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DISARMAMENT

Comprehensive Study on Nuclear Weapons
Summary of a United Nations Study

United Nations

Preface

The cover reproduces the emblem of the United Nations and the emblem of the World Disarmament Campaign, a global information programme on disarmament and international security launched by the General Assembly in 1982 at its second special session devoted to disarmament. The programme has three primary purposes: to inform, to educate and to generate public understanding of and support for the objectives of the United Nations in the field of arms limitation and disarmament. In order to achieve those goals, the programme is carried out in all regions of the world in a balanced, factual and objective manner.

As part of the programme's activities, the Department for Disarmament Affairs provides information materials on arms limitation and disarmament issues to the non-specialized reader. Such materials cover, in an easily accessible style, issues which may be of particular interest to a broad public. This is one such publication. It is published in the official languages of the United Nations and intended for worldwide dissemination free of charge.

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Comprehensive Study on Nuclear Weapons

Summary of a United Nations Study

Background

In December 1988, by resolution 43/75 N, the United Nations General Assembly requested the Secretary-General to carry out a comprehensive update of a 1980 study on nuclear weapons. The study was to take into account recent relevant studies, and consider the political, legal and security aspects of: (a) nuclear arsenals and pertinent technological developments; (b) doctrines concerning nuclear weapons; (c) efforts to reduce nuclear weapons; (d) physical, environmental, medical and other effects of the use of nuclear weapons and of nuclear testing; (e) efforts to achieve a comprehensive nuclear-test ban; (f) efforts to prevent the use of nuclear weapons and their horizontal and vertical proliferation; and (g) the question of verification of compliance with nuclear-arms limitation agreements.

To assist him in carrying out this task, the Secretary-General appointed 12 experts from the following countries: Argentina, Bulgaria, Egypt, France, Indonesia, New Zealand, Senegal, Sri Lanka, Sweden, the USSR, the United States, and Venezuela. The Swedish expert, Ambassador Maj Britt Theorin, chaired the Group.

The Group's report is presented in nine chapters, eight of which are summarized here; chapter 9, entitled "Conclusions", is included in its entirety. Two appendices to the study (not included in this publication) contain the official doctrines of the nuclear-weapon States and a chart of their land- and sea-based nuclear weapons.

In his foreword to the report, the Secretary-General observes that the study represents the most comprehensive review of the relevant developments in the field over the last decade and was carried out during a period of "far-reaching changes in international relations" and an "unprecedented evolution in the relationship between East and West". This period experienced for the first time the initiation of an effective process of reduction of nuclear weapon stockpiles. In addition, he points out:

> "The study contains several significant conclusions. One of them is that the quantitative growth of nuclear-weapon arsenals has been stopped. The total number of nuclear warheads in the world has declined and this trend is expected to continue. The danger of nuclear confrontation has been significantly reduced if not eliminated altogether. On the other hand, however, qualitative improvements of nuclear-weapon systems, though confined to several areas, continue without significant restrictions. The question of the cessation of nuclear-weapon tests remains a highly divisive issue in international discussions."

Highlights of the study

Introduction

The update of the 1980 study was prepared against the background of global quantitative and continued qualitative developments of nuclear weapons on the one hand and major breakthroughs in arms limitation and disarmament negotiations on the other. On the technical level, research, development, production and deployment of new weapons have continued steadily, with the attendant introduction of more accurate nuclear ballistic missile systems and the deployment of highly accurate nuclear-armed cruise missiles.

As of 1990 there were about 50,000 nuclear warheads deployed around the world on the territories of the nuclear-weapon States and some non-nuclear-weapon States, as well as on the high seas. Each of the two major Powers has at least 10,000 nuclear warheads that can be set into action in a major strategic attack within minutes or hours.

There are five States that have officially acknowledged that they possess nuclear weapons: China, France, the Soviet Union, the United Kingdom and the United States. According to the figures given by the Stockholm International Peace Research Institute (SIPRI), the nuclear arsenals of the Soviet Union and the United States continue to contain more than 95 per cent of the total number of nuclear weapons in the world.

In the same decade the first agreement providing for actual reductions in nuclear weapons, the Treaty between the United States of America and the Union of Soviet Socialist Republics on the Elimination of Their Intermediate-Range and Shorter-Range Missiles (INF Treaty), was signed in 1987. It provides for the elimination of a whole category of nuclear weapons under a system of unprecedented intrusive verification. This Treaty has paved the way for further progress on other arms limitation agreements. The nuclear-arms race may be turned around by the strategic offensive arms reduction treaty (START), the basic provisions of which – to reduce strategic nuclear weapons by 30 to 35 per cent – were agreed to by the Soviet Union and the United States in June 1990.

Although qualitative improvements in nuclear weapons continue and nuclear testing remains a contentious issue, the diminishing tension and the growing cooperation between East and West might facilitate the resolution of these issues as well. However, the possibility of the proliferation of nuclear weapons to additional States is of increasing concern. Some believe that the current political climate presents opportunities for taking steps that would minimize the chance or effect of possible untoward developments in the future.

The study refers to figures, estimates and other data based on various open academic and other non-governmental sources. Some data are, however, officially published by nuclear-weapon States, though such information is generally classified.

The Governments of the respective nuclear-weapon States do not necessarily concur with the data given by non-official sources.

Existing nuclear weapons: technical data and statistics

Nuclear weapons represent a historically new form of weaponry, which, by their multiple and far-reaching effects, provide a means of warfare whose mass destructive potential is unparalleled in human experience. Nuclear technology makes it possible to release more energy in one micro-second from a single nuclear weapon than all the energy released by conventional weapons used in all wars throughout history. In addition, nuclear weapons differ from conventional ones by the nature of their destructive effects, which comprise three elements: blast, heat and radiation. While the blast and heat are of an instantaneous nature, the radiation, which is peculiar to nuclear weapons, has both immediate and long-term effects. These effects have the potential to extend to areas beyond the borders of the target country.

The individual explosive yield of currently deployed nuclear warheads is estimated to span the spectrum from 100 tons to more than 1 million tons equivalent of conventional high explosive. In the 1970s and early 1980s the trend was towards deploying nuclear warheads of smaller individual yields that had a greater accuracy in their delivery. Even with this trend the aggregate explosive power of present nuclear arsenals remains in the region of 13,000 million tons of TNT, or 1 million times the explosive energy of the Hiroshima atomic bomb.

The essential part of a nuclear weapon is the nuclear explosive device or warhead. Warheads may be built into various kinds of missiles, gravity bombs, artillery shells and so on. The term "nuclear weapon" usually denotes both the nuclear warhead and the delivery vehicle that takes the warhead to the target, particularly when this vehicle is a missile. Over the years, both warheads and delivery vehicles have undergone significant processes of development and improvement. A "nuclear-weapon system" may include specially designed platforms, from which weapons are launched, as well as supportive systems for command, control and so on.

There are two basic types of nuclear warheads: those based solely on fission (previously often called atomic weapons) and those which also utilize fusion (sometimes called thermonuclear or hydrogen weapons). The energy released in a nuclear explosion (yield) is usually measured in kilotons (kt) or megatons (Mt), corresponding to the energy released by a thousand or a million metric tons of the conventional explosive TNT (trinitrotoluene). The energy released by a thermonuclear weapon (H-bomb) comes from both the fission "trigger" and the fusion materials.

All nuclear weapons contain at least a few kilograms of weapon-grade plutonium or highly enriched uranium – the fissile material. Tritium is used in all thermonuclear warheads (hydrogen bombs). The majority of nuclear weapons developed in the world today use plutonium-239 (produced by neutron irradiation of uranium-238), rather than uranium-235, as fissionable material.

The most important delivery vehicles for nuclear weapons are different types of rocket or jet-propelled missiles. There is, however, a variety of nuclear weapons that are designed to be delivered on targets by other means, e.g. gravity bombs, artillery shells, torpedoes, and depth charges. Long-range land-based and sea-based delivery vehicles are mainly ballistic missiles, while cruise missiles are important at somewhat shorter ranges. A ballistic missile is a pilotless rocket-propelled projectile. It consists of one or more fuel stages and the final stage which is sometimes called the warhead. Long-range missiles of this kind, through vertical trajectory, are capable of reaching outer space and travelling long distances before re-entering the atmosphere and reaching the target; hence the term "re-entry vehicle" (RV).

An important characteristic of ballistic missiles is the so-called throw-weight, which refers to the maximum weight of the useful load (warhead, guidance unit and penetration aids) that the missile is capable of carrying over its designated range.

Aerodynamic or cruise missiles, which are propelled by jet engines, sustain their flight through the use of aerodynamic lift over most of their flight path and travel through the atmosphere parallel to the ground like an aircraft (horizontal trajectory). They can be guided by remote control or by on-board navigation devices. The latter enable them to dodge obstacles in their path and make their detection by radar more difficult. They have a high level of accuracy.

Airborne nuclear-weapon systems are various types of aircraft which can carry either nuclear bombs or missiles with nuclear warheads.

Strategic nuclear weapons are generally aimed at an opponent's overall military and economic potential and have long-range or intercontinental capability. Theatre or tactical nuclear weapons may be used against selected military targets on or behind the immediate battlefield (airbases, supply depots, reserve forces) that are related to activities at the battlefield. Consequently, they operate at much shorter ranges than strategic weapons. Weapons envisaged for use against targets in the zone of direct combat are often called battlefield weapons. As a rule they have rather short-range capability. Some may even be stationary.

Strategic nuclear forces consist of land-based intercontinental ballistic missiles (ICBMs), submarine-launched ballistic missiles (SLBMs) and strategic bombers.

Tactical nuclear weapons can be deployed on land as well as at sea. The land-based forces include weapons such as ground mobile rockets and missiles, and air-launched bombs and missiles. Yields may vary from 1 kt or less to 1 Mt. Tactical nuclear weapons deployed at sea are mounted on a variety of ships, submarines, naval aircraft and helicopters, and consist of bombs, surface-to-surface missiles (SSMs), surface-to-air missiles (SAMs) and anti-submarine warfare (ASW) rockets, torpedoes

and depth charges. In principle, artillery pieces of about 150 mm calibre or larger are nuclear-capable.

The composition and development of the strategic nuclear arsenals of the five nuclear-weapon States reflect these countries' military postures, which are by no means identical. Nevertheless, the common denominator between them, with the exception of the United Kingdom, is their reliance on the so-called triad arrangement – land-based, sea-based and bomber forces – but with different emphasis on one or the other leg of the triad. The military rationale for this arrangement lies in the differences of range, yield, accuracy, level of reliability, survivability and readiness between the various types of weapon systems.

Historically, the United States first concentrated on manned bombers as its main means of delivery for nuclear weapons. A substantial ICBM and SLBM capacity was developed in the early to mid-1960s. Concerning the land-based forces, the United States has an estimated 1,000 ICBMs with 2,450 warheads. As regards the sea-based forces, the United States has 33 submarines (SSBNs) equipped with 592 SLBMs and about 5,100 warheads. The third part of the United States triad consists of approximately 350 strategic bombers with some 4,500 warheads.

The Soviet Union has long chosen to emphasize the ICBM arm of its strategic triad. Currently, the Soviet Union deploys several ICBM systems, totalling 1,356 ICBMs, with approximately 6,450 warheads. Concerning the sea-based forces, the Soviet Union

has deployed 930 SLBM launchers of various types on SSBs (submarines, ballistic missile equipped) and SSBNs with 3,642 warheads. The Soviet Navy also has a sea-launched cruise missile (SS-N-21), comparable to the United States Tomahawk, which it first deployed in 1987. Regarding bombers, the Soviet Union currently maintains 162 "Bear" and "Blackjack" strategic bombers. Some of the bombers are believed to have been recently fitted with cruise missiles.

Although the United Kingdom has never simultaneously deployed a nuclear triad, at different times it has had in service bombers, and land-based and sea-based ballistic missiles. At present, 4 British "Polaris" SSBNs are each equipped with 16 missiles, carrying two warheads, making a strategic force total of 64 SLBMs with 128 warheads.

France maintains a nuclear triad composed of bombers, land-based intermediate/medium-range ballistic missiles (IRBMs) and SLBMs. The French nuclear bomber force consists of 20 Mirage IV; as regards the ballistic missiles, France deploys 18 IRBMs (S-3), each with one 1 Mt warhead. The most important part of the French triad is its SLBMs, which presently consist of 6 SSBNs with a total of 256 warheads.

China's strategic forces are the smallest of the five nuclear-weapon States. The oldest leg of its triad consists of bombers; their total number is believed to be between 120 and 150 aircraft. The Chinese ground-based missile force consists of

approximately 150 missiles, none of which have multiple warheads. China now deploys 2 submarines with 12 SLBMs (CSS-N-3) on them.

Following the 1987 INF Treaty between the United States and the Soviet Union, which provides for the elimination of land-based ballistic and cruise missiles of intermediate and shorter-range (5,000-500 km), only missiles of ranges less than 500 km remain in the tactical arsenals of these two nuclear-weapon States. The United States and the Soviet Union have substantial numbers of tactical nuclear weapons deployed at sea.

To ensure that the political and military leaders of the nuclear-weapon States have access to relevant and timely information, and that they remain in communication with their nuclear forces and each other, it is necessary to have an elaborate system of reconnaissance, data processing facilities and communication networks. The two major Powers in particular have paid great attention to such systems. Some of their components are space-based sensors or communication links, others are ground-based and still others could be airborne. The totality of these assets, with their associated procedures and routines, is often referred to as "C^3I", which stands for command, control, communications and intelligence. In some cases, C^3I facilities have been hardened against nuclear attack to permit them to operate in a post-attack environment.

With a view to minimizing the risk of nuclear-weapon accidents, false alarms, unauthorized launches, terrorist attacks, theft, sabotage, or seizure in countries where

nuclear weapons are deployed, the nuclear-weapon States have developed various safety measures for storing and handling nuclear weapons.

Trends in the technological development of nuclear-weapon systems

Nuclear weapons have undergone tremendous change and development since their inception some 45 years ago. Apart from the basic principle of nuclear reactions as the source of energy, there remains very little resemblance between the first two bombs exploded in Hiroshima and Nagasaki, which were technically very primitive, and the ballistic missiles equipped with a number of multiple independently targetable re-entry vehicles (MIRVs) in the nuclear-weapon arsenals today.

The first turning-point in the development of warheads was the successful utilization, in the early 1950s, of fusion reactions in nuclear explosives. This made it possible to produce thermonuclear devices capable of releasing extremely large amounts of energy. As a result, through the 1950s and early 1960s, the tendency was generally to build more powerful weapons, i.e. with a greater explosive yield.

On the other hand, a development to reduce the size and weight of warheads was also initiated in the 1950s. As a consequence, it became technically feasible to produce various small nuclear charges for a variety of non-strategic uses, thus considerably expanding the potential role of nuclear weapons in a conflict situation. For instance, nuclear artillery shells were first tested in 1953.

For strategic warheads, the trend towards larger yields was reversed during the 1970s, especially in the United States. The fact that warheads with considerably lower yields were introduced was related mainly to significant improvements in accuracy of the delivery systems, in particular ICBMs.

The first generation of multi-warhead systems became known as "multiple re-entry vehicles" (MRV). The missile carries several warheads (2-4), thus considerably increasing the probability of the target's destruction. The next generation, called "multiple independently targetable re-entry vehicles" (MIRV), is capable of directing each warhead against different individual targets located at varying distances up to perhaps 500 km from each other. This development has increased the effectiveness of ballistic missiles.

The MRV warheads were deployed in the United States towards the mid-1960s on SLBMs, and MIRV around 1970 on both ICBMs and SLBMs. By the 1980s, both the United States and the Soviet Union had deployed either MRVs or MIRVs on their major weapons systems. The other three nuclear-weapon States had also been developing similar technologies, which some of them deployed in subsequent years.

As early as around 1970, there was some discussion regarding the development of a third generation of multiple warheads, the so-called "manoeuvrable re-entry vehicle" (MARV) technology. The main characteristic of these warheads would be their ability to readjust their flight patterns after having re-entered the atmosphere,

which would increase their probability of penetrating an anti-ballistic missile (ABM) defence. With the aid of autonomous sensors, the MARV might also be able to attack mobile targets with a higher degree of accuracy. Reportedly, this technology has not been deployed.

By the 1980s, the development of modern cruise missiles had gained momentum, owing to advances in propulsion and navigation technology, even though problems remained. With ranges up to at least 2,500 km and an expected accuracy of a few tens of metres, cruise missiles were envisaged to fill both a strategic role – in their air-launched version (ALCM) – and a theatre role when deployed on ships (SLCM) or on ground-mobile launchers (GLCM).

In the area of delivery vehicles, several new developments have taken place. Concerning land-based missile forces, two features are of particular military significance: the more widespread replacement of liquid fuel rockets with solid fuel, and the introduction of mobile ICBMs.

The major developments concerning the strategic air forces of nuclear-weapon States have been the advent of stealth technology for advanced bombers and air-launched cruise missiles. Stealth technology is a combination of aircraft design, improved electronics and special material coatings designed to absorb radar waves. This technology is intended to enable aircraft and missiles to fly undetected by existing radar systems in carrying out their mission. Countermeasures to stealth technology are being

explored, which include various special forms of radar, such as very low-frequency, bistatic or carrier-free radar. None of these techniques is yet capable of negating stealth technology, however.

Air-launched cruise missiles (ALCMs) are designed to allow manned bombers to avoid having to face the challenge of heavy air defences while performing their mission, as they are able to launch their ALCMs before penetrating enemy airspace. Thus, ALCMs effectively replace the gravity bomb and give older bombers, such as the American B-52 or the Soviet "Bear", increased longevity. The sophisticated guidance system employed on ALCMs also increases the accuracy of bomber-delivered weapons.

Research is also under way for advanced cruise missiles (ACM) that would use stealth technology, as well as for an advanced strategic air-launched missile that would achieve supersonic speeds. Both these types of missiles would provide maximum penetration ability against air defences.

In the area of maritime nuclear forces, apart from continuing efforts to make nuclear submarines ever more quiet and to improve communication links with them, the two main development features of the 1980s have been the continued replacement of single-warhead and MRV missiles with MIRVed missiles, on the one hand, and the development and deployment of sea-launched cruise missiles (SLCM), on the other. There has also been a corresponding improvement in the accuracy of both the MIRVs

and SLCMs. Both the United States and the Soviet Union are thought to be improving the accuracy of SLBM forces as well.

Parallel with technological developments in the field of nuclear weapons, at various times efforts were made by nuclear-weapon States to develop defence systems against strategic ballistic missiles carrying nuclear weapons to decrease the effectiveness of such systems. At present, research and development of strategic defence systems are progressing in a number of directions, which could lead to systems that might be used against RVs of ICBMs and SLBMs, or against the buses carrying the RVs or against the missiles themselves.

Unlike the situation with earlier ABM weapons, which focused on interception solely during the terminal phase of an RV's flight, interest in new ballistic missile defence (BMD) weapons turned in the 1980s to the destruction of ICBMs and SLBMs along their entire trajectory. There is a whole array of existing and conceptual weapons technologies under consideration for use in BMD. System components could be either ground-, air- or space-based. There are several basic types of new BMD weapons being researched: kinetic energy weapons (KEW), lasers and particle beams.

In the 1980s, as military satellites became more integrated into military observation, communications and weapon guidance, their importance as targets also increased. Renewed focus on this field also arose as a result of a belief that a number of

ballistic missile defence technologies could find an initial application as anti-satellite (ASAT) systems.

There has been considerable debate over the feasibility and merit of the United States Strategic Defense Initiative (SDI), put forward in 1983. The Soviet Union has also been carrying out research into technologies that could be used in a BMD system.

Doctrines and strategies concerning nuclear weapons

Military doctrines are developed basically to determine the conditions under which force would be used and as guidelines for force structuring and war plans. Throughout history military doctrines have changed considerably, reflecting changes in perceptions, the evolution of the international environment and the development of different means of warfare. Similarly, various military doctrines relating to the use or threat of use of nuclear weapons have been continuously revised over the past 40 years in conjunction with the changes in the nuclear potentials of the major Powers and the rapid technological developments in the field.

The concept of deterrence is as old as the phenomenon of war. Generally, deterrence is based on the threat of use of force to prevent someone from carrying out certain hostile acts. Nuclear deterrence by the threat of massive destruction is based on the idea that if one nuclear-weapon State launches an attack on another nuclear-weapon

State, the defender will have sufficient force left after the attack in order to be able to launch a retaliatory strike that would inflict unacceptable damage on the aggressor. Thus, according to this concept, the aggressor would be dissuaded from initiating an attack. The question of nuclear deterrence takes on particular significance at the regional level with respect to those States which reportedly possess nuclear warheads or nuclear explosive devices and which, at the same time, are not parties to the Treaty on the Non-Proliferation of Nuclear Weapons. It relates also to the possibility that nuclear weapons could be used to threaten and endanger the security of a region and of neighbouring States, creating for them the need to devise appropriate security arrangements on which they can rely.

Several fundamental issues have been debated more or less since the inception of the nuclear age. One is whether nuclear weapons are indispensable for an effective deterrence. Another is whether they can deter conventional attack or only nuclear attack. Major uncertainty also surrounds critically important questions under what circumstances a certain State would in fact use its nuclear weapons.

Other issues raised are whether or not a nuclear-weapon State can credibly extend nuclear deterrence to its allies ("extended deterrence"); whether an assured retaliatory capability is sufficient for deterrence ("minimum deterrence") or if this calls for larger and more varied forces, i.e. a "war-fighting" capability; and, finally, whether deterrence in reality rests on the mere existence of powerful nuclear arsenals ("existential deterrence"). The question still remains as to how much and what type of

nuclear weaponry are sufficient for deterrence. In the view of many, this has, in the past, led to an arms race resulting in excessive nuclear arsenals.

Different States assess nuclear weapons and deterrence differently. There are those who believe that nuclear deterrence has played an important role in preventing the outbreak of a world conflict and that nuclear deterrence will continue to be a prerequisite for international stability and world security for the foreseeable future. Others consider that the risks of a failure of deterrence are too high to be worth taking, since nuclear war could cause intolerable destruction in any part of the globe, no matter how distant from the centre of conflict. They believe that nuclear weapons should be banned and abolished and that viable security alternatives must be considered on the basis of broad multilateral cooperation rather than on a permanent adversarial relationship.

The views on nuclear-weapon doctrines, including deterrence, are described briefly in the chapter; in an appendix, the five nuclear-weapon States submitted, for publication in the study, short descriptions of their doctrinal views on the use of nuclear weapons.

Development, production and testing of nuclear weapons

The international community is divided on the issue of the possession of nuclear weapons. The overwhelming majority of States have refrained from acquiring such

weapons. More than 45 years after the first nuclear devices were developed, only a small number of States have acquired nuclear arms. Significantly, more than 130 States, including three nuclear-weapon States, in the Final Declaration of the 1985 Third Review Conference of the Non-Proliferation Treaty, declared their continued support for the prevention of proliferation of nuclear weapons or other nuclear explosive devices. It appears, therefore, that the vast majority of States believes that acquisition of nuclear weapons would not serve their security interests and that emergence of additional nuclear-weapon States is liable to have considerable regional, or even global, security ramifications.

A decision to develop, build and test a nuclear weapon is complex. Following a political decision to acquire nuclear weapons, a non-nuclear-weapon State must develop the required technologies and ensure the supply of nuclear fissile material. Considerable research, development, engineering and industrial capacity are required to build facilities either to make enriched uranium or to extract plutonium from spent reactor fuel. To build such facilities is a complex and expensive task, which is beyond the domestic capabilities of many countries.

After the decision has been made as to how to acquire the fissile material, a State must decide whether to test its developed weapon. It is probable that a workable first-generation fission weapon could be developed without testing, although it is uncertain how reliable this device would be. The Hiroshima bomb was not tested, and design and construction may well be easier today with the use of supercomputers. To

develop advanced nuclear weapons, such as fusion weapons, would, however, require testing.

The testing of nuclear warheads is a critical element in the production of nuclear weapons, because each new type of nuclear weapon typically requires the development of a new warhead. It is believed that most testing is done to develop specific new warheads, with half a dozen explosions required to develop a brand new design. Further tests are conducted to check weapons as they come off the production line, and also for their reliability when they reach the stockpile. Nuclear-test explosions are also used to research new kinds of nuclear weapons. "Weapons effects" tests are also carried out to measure the effect of radiation on military equipment. Most details of nuclear tests are kept secret.

All five nuclear-weapon States conduct nuclear tests as part of their weapons programmes. Between 1945 and 1989 there were 1,819 internationally recorded tests (an average of one test every nine days) with a total yield of many hundred megatons. Testing has been carried out on every continent except South America and Antarctica, as well as on a number of island territories in the Pacific Ocean. The United States, the Soviet Union and China test at isolated sites within their respective mainlands. The United Kingdom uses the American test site in Nevada. France has two test sites in French Polynesia.

Except for a few underwater tests, the early tests were carried out in the atmosphere, provoking widespread concern about the effects of radioactive fallout. Since the 1963 Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and under Water (PTBT), the United States, the Soviet Union and the United Kingdom have conducted their testing at underground sites. France continued to carry out atmospheric tests on French territory in the South Pacific till 1974, when it changed to underground testing only. China ended atmospheric testing in Sinkiang in 1980. The study also examines the effects of underground testing.

Effects of use of nuclear weapons and consequences of nuclear war

The existing knowledge of the effects of the use of nuclear weapons is far from complete. In only two instances were nuclear weapons used in actual war conditions, against the Japanese cities of Hiroshima and Nagasaki in 1945. The outcome of these explosions has been painstakingly investigated, yet considerably different data are given by different sources, in particular with regard to the number of casualties. Even in recent years, new findings have been brought to light about the detailed effects of the bombings of Japan.

Studies carried out to determine the effects of the use of nuclear weapons have all used different war scenarios and applied various other assumptions. The scenarios ranged from the explosion of one nuclear weapon to an all-out nuclear exchange. Other scenario parameters are, for instance, the explosive yield and height of

burst of the individual weapons, the character of their targets, especially the population density in the target area, and climate and weather conditions.

The explosion of a nuclear weapon causes damage in several ways: intense thermal radiation, a powerful blast wave and nuclear radiation from the fireball and from radioactive fallout. There is also a pulse of electromagnetic radiation harmful to electrical systems. Of these, the fallout has a delayed effect, while all the others are immediate. The study examines the physical, medical, environmental and other effects of one nuclear explosion, of a nuclear exchange, and of damaging nuclear installations.

The 1980 United Nations study assumed in a "worst case scenario" that the source of radiation would be global fallout from 10,000 Mt of total explosive yield. It quotes one consequence of this to be between 5 and 10 million excess fatalities from cancer over a period of about 40 years. The recent scientific findings, as adopted by the United Nations Scientific Committee of the Effects of Atomic Radiation (UNSCEAR), would indicate corresponding numbers of 25-50 million, with an additional number of non-lethal tumours (including thyroid cancer) totalling perhaps 10 million. The cases of hereditary ill health caused by radiation may number a million or so in the first two generations and several million over the indefinite future.

After a nuclear-weapon strike against population centres, economic activities, especially in contaminated areas, would be disrupted for months and perhaps years. Sanitary conditions would deteriorate. Food and water supplies would be severely

contaminated. Health facilities and medical care, insufficient to handle the expected casualties in peacetime conditions, would be unable to cope to an even greater extent after a nuclear exchange.

Increasing attention is being paid to a nuclear war's effects on the environment. For instance, a partial depletion of the ozone layer would increase the amount of ultraviolet radiation at the surface of the earth. Although the full biological implications of increased ultraviolet radiation to ecosystems at various latitudes are not known, skin cancer is related to large amounts of ultraviolet radiation. Plants and animals might also be affected. Ocean phytoplankton, the basis of the world food chain, has been shown to be particularly sensitive.

Nuclear weapons and international security

The Charter of the United Nations, which took effect in the aftermath of the Second World War, has laid down a broad foundation for world peace and order in the post-war era and has envisaged mechanisms for its preservation. It recognized the inherent right of States to individual or collective self-defence in case of an armed attack and stated that nothing in the Charter precluded the existence of regional arrangements for the maintenance of international peace and security as appropriate for regional action. An overwhelming majority of non-nuclear-weapon States have formally renounced the possibility of acquiring or possessing nuclear weapons by adhering either to the 1968 Treaty on the Non-Proliferation of Nuclear Weapons or the two to existing treaties

establishing a regional nuclear-weapon-free zone (Latin America and the Caribbean) or a nuclear-free zone (South Pacific) or by adhering to both of the above.

While not possessing nuclear weapons themselves, some of the non-nuclear-weapon States, through various arrangements, including regional military alliances, have associated themselves with respective nuclear-weapon States, thereby accepting the so-called "nuclear umbrella" as an element of their defence, and consider that in their circumstances nuclear deterrence is a means to prevent war, including nuclear war. Other non-nuclear-weapon States have excluded this option from their national security considerations and have taken the position that nuclear weapons would threaten the very survival of the human race if they were ever used in a major conflict.

Some States hold that international peace and security cannot be fully guaranteed until the elimination of all nuclear weapons is ultimately attained. On their initiative, the General Assembly held its first special session devoted to disarmament in 1978, and adopted a Final Document that called upon all States, in particular the nuclear-weapon States, *inter alia*, to consider as soon as possible various proposals designed to secure the cessation of the nuclear-arms race, the avoidance of the use of nuclear weapons and the prevention of nuclear war and thereby ensure that the survival of mankind is not endangered.

Many proponents of the latter approach have renounced possession of nuclear weapons and pursue a policy of non-alignment or neutrality. In that context, they advocate alternative methods for strengthening international peace and security.

The discussions of international security in the nuclear era have, generally speaking, focused on four specific aspects of the issue: (a) quantitative and qualitative developments of nuclear weapons by the nuclear-weapon States; (b) possible acquisition of nuclear weapons by additional States; (c) geographical spread of the deployment of nuclear weapons; and (d) the prevention of accidental use of nuclear weapons.

The two major Powers have long acquired the potential of inflicting unacceptable levels of destruction on each other. Their main concern since has been whether one side might acquire the potential to deny the other side the capability for a disarming first-strike. This concern has been responsible in large measure for the fuelling of the nuclear arms competition.

The position of the United Kingdom and France is that they could participate in negotiations on their nuclear weapons only if the overall threat to their national security was significantly reduced and, in particular, if the disparity between the nuclear arsenals of the two principal nuclear Powers and their respective arsenals was substantially reduced. They believe, furthermore, that negotiations on nuclear weapons could not be conducted without taking into consideration the threat of chemical weapons and conventional armaments.

China holds the view that the two major nuclear Powers should take the lead in halting the testing, qualitative development, production and deployment of all types of nuclear weapons and in drastically reducing and eliminating them. After that, a broadly representative international conference on nuclear disarmament, with the participation of all nuclear States, could be held to examine steps and measures for the complete elimination of all nuclear weapons.

Under the terms of the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), non-nuclear-weapon States parties agree to apply safeguards administered by the International Atomic Energy Agency (IAEA) to all their peaceful nuclear activities in order to ensure that fissionable material is not diverted to nuclear explosive purposes. The Treaties of Tlatelolco and Rarotonga, respectively, also provide for IAEA safeguards.

International consensus exists that, although measures are necessary to prevent the proliferation of nuclear weapons, all States have the right to develop nuclear energy for peaceful purposes. However, some States are concerned that the conditions governing access to nuclear technology, equipment, material and services do not sufficiently recognize the fact that national security and development may depend on secure access to energy resources. As regards specifically the question of the acquisition of nuclear weapons by additional States, concerns have been expressed, on different occasions and in various contexts, that some non-nuclear-weapon States might develop nuclear-weapon programmes. Among the countries which have been the subject of

international concern in this regard are India, Israel, Pakistan and South Africa. In 1974 India announced that it had carried out a peaceful nuclear explosion; it is the only non-nuclear-weapon State to have done so.

In April 1987, Canada, France, the Federal Republic of Germany, Italy, Japan, the United Kingdom and the United States adopted a regime of parallel export controls designed to counter the proliferation of ballistic missiles or unmanned systems (such as cruise missiles) which provide the most dependable means of delivering nuclear weapons. This regime, entitled the Missile Technology Control Regime (MTCR), also controls export of various missile technologies such as guidance devices, individual rocket stages and re-entry vehicles.

At any given time there are a number of nuclear weapons present in the areas beyond the national territory of the nuclear-weapon States themselves. Some aspects of this geographical spread of nuclear weapons have been the subject of continuing discussions. For example, the majority of non-nuclear-weapon States do not permit the deployment of nuclear weapons on their territory. For many of these States, this policy also applies to nuclear weapons on board ships and aircraft on visits to their territory. Generally speaking, the nuclear-weapon States emphasize their rights under international law to free navigation of the high seas for their naval vessels, including those which may be carrying nuclear weapons, in accordance with the United Nations Convention on the Law of the Sea. A majority of the nuclear-weapon States maintain a

policy of neither confirming nor denying the presence of nuclear weapons on board their ships and aircraft in any particular place at any particular time.

Since the early days of nuclear weapons, nuclear-weapon States have been interested in avoiding any unauthorized or accidental use of nuclear weapons. These efforts have been successful in the sense that no accidental or unauthorized nuclear-weapon explosion has occurred during the several decades in which up to 60,000 nuclear weapons have been handled. While nuclear weapons have been involved in a number of accidents, none of them has ever exploded. Further protective measures are needed.

Nuclear arms limitation and disarmament

Arms limitation and disarmament efforts have been pursued both within and outside the United Nations framework. The United States and the Soviet Union have considered a number of measures bilaterally, particularly those dealing with the limitations of their strategic arms and the elimination of their intermediate/medium-range nuclear missiles (INF). Many other efforts have been undertaken in the regional as well as global context concerning measures aimed at the limitation, reduction and elimination of nuclear weapons and their delivery systems, as well as the prevention of the proliferation of nuclear weapons, cessation of nuclear-weapon tests, and the establishment of nuclear-weapon-free zones in various regions of the world. Over the years, a number of agreements have been reached dealing with various aspects of nuclear weapons.

The study details the Treaty on the Non-Proliferation of Nuclear Weapons, the Treaty of Rarotonga, the Treaty of Tlatelolco, various proposals on establishing nuclear-weapon-free zones, the Antarctic Treaty, the outer space Treaty, the sea-bed Treaty, the INF Treaty, the Strategic Arms Reduction Talks, and the Strategic Arms Limitation Talks.

The study also examines limitations on testing of nuclear explosive devices, constraints on the use of nuclear weapons, security assurances to non-nuclear-weapon States, confidence-building measures, and nuclear weapons and international law.

Conclusions

Nuclear weapons represent a historically new form of weaponry with unparalleled destructive potential. A single large nuclear weapon could release explosive power comparable to all the energy released from the conventional weapons used in all past wars.

Only two nuclear weapons have ever been used in a war. Today, there are about 50,000 nuclear warheads in the possession of the nuclear-weapon States. The quantitative growth of the nuclear-weapon arsenals has, however, been stopped. The number of nuclear warheads is now declining.

In recent years, there has been a marked improvement in the overall international political climate and in relations between a number of States in various

regions of the world. The most far-reaching changes have taken place in Europe, a continent where the two major nuclear Powers and their military alliances have confronted each other for decades. New political patterns are emerging there, whereby long-standing differences are being resolved and the cold war is ending. Although tensions remain in some other regions, several fierce armed conflicts have been brought to an end and the process of peacefully resolving some other conflicts has been initiated. The United Nations has played an important role in the process of conflict-resolution and peace-keeping and thereby made a tangible contribution to the maintenance of international peace and security, one of its main objectives.

These positive developments in the world, in particular the *rapprochement* between East and West, have given strong impetus to arms limitation and disarmament efforts, especially in Europe.

The most tangible results thus far have been achieved in the bilateral negotiations between the United States and the Soviet Union. In December 1987, the Soviet Union and the United States concluded the first agreement in history – the INF Treaty – which provides for the destruction of a whole category of nuclear missiles, and as such represents a major breakthrough in the disarmament process. In terms of quantitative reductions of strategic nuclear weapons, significant progress has been made in bilateral START negotiations between the United States and the Soviet Union. The framework of an agreement signed at Washington in June 1990 at the summit meeting between President Bush and President Gorbachev provides for a drastic cut in various

categories of their strategic offensive arms. Their agreement to continue negotiations on further cuts and effective limitations on qualitative improvements in both strategic and tactical nuclear weapons is most important.

The United States and the Soviet Union have stated that reducing the risk of outbreak of nuclear war is the responsibility not only of the United States and the Soviet Union, but that other States should also make their contribution towards the attainment of this objective.

East and West are expected to reach an agreement on significant reductions of conventional forces in Europe that would facilitate additional cuts of other nuclear weapons stationed in Europe. In addition, several countries in both East and West – including the Soviet Union and the United States – are now unilaterally taking steps to reduce and to restructure their military forces.

Notwithstanding the bilateral agreements between the United States and the Soviet Union concerning nuclear weapons, their nuclear stockpiles will continue to be far in excess of those of the other nuclear-weapon States for the foreseeable future.

Qualitative improvements of nuclear weapons have continued. Nuclear tests are still carried out, though at a reduced rate. The production of fissionable material for weapons purposes has been reduced.

Most countries in the world consider that an early end to nuclear testing by all States in all environments would be an essential step towards preventing the qualitative

improvement and the development of new nuclear weapons and would also contribute to the goal of non-proliferation. Most nuclear-weapon States consider that their reliance on nuclear weapons for their security requires their continued testing and do not agree that a comprehensive test ban is an urgent necessity.

The United States and the Soviet Union have agreed to continue to cooperate in the field of monitoring nuclear-weapon tests. Multilateral and bilateral efforts to perfect verification methods for a comprehensive nuclear-test ban are important for achieving the ultimate complete cessation of such tests.

In the 1980s, the deployment of nuclear weapons at sea also became the subject of growing attention of many States. About 30 per cent of nuclear weapons are earmarked for maritime deployment. Sea-borne strategic nuclear weapons are subject to bilateral negotiations between the United States and the Soviet Union. This is not yet the case with regard to non-strategic sea-based nuclear weapons intended for targets at sea and on land.

Another feature of the 1980s has been the preoccupation of many non-nuclear-weapon States with the question of legal restraints on nuclear weapons, particularly as regards their non-use. Considering that, since 1945, no single nuclear weapon has actually been used, they believe that the de facto non-use of nuclear weapons might eventually serve as the basis for establishing a customary norm on the non-use of nuclear weapons. They believe that the different approaches to international customary

and treaty law that relate to this matter deserve further consideration. Some nuclear-weapon States do not agree with this assessment.

There is a manifest conviction of the entire international community that a major nuclear war would have catastrophic consequences for the whole world. During the last decade, the nuclear Powers have clearly stated their determination to avoid any nuclear conflict. This was most convincingly expressed both in the 1985 solemn declaration by former President Reagan and President Gorbachev that "a nuclear war cannot be won and must never be fought" and in the statement by President Mitterrand that "nuclear weapons are weapons of non-use".

The Heads of State and Government of the North Atlantic Alliance confirmed on 6 July 1990 that they would "never in any circumstance be the first to use force", and announced that in a transformed Europe the Allies concerned would be able to adopt a new strategy making nuclear forces truly weapons of last resort.

In the last decade, the findings of several scientific studies about the possible effects of nuclear war, including the climatic effects subsumed in the concept of "nuclear winter", have added a new dimension to the discussion of the global consequences of nuclear war. These studies, *inter alia*, suggested that a nuclear war might cause more casualties than previously thought in countries other than those immediately involved.

The Chernobyl reactor accident in 1986, though not comparable to a nuclear detonation because it was only the source of radioactive debris and did not have the

other effects peculiar to a nuclear explosion, provided a concrete demonstration of the magnitude of the consequences of even a relatively limited release of radioactive matter.

During the 1980s, the question of the contamination of the environment in connection with military and civilian nuclear activities, and the effects of such contamination, received increased public attention. In this regard, the work being done by the relevant national and international organizations is valuable in helping to understand the impact of these activities on health and the environment.

The momentous changes in the world, particularly in the East-West relationship, have diminished the threat of nuclear confrontation and made it possible to start a real process of reduction of nuclear weapons. The United States and the Soviet Union are engaged in far-reaching bilateral negotiations, which they have agreed should ultimately lead to the complete elimination of nuclear arms everywhere. Other nuclear-weapon Powers have stated that they would be willing to take part in the process of nuclear disarmament at an appropriate stage. Moreover, as recently reiterated by the Disarmament Commission, all States have the right and the duty to be concerned with and to contribute to efforts in the field of disarmament.

However, differences remain between States concerning mainly the timing and procedures for nuclear disarmament measures, on the one hand, and the existence and scope of international norms regarding nuclear weapons, on the other.

The nuclear non-proliferation regime is as important as ever. Its strict observance is of continued fundamental importance. Concern about nuclear proliferation remains acute, particularly in the light of technological developments that could make the acquisition of nuclear weapons by additional States easier, and in the light of the uncertainties surrounding the policies of some States, including some involved in regional rivalries and tensions.

Further efforts are necessary to prevent the acquisition or manufacture of nuclear weapons by additional States, to strengthen the international non-proliferation regime and to achieve wider participation in it. The regime would also be strengthened if NPT parties that have not already done so concluded the requisite safeguard agreements with IAEA.

The right of States to develop nuclear technology for economic benefit must be reconciled with the need to ensure against the further spread of nuclear weapons. Prior to any transfer of fissionable materials, nuclear equipment or know-how, acceptance of appropriate IAEA safeguards is an especially important part of the agreement between supplier and recipient.

To achieve the objectives of non-proliferation of nuclear weapons, global and regional efforts are needed, including those aimed at further strengthening the non-proliferation regime in all its aspects.

International security is now being perceived on the basis that reliance on military strength for national security will be increasingly supplemented by policies of confidence-building and wide cooperation in various fields, and negotiation and dialogue with the view to strengthening the security of all.

Decision of the General Assembly, 1990

On 4 December 1990, the General Assembly adopted without a vote resolution 45/58 E, in which it commended the study and its conclusions to the attention of all Member States. In accordance with one of the provisions of the resolution, the Secretary-General arranged for the reproduction and distribution of the study.

Acronyms

ABM	anti-ballistic missile
ACM	advanced cruise missiles
ALCM	air-launched cruise missile
ASW	anti-submarine warfare
BMD	ballistic missile defence
GLCM	ground-launched cruise missile
IAEA	International Atomic Energy Agency
ICBM	intercontinental ballistic missile
INF Treaty	Treaty between the United States of America and the Union of Soviet Socialist Republics on the Elimination of Their Intermediate-Range and Shorter-Range Missiles
MARV	manoeuvrable re-entry vehicle
MIRV	multiple independently targetable re-entry vehicle
MTCR	Missile Technology Control Regime
NPT	Treaty on the Non-Proliferation of Nuclear Weapons

PTBT	partial test-ban Treaty (Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and under Water)
SALT	Strategic Arms Limitation Talks
SDI	Strategic Defense Initiative
SAM	surface-to-air missile
SLBM	submarine-launched ballistic missile
SLCM	sea-launched cruise missile
SSB	submarine, ballistic missile equipped
SSBN	nuclear-powered, ballistic missile submarine
SSM	surface-to-surface missile
START	Strategic Arms Reduction Talks

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