under-developed countries several points need to be made. If we leave out of account - as seems proper in the present context - short-term finance of all kinds, private grants, and military and defence-support aid, the principal international flows of capital to under-developed countries consist of (1) official grants, (2) official loans and credits on non-commercial terms, (3) long-term loans and credits on commercial terms made by national governments and by international authorities, and (4) private long-term loans or direct investment. Unlike capital flows of the last three types, official grants do not, of course, burden the recipient country's balance of payments. Official loans and credits on non-commercial terms are less burdensome than public or private lending on commercial terms: hence the distinction between the second and third categories.

78. The increased international flow of capital to under-developed countries that is certain to result from disarmament could take any one or more of the forms referred to above. As regards the flow of private capital, it may be assumed that this would continue to respond to commercial considerations. At the present time, nine-tenths or more of official grants and loans are given under bilateral programmes. In so far as political circumstances have had any weight in determining the direction and form of aid, effective disarmament and the related lessening of international tensions should improve the prospects for more co-operative international action.

79. It should be realized that the repayment of loans granted on commercial terms may impose heavy burdens on the balances of payments of under-developed countries. It seems urgent that as large a proportion of economic aid as possible should take the form of grants or "soft" loans. Disarmament would likely facilitate the increased flow of such aid. This is so because the savings afforded by disarmament would provide the aid-giving countries with a favourable opportunity to increase their assistance without imposing an additional burden on civilian expenditure.

80. Because the competing claims in developed countries are also urgent, there is a serious possibility that the financial resources released by disarmament might be rapidly absorbed by purely national aims. It is therefore desirable that an appropriate proportion of these resources should be allocated to international aid in its various forms simultaneously with their use for domestic purposes. It must be emphasized that foreign aid can play only a supplementary role in the development of under-developed countries and that the responsibility for initiation and intensification of development efforts would continue to lie entirely with the governments and peoples concerned.
VII. SOME SOCIAL CONSEQUENCES OF DISARMAMENT

81. The economic and social consequences of disarmament are inextricably intertwined. As already discussed, it would be possible to bring about a significant improvement in many aspects of social life, provided that some of the resources released by disarmament were earmarked for fields such as education and scientific research, health, housing and urban development. In a disarmed world, a general improvement could be expected in the level of living and in the conditions of under-privileged and low-income groups such as the old and retired people whose share in the social well-being is often meagre, even in the more developed countries. With the end of the armaments race, Governments would accord these social objectives a higher priority than in the past.

82. The more rapid rate of economic growth and the increase in productivity that may be expected to result from disarmament might well permit a reduction in working hours, an improvement in the conditions of work and a lengthening of paid vacations. To take full advantage of the resultant longer leisure and the higher level of living, wider cultural facilities would be required. In this context, education acquires special significance as a means of disseminating culture.

83. In the domain of personal and family life, disarmament and recession of the threat of war would decrease tensions which often bring about psychosomatic illnesses. Human life would acquire a new meaning, once war and preparations for war were eliminated.

84. In a disarmed world, the danger that security considerations and armed forces might play an excessive role in forming the values of the community would be eliminated. It is important to note, however, that attention would need to be paid to constructive outlets for individual and collective aspirations.

85. If confidence is one of the necessary conditions for concluding a disarmament agreement, an increase of confidence would also be one of its happiest consequences. A decrease in tensions and in the influence of groups interested in armaments would bring about a profound change in the form and content of international relations. Political and economic conflict between nations, with its attendant risk of war, would more rapidly be replaced by constructive emulation. Scientific co-operation between nations would advance more rapidly, and the peaceful utilization of science and technology would be accelerated. The arts, too, would greatly benefit from an extension of international exchanges.

VIII. CONCLUSION

86. The Consultative Group is unanimously of the opinion that all the problems and difficulties of transition connected with disarmament could be met by appropriate national and international measures. There should thus be no doubt that the diversion to peaceful purposes of the resources now in military use could be accomplished to the benefit of all countries and lead to the improvement of world economic and social conditions. The achievement of general and complete disarmament would be an unqualified blessing to all mankind.
DISARMAMENT AND DEVELOPMENT
ST/ECA/174

INTRODUCTION

1. Pursuant to General Assembly resolution 2685 (XXV) on the economic and social consequences of disarmament, we were asked to suggest in the present report how a link might be established between the Disarmament Decade and the Second United Nations Development Decade and to propose measures for mobilizing public opinion accordingly.

2. We believe that these two objectives - disarmament and development - are of the greatest importance to the world community. The United Nations has agreed to seek each one vigorously in its own right, regardless of the pace of progress in approaching the other.

3. Some general considerations have been our points of departure:

(a) The main motives for pursuing disarmament are to avoid war, to strengthen peace and security throughout the world and to foster a climate of understanding and co-operation. The achievement of these aims would create very favourable conditions for development;

(b) Disarmament agreements have not yet led to any reduction in military expenditure;

(c) In striving by the adoption of measures for disarmament, countries unquestionably also take into account the great economic possibilities implicit in disarmament through the redirection of resources to goals of peaceful development. This is a matter of great importance to all countries, developed and developing alike.

(d) The problems of achieving disarmament and of making rapid progress with economic and social development, as well as the problem of generating more aid for developing countries are essentially political. Disarmament will come only if people change the direction of the policies which have led to arms races. More aid, and other measures aimed at helping developing countries, will come only if people to a greater degree adopt and act upon internationalist values.

(e) There are here two separate political objectives - disarmament and development - and two sets of political motives, one for each. The pursuit of each objective can proceed without the other, and it should proceed urgently. These two objectives can, however, be linked to each other because the enormous amount of resources wasted in the arms race might be utilized to facilitate development and progress;

(f) The blatant contrast between this waste of resources and the unfilled needs of development can be used to help rouse public opinion in favour of effective disarmament, and in favour of the achievement of further progress in development, particularly of the developing countries;
(g) The employment of the resources released by disarmament, especially for development purposes, is not likely to take place spontaneously; it will require concerted action in the part of the Governments of the countries concerned, both developed and developing.

I. DISARMAMENT

4. So far, in the field of disarmament, several important international agreements on certain types of arms have been reached; they have been "partial" or "collateral" measures, mostly of a non-armament character. They may have forestalled increases in military spending, but they have not reduced it.

5. The magnitude of the resources used for armaments was analysed in a recent report of the Secretary-General. World military expenditures in 1970 were roughly $200 billion, i.e., 6.5 per cent of the gross national product (GNP) of the countries of the world. Military expenditures of the countries which provide aid for development are estimated to be approximately 6.7 per cent of their GNP, or 25 times greater than the official development assistance they provide. The major part of the world's military expenditure is made by a very small number of countries; the six main military spenders are responsible for more than four-fifths of the total. If military expenditures continue to grow during the 1970s, at the same average annual rate as in the 1960s (3 per cent a year) they will reach $280 billion (at 1970 prices) in 1980. If their share in the GNP were to remain the same as in 1970, the figure would reach $360 billion.

6. An agreed programme for the Disarmament Decade does not exist. General and complete disarmament under effective international control remains the main objective. Its achievement would represent a momentous political change and would release massive resources for peaceful uses. Partial measures are a second best. They are often seen as first steps to political understanding and general disarmament, but if they are to be fully effective, it is important that they should be agreed to by all the relevant countries. This is not true now. Partial measures do not always lead to reductions in military expenditures.

1/ Economic and Social Consequences of the Arms Race and of Military Expenditures (United Nations publication, Sales No. E.72.IX.16).

2/ These statistics are based on the sources used in the Secretary-General's report (ibid.). The data on military expenditures since 1960 used in that publication were obtained from the United States Arms Control and Disarmament Agency, which has subsequently revised and updated them. (See World Military Expenditures, 1971, Washington, D.C., 1972.) It is the revised and updated statistics that the Group has used in preparing the present report. The six main military spenders are China, the Federal Republic of Germany, France, the United Kingdom of Great Britain and Northern Ireland, the United States of America and the USSR. The projected figures that we have prepared are simply illustrations based on assumptions.
7. One measure which might help the transition from partial measures to general and complete disarmament would be an agreement to limit and reduce military budgets. Without comprehensive over-all economic limitations of this kind, arms limitation agreements expressed in terms of numbers of specific types of weapons cannot prevent an arms race in the form of expenditure on the development and production of entirely new kinds of weapons not covered by existing agreements.

8. The most recent partial measure has been the agreement between the Union of Soviet Socialist Republics and the United States of America on strategic arms, made earlier in 1972. Since it places no limit on qualitative improvements in missiles, it does not ensure a reduction in spending.

9. In the continuing multilateral negotiations for disarmament, there are formal commitments to follow up some of the partial agreements already made with further agreements in the same field - for example, a comprehensive test ban in place of a partial test ban, a ban on the possession and production of chemical as well as biological weapons, and also the genuine demilitarization of the ocean. Some of the commitments have now been on the books for many years.

II. DEVELOPMENT PROSPECTS AND NEEDS

10. The International Development Strategy for the Second United Nations Development Decade (General Assembly resolution 2626 (XXV)) calls for a 6 per cent target rate of growth of gross output for developing countries. If population growth is held down to about 2.5 per cent, the rate of growth of income per person will be about 3.5 per cent. This target - if achieved - is encouraging. But the prospect is nevertheless not satisfactory. At a rate of growth of 3.5 per cent, average income per person in the developing world would rise from the 1970 level of $200 to the level of only around $280 (in 1970 prices) by 1980.

11. One of the basic requirements for raising a country's rate of economic growth is an increase in the volume of resources allocated annually to productive investment. With a few special exceptions, developing countries cannot realistically be expected to be able to provide from domestic savings alone sufficient investment to attain the necessary rate of growth rapidly. Moreover, in some of them, the effective utilization and mobilization of domestic resources often cannot be achieved without foreign technical and financial assistance.

12. The economic growth of developing countries will of course continue to depend still more on the contribution to their external resources made by expansion of their exports, in particular of their exports to high-income countries. To encourage such trade expansion, developed countries must reduce the obstacles which impede exports of developing countries at the present time.

13. At present the flow of official development assistance to developing countries - which depends on governmental decisions taken in the developed countries - amounts to only about 0.35 per cent of the gross national product of the latter countries. In order to achieve the Second United Nations Development Decade target of 6 per cent growth on average, it is estimated that official development assistance from developed countries would have to increase to 0.7 per cent of their GNP.
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14. Even if growth objectives of the Second United Nations Development Decade are attained, the problem of reducing mass poverty and unemployment in the developing countries of the world still remains. More efforts therefore should be made by the world community. In most cases no major problem would arise as to the capacity of developing countries to absorb an increased flow of foreign assistance provided that this assistance is extended on appropriate terms. In particular, there should be a marked increase in untied grants; and, in the case of the poorest countries, possibly for the purpose of increasing consumption.

III. THE INTERRELATIONSHIP BETWEEN DISARMAMENT AND DEVELOPMENT

15. The unanimous conclusion of the report of the Secretary-General entitled Economic and Social Consequences of the Arms Race and of Military Expenditures\(^3\) contains the following statement:

"...A halt in the arms race and a significant reduction in military expenditures would help the social and economic development of all countries and would increase the possibilities of providing additional aid to developing countries.\(^4\)

A. The link with respect to resources in general

16. The transfer to peaceful uses of resources used in each country for military purposes will bring about greater satisfaction of civilian needs of the country. The resources thus released, sometimes referred to as the "disarmament dividend", can be redirected to raise standards of living and to promote faster growth.

17. In the developing world as a whole, the share of gross product claimed by military expenditure is a little more than 4 per cent; in 17 developing countries, mostly in the regions at war in the Far East and the Middle East, the average share climbs to around 13 per cent. On the other hand in 46 countries, mainly in Africa and Latin America, the average share is only 1.5 per cent of their gross product. Therefore, there will be considerable variation among developing countries in respect to the magnitude of their own "disarmament dividend".

18. In case of general and complete disarmament — and also, to a lesser extent, when the cuts in military expenditure are significant — economic assistance granted by developed to developing countries could and should be greatly increased and would merit high priority in the allocation of released resources. The higher the level of per capita income of a developed country, the stronger is the case for it to contribute to the promotion of growth in developing countries, not only through increased economic aid but also through increased international trade.

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\(^3\) See foot-note 1 above.

\(^4\) Ibid., para. 120.
19. Many developing countries import their arms from abroad. Although many of these arms are provided as aid or on easy terms, disarmament would still release significant foreign exchange resources which could be used for the import of investment goods necessary for economic growth. As disarmament is accomplished, the amount of military aid granted by the developed countries should be used for the expansion of economic aid to developing countries.

20. Disarmament could make an important contribution towards closing the increasing economic "gap" between developing and developed countries. A general (proportional) reduction in military expenditures will increase the non-military part of the GNP of the developed countries proportionally more than that of the developing nations. However, a simultaneous increase in the fraction of GNP in the advanced donor countries allocated to international development assistance could not only prevent a widening of the "gap", but contribute greatly to its closing. Such a rise in the fraction of their combined GNP allocated by developed countries to development assistance would have to be larger the greater the difference between the military expenditures - expressed in percentages of their respective GNPs - of the two groups of countries. When applied to the configuration of GNP, military expenditure and development assistance estimated for 1970, a rough calculation shows that a 20 per cent general reduction in military expenditures would contribute to the reduction of the economic gap between the two groups if such developmental assistance were raised globally in the same proportion or slightly more.

21. Recognizing that each donor country will want to determine its own policies for expanded economic assistance, the Group hopes that these decisions will secure an adequate increase in assistance for development.

B. The link with respect to specific resources

22. Most of the resources released by disarmament, total or partial, would be readily transferable to other uses - for example, manpower, food, clothing, transport, fuel and products of the metal and engineering industries. Budgetary action to raise civil demand will be enough to induce redeployment of released resources either to investment or to consumption, public or private.

23. Some other resources, for example, nuclear weapon plants and military aircraft and missile plants may not be readily transferable. Some alternative civil uses may be found, but only a part of the specialized resources could probably be absorbed. For the rest, other industries will have to be brought into the areas where the specialized military production has been concentrated and retraining programmes will be needed for those whose skills become redundant. The Group suggests that Governments, when placing orders for specialized military production or creating specialized plants likely to give rise to these difficulties in the event of disarmament, should make advance plans to deal with the redeployment to peaceful work of the manpower and plant (in so far as the latter is reusable).

24. Apart from catering for these areas of special difficulty, all countries might be urged to consider what would be the most valuable ways of redeploying resources from military to civil use and to consider, in particular: (a) which resources now used by the military might make a particularly valuable contribution to development in any area; and (b) in the light of such an assessment, which
specialized resources would be suitable as aid or technical assistance from developed to developing countries. Planning of this kind would benefit from international co-operation. The Group believes that the feasibility of making such plans should be explored now.

25. Research and development needs special consideration. The world's expenditure on research and development has grown tremendously since the Second World War, but a very large part of the effort has been military. It is estimated by the Secretariat that world expenditure on research and development now amounts to $60 billion, or about 2 per cent of world gross product, of which about $25 billion is for military purposes. An overwhelming part of these expenditures are made in the advanced countries.

26. These research and development resources, when diverted to peaceful uses, might have a great impact on development. There is a vast range of problems in the developing countries and there are huge sophisticated resources absorbed by military research and development in the developed countries. The range of possibilities of transfer appears to be extremely wide. Our conclusion is that it would be useful constantly to consider what disarmament steps are in the offing, how far these may release resources and how they may best be used to promote development either at home or in the developing countries.

27. We considered what specific resources would be released for development by four partial measures we adopted as hypotheses and came the following conclusions:

(a) A comprehensive test ban. It seems uncertain whether peaceful nuclear explosions will prove to be attractive economically very soon. If they do prove to be attractive economically, it is important that they should be made available to the non-nuclear weapons countries, under appropriate international arrangements. There appears to be great continuing scope for the development and application of nuclear energy; resources released by a comprehensive test ban might directly or indirectly permit an expansion of effort here. It is estimated that complete nuclear disarmament would offer promise of additional benefits. More than 20,000 nuclear scientists and engineers would become available, some of whom could be assigned to assist the peaceful nuclear programmes of developing countries.

(b) Chemical disarmament. Biological disarmament has already released resources that are valuable for research into disease, animal and human. Chemical disarmament would add resources useful for ecologically acceptable pest control and toxicological research.

(c) Demilitarization of the sea-bed and deep-sea environment. Sea-related activities of benefit to developing countries could, with appropriate planning, be stimulated by complete demilitarization of the sea-bed and deep-sea environment and by naval and other disarmament. Benefits would be made possible by expanded programmes of research and exploration using water-borne devices and remote sensing from satellites and aircraft. Mineral exploitation of the sea-bed could be facilitated, enabling the world community to better utilize this common heritage of mankind.

(d) The elimination of all foreign bases and withdrawal of foreign troops. This measure would influence the balances of payments between the countries with troops or installations abroad and the countries where those troops or installations are sited.
IV. MOBILIZING PUBLIC OPINION IN FAVOUR OF PROMOTING DISARMAMENT AND DEVELOPMENT

28. The Group considers that at the present stage public opinion should be mobilized mainly with a view to following up the results already achieved in the field of disarmament by new steps towards general and complete disarmament. In the continuing multilateral negotiations for disarmament, there are formal commitments to follow up some of the partial agreements already made with further agreements in the same field. The idea of the Disarmament Decade could be utilized in such publicity endeavours, not least in order to keep public opinion concerned with obtaining real achievements before the Decade is up. If agreement is reached on holding a world disarmament conference, and if the conference is held, this would facilitate the mobilization of public opinion.

29. Likewise, the goals of promoting economic development in order to secure social development for all people in all nations, must receive a greater share in the building of public opinion everywhere.

30. The purpose of mobilizing public opinion for both these imperative goals - disarmament and development - may be effectively served by constantly publicizing reminders of the blatant contrast between the waste of resources on armaments and the great unfilled needs of social and economic development and in particular, the shocking discrepancy between world expenditures for armaments and for aid to the poorer nations.

31. In implementing such action schemes for public information, some of the more specific statements and recommendations of this report should be utilized:

(a) In the United Nations reports on disarmament and on development, the comparison between military and civilian expenditures should be brought to the foreground;

(b) Within the framework of the periodic reviews and appraisal of progress towards achieving the goals and objectives of the International Development Strategy for the Second United Nations Development Decade, progress in disarmament should be given consideration, and considerable publicity should be given to the ensuing debate;

(c) The appeal voiced by a group of experts in 1971 in the report entitled Economic and Social Consequences of the Arms Race and of Military Expenditures should be reiterated. The Group wants particularly to support the general recommendation: "In order to draw the attention of the Governments and peoples of the world to the direction the arms race is taking, the Secretary-General should keep the facts under periodic review".

5/ See foot-note 1 above.

6/ Ibid., para. 120 (4)
(d) Public discussion in international forums and within Member States should be encouraged in regard to the statement in the present report that unless disarmament savings are accompanied by a sufficient increase in development aid, the income gap between developed and developing countries is apt to widen.

(e) The imagination of the public in all countries should be kindled by information on conversion possibilities.

(f) In particular, all media should draw attention to the tremendous inherent potentialities of redirecting military research and development to development objectives.