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PROGRAMME FOR PROMOTING NUCLEAR NON-PROLIFERATION

Briefing Book

Volume I:
The Evolution of the Nuclear Non-Proliferation Regime
(Fourth Edition)

By Emily Bailey, Richard Guthrie, Darryl Howlett and John Simpson

PPNN BRIEFING BOOK — Volume I: The Evolution of the Nuclear Non-Proliferation Regime (Fourth Edition)

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Preface

This is the fourth edition of *PPNN Briefing Book (Volume I)*. The first edition was originally produced for delegates attending the 1990 NPT Review Conference, the second for those attending the 1995 NPT Review and Extension Conference and the third for those attending the 1997 session of the Preparatory Committee of the 2000 NPT Review Conference. Both this Volume and a new Volume II (which consists of key non-proliferation treaties, agreements and other relevant documentation) are presented in a format designed to facilitate their use as reference materials for delegates attending the 1998 Preparatory Committee meeting for the 2000 NPT Review Conference which will be held in Geneva from 27 April to 8 May.

The authors thank Ben Cole, Sarah Hamiduddin, Mustafa Kibaroglu, Stefan Klement and Deborah Ozga for assisting in the preparation of this volume.

It is hoped that both volumes will assist the work of the 1998 Preparatory Committee meeting and contribute to its success.

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The Programme for Promoting Nuclear Non-Proliferation

The Programme for Promoting Nuclear Non-Proliferation [PPNN] is an international networking venture devoted to supporting and reinforcing the nuclear non-proliferation regime and the Treaty on the Non-Proliferation of Nuclear Weapons [NPT].

It was initiated in 1987 through a conviction that the world community did not adequately recognise the dangers of nuclear proliferation or fully support the means of preventing it, notably the NPT. As a consequence, PPNN has attempted to encourage dialogues on these issues between officials and others on both a regional and global basis, as well as disseminating information and analyses about the regime and the problems that confront it. The wide political, functional and geographical representation of its Core Group has resulted in this being done in as objective a manner as possible.

PPNN's activities are underpinned by the conviction that nuclear non-proliferation is an important international objective in its own right. This in turn rests on two assumptions:

- that the risk of a nuclear war or accident will persist as long as there are nuclear weapons; and that all possible steps should be explored to move closer to a world free of nuclear weapons; and
- that nuclear proliferation encompasses a wide range of political, economic and security issues, which must be fully understood and addressed before effective policies can be designed and implemented to prevent it.

This leads to the further beliefs that:

- a strong global nuclear non-proliferation regime is a basic requirement to achieve these objectives;
- that the NPT's legal commitments and obligations are at the heart of that regime and indispensable to it;
- that even the recent relatively modest progress towards reducing nuclear armaments would have been unlikely in the absence of this unique global non-proliferation and disarmament instrument, both because of the assurances it offers the nuclear-weapon states and the forum its review process, and in particular its strengthened review process, provide for pressures upon them; and
- that the non-proliferation and disarmament regime would be undermined, and eventually collapse, without the continued existence of the Treaty.

Nothing more effective than the NPT appears achievable in the immediate future. The NPT was extended indefinitely at the 1995 NPT Review and Extension Conference. The decision was taken in conjunction with decisions on *Principles and Objectives for Nuclear Non-Proliferation and Disarmament* and *Strengthening the Review Process*, and a resolution calling for a zone free of nuclear weapons and other weapons of mass destruction in the Middle-East and for universal membership of the NPT.

The extension has confirmed the Treaty's position as an indispensable element of the international non-proliferation system. However, if the NPT is to remain the main legal instrument against non-proliferation and the cornerstone of the nuclear non-proliferation regime, the decisions taken at the 1995 NPT Conference will have to be respected and implemented effectively. This means making progress towards the ultimate goal of those decisions: the total elimination of nuclear weapons.

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Chapter 1
Evolution of the Nuclear Non-Proliferation Regime 1945–1970

Introduction

The measures put in place to deter the spread of nuclear weapons, more commonly known as the nuclear non-proliferation regime, comprise an integrated network of unilateral, bilateral, regional and multilateral treaties and other standard-setting arrangements. Collectively, these measures provide a comprehensive framework for the behaviour of states, international organizations and other actors in the nuclear area. These measures constitute a global regime which has been evolving since the end of the Second World War.

Early proposals for control of nuclear energy

In January 1946, the United Nations (UN) General Assembly passed a resolution which established the UN Atomic Energy Commission (UNAEC). The remit of the UNAEC was to make proposals for the elimination of nuclear weapons and the use of nuclear energy for peaceful purposes under international control. On 14 June 1946 the United States submitted the so-called Baruch Plan to meet the Commission's objectives. The Plan proposed the following arrangements:

- international managerial control or ownership of all potentially dangerous activities;
- an international organization which would have the power to control, license, and inspect all other atomic energy activities;
- an international organization which would have the duty of fostering the beneficial uses of atomic energy; and
- an organization which would perform research and development tasks in order to keep it in the technical vanguard of atomic energy, so as to enable it to recognize misuse of atomic energy.

The Baruch Plan was never implemented, due to radical differences between the United States and the Soviet Union over how to proceed. During discussion of the Plan, the United States moved to introduce unilateral legislation aimed at maintaining its monopoly over 'the use of atomic energy for the national defense'. The McMahon or Atomic Energy Act was passed on 1 August 1946. This Act established the United States Atomic Energy Commission (USAEC) as the sole owner of all fissionable materials and facilities in the United States and prohibited all exchanges of nuclear information with other states.

The issue of international atomic energy control was revisited following President Eisenhower's 'Atoms for Peace' speech on 8 December 1953. It was stressed that the new proposal was not a disarmament plan, but a bold initiative to open the benefits of atomic energy to the world community. The main features of Eisenhower's proposals were to:

- encourage a global study of the most beneficial uses of atomic energy for peaceful purposes;
- foster the view that the spread of nuclear weapons could be contained more appropriately by international cooperation in the peaceful uses of atomic energy under an international safeguards system; and
- reduce the destructive capacity of the existing nuclear weapon stockpiles and promote positive dialogue on the central issues confronting humankind.

'Atoms for Peace' had both a bilateral and a multilateral dimension. Between 1954 and 1962, when 'Atoms for Peace' was officially terminated, the United States initiated several bilateral technical assistance programmes involving research reactors, nuclear fuels and equipment. International negotiation on implementing the 'Atoms for Peace' proposal began formally after the 9th UN General Assembly, once the United States had allayed the Soviet Union's concerns about the level of international control envisaged over national nuclear installations. These negotiations culminated in a Conference on the Statute of the International Atomic Energy Agency (IAEA), the name given to the new international organization, held at UN Headquarters in New York during September–October 1956. Following agreement at this Conference on the IAEA Statute, the Agency was established on 29 July 1957.

The IAEA, EURATOM and nuclear safeguards

The IAEA turned out to be a different organization to the one envisaged in the Baruch Plan or by President Eisenhower in his 1953 speech. From the outset, the IAEA was unable to fulfil the role of reducing the stockpiles

of fissile material in the three then-existing nuclear-weapon states (the Soviet Union, United Kingdom and United States). Neither did membership of the IAEA place any obligation on a state to: refrain from making nuclear weapons (as France did in 1960) or exploding a nuclear device (as India did in 1974); accept safeguards on its own nuclear activities; or, require that safeguards be applied to its nuclear exports.

Until the mid-1960s, opposition from the Soviet Union and India prevented the IAEA from implementing a comprehensive safeguards system on a global scale. Moreover, early hopes that nuclear power would be utilized in abundance and create a large-scale demand for fissile material were disappointed. Consequently, there was little demand for the IAEA's services as a supplier of nuclear fuel. The decision by the United States to supply plant and fuel to Western Europe under European Atomic Energy Community (EURATOM) safeguards also kept the IAEA out of the only region of the world, outside the United States, where nuclear energy was destined to play a significant role. However, in 1959 the IAEA did begin applying *ad hoc* safeguards to natural uranium that Canada supplied to a research reactor in Japan.

It was not until 1961, when INFCIRC/26 was agreed, that the Agency formally began implementing a safeguards system. INFCIRC/26 was the IAEA's initial safeguards document and provided the organization with its first uniform safeguards procedures, which were applicable only to reactors with less than 100 megawatts thermal output (MW[th]). In 1964 this document was revised to include reactors over this limit.

On 1 January 1958, Western Europe also established a regional nuclear organization within the framework of the European Communities (EC). EURATOM has since had the task of co-ordinating nuclear energy development within the EC and implementing a regional safeguards system to ensure that nuclear materials are not diverted 'to purposes other than for those which they are intended'. The EURATOM safeguards system covers all civilian nuclear energy activities in the Member States of the EC (now European Union [EU]), including those of France and the United Kingdom. The military programmes of the latter states are excluded from EURATOM safeguards coverage, however.

The move to internationalise atomic energy, and promote it for peaceful use, also affected United States' domestic legislation. In August 1954 the United States passed another Atomic Energy Act which paved the way for the USAEC to negotiate bilateral cooperation agreements to encourage the global dissemination of atomic energy for peaceful purposes under effective safeguards.

In 1958, the United States amended the 1954 legislation to allow the transfer of information related to United States' nuclear weapons to enable their delivery by allies within the North Atlantic Treaty Organization (NATO) in time of war. The Act also stipulated that more detailed transfer of information and technology relating to these weapons would be made available to those allies which had already made 'substantial progress in the development of atomic weapons'. Only one agreement was signed at first as a result of this latter provision, the 1958 Military Agreement for Cooperation between the United States and the United Kingdom, an agreement with France following much later.

As the IAEA's new safeguards system evolved during the early 1960s, the United States began transferring to the IAEA its bilateral safeguards responsibilities for nuclear plant and materials it had supplied to other states. The IAEA also gained new status during this period as a result of an increase in the demand for nuclear power and as orders for new reactors increased.

Fissile material cut-off and nuclear testing prohibitions

The idea of a fissile material cut-off was first discussed in international forums in late 1953, albeit camouflaged as President Eisenhower's 'Atoms for Peace' plan. At this time a main concern of the United States was that the Soviet Union would soon possess sufficient fissile material, and thus numbers of nuclear bombs, to have a capability of delivering a surprise 'knock-out blow' on United States' military forces before they had time to mobilise. One obvious way of slowing down the Soviet Union's capacity for this action was to constrain the amount of fissile material it had available for military explosive purposes. A key element of Eisenhower's speech was, therefore, a proposal that both the Soviet Union and the United States should transfer significant quantities of fissile material to the proposed IAEA for use in peaceful applications of atomic energy. This would have the consequence of reducing the fissile material available to the Soviet Union for military use.

This proposal was only implemented in a very limited form. It was replaced from 1956 onwards by a series of more overt United States' proposals for a total halt in the production of fissile materials for military purposes.

These were seen as part of a package of measures to freeze, and ultimately reverse, the 'nuclear arms race'. The idea was to start with a Comprehensive Test Ban Treaty (CTBT) and a fissile-material cut-off, to follow this by measures to halt the production of additional nuclear weapons, and finally to initiate a phased dismantling of national stockpiles. Given the United States' superiority in the number of weapons and in the size of its stockpile of fissile materials at this time, the proposals were greeted with little enthusiasm by the Soviet Union.

From 1958 onwards the issue of a fissile-material cut-off was relegated to a secondary position as attention focused on negotiating a CTBT. This latter measure was viewed as a means for both halting the development of more powerful atomic and thermonuclear weapons and stopping the pollution caused by radioactive fallout from atmospheric testing.

The negotiations on a CTBT occurred in the context of a Soviet Union–United Kingdom–United States moratorium on nuclear testing from 1958 to 1961, and against a backdrop of calls for these three nuclear-weapon states, the only ones in existence at this time, to engage in nuclear disarmament.

These CTBT negotiations did not result in an agreement. The primary barrier throughout the negotiations was how to verify compliance. There was a failure to agree a system of inspections and controls that could provide adequate assurance of detection of violation, especially through underground testing.

In 1963 the Soviet Union, United Kingdom and United States did agree the Partial Test Ban Treaty (PTBT) — also known as the Limited Test Ban Treaty (LTBT) — which prohibited nuclear testing in the atmosphere, in outer space and underwater. This meant that future testing by those states which signed the PTBT had to be conducted underground. The only prohibition on underground testing contained in the Treaty was in circumstances where a nuclear explosion caused 'radioactive debris to be present outside the territorial limits of the State under whose jurisdiction or control' the test was conducted.

By the time the PTBT was opened for signature in 1963, the potential significance of a fissile-material cut-off had been reduced further. The measure was no longer regarded as a means of constraining the Soviet Union–United States nuclear arms race. However, since 1964 several developments have occurred favourable to the negotiation of a fissile-material cut-off. The first has been the creation of both the IAEA and EURATOM nuclear safeguarding systems. In the case of EURATOM, all fissile materials in the member states are theoretically owned collectively. However, as noted earlier, the two nuclear-weapon states in the EU, France and the United Kingdom, have a right to hold back military materials from EURATOM safeguards. In the case of the IAEA, the desire to have 'equality of misery' in the safeguarding of civil nuclear facilities led the nuclear-weapon states to make voluntary offers to the IAEA to place some of their civil facilities under safeguards. This has resulted in the IAEA applying safeguards to some reactors, enrichment and reprocessing plants in these states. In addition, the experience of the implementation of IAEA safeguards to reactors and other fuel cycle facilities has provided convincing evidence that clandestine diversion of significant quantities of fissile materials from safeguarded facilities is very difficult, if not impossible.

Nuclear-weapon-free zones (NWFZ) and measures of restraint in specific environments

Several measures to prevent the nuclearization of specific environments and geographical areas were developed in the period up to 1970. The first was the Antarctic Treaty of 1959, which, among other things, included provisions for banning all nuclear explosions and the disposal of radioactive waste in the Antarctic. This Treaty served as a model for later measures because it sought to limit the spread of nuclear weapons by preventing their introduction into specific areas (a 'non-armament' provision).

The first NWFZ covering a populated geographic region was created by the Treaty for the Prohibition of Nuclear Weapons in Latin America (the Tlatelolco Treaty), which was opened for signature in 1967. Article I of this Treaty obliges its parties to use all nuclear materials and facilities on their territories exclusively for peaceful purposes and to prevent:

> (a) The testing, use, manufacture, production or acquisition by any means whatsoever of any nuclear weapons, by the Parties themselves, directly or indirectly, on behalf of anyone else or in any other way, and
> (b) The receipt, storage, installation, deployment and any form of possession of any nuclear weapons ...

The Tlatelolco Treaty also has two Additional Protocols for signature by non-Latin American states. Protocol I contains provisions for those which have territories in the geographical remit of the zone. Protocol II involves undertakings by those states which possess nuclear weapons.

The original verification provisions of the Treaty involved the establishment of a regional organization to ensure compliance, the Agency for the Prohibition of Nuclear Weapons in Latin America (called OPANAL after the acronym of its title in Spanish). OPANAL was granted the right to conduct special inspections in the zone, while the Treaty also obliged its parties to negotiate safeguards agreements with the IAEA to ensure peaceful use of nuclear energy within their territories.

In 1967 the Outer Space Treaty was signed. This contains an explicit prohibition obliging its signatories 'not to place in orbit around the Earth, install on the moon or any other celestial body, or otherwise station in outer space nuclear weapons or any other weapons of mass destruction' (Article IV).

Negotiation of the Treaty on the Non-Proliferation of Nuclear Weapons (NPT)

Between 1958 and 1961, Ireland sought to draw attention within the UN to the dangers posed by additional states acquiring nuclear weapons. As a consequence, in 1961, the UN General Assembly adopted what became known as the 'Irish Resolution'. This called for measures to limit the spread of nuclear weapons to additional countries and for all states to refrain from transfer or acquisition of such weapons.

Negotiation of the text of the NPT was conducted via three distinct channels of communication. The first, and most important, channel involved the Soviet Union and the United States in direct bilateral contacts. The second involved multilateral negotiation on the actual text of the NPT in the Eighteen-Nation Disarmament Committee (ENDC) in Geneva. The third involved the United States and its NATO allies, who were concerned about the implications of such a treaty for consultations on, and planning of, nuclear defence within the Alliance.

Three concerns permeated these negotiations. The first was how to manage the proliferation potential inherent in the increasing global numbers of large-scale nuclear power plants. The second was how to deal with the issue of the transfer of nuclear devices from nuclear-weapon states to their allies, an issue raised by the United States proposal for a NATO Multilateral Nuclear Force (MLF). The MLF concept envisaged a multinational nuclear force of surface vessels or missile-capable submarines within a NATO command structure which would be distinct from European national nuclear forces. Finally, the provision of adequate verification of the prospective treaty had to be addressed. To the extent that particular states were the focus of discussion, it was industrialized states, such as Germany and Japan, which dominated attention, rather than any states in the developing world.

A breakthrough in the conceptualization of a non-proliferation treaty came as a result of resolution 2028 adopted by the UN General Assembly in 1965. This resolution incorporated five principles for such a treaty:

- the Treaty should be void of any loop-holes which might permit nuclear or non-nuclear powers to proliferate nuclear weapons in any form;
- the Treaty should embody an acceptable balance regarding the mutual responsibilities and obligations of the nuclear and non-nuclear powers;
- the Treaty should be a step towards the achievement of General and Complete Disarmament and, more particularly, nuclear disarmament;
- there should be acceptable and workable provisions to ensure the effectiveness of the Treaty; and
- nothing in the Treaty should adversely affect the right of any group of states to conclude nuclear-weapon-free zone treaties.

Although this resolution provided a conceptual basis for a non-proliferation treaty, agreement on an actual text proved elusive. In the Autumn of 1966, the Soviet Union and the United States began bilateral discussions in an attempt to resolve the outstanding issue of the MLF. Language was eventually agreed early in 1967 which effectively foreclosed on the option of multilateral nuclear sharing within NATO.

Debate within the ENDC throughout 1967 focused on the issue of adequate verification of the proposed treaty. The Soviet Union was concerned that the EURATOM safeguards system would not provide adequate assurance that states in Western Europe would uphold their non-proliferation obligations. Instead, the Soviet Union wanted the IAEA to assume full responsibility for safeguards in the region. Wording was eventually agreed in early 1968 for a specific paragraph in Article III of the draft treaty acknowledging EURATOM's safeguards role under the NPT:

> Non-nuclear-weapon States Party to the Treaty shall conclude agreements with the International Atomic Energy Agency to meet the requirements of this Article either *individually or together with other states* [meaning EURATOM, emphasis added] ...

On 11 March 1968 the Soviet Union and the United States presented a joint draft treaty to the ENDC and, following amendments, this was endorsed by the UN General Assembly on 12 June 1968. The NPT was opened for signature on 1 July 1968, and signed on that date by the three depositary states of the Treaty — the Soviet Union, United Kingdom and United States — and 59 other states. The Treaty entered into force on 5 March 1970.

Security Assurances

During negotiation of the NPT, a major debate occurred over the linkage between nuclear security assurances and nuclear non-proliferation. The non-nuclear-weapon states raised two concerns related to this linkage. The first was that if states were to forgo the nuclear-weapon option by signing the NPT, would alternative arrangements be made available to ensure their security? The alternatives discussed at the time were positive assurances of assistance from nuclear-weapon states in the event of nuclear threats and negative assurances from the nuclear-weapon states that they would not use their capabilities against non-nuclear-weapon states. Although demands were made to include assurances of both kinds in the NPT text, these demands were rejected. However, the negotiating parties did agree to include a statement in the last preambular paragraph of the NPT which recalls that, in accordance with the UN Charter, 'States must refrain in their international relations from the threat of the use of force against the territorial integrity or political independence of any State'.

The second concern of the non-nuclear-weapon states was that while allies of the Soviet Union and the United States were covered by nuclear guarantees from the latter states as part of their alliance relationships, states in the non-aligned world had no such security guarantees. These concerns manifested themselves in a desire on the part of the non-aligned states for global nuclear assurances, especially negative ones. This was because they feared that the existing nuclear-weapon states would use nuclear weapons on their territories.

There were other complications which made negotiating any security assurances difficult at this time. Many non-aligned states were concerned that their non-alignment would be compromised unless the security assurances were provided by all the nuclear-weapon states through a neutral body such as the UN, rather than on a bilateral basis. Moreover, because not all the non-nuclear-weapon states were going to become parties to the NPT, debate focused on whether the assurances should be reserved for those that were going to sign to encourage those outside to join, or whether all non-nuclear-weapon states should be offered assurances because, as some states claimed, the use of nuclear weapons contravened the 'spirit' of the UN Charter.

To allay the concerns of the non-nuclear weapon states, the three nuclear-weapon states parties to the Treaty, sought a solution outside the NPT. These efforts culminated on 19 June 1968 with UN Security Council resolution 255. This resolution contains positive security assurances committing the Security Council and 'above all its nuclear-weapon State permanent members, ... to act immediately in accordance with their obligations under the United Nations Charter' in the event of a nuclear attack against a non-nuclear-weapon state.

Conclusion

By the time the NPT entered into force on 5 March 1970, the basis of a nuclear non-proliferation regime already existed. It was the entry into force of the NPT, however, which provided the regime with a central international legal foundation upon which further elements could be built. While the nuclear non-proliferation regime might still have evolved further after 1970 without the NPT, it is unlikely that it would have embodied as much international recognition and legal force as it currently displays.

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Chapter 2
Nuclear Energy and Nuclear Weapons: An Introductory Guide

Nuclear Materials

A chemical element consists of basic building blocks, called atoms, which themselves contain 'sub-atomic' particles. These particles are of three types: protons, neutrons and electrons. Protons (positively charged particles), together with neutrons (uncharged particles) make up an atom's core or nucleus. Electrons (negatively charged particles) are identical in number to the protons, but are found outside of the nucleus of the atom. All chemical elements are defined and distinguished from each other by the number of protons/electrons their atoms contain, termed their atomic number. Examples of atomic numbers are 1 for an atom of hydrogen and 93 for an atom of plutonium.

While all atoms of an element must have the same number of protons/electrons, they may contain differing numbers of neutrons. These variants are called isotopes of an element. They have different nuclear properties and masses/weights but their chemical properties are identical: thus they can only be separated by making use of their differing masses, and not by chemical means.

Isotopes are normally identified by the sum of their protons and neutrons. Thus 'Uranium 235', often shortened to the notation 'U^{235}' (or 'U-235') indicates the isotope of uranium that contains 235 (92+143) protons and neutrons in the nucleus of each atom. 'Plutonium 239', or 'Pu^{239}' (or 'Pu-239') indicates the isotope of plutonium that contains 239 (93+146) protons and neutrons in the nucleus of each atom.

Nuclear Reactions

Fission

Nuclear fission is the splitting of the nucleus of an atom into two or more parts. This is a process which normally only occurs when heavy elements such as uranium and plutonium are bombarded by neutrons under favourable conditions. Not all isotopes of these elements fission under such circumstances; those that do are called fissile materials. The most frequently used fissile materials are the isotopes Uranium 235 (U-235) and Plutonium 239 (Pu-239).

These isotopes are not found in their pure form in nature. U-235 forms only 0.7 per cent of natural uranium ore which is mostly made up of non-fissile U-238. Plutonium does not exist at all in natural form and has to be manufactured from uranium. This is done by placing it inside a reactor, where some U-238 nuclei will capture slow moving neutrons to form fissile Pu-239.

When a fissile material is bombarded with neutrons, it splits into atoms of lighter elements. This process releases large quantities of energy and neutrons. If these neutrons hit and split additional 'fissile' nuclei, more neutrons are released to continue the reaction. If there is a sufficient concentration of atoms of fissile isotopes, known as a 'critical mass', this reaction will be self-sustaining. This is a 'chain reaction'.

A critical mass is the smallest amount of material required for a chain reaction. This may be affected by variables such as the concentration of the fissile isotopes in the material; its density — if it is compressed the critical mass is reduced; and its physical configuration — a sphere or some other shape.

Fusion

Fusion takes place when two nuclei of light elements such as hydrogen fuse together to make a heavier one. While this process releases much larger quantities of energy than the fission process, it also requires large amounts of energy to initiate it. For fusion to occur, the repellant forces that arise between the positively charged protons in the two nuclei have to be overcome, and temperatures of over 100 million degrees centigrade are normally required for this to occur. The most frequently used materials to generate fusion reactions are tritium (H-3), deuterium (H-2) and the solid Lithium-6 Deuteride, which when heated to the temperature of the fusion reaction, breaks down into tritium and deuterium.

Nuclear Reactors

Fission Reactors

There are several features common to all fission or (as they are more usually termed) nuclear reactors.

The first of these is that they contain a core or mass of fissile material (the fuel) which may weigh tens of tons, within which energy is produced by sustaining a regulated chain reaction. The fissile material used varies between reactor types, but it may be natural uranium (which contains 0.7 per cent fissile U-235) or uranium which has been enriched to increase the percentage of U-235 to around 3 per cent. Alternatively, plutonium 239 produced by the irradiation of U-238 in a reactor, or uranium 233 (U-233) produced from thorium 232 (Th-232) may be used, or a combination of these mixed with uranium (mixed oxide fuels or MOX). This fuel is usually in rod or pin form, and is clad in a gastight containment material such as stainless steel.

A second related feature is the presence of a means of regulating the chain reaction. This normally takes the form of control rods which absorb neutrons, and which can be inserted into the core to reduce the rate of fission or to shut down the reactor.

The fissile core of a reactor is usually surrounded by a third common feature, a moderator. This material is chosen because it slows down some of the faster neutrons so that these can more easily hit nuclei and initiate fission, and thus maintain the chain reaction. The moderator can be ordinary (or light) water, heavy water (deuterium oxide) or graphite.

A fourth common feature is a means of removing the heat produced by the chain reaction from the core of the reactor. This cooling system can also provide the heat and steam to drive turbines and thus generate electricity.

Finally, there is a containment vessel which serves to shield the radioactive core from other parts of the reactor system. Lining this vessel is a reflector which increases the efficiency of the fission process. In addition, a reactor will itself normally be surrounded by a further thick containment structure, whose purpose is to contain any release of radioactivity and prevent it escaping into the surrounding environment.

Reactors have been built to serve four broad purposes. First, a significant proportion of the reactors in the world are large units designed to produce steam to drive turbo-generators, and thus to generate electricity for civil uses. Second, there are smaller units of a similar type which are used in naval vessels, especially submarines, to generate electricity for propulsion purposes or to drive turbines. Third, there are many small materials testing and research reactors, which usually have no turbo-generators attached and are used mainly for experimental purposes. Finally, there are large units used by the nuclear-weapon states to produce plutonium for military explosive purposes, some of which do not have turbo-generators attached to them.

There exist five different nuclear reactor technologies:

Light Water Reactors (LWRs)

This is the most widespread power reactor type found in the world today. It uses low enriched (3%) uranium as fuel, which enhances its efficiency as an electricity generator by enabling the fuel to stay longer in the reactor. It also uses ordinary water as both a moderator and coolant. There are two variants of this reactor, Pressurized Water Reactors (PWRs) and Boiling Water Reactors (BWRs), the chief difference between them being in their method of producing steam to make electricity. Small LWRs are also used to power submarines and other naval vessels. LWRs are a costly and inefficient way of producing Pu-239.

Heavy Water Reactors (HWRs)

In these type of reactors, heavy water is used as both the moderator and coolant. Heavy water absorbs so few neutrons that it permits the use of natural uranium as fuel. This type of reactor, the majority of which are called CANDUs, uses up so much of the fissile U-235 in its natural uranium fuel that it is probably uneconomic to reprocess and recycle it, and the preferred option is to store it and dispose of it as waste. It is also a good producer of plutonium, and this type of reactor has been used in the United States without any turbo-generators attached to produce materials for weapon purposes. To produce Pu-239, rather than to minimize electricity generation costs, fuel re-loading takes place more frequently. Thus a distinction between civil and military use is the length of time the fuel remains in the reactor.

Gas Cooled Reactors (GCRs or MAGNOX)

These are moderated with graphite and cooled with carbon dioxide gas. Most use natural uranium fuel encased in a magnesium oxide-based cladding called MAGNOX. As this corrodes if stored in water, it needs to be reprocessed for environmental and safety reasons. Its design originated in the reactors used to produce plutonium for military purposes in France, the United Kingdom and the USSR.

High Temperature Gas Cooled Reactors (HTGRs)

The HTGR is cooled with helium gas and moderated with graphite. Highly enriched uranium is used as fuel (93 per cent U-235), though this may be mixed with Th-232. The attraction of this type of reactor is that much of the uranium in the fuel is burned up, requiring infrequent reloading, and the extremely high operating temperatures enable it to be linked to very efficient, modern turbo-generators when used to produce electricity.

Liquid Metal Fast Breeder Reactors (LMFBRs)

Breeder reactors normally have a core of highly enriched uranium or plutonium, which can produce enough surplus neutrons to convert U-238 in a blanket around the core into Pu-239 at a rate faster than its own consumption of fissile material. They thus produce more fuel than they consume. They operate without a moderator, and at very high temperatures. The coolant is normally a liquid metal, such as sodium, which allows for the rapid removal of heat. These reactors have traditionally been seen as a means of utilising the plutonium produced by the other types of reactor, but are also capable of producing plutonium ideal for use in weapons.

Fusion Reactors

Although many attempts have been made to produce a working fusion reactor, these only exist in experimental form. The temperatures at which fusion is achieved are so great that no known material will hold the fusing materials. Containment of the material is being attempted using magnetic fields.

Nuclear Weapons

Fission Devices

A fission weapon or device is designed so that a critical mass of fissile material can be assembled and held together before the device blows itself apart. The yield of the weapon is determined by the amount of fissile material involved, the number of nuclei fissioned, and the number of generations of fissions that can be achieved before disassembly takes place.

A simple fission weapon design, also known as a first-generation nuclear weapon, can be of either the 'gun barrel' or 'implosion type. A gun device involves bringing together rapidly two sub-critical masses of highly enriched uranium by propelling one of them with an explosive along a thick tube or gun-barrel so that it impacts with considerable velocity upon the other. This creates conditions for a chain reaction. This method is conceptually simple but the explosive power of the weapon tends to quickly force the fissile material apart so that little of the material goes through the fission process. It is therefore relatively inefficient in its use of fissile material. This method cannot be used with plutonium.

An implosion weapon works by compressing a sub-critical spherical mass of fissile material until it becomes critical. The fissile material is surrounded by a neutron reflector, usually of beryllium, and a heavy metal tamper of either U-238 or tungsten. Surrounding this assembly is a further hollow sphere of conventional explosives. If the conventional explosive can be detonated so as to produce a uniform, symmetrical implosion, the tamper is propelled inwards into the sphere of fissile material, and compresses it into criticality. The forces generated by the conventional explosives then contain the gaseous sphere of fissile materials while many repetitions of the fissile reaction occur, and the full yield of the device is produced.

Boosted-Fission Devices

A fission device can be 'boosted' to increase its yield by placing within its core a small quantity of fusion material, such as tritium. At the great temperatures and pressures found within the gaseous core of an exploding device, this material fuses and releases an extra quantity of neutrons which, in turn, produce additional fissions in the uranium or plutonium used in the device. More of the fissile material is thus consumed than in a simple fission device, the efficiency of the fission process is improved and a higher yield produced.

Fusion (Thermo-nuclear) Devices

The energy released by such a device, also known as a second-generation nuclear weapon, arises primarily from nuclear fusion in isotopes of hydrogen such as tritium and deuterium. A large energy source, such as a fission device, is needed to start a fusion reaction. A fusion weapon thus has at least two stages which contribute to the yield, the fission trigger or primary device and the thermonuclear secondary device. In addition, these two devices may be contained in a shell of U-238 which constitutes a third stage of the device. This material, whilst it cannot maintain a self-sustaining fission explosion, can be made to fission where there is a constant external supply of fast neutrons from other fission or fusion reactions. There can be any number of fission-fusion-fission-fusion steps, and so no limit in theory to the size and yield of a thermonuclear weapon.

Nuclear Testing

In order to develop and build an operational nuclear explosive device different types of testing are needed. It is possible to test the functioning of a nuclear weapon with a high degree of reliability not only in a full-scale nuclear explosion, but also through sophisticated tests conducted on a smaller scale. The implosion mechanism of a nuclear weapon can be studied with the help of hydrodynamic experiments (HDEs) where the fissile material in the core is replaced by non-fissile substances. The first stages of an explosive nuclear chain reaction may be observed in hydronuclear experiments (HNEs) where only a small amount of fissile material is placed in the core of a device, allowing it to sustain a nuclear chain reaction for a few generations only. Additionally, subcritical experiments and other laboratory experiments (e.g., nuclear fusion induced by laser ignition) can be used to get a better understanding of the physical processes involved in the development, design and construction of a nuclear explosive device.

Weapon-Grade Fissile Materials

The size of a fission device is directly related to the concentration of fissile isotopes in the material in the core. For purposes of producing a practical weapon, the minimum enrichment required for uranium is about 50 per cent. However, to enable compact, light designs to be produced, the present nuclear powers are assumed to use in their weapons about 10–25 kilos of uranium enriched to over 90 per cent U-235. This enriched material is produced in an enrichment plant (see below).

Plutonium is often preferred to uranium in weapon designs, as less plutonium than uranium is required to produce a given yield — about 5–8 kilos is assumed to be required for a simple device. Plutonium with 93 per cent or above Pu-239 constitutes weapons grade material, though there are claims that devices have been exploded using plutonium with much lower concentrations of this isotope. Such weapons, however, tend to have uncertain yields and give off dangerous radiation, so the higher concentrations are preferred.

All fission reactors produce plutonium, but reasonably pure Pu-239 can only be obtained by withdrawing the uranium fuel after a short period (2–6 months) in the core. If the fuel is left in for a longer period, significant amounts of Pu-240 and other heavier isotopes are contained in the plutonium. Typically, Light Water Rectors (LWRs) will have plutonium in their used fuel which has a concentration of Pu-239 below 80 per cent. Plutonium is obtained from spent reactor fuel through a chemical process known as reprocessing.

Enrichment

Uranium must be enriched if it is to be used in certain reactor types and in weapons. This means that the concentration of fissile U-235 must be increased by physical, rather than chemical, means before it can be fabricated into fuel. The natural concentration of this isotope is 0.7 per cent, but a concentration of 3 per cent is necessary in order to sustain a chain reaction in an LWR. Some 90 per cent enrichment is required before use in HTGRs, the majority of submarine propulsion units or fission weapons. This process of enrichment is not linear, and as much enrichment effort, or 'separative work' as it is usually termed, may be involved in achieving enrichment from, say 0.7 to 1 per cent as from 10-90 per cent.

There are six main techniques for increasing the concentration of U-235:

Gaseous Diffusion

This was the first method of enrichment to be commercially developed. The process relies on a difference in the mobility of different isotopes of uranium when they are converted into gaseous form. In each gas diffusion stage uranium hexafluoride gas (UF_6) is pumped under pressure through a porous nickel tube (a cascade) which causes the lighter gas molecules containing U-235 to pass through the porous walls of the tube more rapidly than those

containing U-238. This pumping process consumes large amounts of energy. The gas which has passed through the tube is then pumped to the next stage, while the gas remaining in the tube is returned to lower stages for recycling. In each stage, the concentration of U-235 is increased only slightly, and enrichment to reactor grade requires a facility of approximately 1200 stages. Enrichment to weapons grade requires about 4000 stages. Industrial scale facilities of this type require electricity supplies of hundreds of megawatts of power.

Gas Centrifuge

In this type of process uranium hexafluoride gas is forced through a series of rapidly spinning cylinders, or centrifuges. The heavier U-238 isotopes tend to move to the side of the cylinder at a faster rate than the lighter molecules containing U-235. The gas at the centre is removed and transferred to another centrifuge, where the process is repeated. As it moves through a succession of centrifuges, the gas becomes progressively richer in the U-235 isotope. Electricity requirements for this process are relatively low compared with gaseous diffusion, and as a consequence this process has been adopted for most new enrichment plants.

Aerodynamic Separation/Becker Process

The Becker technique involves forcing a mixture of hexafluoride gas and either hydrogen or helium through a nozzle at high velocity and then over a surface in the shape of a curve. This creates centrifugal forces which act to separate the U-235 isotopes from the U-238. Aerodynamic separation necessitates fewer stages to achieve comparative enrichment levels than either gaseous diffusion or gas centrifuges but consumes much more energy.

Laser Enrichment

The laser enrichment technique involves a three stage process; excitation, ionization and separation. There are two techniques to achieve these effects, the 'Atomic' approach, and the 'Molecular' approach. The Atomic approach is to vaporize uranium metal and subject it to a laser beam at a wavelength that excites only U-235 molecules. The vapour is then exposed to a second laser beam that ionizes the U-235 atoms, but not the unexcited U-238 atoms. Finally, an electric field sweeps the U-235 atoms onto a collecting plate. The Molecular approach also relies on differences in the light absorption frequencies of uranium isotopes, and begins by exposing molecules of uranium hexafluoride gas to infra red laser light. U-235 atoms absorb this light, thereby causing an increase in their energy state. An ultra-violet laser can then be used to break up these molecules and separate the U-235. This process has the potential to produce very pure U-235 with minimum energy requirements, but has not yet advanced to an industrial scale level of production.

Electro-Magnetic Isotope Separation (EMIS)

The EMIS process of enrichment is based on the fact that an electrically charged atom, travelling through a magnetic field, moves in a circle whose radius is effected by the ion's mass. EMIS is achieved by creating a high current beam of low energy ions and allowing them to pass through a magnetic field created by giant electro-magnets. The lighter isotopes are separated from heavier isotopes by their differing circular movements.

Chemical Separation

'Chemical Separation' is something of a misnomer as the differing isotopes of an atom are chemically identical. This form of enrichment exploits the fact that ions of these isotopes will travel across chemical 'barriers' at different rates because of their different masses. There are two methods to achieve this: the method developed in France of solvent extraction; and the process of ion exchange used in Japan. The French process involves bringing together two immiscible liquids in a column, giving an effect similar to that of shaking a bottle of oil and water. The Japanese ion exchange process requires an aqueous liquid and a finely powdered resin which slowly filters the liquid.

Reprocessing

This is a process whereby the uranium and the plutonium in spent fuel discharged from a reactor is separated from the other 'fission products' by chemical means. It may then be recycled into reactor fuel or, in the case of plutonium, may be used in weapons. Reprocessing is usually carried out using mechanical and solvent extraction techniques, and occurs in three steps.

Solution

After a period of storage to reduce their radioactivity the fuel assemblies are cut into short sections in what is termed the 'head-end' stage. These pieces are then placed in a nitric acid solution to dissolve the fuel. This acid

solution is centrifuged to remove undissolved solids, and chemically treated in preparation for the separation process.

Separation

In this separation stage the 'Plutonium Uranium Recovery by Extraction' (PUREX) method may be employed, with the solution being fed into extraction columns and mixed with various chemicals. The plutonium and uranium emerge from this in the form of nitrates.

Purification

The third stage involves purifying the recovered materials. The uranium can then be recycled into new fuel, often after enrichment, while the plutonium can be used as fuel in breeder reactors, can be used to make mixed oxide (MOX) fuel or, if of a suitable isotopic composition, could be used in weapons.

Chapter 3
Nuclear Energy and Nuclear Power

Introduction

At least five types of peaceful uses of nuclear energy are theoretically possible: propulsion; civil engineering and mining; research; medical, agricultural, and industrial uses of isotopes; and electricity production. Despite several attempts during the 1960s to use nuclear power as a civilian propulsion source, its development in this role has been largely restricted to naval use by the five nuclear-weapon states recognized by the NPT. Similarly, after extensive test programmes in the 1960s, the use of nuclear explosives for civil engineering and mining purposes has now been abandoned with the opening for signature of the Comprehensive Test Ban Treaty in 1996. Research activities and the use of isotopes continue to be developed, but the most extensive use of the technology for peaceful purposes is in electricity production. This is also the peaceful nuclear activity which has the closest links with the production of fissile materials for military explosive purposes.

In the 1950s, nuclear energy was seen as the leading technology in the expansion of electricity production. Initially, it was believed that this expansion would not pose a weapon-proliferation risk as plutonium created in the efficient operation of power reactors was thought to be incapable of being used for explosive purposes. When this assumption was accepted to be incorrect, the IAEA was created to implement safeguards measures to monitor the operations of power reactors, their associated facilities and the nuclear materials they utilized. The IAEA never aspired to prevent the misuse of such facilities or materials in this context: rather its aim was, and is, to deter such misuse by providing the international community with early warning of any diversions from declared uses.

Following the oil supply crisis of 1973, many nuclear power reactors were ordered, *inter alia*, to offer enhanced security of electricity supply. However, the costs and time involved in their construction, and concerns over the environmental, health and other risks associated with their operation and the disposal of their waste products, led to the cancellation of some of these orders. By the later 1980s, a slow but steady decline in support for the technology could be observed in several of the states which had been the leaders in its development.

Relatively few non-nuclear-weapon states currently have significant nuclear energy programmes, but the theoretical proliferation risk posed by their ability to produce militarily useful fissile materials remains. One obvious way to reduce this risk is to impose a global ban on all production and use of the fissile materials associated with nuclear weapons, namely highly enriched uranium and plutonium. The dismantling of a significant percentage of the nuclear arsenal of Russia and the United States during the 1990s has facilitated a global ban on the operation of any facility dedicated to the production of U-235 and Pu-239 for military purposes in the five nuclear-weapon states. It has also, at least in theory, opened the way for strengthening the technical foundations of the nuclear non-proliferation regime by imposing more comprehensive restrictions on the production and use of fissile materials.

These proposals have, however, conflicted with plans evolved after the 1973 oil supply crisis to develop and build a new generation of power reactors which both use and produce plutonium as a fuel [fast-breeder reactors], and with arguments that nuclear waste (used fuel) can be most effectively disposed of through separation and recycling in existing reactors as part of their fuel load [MOX fuel] rather than by indefinite storage in the form in which it emerges from power reactors. Japan, France and the United Kingdom are the focus for this debate, the latter two because they operate plants which are contracted to reprocess fuel from Japanese and German electricity utilities, the former because it is the sole non-nuclear-weapon state currently operating both enrichment and reprocessing plants. The availability of plutonium from dismantled nuclear weapons, and the low cost of natural uranium, has been perceived to undermine the economic case for implementing, under current conditions, these plans for separating and using plutonium created in power reactors. This has served to extend the range of disagreement between those seeking to implement these plans and those arguing for a stronger technical foundation to the nuclear non-proliferation regime.

The degree of reliance to be placed on technical, as against political, solutions to nuclear proliferation is thus an issue that has persisted for half a century. In its current form, advocates of 'technical fix' solutions suggest either closing down all nuclear energy activities, particularly power reactors, or just those facilities which are regarded as proliferation sensitive (i.e., those used for the recovery of plutonium from used fuel or the high enrichment of uranium). While this technical solution is appealing, as intentions are more open to rapid change than

capabilities, its advocacy also has the unfortunate effect of implicitly undermining faith in political non-proliferation commitments and the global nuclear non-proliferation regime.

Current nuclear power projections

The global nuclear energy industry grew substantially during the period 1969–1979. After 1979, the industry suffered a slow-down in new orders, which has continued into the 1990s. The causes of this depression in new plant ordering include: the costs of constructing new reactors; the increasing lead-times involved in construction; little or no growth in the demand for electricity; questions over nuclear waste disposal; and safety fears in the wake of the 1981 Three Mile Island accident in the United States, the 1986 Chernobyl accident in Ukraine, and well-publicised problems with older reactors in Eastern Europe and the Russian Federation.

Current electricity generation derived from nuclear power is approximately 17 per cent of the global total. World-wide, 32 states have operating 437 nuclear power reactors with a total capacity of 344 GW(e) for the production of electricity, while another 39 units, with a total capacity of 33 GW(e), are under construction. Lithuania derives 86 per cent of its total electricity generating needs from nuclear power, the highest share for any state, followed by France with 76 per cent.

Future expansion of the share of nuclear power in electricity generation is most likely to occur in East and South Asia with South Korea, Japan, China, Taiwan (Province of China) and India at the forefront. In Japan, for example, its 'Long-Term Program for Development and Utilization of Nuclear Energy' has identified nuclear power as a key energy source for the future and estimates that 40 new 1000 MW(e) plants will be needed to meet projected demand. Similarly, India's government wants to increase the share of nuclear energy in electricity generation by early next century from the current level of 2 per cent. But elsewhere, nuclear power is not being expanded and, in some cases, such as Sweden, there are plans to phase it out completely. In Spain and Switzerland prohibitions have been placed on further reactor construction; the United States has placed no new orders for nuclear plant since 1975; and Italy has confirmed its 1989 decision to abandon nuclear power.

Projections of the expansion in total nuclear generating capacity have continually been downgraded since the high point of such growth estimates in the 1970s. Current assessments are that total global capacity in 2000 will be approximately 365 GW(e). The range of uncertainty in the estimates increases after that date because of the problematic impact of technical, economic, environmental and political factors. In particular, if lead-times from initial planning to commissioning are in the order of 8–15 years, decisions taken now to build reactors are unlikely to reach fruition before 2010. Much will therefore depend on decisions made over the next decade. Current projections of the situation in 2015 range from a low of 375 GW(e), which represents a decrease in nuclear power's share in the world's electricity supply from its current 17 to 12 per cent, to a high of 535 GW(e), implying a lesser drop in its share in total electricity generation from 17 to about 14 per cent.

These projected figures could be affected by several factors, including:

- *the total demand for energy.* The assumption is that global demand for energy will continue to expand, given estimates of both population growth and industrial development in both the developed and developing worlds. The world's population is expected to grow from 5.4 billion in 1991 to 8.2 billion by 2021, an increase of 52%. The greater share of this expanding energy market, given historic trends, is expected to be accounted for by electricity. Similarly, the World Energy Conference (WEC) has estimated that during the period to 2021 electricity growth rates in the developed world will be between 1 and 2.5% per year, and in the developing world between 2.5 and 5.5%;
- *the long-term influence of environmental factors.* Concerns about global warming could see a re-assessment of nuclear power's contribution to the predicted increase in global energy demand. Conversely, attention could focus on energy conservation, rather than on generation, and on the environmental risks and consequences of nuclear power production, including problems over the disposal of radioactive waste;
- *the demand for electricity within total energy demand.* The rate of growth in electricity consumption has been falling since 1980 and it has been the nuclear plants which have been the first to be cancelled, owing to high construction costs and thus capital investment; lack of standardization; and the increasing costs of complying with regulatory provisions;
- *the share of nuclear energy in supplying the total quantity of electricity required.* It is extremely difficult to assess the relative costs of nuclear and other alternative sources of electricity production beyond 2000, given the volatility of energy resource and fuel markets, the as yet unquantified costs associated with the decommissioning of nuclear reactors, and the uncertain long-term interest rates on borrowed money;

- *the future economic life of existing power reactors.* Some first generation power reactors have already been retired. Some are approaching the end of their economic production lifetimes and will soon be ready for decommissioning. The safety and operational problems with the RBMK and VVER reactors in the former Soviet Union and in Eastern Europe, for example, have resulted in plans to decommission some of these reactors and others may follow. Elsewhere, research, experimental and demonstration reactors are in various stages of decommissioning and dismantlement. However, many of the larger Pressurized Water Reactors (PWRs) were not commissioned until the 1980s and are therefore not planned to be shutdown until well into the next century. Moreover, it has been suggested that some of the more advanced nuclear plants currently in commission could have their planned operating lifetime extended significantly at relatively low cost, through activities such as replacing their turbo-generators with more modern standardised equipment;
- *the willingness of utilities to place orders in the near future for new nuclear power reactors, and of governments to facilitate such decisions and the resulting construction process.* Nuclear electricity's share in total production will depend heavily on whether new nuclear plant will be ordered over the next decade to replace the existing nuclear stock, and whether its capacity will be larger or smaller than the capacity it is replacing. This in turn will depend on the relative cost competitiveness of nuclear generating plant, general perceptions of the utility and safety of nuclear power plants, and attitudes of individual national governments towards such nuclear power programmes. Where such programmes are not underwritten by an express political will for their retention, either through direct state control or some form of legislative underpinning, the outlook for them is likely to be uncertain.

Fuel requirements

Uranium is no longer regarded as the scarce raw material it was once thought to be. The global uranium market has recently witnessed the appearance of additional supplies of uranium from a variety of sources, including the nuclear weapons reduction process in the former Soviet Union and the United States. On 18 February 1993, an agreement was signed between Russia and the United States which commits both parties to cooperate in the rapid conversion of High-Enriched Uranium (HEU) into Low-Enriched Uranium (LEU) and for the United States to purchase 500 tons of HEU from the dismantling of nuclear weapons in Russia. As a consequence, global uranium production, fuel fabrication and enrichment capacities are currently in excess of projected demand.

These developments, when coupled with improvements in fuel design, fuel management technologies and fuel burn-up levels, reduce the demand for replacement fuel assemblies, and offer assurance of fuel supply for the foreseeable future. Even if there were to be a major increase in the total number of operating power plants, uranium resources would still be able to meet the demand. There are thus few current incentives to expand these 'front-end' element of the fuel-cycle infrastructure.

At the 'back end' of the fuel-cycle, plutonium and uranium recovered from the reprocessing of used fuel can be used to manufacture fuel elements for use in both light water and fast reactors. By recycling plutonium and uranium in the form of MOX and reprocessed uranium (RepU) fuel, it is possible to reduce still further uranium requirements. Fourteen states have adopted reprocessing as a means of spent fuel management. Major plutonium separation programmes are underway in Europe (France and the United Kingdom), the Russian Federation and Japan. In the latter, the recycling policy has been designed specifically to meet its expected future energy demand, reduce its dependence on external energy sources and thus enhance its energy self-sufficiency. Although there is increasing acceptance that such recycled fuel is currently more costly to produce than that made from newly mined uranium, this is judged in some cases to be more than offset by the energy security and radioactive waste disposal advantages that can be derived from it.

Nuclear safety

The accident at Chernobyl in the former Soviet Union, which resulted in the release into the atmosphere of significant quantities of radioactive material, has prompted international concern about nuclear safety standards and had an immediate effect on the global nuclear industry. Programmes to expand nuclear energy were curtailed in several states as concern about the consequences of the Chernobyl accident led to a re-assessment of plans.

One consequence of the Chernobyl accident has been greater international oversight of nuclear safety criteria and pressures to improve existing standards and to shut-down those reactors deemed potentially dangerous. Improvements in East–West relations have led to better co-operation on nuclear safety issues and the establishment of the World Association of Nuclear Operators (WANO), a non-governmental organization which seeks to improve the flow of information on reactor design, operation and safety standards. The IAEA has also taken a lead in providing greater international oversight of safety standards through its Operational Safety Review

Teams (OSARTs), which visit nuclear plants and assess issues relevant to their safe operation, such as maintenance and training standards. In 1994, the Convention on Nuclear Safety was signed under the auspices of the IAEA.

Concern about operational safety hazards has had a marked affect on public attitudes to nuclear energy around the world and this will be a significant factor in assessments of the role of nuclear energy in the future. Hopes for reviving interest in nuclear energy lie in part with research into, and development of, 'inherently safe' reactors, though no firm orders have yet been placed for such plants.

Environmental factors

A number of environmental factors impinge upon the operations of nuclear plant. It has been argued that the nuclear generation of electricity is less environmentally harmful than coal-fired generation on the grounds that the latter involves extensive mining, causes air pollution, and could contribute to global warming from a build up of greenhouse gases resulting from the combustion of fossil fuels. Thus amid growing concern over the environmental impact of nitrous oxide, sulphur dioxide and carbon dioxide released from the combustion of fossil fuels, it may be argued that nuclear energy is one of the few available methods of large scale electricity generation which does not involve potentially damaging releases of gases from combustion.

The major environmental problem associated with the nuclear industry, apart from the possibility of contamination by radioactive fall-out resulting from a nuclear accident, is the disposal of radioactive waste. Although there have been technical advances in methods of its disposal, and the development of repositories for low level and intermediate waste, the issue remains controversial. The repositories are not considered satisfactory, especially for long-term storage and for high level waste, and have generated significant local political opposition, as well as being regarded as future 'plutonium mines' if used for the disposal of irradiated fuel.

Economic costs of nuclear power

It has been argued that in many regions of the developed world nuclear power is commercially cost-effective. Critics of nuclear power claim that such calculations, based on the running costs of nuclear reactors, are misleading since they fail to take into account a number of long-term and often hidden costs, such as those associated with the disposal of radioactive waste and the decommissioning of old radioactive plant. Costs that could also affect nuclear power's competitiveness in the future include those resulting from efforts to improve safety standards and government regulatory oversight, public opposition and construction delays. In the developing world, these factors, in particular the severe capital cost over-runs on some programmes, have also affected many power plants under construction and have led to some cancellations.

The Future of Nuclear Power

The NPT states in Article IV that all its States Parties have an inalienable right to share in the use of nuclear energy for peaceful purposes. Since the early 1980s, reduced fossil fuel prices and the increased fuel-efficiency of the plants that use such fuels have made nuclear energy programmes unattractive to many states. The cost of embarking on a nuclear programme is now considered prohibitive for most developing states, unless extremely preferential assistance can be offered. Attempts have been made to set up such assistance, including arrangements which might offer preferential treatment to NPT parties. However, a study conducted by the IAEA on the possibilities for preferential financing of nuclear plants in developing countries offered few concrete solutions to this problem. Thus for many developing states, Article IV continues to offer industrial rights which currently cannot be realized.

The slow-down in the ordering of new nuclear-power reactors since the end of the 1970s seems set to continue. By the year 2000, global nuclear power capacity will be slightly larger than at present because plants now under construction are due for completion. Beyond that date, the picture remains one of uncertainty, as retirements of plant parallel any new construction.

Areas of the nuclear industry where growth can be confidently expected for the remainder of the century and beyond are in the decommissioning of older generation nuclear plant (including plant entombment, partial demolition and final dismantlement) and nuclear waste management. In addition, current trends suggest a geographical migration of construction of any new nuclear-power reactors away from North America and Western Europe towards Asia.

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Chapter 4
The NPT and its Review Conferences

Introduction

The Treaty on the Non-Proliferation of Nuclear Weapons (NPT) is the foundation stone of the nuclear non-proliferation regime. This Treaty now has over 185 parties and remains the only global legal instrument in which:

- nuclear-weapon state parties promise not to transfer nuclear weapons or nuclear explosive devices to any other state; nor to assist any non-nuclear-weapon state to acquire nuclear weapons or nuclear explosive devices [Article I];
- non-nuclear-weapon state parties pledge not to acquire nuclear weapons or nuclear explosive devices [Article II];
- non-nuclear-weapon state parties accept as mandatory the safeguards of the IAEA over all their nuclear activities [Article III];
- all state parties are pledged to co-operate in developing the peaceful potential of nuclear energy [Article IV]; and
- nuclear-weapon state parties promise to negotiate nuclear disarmament 'in good faith' [Article VI].

In 1967, when the NPT was in the final negotiating stages, some West European states were unwilling to pledge themselves to non-nuclear-weapon status in perpetuity. They wanted the Treaty to include a proviso enabling any party to withdraw from it at the end of a fixed period or periods, as well as the current conditional ability, contained in Article X.1, to do so should 'extraordinary events, related to the subject matter of this Treaty, have jeopardised the supreme interests of its country'.

The United States and the former Soviet Union had proposed that the NPT should be of indefinite duration, but had to accept a compromise in order to persuade these West European states to sign the Treaty. This resulted in Article VIII.3, which provided for conferences to review the working of the Treaty every five years; and Article X.2, which avoided any contemporary decision on the duration of the Treaty by providing that:

> twenty-five years after the entry into force of the Treaty, a conference shall be convened to decide whether the Treaty shall continue in force indefinitely, or shall be extended for an additional fixed period or periods. This decision shall be taken by a majority of the Parties to the Treaty.

The 1995 NPT Review and Extension Conference, unlike the previous review conferences in 1975, 1980, 1985 and 1990, therefore had the additional task of deciding on the future duration of the Treaty, as well as reviewing its implementation.

The precedents set by past NPT review conferences

Past NPT review conferences have sought to record the results of their review of the implementation of the Treaty in what has been termed the Final Declaration, the intention being that the conference should adopt it by consensus. On two occasions, 1975 and 1985, this proved possible — on three others, 1980, 1990 and 1995 it was not.

NPT review conferences were specifically tasked by Article VIII.3 'to review the operation of this Treaty with a view to assuring that the purposes of the Preamble and the provisions of the Treaty are being realised'. They therefore focused closely on the Treaty text.

Historically, a review conference has lasted twenty working days, preceded by three or four sessions of a Preparatory Committee (PrepCom). The activities within the conferences themselves were divided into three successive phases:

- in the first phase, lasting 6–8 days, heads of delegation of the states parties in attendance have had the opportunity to make a formal plenary speech outlining their positions on the issues expected to be addressed in the review of the Treaty;
- in the second phase, lasting 6–8 days, the NPT text has been divided between three Main Committees, each working towards agreement on a text reviewing the implementation of their sections of the Treaty. Main

Committee I has normally addressed the security and disarmament aspects of the Treaty; Main Committee II IAEA safeguards; and Main Committee III, the peaceful uses of nuclear energy. Although these Committees could in theory have met in parallel, in practice they have usually met consecutively due to the difficulty that parallel meetings posed for small delegations;

- in the final phase, occupying the last 4–6 days, the Conference has attempted to integrate the three Main Committee texts into a Final Declaration. It is at this stage that differences on wording have had to be narrowed down and attempts made to resolve them via four separate forums: a Drafting Committee; an informal group of 'Friends of the President' or 'Consultative Group'; by the President himself; and in a variety of *ad hoc* informal groupings. The standard practice has been to seek to adopt this text in its totality by consensus, and if no consensus exists, for the Conference to produce no Final Declaration. In practice, this has meant that a single state party could prevent this document from being adopted.

With a conference involving 150 or more states, caucus groups have played a very significant role in its management by enabling differences to be resolved between the leaders of these groups, rather than in plenaries of all the parties. Three such groups have traditionally existed: the Neutral and Non-Aligned Group; the Socialist/East European Group; and the Western European and Others Group. Each Group has provided a Chair for one of the three Main Committees, while the President has traditionally come from the Neutral and Non-Aligned Group.

The Strengthened Review Process agreed in 1995

The NPT review and extension conference in 1995 took the legal decision to give the Treaty an indefinite duration without a vote. As part of this procedure, it also agreed to implement a strengthening of the review process and to accept a set of principles and objectives for nuclear non-proliferation and disarmament. In addition, it passed a resolution calling for a zone free of nuclear weapons and other weapons of mass destruction in the Middle-East and for universal membership of the NPT.

Prior to 1995, the NPT review process focused almost entirely upon the five-yearly conferences. These examined the implementation of the Treaty, and how this might be improved and promoted, rather than the wider issues of the principles and objectives that might guide future action to strengthen the regime.

In 1995, however, several significant changes in this process were agreed. One was that the holding of a review conference every five years was made mandatory, rather than optional. A second was that meetings of the PrepCom for such conferences were to take place on an annual basis in all except the year immediately following a review conference. A third was that these PrepComs were to deal with principles, objectives and ways to promote the full implementation of the Treaty, rather than just procedural matters as had been previously the case. The effect was to make the review process into one with annual events over a four-year period followed by a one-year gap, rather than a single four week event every five years.

These changes were contained in document NPT/CONF.1995/L.4, *Strengthening the Review Process for the Treaty*. The document failed to address several key organisational issues, however, such as how the discussions on substance were to be structured, where and when meetings were to be held, and how the substantive work of the PrepCom meetings was to relate to that of a review conference. Another important document agreed by the 1995 conference was NPT/CONF.1995/L.5, *Principles and Objectives for Nuclear Non-Proliferation and Disarmament*. This has been variously described as containing a set of yardsticks; a rolling report card; a template; and an agenda for action for measuring progress towards the full implementation of the Treaty. It is divided into seven sections: Universality; Non-Proliferation; Nuclear Disarmament; Nuclear-Weapon-Free Zones; Security Assurances; Safeguards and the Peaceful Uses of Nuclear Energy. Some of these sections contain specific targets for the parties to seek to attain by the review conference in 2000, others are less precise in their proposals for implementation of the Treaty. Some sections go beyond the Treaty itself in dealing with issues which are not specifically mentioned in the Treaty text.

The PrepComs for the 2000 Review Conference

The first session of the Preparatory Committee for the 2000 Review Conference was held in New York from 7 to 18 April 1997. Many states presented ideas as to how the work of the PrepCom could lead into the work of the review conference itself. Following much discussion, the Chairman drafted a working paper which could

form the basis of further discussions in future PrepCom sessions and which might serve as the framework for developing recommendations for transmission by the 1999 PrepCom to the Review Conference in 2000.

The Working Paper noted that:

> At this stage, there was general agreement, subject to review and updating at subsequent sessions of the Preparatory Committee, and pending final agreement on all draft recommendations at the last session, on the following points:
> Reaffirmation of commitment to the preamble and the articles of the Treaty;
> Reaffirmation of commitment to efforts designed to promote the full realization and effective implementation of the provisions of the Treaty, as well as reaffirmation of the decisions on principles and objectives for nuclear non-proliferation and disarmament and on strengthening the review process for the Treaty as well as the resolution on the Middle East adopted by the 1995 Review and Extension Conference of the Parties to the Treaty on the Non-Proliferation of Nuclear Weapons.

Subject areas for future work identified in the Working Paper were: universality, non-proliferation, nuclear disarmament, nuclear-weapon-free zones, security assurances, safeguards and peaceful uses of nuclear energy.

The Working Paper included:

> a list of the specific proposals put forward by delegations for consideration by the Preparatory Committee on the understanding that the proposals are without commitment by the Preparatory Committee and without prejudice to the position of any delegation, and that the list is not exclusive and delegations are free to submit new proposals or modify or withdraw old ones at any further sessions of the Preparatory Committee.

The full text of the Working Paper is reproduced in Volume II of the *PPNN Briefing Book.*

Following discussions about the arrangements for the second session of the PrepCom, the Chairman of the first session issued the following statement:

> It is understood that within the existing agenda and in accordance with the methods of work adopted at the first session, the Committee also recommended that time should be allocated at the second session for the discussion on and the consideration of any proposals on the following subject areas, without prejudice to the importance of other issues:
> - Security assurances for parties to the Treaty on the Non-Proliferation of Nuclear Weapons;
> - The resolution on the Middle East;
> - The provision in paragraph 4(b) of the principles and objectives on a non-discriminatory and universally applicable convention banning the production of fissile material for nuclear weapons or other nuclear explosive devices.
>
> It is noted that there was no objection to my making this statement.

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Chapter 5
Arms Control and Disarmament

Introduction

The NPT deals with disarmament issues under preambular paragraphs 8–12 and in Article VI. In its preamble, parties to the Treaty declare their intention: 'to achieve, at the earliest possible date, the cessation of the nuclear arms race and to undertake effective measures in the direction of nuclear disarmament'; 'to seek to achieve the discontinuance of all test explosions of nuclear weapons for all time and to continue negotiations to this end'; and to pursue negotiation on a 'Treaty on general and complete disarmament under strict and effective international control'.

Under Article VI each party to the Treaty 'undertakes to pursue negotiations in good faith on effective measures relating to cessation of the nuclear arms race at an early date and to nuclear disarmament, and on a treaty on general and complete disarmament under strict and effective international control'.

Arms control and disarmament developments 1970–1975

A *Treaty on the Prohibition of the Emplacement of Nuclear Weapons and Other Weapons of Mass Destruction on the Seabed and the Ocean Floor* was signed by the Soviet Union, the United States and the United Kingdom on 11 February 1971 and entered into force on 18 May 1972. Parties to the Treaty undertook not to place on the seabed 'any nuclear weapons or any other types of weapons of mass destruction as well as structures, launching installations, or any other facilities specifically designed for storing, testing or using such weapons'.

On 30 September 1971 the Soviet Union and the United States signed the *Agreement on Measures To Reduce the Risk of Outbreak of Nuclear War Between the United States of America and the Soviet Union.* The Agreement covered three main areas:

- a pledge by both states to take measures each considered necessary to maintain and improve its organizational and technical safeguards against accidental or unauthorized use of nuclear weapons;
- arrangements for immediate notification should a risk of nuclear war arise from such incidents, from detection of unidentified objects on early-warning systems, or from any accidental, unauthorized, or other unexplained incident involving a possible detonation of a nuclear weapon; and
- advance notification of any planned missile launches beyond the territory of the launching party and in the direction of the other party.

The Soviet Union and United States also signed at the same time the *Agreement on Measures To Improve the USA–USSR Direct Communications Link.* This Agreement updated one signed in 1963 and provided for the installation of two satellite communications circuits between the two countries, with a system of multiple terminals in each state.

The *Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction (the Biological Weapons Convention)* was opened for signature on 10 April 1972 and entered into force on 26 March 1975 when 37 signatories had ratified it.

On 26 May 1972 the United States and the Soviet Union signed the *Treaty on the Limitation of Anti-Ballistic Missile Systems* and the *Interim Agreement on Certain Measures With Respect to the Limitation of Strategic Offensive Arms (SALT-1).* Both entered into force on 3 October 1972.

The United States and the Soviet Union signed the *Agreement on the Prevention of Nuclear War'* on 22 June 1973, providing for:

- guidelines on the conduct of both parties towards each other and third parties regarding the avoidance of nuclear war; and,
- agreed consultation procedures if the two states were in a situation of nuclear confrontation.

On 3 July 1974 the United States and the Soviet Union signed the *Protocol to the Treaty on the Limitation of Anti-Ballistic Missile Systems.* This limited each state to one ABM deployment area only. At the same time,

they signed the *Treaty on the Limitation of Underground Nuclear Weapon Tests and Protocol Thereto (the Threshold Test Ban Treaty [TTBT]).* This Treaty prohibited underground tests with a yield exceeding 150 kilotons.

First NPT Review Conference — 1975

In its Final Declaration, the 1975 NPT Review Conference:

- welcomed the various agreements on arms limitation and disarmament but expressed 'its serious concern that the arms race, in particular the nuclear arms race, is continuing unabated';
- urged constant and resolute efforts by each party, especially the nuclear-weapon states, to achieve an early and effective implementation of Article VI;
- expressed the view that 'the conclusion of a treaty banning all nuclear weapons tests is one of the most important measures to halt the nuclear arms race';
- looked forward to the commencement of follow-on negotiations on further limitations of, and significant reductions in, the nuclear weapon systems of the nuclear-weapon states party to the negotiations on the limitation of strategic arms;
- expressed the hope that all parties to the Treaty would work towards the conclusion of a treaty on general and complete disarmament under strict and effective international control; and
- expressed the view that the United Nations should consider ways to improve existing facilities for the collection, compilation and dissemination of information on disarmament issues.

Arms control and disarmament developments 1975–1980

The Soviet Union and the United States signed the *Treaty on Underground Nuclear Explosions for Peaceful Purposes and Protocol Thereto* on 28 May 1976. This contained mutual guidelines governing underground nuclear explosions for peaceful purposes.

On 18 May 1977 the *Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques* was opened for signature.

During 23 May–1 July 1978, the United Nations General Assembly held its first Special Session on Disarmament (SSOD-I).

On 18 June 1979 the Soviet Union and the United States signed the *Treaty on the Limitation of Strategic Offensive Arms and Protocol Thereof (SALT-2).* This agreement was never ratified, but it placed a sublimit of 820 on launchers for MIRVed ICBMs, 1,200 on launchers for MIRVed ICBMs and SLBMs, and 1,320 on launchers for MIRVed ICBMs, SLBMs, and heavy bombers equipped with long-range ALCMs. SALT-2 also placed a limit of 2,250 on all MIRVed ICBMs, SLBMs, heavy bombers equipped with long-range ALCMs, unMIRVed missiles and bombers not carrying cruise missiles.

Second NPT Review Conference — 1980

The Second NPT Review Conference concentrated on the universal acceptance of the NPT, the increasing danger of the dissemination of nuclear weapons, and progress (or lack of it) on nuclear disarmament. Lack of agreement between the Group of 77 and the nuclear-weapon states over the latter subject meant that the 1980 NPT Review Conference concluded without a consensus Final Declaration. The position of the Group of 77 reflected a strong dissatisfaction with the nuclear-weapon states' record of implementation of Article VI. The Group of 77 proposed the following actions to enhance this record:

- the nuclear-weapon states should agree to participate in an *ad hoc* working group that would begin negotiations on the cessation of the qualitative improvement and development of nuclear weapons systems; the ending of the production of all types of nuclear weapons and their means of delivery, and of fissionable material for weapons manufacture; and the initiation of a comprehensive phased programme to reduce stockpiles of nuclear weapons and their means of delivery;
- the Soviet Union and the United States should ratify the SALT 2 Agreements and begin negotiations on SALT 3, and in the meantime keep to the provisions of the SALT 2 even though it was not yet ratified;
- the nuclear-weapon states should support the creation of an *ad hoc* working group to start multilateral negotiations on a comprehensive test ban treaty; and

- a trilateral moratorium on nuclear testing should be initiated.

These proposals proved unacceptable to the nuclear-weapon states.

Arms control and disarmament developments 1980–1985

On 3–21 March 1980 the First Review Conference of the parties to the Biological Weapons Convention was held in Geneva.

On 3 March 1980 the *Convention on the Physical Protection of Nuclear Material* was signed in Vienna and New York.

On 10 April 1981 the *Convention on Prohibitions or Restrictions on the Use of Certain Conventional Weapons Which may be Deemed to be Excessively Injurious or to Have Indiscriminate Effects* was opened for signature in New York. It entered into force on 2 December 1983.

During 7 June–10 July 1982, the United Nations General Assembly held its second Special Session on Disarmament (SSOD-II).

On 23 March 1983 President Reagan of the United States announced the initiation of the Strategic Defense Initiative (SDI). In statements at the time, President Reagan said he believed that SDI would make nuclear weapons 'impotent and obsolete' and thereby abolish the threat posed by nuclear weapons.

On 17 January 1984 the Stockholm Conference on Confidence- and Security-Building Measures (CSBMs) and Disarmament in Europe began with 35 states attending.

On 7–8 January 1985 the Soviet Union and the United States agreed that they would undertake bilateral negotiations on nuclear and space arms, with 'the objective of preventing the arms race in space and terminating it on earth', leading to the 'complete elimination of nuclear arms everywhere'.

Third NPT Review Conference — 1985

The Final Declaration of the 1985 NPT Review Conference contained 29 paragraphs on the Review of Article VI and preambular paragraphs 8–12. In it, the Conference:

- noted that the Tenth Special Session of the General Assembly of the United Nations concluded that 'the achievement of nuclear disarmament will require urgent negotiations of agreements at appropriate stages and with adequate measures of verification satisfactory to the States';
- noted that the destructive potentials of the nuclear arsenals of nuclear- weapons states parties were undergoing continuing development;
- was concerned about 'developments with far reaching implications and the potential of a new environment, space, being drawn into the arms race';
- regretted the continuing development and deployment of nuclear weapons systems during the period under review;
- examined the current situation on measures taken relating to the cessation of the nuclear arms race, recalling Strategic Arms Limitation Talks and bilateral negotiations between the Soviet Union and the United States of America; and
- noted the lack of developments on items on the agenda of the Conference on Disarmament, particularly 'those relating to the cessation of the nuclear arms race and nuclear disarmament, the prevention of nuclear war including all related matters and effective international arrangements to assure non-nuclear-weapon States against the use or threat of use of nuclear weapons'.

It also:

- concluded that as no agreements had been achieved in the period under review on the cessation of the nuclear arms race, on nuclear disarmament, or on complete disarmament, the objectives of article VI and preambular paragraphs 8 to 12 had not yet been reached;
- noted the importance of Article VI in strengthening the Treaty, and reaffirmed the commitment of all states to the implementation of this article;

- welcomed the bilateral negotiations between the Soviet Union and the United States of America on questions concerning space and nuclear arms;
- recommended that the Conference on Disarmament proceed to early multilateral negotiations on nuclear disarmament;
- expressed determination to attain 'the discontinuance of all test explosions of nuclear weapons for all time';
- noted the United Nations General Assembly resolutions since 1981 on a moratorium of nuclear weapons testing pending the conclusion of a comprehensive test ban treaty, and resolutions since 1982 for a freeze on all nuclear weapons in quantitative and qualitative terms; and
- concluded that nuclear-weapons states 'should makes greater efforts to ensure effective measures for the cessation of the nuclear arms race at an early date'.

Arms control and disarmament developments 1985–1990

On 8–26 September 1986 the Second Review Conference of the Biological Weapons Convention agreed an exchange of information on all high containment biological research facilities.

On 19 September 1986 the Stockholm Document on CSBMs was signed by the Soviet Union, the United States and 33 European states. This agreement meant that advanced notification had to be given for large-scale military exercises.

On 9 November 1987 the Soviet Union and the United States began talks on further nuclear test restrictions in Geneva, and on 7 December 1987 signed the *Treaty on the Elimination of Intermediate-Range and Shorter-Range Missiles (INF Treaty)*. This provided for the elimination of their missile delivery systems between 500–1,000 (shorter) and 1,000–5,500 kilometres (intermediate) range. It contained two Protocols: the first specified the way the missiles would be destroyed, the second specified procedures for verification. The INF Treaty came into force on 1 June 1988.

During 31 May–25 June 1988, the United Nations General Assembly held its third Special Session on Disarmament (SSOD-III).

On 7 January 1989, States Parties to the 1925 Geneva Protocol met in Paris under the title 'World Conference on Chemical Weapons'.

Fourth NPT Review Conference — 1990

The Fourth NPT Review Conference failed to produce a Final Declaration. This was due to a lack of agreement over the implementation of Article VI and preambular paragraphs 8 to 12, especially over the negotiation of a Comprehensive Test Ban Treaty (CTBT).

At the Conference, non-aligned states noted that there had been some progress towards disarmament, but that 'the qualitative improvements in nuclear weapons continued unabated'. These states emphasized the importance of the signing of a CTBT and the obligations of the nuclear-weapon states towards disarmament. In contrast the nuclear-weapon states rejected the idea that the extension of the NPT should be linked to the signing of any other arms control agreement, such as the CTBT, and praised the progress in arms control since 1985. The Soviet Union recommended immediate negotiations on a CTBT, in contrast to the United States and the United Kingdom who considered that it was a longer-term objective.

Arms control and disarmament developments 1990–1995

On 1 June 1990 the Soviet Union and the United States signed an agreement on *Destruction and Non-Production of Chemical Weapons and on Measures to Facilitate the Multilateral Convention on Banning Chemical Weapons* (Bilateral Destruction Agreement or BDA). This bilateral agreement stated that the Parties would 'make every effort to conclude and bring into force at the earliest date a convention providing for a global ban on the development, production, stockpiling, and use of chemical weapons and on their destruction'. On the same day, they also signed new Protocols to both the *Treaty on the Limitation of Underground Nuclear Weapon Tests* and the *Treaty on Underground Nuclear Explosions for Peaceful Purposes.* Both entered into force on 11 December 1990.

On 19 November 1990 the *Treaty on Conventional Armed Forces in Europe (CFE)* was signed by the Group of 23 (16 NATO states and 7 Warsaw Pact states) within the framework of the Conference on Security and Co-operation in Europe (CSCE). The CFE Treaty limited the deployment of five categories of weapons within Europe: tanks, armoured combat vehicles, artillery, combat aircraft, and helicopters.

During 8–18 January 1991 an Amendment Conference for the *Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space, and Under Water (PTBT)* was held in New York. The Conference was tasked with discussing how the PTBT could be amended to become a CTBT. By a majority vote (the United Kingdom and the United States opposing, with 19 abstentions), participants mandated Indonesia to continue consultations on turning the PTBT into a CTBT.

The *Strategic Arms (Limitation and) Reduction Treaty (START-1)* was signed by the Soviet Union and the United States on 31 July 1991. This Treaty created a 4,900 ceiling on nuclear warheads for ballistic missile, and removed 350 US and 1,000 USSR strategic nuclear delivery vehicles (ICBMs, SLBMs and heavy bombers). It also allowed the deployment of mobile ICBMs, and mandated the exchange of detailed data on USSR and US nuclear arms inventories.

On 9–27 September 1991 the Third Review Conference of the Biological Weapons Convention met to discuss the spread of biological weapons research, and agreed to strengthen measures to enforce the Convention.

On 23 May 1992 Belarus, Kazakhstan, Russia, Ukraine and the United States signed the Lisbon Protocol to START-1.

The Concluding Act of the Negotiation on Personnel Strength of Conventional Armed Forces in Europe (CFE-1A) was signed on 10 July 1992. On 17 July 1992 both the CFE Treaty and CFE-1A entered into force.

On 1 October 1992 the United States initiated a nine-month nuclear testing moratorium. The legislation implementing the moratorium also limited the number of tests that the United States could conduct in the period to 30 September 1996. It also directed the United States to resume testing talks with Russia and devise a strategy for achieving a multilateral CTBT.

On 4 November 1992 the Russian parliament approved the START-1 Treaty. On 3 January 1993 the Russian Federation and the United States signed the *Treaty on Further Reduction and Limitation of Strategic Offensive Arms (START-2).* This Treaty was intended to reduce the USSR's and United States' strategic forces to a maximum of 4,250 (later reduced to 3,000–3,500) warheads; to abolish multi-warhead land-based missiles (all MIRVed ICBM warheads); and to limit submarine-launched ballistic missiles (SLBMs) to 1,750 on each side. The implementation of START-2 was conditional upon START 1 entering into force. It did so on 5 December 1994, when Belarus, Kazakhstan, the Russian Federation, Ukraine and the United States exchanged the relevant documents.

On 13 January 1993 the *Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction (CW Convention)* was signed in Paris by 130 states. It entered into force on 29 April 1997.

On 10 August 1993 the Conference on Disarmament mandated its Ad Hoc Committee on a Nuclear Test Ban to negotiate a CTBT.

On 16 March 1994 a joint statement was made by Russia and the United States on the *Inspection of Facilities Containing Fissile Materials Removed from Nuclear Weapons.* Both states agreed to look at the possibility of placing fissionable materials under IAEA safeguards, to ensure that materials released in nuclear disarmament would not be re-used to produce nuclear weapons. At the same time, Russia proposed that both governments should cease military use of plutonium separated after the date of the agreement, and that Russia would cease production and chemical separation of weapons-grade plutonium after the conversion of the three dual-use production reactors to purely civilian use.

On 18 March 1994 the United States Department of Energy and Russia's Ministry of Atomic Energy agreed a *Protocol on Highly Enriched Uranium Transparency Arrangements in Furtherance of the Memorandum of*

Understanding of 1 September 1993. This implemented mutual transparency and access arrangements at a number of Russian and United States nuclear facilities.

On 19 September 1994 states parties to the Biological Weapons Convention met for a special conference to consider a report of an *ad hoc* group of governmental experts on verification measures for the Convention. The Conference agreed to establish a new 'Ad Hoc Group' to prepare a legally-binding protocol to the Convention.

On 4 March 1995 Russia and the United States signed two agreements in Moscow, the first of which provided for United States assistance to Russia in assuring the safe transport of strategic nuclear weapons from Belarus, Kazakhstan, and Ukraine to Russia. The second agreement dealt with US assistance 'in ensuring the safe storage of nuclear ammunition'.

On 23 March 1995 the United Kingdom announced that by the end of 1998 it would retire all its free-fall WE177 bombs, thus ending the Royal Air Force's nuclear delivery role.

On 28 March 1995 it was reported that Russia had dismantled only four nuclear submarines in 1992, three in 1993, and two in 1994 due to a lack of funds and spent fuel storage space. Under the START-1 agreement, Russia is mandated to dismantle 61 submarines by the year 2000.

On 25 April 1995, Russian and Kazakhstan officials announced that, in accordance with START I and a March 1994 joint resolution, the last warheads from the 104 SS-18 ICBMs that remained on Kazakhstan territory had been removed to Russia. Work began on destroying the 52 missile silos at the Derzhavinsk base in Kazakhstan in April 1995, with the aim of eliminating those silos plus the 52 at Zhangiz-Tobe in Kazakhstan before 1998.

NPT Review and Extension Conference — 1995

Although the conference failed to agree a consensus Final Declaration, mainly because of disagreements over interpretations of the nuclear-weapon states' disarmament record, it did agree a programme of action for disarmament in its decision document on *Principles and Objectives for Nuclear Non-Proliferation and Disarmament.*

This document reiterated that 'the ultimate goal' of the NPT was 'the complete elimination of nuclear weapons and a treaty on general and complete disarmament under strict and effective international control'. It stated that the undertakings with regard to nuclear disarmament set out in the NPT are expected to 'be fulfilled with determination', while the nuclear-weapon States reaffirmed their commitment, as stated in article VI, to pursue in good faith negotiations on effective measures relating to nuclear disarmament. There followed a 'programme of action which included '[t]he completion ... of the negotiations on a universal and internationally verifiable Comprehensive Nuclear Test Ban Treaty no later than 1996'; '[t]he immediate commencement and early conclusion of negotiations on a non-discriminatory and universally applicable convention banning the production of fissile material for nuclear weapons or other nuclear explosive devices'; and the 'determined pursuit by the nuclear-weapon states of systematic and progressive efforts to reduce nuclear weapons globally, with the ultimate goal of eliminating those weapons'. In addition, the nuclear-weapon states were to exercise 'utmost restraint' pending the entry into force of a Comprehensive Test Ban Treaty.

Arms control and disarmament developments 1995–1997

On 4 May 1995 the New Delhi conference of the leaders of the members of the South Asian Association for Regional Cooperation (SAARC) passed a resolution calling on the UN's Conference on Disarmament (CD) to negotiate international treaties prohibiting the use or threat of use of nuclear weapons, and to begin negotiations to eliminate completely nuclear weapons within a set time.

On 15 May 1995 China conducted an underground test explosion at Lop Nor four days after the NPT was extended indefinitely. This was followed by a further test on 17 August.

On 5 September 1995 France conducted the first test at Mururoa Atoll in its nuclear test programme announced on 13 June 1995. The second followed on 1 October; the third on 27th of that month; the fourth on 21 November; the fifth on 27 December and the sixth on 27 January 1996. On 29 January it was announced that this would be the last test in the series.

On 16 November 1995 China issued a 'White Paper on Arms Control and Disarmament'. In the paper, China denied selling chemical, nuclear or other weapons of mass destruction and criticized the other four nuclear weapons states for their arms sales, stating that they used them to interfere in other nations' domestic affairs. China was also critical of the other nuclear weapons states' discriminatory anti-proliferation and arms control practices, and stated that they have 'neither abandoned their policy of nuclear blackmail nor stopped their development of nuclear weapons and outer-space weapons, including guided-missile defense systems'.

On 24 December 1995 in Canberra, Australia, the Prime Minister of Australia announced the establishment of the Canberra Commission on the Elimination of Nuclear Weapons. This reported on 14 August 1996.

On 26 January 1996 the United States Senate ratified START-2.

On 1 June 1996 Ukraine's President Kuchma announced that the last of the strategic nuclear warheads still in his country had been transferred to Russia.

On 17 June 1996, the Conference on Disarmament unanimously decided to admit 23 new members, increasing its membership to 61.

The International Court of Justice, on the request of the UN General Assembly, offered an advisory opinion on 8 July 1996 that the threat or use of nuclear weapons would generally be contrary to the rules of international law applicable in armed conflict, and in particular the rules and principles of humanitarian law. It also decided unanimously that, in relation to Article VI of the NPT, 'there exists an obligation to pursue in good faith and bring to a conclusion negotiations leading to nuclear disarmament in all its aspects under strict and effective international control'.

On 29 July 1996 China conducted an underground nuclear test at Lop Nor test site. Following it, China declared that it would be its last and that it would observe an indefinite halt to all tests.

On 7 August 1996, 28 states of the G-21 group of non-aligned nations submitted a proposal to the Conference on Disarmament on a 'Programme of Action for the Elimination of Nuclear Weapons'.

In August 1996, the negotiations for a CTBT failed to achieve consensus on a text. A text that had received support from a large majority of the States participating in the CD was forwarded to the 50th United Nations General Assembly by a group of States known as the 'friends of the CTBT' in early September 1996, and on the 10th a resolution was passed asking the United Nations, as depositary, to open it for signature at the earliest possible date. 138 states had signed by the end of the year. (The latest list of signatures and ratifications is reproduced in Volume II of the *PPNN Briefing Book*.)

On 31 October 1996, Hungary deposited its instrument of ratification to the Chemical Weapons Convention, becoming the 65th state to do so. This triggered the 180-day countdown to the Convention's entry into force on 29 April 1997.

On 24 November 1996 Belarus's President Lukashenko announced that the last of the SS-25 strategic ballistic missiles deployed on its territory would be removed to the Russian Federation on 26 November.

In Helsinki in March 1997, the Heads of State of the United States and the Russian Federation agreed that:

- the dealine for implementation of START-2 would be extended to the end of 2003;
- once START-2 had been ratified by both states, they would begin negotiations on START-3 with the intention of reducing the numbers of their strategic warheads to 2000–2500; and
- the ABM Treaty of 1972 was to be maintained in its existing form, but it was accepted that the deployment of theatre missile defence systems would not run counter to its provisions.

During 1997 the Ad Hoc Group preparing a protocol to the Biological Weapons Convention adopted a rolling text. Many states indicated that they wished the work on this text to be completed during 1998.

During a visit to Moscow in September 1997, France's Head of State said that his country no longer deployed land-based nuclear missiles and that its 18 remaining missiles of this type had been dismantled.

Sixth NPT Review Conference — 2000

The 1997 session of the Preparatory Committee for the 2000 NPT Review Conference included the following text in the 'Chairman's Working Paper' under the heading 'Nuclear disarmament':

The importance of all States to make every effort to promote the earliest entry into force of the Comprehensive Nuclear-Test-Ban-Treaty, in accordance with article XIV of that Treaty.

Reaffirmation of the need for immediate commencement and early conclusion of negotiations on a non-discriminatory and universally applicable convention banning the production of fissile material for nuclear weapons or other nuclear explosive devices, in accordance with the statement of the Special Coordinator of the Conference on Disarmament and the mandate contained therein.

Recognition of the progress in nuclear weapons reductions by the nuclear-weapon States, including those made unilaterally or bilaterally under the START process, as steps towards nuclear disarmament; reaffirmation of the commitment by the nuclear-weapon States to the determined pursuit of systematic and progressive efforts to reduce nuclear weapons globally, with the ultimate goal of eliminating those weapons and of the commitment by all States to the achievement of general and complete disarmament under strict and effective international control.

Chapter 6
Security Assurances and Nuclear-Weapon-Free Zones

Introduction

Since the negotiation of the NPT, the non-nuclear-weapon states parties have sought assurances from the nuclear-weapon states to guarantee their security from nuclear attack because the former states have forgone their right to acquire or manufacture nuclear weapons.

Formal security assurances are not included in the NPT. However, the negotiating parties did agree to include a statement in the last preambular paragraph of the Treaty, which recalls that, in accordance with the UN Charter, 'States must refrain in their international relations from the threat of the use of force against the territorial integrity or political independence of any State'. Many non-nuclear weapon states considered this statement inadequate to meet their security needs and subsequently tried to obtain more stringent and specific security assurances.

The right to conclude nuclear-weapon-free zone (NWFZ) treaties is directly incorporated in the NPT. Article VII reaffirms 'the right of any group of States to conclude regional treaties in order to assure the total absence of nuclear weapons in their respective territories'. One means through which legally binding security assurances have been offered by the nuclear-weapon states is through the protocols to NWFZs.

Security assurances and NWFZ developments 1970–1975

In 1971 the United States ratified Protocol II of the Treaty of Tlatelolco. This contains the obligations of the nuclear-weapon states under the Treaty, and commits them to respect the NWFZ and to undertake 'not to threaten to use nuclear weapons against the Contracting Parties of the Treaty for the Prohibition of Nuclear Weapons in Latin America'. China and France ratified this Protocol in 1974. [The United Kingdom had ratified both Protocol I and II in 1969.] In 1971 the Netherlands ratified Protocol I of the Treaty of Tlatelolco concerning the maintenance of the NWFZ in the territories for which, *de jure* or *de facto*, they are internationally responsible and which lie within the limits of the geographical zone of the Treaty.

In 1974 Iran and Egypt co-sponsored a proposal to establish a NWFZ in the Middle East, while in the same year Pakistan proposed at the United Nations General Assembly that a NWFZ be established in South Asia (this concept had first been advanced in November 1972).

By 1975 the Treaty of Tlatelolco was in force for 20 states of the 33 eligible to sign it (Barbados, Bolivia, Columbia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Grenada, Guatemala, Haiti, Honduras, Jamaica, Mexico [the Depositary State], Nicaragua, Panama, Paraguay, Peru, Trinidad & Tobago, Uruguay, and Venezuela).

First NPT Review Conference — 1975

Under the Review of Article VII and the Security of Non-Nuclear-Weapon States, the Final Declaration of the Conference:

- emphasized the 'particular importance of assuring and strengthening the security of Non-Nuclear-Weapon States Parties which have renounced the acquisition of nuclear weapons';
- noted the 'continued determination of the Depositary States' to honour United Nations Security Council resolution 255(1968);
- considered that the establishment of NWFZ represented 'an effective means of curbing the spread of nuclear weapons'; and
- recognized, that to be effective, a NWFZ requires the co-operation of the nuclear-weapon states and urged them to provide 'binding security assurances to those States which become fully bound by the provisions of such regional arrangements'.

Security assurance and NWFZ developments 1975–1980

In 1976 and 1977 respectively, the Bahamas and Suriname brought the Treaty of Tlatelolco into force, bringing the total number of parties to 22. The former Soviet Union ratified Protocol II of the Treaty of Tlatelolco in 1979, thus making all the nuclear-weapon states parties to it.

At the First United Nations Special Session on Disarmament (UNSSOD-1) in 1978, China, France, the former Soviet Union, the United Kingdom and the United States all issued unilateral statements on negative security assurances. Each assurance embraced specific qualifications related to each states' nuclear doctrine and security arrangements. Only China issued an unconditional negative security assurance. The Final Document of UNSSOD-1 urged the nuclear-weapon states to 'pursue efforts to conclude, as appropriate, effective arrangements to assure non-nuclear-weapon States against the use or threat of use of nuclear weapons'.

In 1979 the Committee on Disarmament established an *Ad Hoc Committee* open to all member states to consider 'Effective International Arrangements to Assure Non-Nuclear-Weapon States Against the Use or Threat of Use of Nuclear Weapons'. On 27 March 1979 Pakistan submitted a document to this forum entitled 'Conclusion of an International Convention to Assure Non-Nuclear-Weapons States against the Use or Threat of Use of Nuclear Weapons', which stipulated in Article I that security assurances would be extended to 'non-nuclear-weapon states not parties to the nuclear security arrangements of some nuclear states'. On 21 June 1979 Bulgaria, Czechoslovakia, German Democratic Republic, Hungary, Mongolia, Poland, and the Soviet Union submitted a working paper entitled 'Draft international convention on the strengthening of guarantees of the security of non-nuclear States' in which:

- Article I stated 'The nuclear-weapon States Parties to this Convention pledge themselves not to use or threaten to use nuclear weapons against non-nuclear States Parties to this Convention which renounce the production and acquisition of nuclear weapons and which have no nuclear weapons in their territory or anywhere under their jurisdiction or control, on land, on the sea, in the air or in outer space'; and
- Article II stated 'The obligation set forth in article I of this Convention shall extend not only to the territory of non-nuclear States Parties, but also to the armed forces and installations under the jurisdiction and control of such States wherever they may be, on land, on the sea, in the air or in outer space'.

On 17 July 1980 Pakistan submitted a working paper entitled 'Possible draft resolution for adoption by United Nations Security Council as an interim measure on "Effective international arrangements to assure non-nuclear-weapon States against the use or threat of use of nuclear weapons".' The draft resolution:

- called upon those States possessing nuclear weapons to undertake not to use or threaten to use nuclear weapons against non-nuclear-weapon States under any circumstances; and
- urged the Committee on Disarmament to pursue negotiations for this purpose and conclude, without delay, a binding international instrument to assure non-nuclear-weapon States against the use or threat of use of nuclear weapons.

A working paper by Bulgaria was also presented during the same session entitled 'Forms of the arrangements to assure non-nuclear-weapon States against the use or threat of use of nuclear weapons'. This paper divided the security assurance arrangements into three forms:

- unilateral non-use declarations, of which there are two types: individual declarations and identical non-use declarations;
- international conventions with uniform non-use formula; and
- Security Council resolutions, of which there are three types: a Security Council resolution containing a uniform non-use formula or identical declarations; a Security Council resolution containing or referring to the non-use declarations already made; a Security Council resolution taking note only of the individual non-use declarations.

Second NPT Review Conference — 1980

During the Review of Article VII and the Security of Non-Nuclear-Weapon States the participants agreed a draft report for inclusion in a Final Declaration which:

- recognized that NWFZ, properly constituted, could curb the spread of nuclear weapons and contribute to the security of the states in the region;

- invited the nuclear-weapon states to undertake binding commitments to refrain from the use or threat of use of nuclear weapons against states in such zones;
- expressed satisfaction that all five nuclear-weapon states had adhered to Protocol II of the Treaty of Tlatelolco;
- confirmed the continued validity of UN Security Council resolution 255;
- noted that states should have the right to decide if, and under what conditions, the assistance envisaged by resolution 255 might be granted;
- noted the unilateral declarations made by the three depositary states of the NPT at UNSSOD-1; and
- expressed the view that effective international arrangements to assure non-nuclear-weapon states against the use or threat of use of nuclear weapons would further efforts to halt the proliferation of nuclear weapons.

However, the Conference failed to reach consensus on the entire Final Declaration.

Security assurances and NWFZ developments 1980–1985

In 1981 the Japanese Socialist Party and the Democratic People's Republic of Korea proposed a nuclear-free peace zone in Northeast Asia.

In 1982 the Soviet Union, China and France issued further unilateral statements on negative security assurances at the Second United Nations Special Session on Disarmament (UNSSOD-2).

In 1983 Antigua and Barbuda ratified the Treaty of Tlatelolco, bringing the number of parties to 23.

In 1981 Sweden proposed to the Ad Hoc Committee on Radiological Weapons of the CD, that any Convention banning radiological weapons should also prohibit military attacks on civilian nuclear facilities. In August 1984, Sweden presented a working paper of proposals for parts of a treaty prohibiting radiological weapons and the release or dissemination of radioactive materials for hostile purposes, to the Ad Hoc Committee. The paper proposed that the use of radioactive material for hostile purposes causing destruction, damage or injury by means of radiation should be prohibited, irrespective of the method applied. This included attacks on nuclear facilities. The prohibition would encompass four categories of facilities: nuclear reactors; intermediate spent fuel storage sites; reprocessing plants and waste deposits. Thresholds would be established to determine which facilities would be covered by the treaty. The paper also discussed how they might be identified and registered.

On 6 August 1985 the South Pacific Forum meeting at Rarotonga endorsed a text of the South Pacific Nuclear-Free Zone Treaty (Treaty of Rarotonga). It contains restrictions on: the manufacture or acquisition of nuclear explosive devices; peaceful nuclear activities; nuclear testing; and the dumping of radioactive waste within the area covered by the Zone.

Third NPT Review Conference — 1985

The Final Declaration of the 1985 Conference contained 20 paragraphs concerning its Review of Article VII and the Security of Non-Nuclear-Weapon States. The main points were that the Conference:

- emphasized the importance of concluding NWFZ 'in harmony with internationally recognized principles', as stated in the UNSSOD-1 Final Document;
- expressed 'its belief that concrete measures of nuclear disarmament would significantly contribute to creating favourable conditions' for the establishment of NWFZ;
- urged all concerned parties to establish a NWFZ in the Middle East;
- considered that the 'development of a nuclear weapon capability by South Africa ... frustrates the implementation of the Declaration on the Denuclearization of Africa and that collaboration with South Africa in this area would undermine the credibility and stability of the Non-Proliferation Treaty regime'; and
- called upon all states, 'particularly the nuclear-weapon States, to continue the negotiations in the Conference on Disarmament devoted to the search for a common approach [on nuclear security assurances] acceptable to all, which could be included in an international instrument of a legally binding character'.

Security assurances and NWFZ developments 1985–1990

On 11 December 1986 the Treaty of Rarotonga entered into force.

In December 1988 India and Pakistan signed an agreement not to attack each other's nuclear facilities

By 1990 eleven states were party to the Treaty of Rarotonga (Australia, the Cook Islands, Fiji, Kiribati, Nauru, New Zealand, Niue, Papua New Guinea, Solomon Islands, Tuvalu, and Western Samoa). China and the Soviet Union had signed Protocol 2, which commits parties to undertake 'not to use or threaten to use any nuclear explosive device' against those adhering to the Treaty, and Protocol 3, which commits parties 'not to test any nuclear explosive anywhere within the South Pacific Nuclear Free Zone'.

In April 1990 Egypt proposed the establishment of a Zone Free of Weapons of Mass Destruction (ZFWMD) in the Middle East.

On 3 July 1990 OPANAL, the executive body of the Tlatelolco Treaty, approved a resolution which added language to its text making it, the 'Treaty for the Prohibition of Nuclear Weapons in Latin America and the Caribbean'.

Fourth NPT Review Conference — 1990

On 27 April 1990 Egypt submitted a Working Paper encompassing positive security assurances to the Preparatory Committee for the Fourth NPT Review Conference and later to the Conference itself. This Working Paper:

- recommended that the UN Security Council adopt a new resolution (to replace resolution 255) to provide credible and universally acceptable security assurances;
- proposed that a wider definition of 'assistance' should be provided through the new resolution to encompass technical, financial and humanitarian assistance; and
- called for credible sanctions to be imposed against any state that attacked a non-nuclear weapon state party to the NPT with nuclear weapons.

On 1 June 1990 Nigeria submitted a draft agreement for discussion at the Conference for an international convention on negative security assurances. The draft convention sought a common formula which called for:

- the extension of negative security assurances to all states in the NPT which either did not belong to a nuclear alliance or which belonged to a nuclear alliance but did not have nuclear weapons stationed on their territory; and
- those states which belonged to a nuclear alliance to undertake not to participate in, or contribute to, a military attack against any nuclear-weapon state or its allies, parties to the NPT, except in self-defence.

Two working papers related to attacks on nuclear facilities were tabled by the Islamic Republic of Iran and by Hungary, the Netherlands and Sweden, respectively.

There was no Final Declaration in 1990 so no language on security assurances or NWFZs was adopted by the Conference.

Security assurances and NWFZ developments 1990–1995

On 10 October 1990 the Secretary-General of the United Nations published a study on 'Effective and verifiable measures which would facilitate the establishment of a nuclear-weapon-free zone in the Middle East'.

On 19 December 1990 the United Nations General Assembly adopted a resolution on the 'Conclusion of effective international arrangements to assure non-nuclear-weapon States against the use or threat of use of nuclear weapons'. Operative paragraph 5 of this resolution contained a recommendation that:

> The Conference on Disarmament should actively continue intensive negotiations with a view to reaching early agreement and concluding effective international arrangements to assure non-nuclear-weapon States against the use or threat of use of nuclear weapons, taking into account the widespread support for the conclusion of an international convention and giving consideration to any other proposal designed to secure the same objective.

At the 1991 session of the Ad Hoc Committee of the Conference on Disarmament on 'Effective International Arrangements to Assure Non-Nuclear-Weapon States Against the Use or Threat of Use of Nuclear Weapons' Egypt submitted a further Working Paper on security assurances which sought to update and enhance UN Security Council resolution 255. This Working Paper called for the initiation of 'a process whereby nuclear-weapon States Party to the NPT would conduct consultations collectively or individually with nuclear-weapon States not currently party to the Treaty on security assurances taking into account United Nations Security Council resolution 255 of 1968...'.

On 27 January 1991 the agreement between India and Pakistan not to attack each others' nuclear facilities entered into force.

On 3 April 1991 the United Nations Security Council adopted resolution 687 which incorporated a paragraph identifying the need to work towards the establishment of a ZFWMD in the Middle East.

On 10 May 1991 OPANAL removed the provision (Article 25.2) of the Treaty of Tlatelolco barring membership for states with territorial disputes within the zone. France then ratified Protocol I on 24 August 1992.

In May 1991 a United Nations Group of Experts, in co-operation with the Organization for African Unity (OAU) met in Addis Ababa, Ethiopia to discuss the terms of an African NWFZ Treaty which had first been advocated during the founding meeting of the OAU in 1964. Subsequent meetings of the group were held in 1992 (Addis Ababa); 1993 (Harare) and 1994 (Windhoek and Addis Ababa).

On 31 December 1991 the Democratic People's Republic of Korea and the Republic of Korea signed a 'Joint Declaration on the Denuclearization of the Korean Peninsula'. This was followed on 18 March 1992 by the 'Agreement on the Formation and Operation of the North–South Joint Nuclear Control Committee'.

France submitted a working paper to the Conference on Disarmament in August 1992 which proposed that security assurances should apply, in the form of an international convention, to non-nuclear-weapon states which are parties to a legally-binding instrument not to manufacture or acquire nuclear weapons (such as, parties to the NPT, a regional NWFZ, or states that have concluded a full-scope safeguards agreement with the IAEA). These assurances would be nullified if the non-nuclear-weapon state participates in an aggression against the nuclear-weapon state in alliance or association with another nuclear-weapon state.

In 1992 St.Vincent and the Grenadines ratified the Treaty of Tlatelolco and in September of that year Cuba stated that it would accede once all states had assumed their responsibilities under it. On 18 January 1994 Argentina and Chile became full parties to the Treaty of Tlatelolco. On 4 March the Quadripartite Agreement between Argentina, Brazil, the Brazilian–Argentine Agency for Accounting and Control of Nuclear Materials (ABACC) and the IAEA entered into force upon completion of the ratification procedures. On 30 May Brazil became a full party to the Treaty of Tlatelolco by depositing its instruments of ratification of the Treaty amendments and waiving the entry into force provision. Dominica, Belize and Chile also ratified in 1993–4, resulting in the Treaty having 29 parties by early 1995. As a consequence of these decisions, Cuba signed the Treaty in March 1995.

In 1993, the CD did not convene its Ad Hoc Committee on Radiological Weapons, and the issue of prohibiting military attacks on civilian nuclear facilities slipped from the agenda.

On 14 September 1994 Indonesia submitted a letter to the Chair of the Third Preparatory Committee (PrepCom) for the 1995 NPT Review and Extension Conference held in Geneva, which transmitted a document prepared by the Group of Non-Aligned and other States on Substantive Issues. The document contained the following two paragraphs on NWFZ:

> the nuclear-weapon states should 'abide and adhere to those international instruments that have established nuclear-weapon-free zones, and to support the initiatives taken by a State or States Parties with a view to establishing nuclear-weapon-free zones, freely arrived at among States of the region concerned, particularly in the regions of the Middle-East and Africa.
>
> Furthermore, deployments of nuclear weapons by NWSs on foreign territories, particularly in NNWSs territories, should be prohibited as it negates the objectives of a nuclear-weapon-free zone. All States that have deployed nuclear weapons outside their boundaries should withdraw all those weapons back to their own territories'.

The document also contained the following statement on security assurances:

> Pending the total and complete elimination of nuclear weapons, unconditional security assurances to the NNWSs has been regarded as one of the major concerns. In the context of an acceptable balance of mutual responsibilities and obligations, it is the primary right of States Parties to the NPT to be assured of non use and threat of use of nuclear weapons. Nuclear Weapon States Parties should agree to a legally binding instrument on this issue before the 1995 Conference. The CD should intensify negotiations with a view to concluding an international convention to assure non-nuclear-weapon States against the use or threat of use of nuclear weapons.

The United States and the Democratic People's Republic of Korea signed an agreement on 21 October 1994 in which (a) the United States provided formal security assurances to the DPRK against the threat or use of nuclear weapons and (b) the DPRK agreed to take steps to implement the North–South Joint Declaration on the Denuclearization of the Korean Peninsula.

At the Budapest Summit of the Conference on Security and Co-operation in Europe (CSCE), held on 5 December 1994, the Russian Federation, the United States and the United Kingdom issued a Joint Declaration containing a Memorandum on Security Assurances for Belarus, Kazakhstan and Ukraine in connection with all three states' accession to the NPT. On the same day France made a unilateral declaration containing formal security assurances to Ukraine.

In February 1995 China gave security guarantees to Kazakhstan. These committed it not to use or threaten to use nuclear weapons against Kazakhstan, and called upon other nuclear weapons states to give similar assurances 'so as to enhance the security of all non-nuclear-weapon states, including Kazakhstan'.

On 6 April 1995, shortly before the opening of the Review and Extension Conference of the NPT, China and France addressed individual letters to the Secretary-General of the United Nations, annexing the contents of the unilateral declarations on security assurances each had issued the previous day to the Conference on Disarmament in Geneva. The United Kingdom did the same in reference to its declaration of 6 April 1995 on this subject. The letter from China repeated that country's no-first-use pledge and refered to 'complete prohibition and thorough destruction of nuclear weapons'. On the same day, the Russian Federation transmitted a similar letter to the Secretary-General annexing the contents of two statements on security assurances made by a representative of its Ministry of Foreign Affairs on 5 April 1995. The second of these statements affirmed Russia's intention not to use nuclear weapons against non-nuclear-weapon State parties to the NPT, unless such a state or states were to mount an attack in association with a nuclear-weapon state on Russian territory, forces, allies or states towards which it has a security commitment. The United States also addressed a letter to the Secretary-General of the United Nations that day annexing the contents of a statement by its Secretary of State regarding a declaration by its President on security assurances.

On 11 April 1995 the United Nations Security Council unanimously adopted resolution 984 on security assurances, sponsored by the five nuclear-weapon states.

Fifth NPT Review and Extension Conference — 1995

Among the decisions taken by the NPT Conference in New York from 17 April to 12 May 1995 was one on *Principles and Objectives for Nuclear Non-Proliferation and Disarmament.* This reiterated that the development of nuclear-weapon-free zones 'especially in regions of tension, such as the Middle East, as well as the establishment of zones free of all weapons of mass destruction should be encouraged as a matter of priority, taking into account the specific characteristics of the each region', and indicated that the establishment of additional nuclear-weapon-free zones 'by the time of the Review Conference in the year 2000 would be welcome'. It also stated that 'The cooperation of all the nuclear-weapon States and their respect and support for the relevant protocols is necessary for the maximum effectiveness of such nuclear-weapon-free zones and their relevant protocols'.

In the field of security assurances the decision stated that 'further steps should be considered to assure non-nuclear-weapon states party to the Treaty against the use or threat of use of nuclear weapons' and that these 'could take the form of an internationally legally binding instrument'.

The Conference also adopted a 'Resolution on the Middle East' sponsored by Russia, the United States and the United Kingdom. In this, the states in the Middle East are called upon by the Conference 'to take practical steps in appropriate forums aimed at making progress towards, *inter alia*, the establishment of an effectively verifiable

Middle East zone free of weapons of mass destruction, nuclear, chemical and biological, and their delivery systems, and to refrain from taking any measures that preclude the achievement of this objective'.

As there was no Final Declaration in 1995, no consensus language on security assurances or NWFZs was adopted by the Conference in that context.

Security Assurances and NWFZ developments 1995–1997

Between 29 May and 2 June 1995, the final draft of the Pelindaba Treaty, the document creating a nuclear-weapon-free zone in Africa, was agreed in Johannesburg and Pelindaba, South Africa. It was endorsed by African Heads of State meeting in Addis Ababa later in June.

On 12 December 1995 the UN General Assembly passed a resolution introduced by Egypt that urged Middle Eastern countries to join the NPT and establish a regional nuclear-weapon-free zone.

On 15 December 1995 the Southeast Asia Nuclear-Weapon-Free Zone (SEANWFZ) treaty was signed in Bangkok by leaders of the then seven ASEAN nations, as well as the other three states in the region. Article 1 of the Treaty defined the Zone as comprising the territories of all states in Southeast Asia and their respective continental shelves and exclusive Economic Zones (EEZ). Through a Protocol to the Treaty, the five nuclear-weapon states could commit themselves not to violate the Treaty and to provide negative security assurances to the States Parties. After the signing ceremony some of the nuclear-weapon states expressed reservations about restrictions on freedom of navigation and other matters that they believed were inherent in the Treaty text.

In February 1996 Australia's Minister of Foreign Affairs called for the establishment of a nuclear-weapon free area in the Southern Hemisphere. His proposal was to link the NWFZ created in the South Pacific, Latin America and Africa by the Treaties of Rarotonga, Tlatelolco and Pelindaba respectively, so as to create a 'super nuclear-weapon-free zone'.

On 25 March 1996, France, the United Kingdom and the United States joined China and the Russian Federation as signatories of the three protocols to the Treaty of Rarotonga, the South Pacific Nuclear-Free Zone Treaty. These were ratified by the United Kingdom on 19 September 1997.

On 11 April 1996 the Pelindaba Treaty was opened for signature by the 53 states of the OAU at a ceremony in Cairo. Entry into force will occur when it has been ratified by 28 states. Article 1 of the Treaty defines the zone as 'the territory of the continent of Africa, islands States members of OAU and all islands considered by the Organisation of African Unity in its resolutions to be part of Africa'. The zone encompasses the land territory, internal waters, territorial seas, archipelagic waters, and associated air space and sea bed only. Protocol I of the Treaty contains negative security assurances from the five nuclear weapons states, while Protocol II bans them from testing or promoting the testing of nuclear explosives in the zone. China, France, the United Kingdom and the United States signed these protocols at the time of the opening ceremony in Cairo. Russia attended the signing ceremony but did not sign until May. It cited the presence of a US military base on the island of Diego Garcia as the cause of the delay. Protocol III, covering territories within the zone for which non-African states have responsibility, was signed by France but not by Spain.

Sixth NPT Review Conference — 2000

The 1997 session of the Preparatory Committee for the 2000 NPT Review Conference included the following text in the 'Chairman's Working Paper' under the heading 'nuclear-weapon-free zones':

> Welcome for the steps taken to conclude further nuclear-weapon-free-zone treaties since 1995 and reaffirmation of the conviction that the establishment of internationally recognized nuclear-weapon-free zones freely arrived at among the States concerned enhances global and regional peace and security.
>
> Recognition of the importance attached by signatories and States parties to the Treaties of Tlatelolco, Rarotonga, Pelindaba and Bangkok to establishing a mechanism for cooperation among their respective Treaty agencies.

The 'Chairman's Working Paper' includes the following text under the heading 'security assurances':

> Reaffirmation of the view that further steps, which could take the form of an international legally binding instrument, should be considered to assure non-nuclear-weapon States party to the Treaty against the use or threat of use of nuclear weapons.

Chapter 7
Nuclear Safeguards and Physical Protection

Introduction

The initial international legal basis for the IAEA to establish a safeguards system is found in the Statute of the IAEA. Article II of this calls upon the organization to ensure, so far as it is able, that assistance provided by it, at its request or under its supervision or control is not used in such a way as to further any military purpose. Although this Article provides the basis for the IAEA safeguards system, the substance of that system is to be found in safeguards documents agreed between the IAEA and the states concerned.

The basis for the IAEA to implement safeguards under the NPT is contained in Article III and preambular paragraphs 4 and 5. Under Article III(i) of the NPT a non-nuclear-weapon state agrees to accept safeguards implemented by the IAEA, 'for the exclusive purpose of verification of the fulfilment of its obligations assumed under this Treaty with a view to preventing diversion of nuclear energy from peaceful uses to nuclear weapons or other nuclear explosive devices'. When the NPT entered into force in 1970, the IAEA negotiated a new safeguards document to encompass the specific obligations pursuant to this Treaty.

Although discussion related to the physical protection of nuclear material has been a perennial theme on the international agenda, this area has been the sole prerogative of national governments and the IAEA has acted primarily as a standard-setting organization for guidance on the minimum measures to be adopted by those governments.

The safeguards and physical protection concepts

The term nuclear safeguards is really a misnomer as these measures are not designed to guard anything safely. Measures to prevent unauthorized or criminal acts such as theft, sabotage, hijacking, terrorist attack, or forcible seizure involving nuclear material, are the sovereign prerogative of states and are referred to as measures for physical protection.

Nuclear safeguards, as they have evolved, have encompassed both assurance and deterrent philosophies. Nuclear safeguards are predominantly regarded as an attempt to: **build confidence** in the international community by providing assurances that a state is faithfully abiding by its international obligations, such as a treaty commitment (the assurance of compliance function); and, **deter** any breaches of international obligations by implementing measures designed to detect diversion of nuclear materials at an early date and thereby subject the violator to possible future recrimination (the deterrence function).

The aims and methods of IAEA safeguards can be summarised as follows:

- to detect the diversion of a significant quantity (SQ) of nuclear material — i.e., sufficient to make one crude bomb, defined as 8kg of plutonium (Pu) or 25 kg of high-enriched uranium (HEU);
- to make these detections within a conversion time — i.e., the minimum time needed to build a bomb with the diverted fissile material; and
- to inspect the accounting records of member states and compare amounts of nuclear material that appear on the books with the quantities the IAEA measures during inspections (these periodic inspections are supplemented with containment and surveillance methods, such as still cameras, video systems and tamper proof seals).

Physical protection measures share some of the same requirements as those devised for safeguards implementation, such as ensuring adequate containment of nuclear facilities to prevent theft or clandestine diversion and the development of sturdy containers for storage of nuclear materials. The two concepts diverge because physical protection measures usually require: trained and armed personnel with formal policing powers; security alarm systems; perimeter fencing and monitoring; and specially designed vehicles for transportation use. The more sensitive the facility or nuclear material the more stringent must be the measures for physical protection.

Safeguards and physical protection developments 1970–1975

In March 1971 a special committee established by the IAEA drafted the model NPT safeguards document, INFCIRC/153, or 'The Blue Book' as it is otherwise known. This document provides the basis for all safeguards agreements negotiated by the IAEA with non-nuclear-weapon states party to the NPT. These agreements must be concluded within eighteen months from the time of accession to the Treaty.

During negotiation of the NPT and INFCIRC/153, it was decided that human inspection would be kept to a minimum. Safeguards applied under the NPT consequently focused on the **flow of nuclear material (both source and special fissionable material)**, measured at strategic points within a nuclear facility, by instruments rather than human inspectors. This strategy was designed to minimize intrusion, interference and the risk of industrial espionage by IAEA inspectors.

By focusing on the flow of nuclear material, INFCIRC/153 safeguards became a system of material accountancy geared to the quantity and fissile characteristics of nuclear material moving through a national fuel cycle. Seventy per cent of the IAEA's safeguards budget was consequently absorbed in applying safeguards in three states — Canada, Germany and Japan — and another sizable share in states that have relatively large nuclear programmes — such as Belgium, Sweden and Spain.

Another consequence of the material accountancy strategy was that the safeguards system was material oriented. The system assessed each plant (specifically, each 'material balance area' [MBA] within the plant), rather than the total nuclear picture of a state. It was the amount of nuclear material in each MBA which determined the frequency of inspection. This generated some serious anomalies. For example, in a situation where a state has enough separated fissile material to make a nuclear explosive device, if the material was divided roughly equally between two plants or two MBAs, inspections would be once a year for each MBA. If the material was located in a single MBA, the inspection frequency would be twelve times a year.

Once a non-nuclear-weapon state has adhered to the NPT, it is required to make an initial declaration to the Agency of all nuclear material under its jurisdiction. IAEA inspectors then visit the facilities and stores containing nuclear material to verify the accuracy and completeness of this initial report. The Agency then draws up a facility attachment specifying the strategic points in the facility or store where its inspectors will conduct future routine inspections. If, subsequently, a serious loss of material is reported or detected, or the information provided by the state is regarded by the IAEA as inadequate, the Agency may carry out special inspections at any location in the state where it has good reason to believe that a proscribed activity is taking place or unreported material is present. Until 1993 the IAEA did not make any use of this right.

Monthly reports are sent to the IAEA of any changes in the inventory of each MBA. From these reports the Agency is able to calculate what material should be in every MBA designated within a nuclear facility. At regular intervals, and in the presence of IAEA inspectors, the plant manager measures the actual amount and composition of the material in each MBA. Any significant difference between the amount of nuclear material that should be in a particular MBA and the amount that actually is there, has to be accounted for. If the loss of a SQ cannot be satisfactorily explained, a diversion of material may be suspected.

IAEA inspectors also carry out the following procedures. They draw a comparison between the operating records of the facility and the reports the manager has sent to the Agency; ensure that seals placed on parts of the facility or stores are intact; and check that the records made by surveillance instruments indicate no unreported movements of material. Samples of nuclear material may be taken to verify that its composition is what has been reported. The NPT INFCIRC/153 verification system concentrates upon nuclear material, rather than other aspects of nuclear weapon manufacture, for three main reasons: nuclear material is the feed stock for nuclear weapon manufacture; it is in short supply; and it can be relatively easily monitored.

An international safeguards system cannot physically prevent a state from diverting nuclear materials or producing them secretly. The objective of the system is to provide international assurance of '...the timely detection of the diversion of significant quantities of nuclear material from peaceful nuclear activities to the manufacture of nuclear weapons ...' and to deter such diversion 'by the risk of early detection'. If a diversion is detected it would be for the parties to the Treaty, acting singly or collectively through the UN Security Council, to take appropriate action.

Specific withdrawal of nuclear material from safeguards for use in non-explosive military activities, such as reactors for nuclear submarines, is not excluded under the provisions of INFCIRC/153, although withdrawal is subject to strict conditions set out in Article 14. So far no state has invoked this right.

To take account of the particular circumstances of the European Economic Community (now European Union [EU]), where a regional safeguards system had been established under the auspices of the European Atomic Energy Community (EURATOM), a variation of the model NPT-safeguards document was subsequently negotiated. This document, INFCIRC/193, was signed by the IAEA, EURATOM and the seven non-nuclear-weapon state members of EURATOM (Belgium, Denmark, the Federal Republic of Germany, Ireland, Italy, Luxembourg and the Netherlands) in April 1973.

INFCIRC/193 was designed to allow for the implementation of nuclear safeguards under the terms of Article III(i) and (iv) of the NPT in the EU non-nuclear-weapon states parties to the Treaty. This document does not apply to the two nuclear-weapon states in the European Community, the United Kingdom and France. For these states, separate 'voluntary offer' safeguards documents were later agreed. INFCIRC/193 contains much the same basic safeguards language as INFCIRC/153 but makes specific allowance for the regional and multinational nature of the EURATOM safeguards system. The IAEA and EURATOM both apply their own system of safeguards at facilities in the non-nuclear-weapons states of the EU, although the agreement designates that EURATOM conducts more inspections than the IAEA. At more sensitive facilities, however, the concept of joint-inspection teams operates, with the two organizations combining safeguards resources to conduct regular inspections. Information derived from these inspections allows the IAEA to form its own independent conclusion concerning nuclear activities in the Community.

In 1975 the Director General of the IAEA established the Standing Advisory Group on Safeguards Implementation (SAGSI) to evaluate the IAEA's safeguards operation. SAGSI has continued in an advisory role and has made several recommendations relating to, *inter alia*, data management, reporting and organization of the safeguards division.

In 1971, the IAEA established an Advisory Group of Experts to assess the problem of physical protection and make recommendations for possible improvements to existing measures. This recognized a need for measures, supplementary to the IAEA's safeguards systems, to meet the potential threat of theft of nuclear material or sabotage of nuclear facilities. The IAEA Advisory Group produced a set of recommendations relating to the physical protection of nuclear material (when in use, transit and storage) in 1972. These were subsequently amended and published by the IAEA in 1975 as a guide to minimum standards that states should adopt for the physical protection of nuclear materials.

First NPT Review Conference — 1975

Developments in safeguards and physical protection were major themes in 1975 and these were well reflected in the Final Declaration. The Conference:

- noted that the IAEA's safeguards system did not infringe the sovereign rights or hamper the economic, scientific or technological development of states parties;
- expressed its full support for effective IAEA safeguards;
- recommended that more support be given to improving safeguards and that measures should also be taken to 'restrict within appropriate limits the respective shares of developing countries in safeguards costs';
- that 'due regards' should be paid 'to the importance of recruiting the staff on as wide a geographical basis as possible' and that safeguards training should be made available to personnel from all geographic regions; and
- urged that action should be taken within the IAEA to elaborate further 'concrete recommendations for the physical protection of nuclear material in use, storage and transit, including principles relating to the responsibility of States, with a view to ensuring a uniform, minimum level of effective protection for such material'.

Safeguards and physical protection developments 1975–1980

Before INFCIRC/193 could be implemented in the European Economic Community it was necessary to make changes to certain Community regulations. A new document, Regulation 3227/76, was consequently drafted to accommodate these changes and entered into force in December 1976.

Following Japan's ratification of the NPT in 1976, the IAEA negotiated a separate agreement with its government, INFCIRC/255, which provided a safeguards framework similar to the one agreed with EURATOM. This document entered into force in December 1977.

In September 1977 the IAEA completed its first Safeguards Implementation Report (SIR). The SIR was initiated on the advice of SAGSI so that IAEA Member States would have an annual evaluation of the Agency's safeguards operation, highlighting any difficulties encountered over implementation. The SIR is divided into two separate reports: one is a general report giving statistics and broad conclusions about safeguards performance in a particular year and recommendations for improvement; the other is a more specific report available to senior IAEA personnel for evaluation purposes.

When the NPT was in the final stages of negotiation, concern was expressed by several industrialised non-nuclear-weapon states that the imposition of safeguards was likely to place an additional economic burden on their nuclear industries. These states argued that this burden would place them in an unfavourable trading position in relation to the nuclear-weapon states. They also asserted that safeguards would increase the possibility of industrial espionage and jeopardise the confidentiality of both proprietary information and contractual relationships. To meet these objections, the United Kingdom and the United States agreed to place their civil nuclear industries under IAEA safeguards. This was not required under the terms of the NPT because both were categorized as nuclear-weapon states. Hence, the safeguards documents thus concluded were generally referred to as 'voluntary offer' agreements. A safeguards agreement was negotiated between the IAEA and the United States in November 1977 and came into force in 1980 (INFCIRC/288). In the case of the United Kingdom, the negotiation of an acceptable safeguards document also had to involve EURATOM, which it had joined in 1973. An agreement between the United Kingdom, the IAEA and EURATOM entered into force in August 1978 (INFCIRC/263). In July 1978, France, at that time a member of the European Community but not a party to the NPT, concluded its own safeguards agreement with EURATOM and the IAEA (this agreement entered into force in September 1981 [INFCIRC/290]).

In 1980 the IAEA issued the document *Guidelines for States' Systems of Accounting for and Control of Nuclear Materials* (or SSACs as these systems are known) which provided guidance for the organization and functions of SSACs designed to meet the obligations of states arising from safeguards agreements.

Between 1977 and 1979, a draft convention on physical protection was prepared and circulated by the Director General of the IAEA and a number of meetings were held under IAEA auspices to negotiate a final text. The Convention on the Physical Protection of Nuclear Material was opened in March 1980 for signature and entered into force on 8 February 1987. It is concerned with preventing the unlawful seizure and use of nuclear material by establishing agreed conditions for its safe transfer and storage. The Convention applies primarily to nuclear material used for peaceful purposes which is in transit between states, but certain provisions also apply to nuclear material used for peaceful purposes while in domestic use and in storage. Finally, the Convention makes provision for review conferences to be held at periodic intervals of not less than five years.

Second NPT Review Conference — 1980

Although the 1980 Review Conference did not reach a consensus Final Declaration, there was nevertheless extensive discussion on safeguards and physical protection during the review of Article III and preambular paragraphs 4 and 5. In its draft report on these discussions, the Conference:

- noted that no diversion of nuclear material had been identified by the IAEA;
- expressed satisfaction that safeguards did not hamper the economic, scientific or technological development of parties;
- emphasized that continual improvements in safeguards were necessary to handle an increasingly complex nuclear fuel-cycle;
- disagreed over whether full-scope safeguards should be made a condition of nuclear supply to non-NPT parties;
- agreed that all non-nuclear-weapon states not party to the Treaty should submit all their nuclear activities to IAEA safeguards; and
- welcomed the opening for signature of the Convention on Physical Protection and urged all parties to become members at an early date.

Safeguards and physical protection developments 1980–1985

In November 1980 the Hexapartite Safeguards Project (involving the IAEA, EURATOM, Australia, the Federal Republic of Germany, Japan, the Netherlands, the United Kingdom and the United States), was initiated to devise a system of safeguards for centrifuge enrichment plants. The Project was successfully concluded in 1983.

In June 1981, Israel carried out an air attack on Iraq's uncompleted OSIRAK reactor. The reactor was damaged but the irradiated fuel which was on-site at the time of the attack remained intact and under safeguards. The attack was condemned by the United Nations General Assembly and the Security Council, and by the IAEA's Board of Governors.

In 1981 and 1982 two studies were published on the application of safeguards at reprocessing plants. The first was a 1981 Overview Report of the International Working Group on Reprocessing Plant Safeguards. This was followed by the TASTEX (Tokai Advanced Safeguards Technology Exercise, involving the IAEA, France, Japan and the United States) Technical Report (1982).

In the period 1980 to 1984, as in previous years, the IAEA stated that it 'did not detect any anomaly which would indicate the diversion of a significant amount of safeguarded material — or the misuse of facilities or equipment subject to safeguards under certain agreements — for the manufacture of any nuclear weapon, or for any other military purpose, or for the manufacture of any other nuclear explosive device, or for purposes unknown. With the exception of two cases where the Agency was unable to draw conclusions during part of the period 1980 to 1983 (which had subsequently been rectified), 'the Agency considered it reasonable to conclude that the nuclear material under Agency safeguards during the period 1980 to 1984 remained in peaceful nuclear activities or, with the exception of one case in 1984' (where an export of depleted uranium had not been duly notified to the IAEA but was later made available to the Agency for examination by the recipient state), 'was otherwise adequately accounted for.'

In February 1985, the former Soviet Union concluded a safeguards agreement with the IAEA (INFCIRC/327) under the 'voluntary offer' arrangements.

Third NPT Review Conference — 1985

IAEA safeguards were a major theme at the 1985 Review Conference. This was reflected in the Final Declaration which devoted 22 paragraphs to the issue. The section dealing with the Review of Article III and preambular paragraphs 4 and 5 stated that the Conference:

- expressed the conviction that IAEA safeguards provided assurance that [NPT parties] were complying with their undertakings and played 'a key role in preventing the proliferation of nuclear weapons and other nuclear explosive devices. Unsafeguarded nuclear activities in non-nuclear-weapon States pose serious proliferation dangers';
- expressed its satisfaction that four of the five nuclear-weapon states had concluded voluntary safeguards agreements with the IAEA;
- recommended that all non-nuclear-weapon state parties to the Treaty concluded agreements with the IAEA as soon as possible;
- noted the improvements in IAEA safeguards mechanisms; and
- called upon all states to 'take IAEA safeguards requirements fully into account while planning, designing and constructing new nuclear fuel cycle facilities and while modifying existing nuclear fuel cycle facilities'.

In the section dealing with the Review of Article IV and preambular paragraphs 6 and 7, the Conference also:

- expressed 'its profound concern about the Israeli military attack on Iraq's safeguarded nuclear reactor on 7 June 1981';
- recognized that 'an armed attack on a safeguarded nuclear facility, or threat of attack, would create a situation in which the Security Council would have to act immediately in accordance with the provisions of the United Nations Charter';
- encouraged parties to 'be ready to provide immediate peaceful assistance in accordance with international law to any Party to the NPT, if it so requests, whose safeguarded nuclear facilities have been subject to an armed attack'; and

- considered that such attacks could involve grave dangers due to the risk of the release of radioactivity and that such attacks or threats of attack jeopardize the development of the peaceful uses of nuclear energy'.

The 1985 Final Declaration also had two statements attached, one by the Representative of the Islamic Republic of Iran, the other by the Representative of Iraq. These statements were a product of an agreement of the Conference on 21 September 1985. They concerned alleged attacks by Iraq on Iran's uncompleted Bushehr nuclear power facility.

Safeguards and physical protection developments 1985–1990

In October 1988 the Federal Republic of Germany, France, Japan, the United Kingdom and the United States established the LASCAR (Large Scale Reprocessing) group to assist the IAEA develop safeguards for the new generation of large reprocessing plants.

China concluded a safeguards document with the IAEA which entered into force in September 1989 (INFCIRC/369). This document meant that all five nuclear-weapon states had concluded voluntary safeguards agreements with the IAEA. Each of these agreements include provisions defining what facilities and materials are designated for safeguards and therefore differ significantly from those agreements concluded by the IAEA with non-nuclear-weapon states pursuant to the NPT.

In 1989, the IAEA carried out 2,200 safeguards inspections worldwide. It also stated, as in previous years, that it had detected no diversion 'of a significant amount of safeguarded material to the production of nuclear weapons or other nuclear explosive devices'.

Fourth NPT Review Conference — 1990

Although the 1990 Conference did not reach a consensus Final Declaration, a draft committee report on the review of the relevant articles was later published for information by the IAEA at the request of states attending its 1990 General Conference. This outlined the ideas and proposals concerning safeguards which had been discussed during the review of Article III and preambular paragraphs 4 and 5. Apart from the Conference reaffirming its conviction that IAEA safeguards provide 'a key role in preventing the proliferation of nuclear weapons', it also:

- called upon states parties 'to continue their political, technical and financial support of the IAEA safeguards system in order to ensure that the IAEA is able to meet its international legal obligations pursuant to safeguards agreements under the Treaty, and its increasing safeguards responsibilities';
- recognized the 'importance of State systems of accounting and control and of the EURATOM system, and of co-operation between these systems and the IAEA';
- welcomed the entry into force of the Convention on the Physical Protection of Nuclear Material and noted that in the context of physical protection, 'particular attention must be paid to material of direct use, including separated plutonium';
- called on the nuclear-weapon states to 'maintain the highest standards of security and physical protection of nuclear weapon systems and materials';
- recognized the non-proliferation benefits of the conversion of research reactors from high enriched uranium to low enriched uranium fuel;
- expressed concern that 51 states parties had not yet concluded safeguards agreements with the IAEA pursuant to the NPT and urged them to do so;
- called for the 'wider application of safeguards in the nuclear-weapon States' and for 'substantial progress towards the separation of the peaceful and military nuclear facilities' in these states; and
- recognized that 'in the event of questions arising about the commitment to the non-proliferation objectives of the Treaty of any State Party, and in particular about the safeguards coverage of its source or special fissionable materials, there are several courses of action open to the Agency', and urged that the Agency take full advantages of its rights, 'including the use of special inspections as outlined in paragraphs 73 and 77 of INFCIRC/153'.

Safeguards and physical protection developments 1990–1995

Iraq

In April 1991 the United Nations Security Council adopted resolution 687 which set the terms of the 1991 Persian Gulf War cease-fire. The Resolution obliged Iraq to refrain from acquiring or developing nuclear weapons or nuclear-weapons usable material and to inform the UN and the IAEA of the whereabouts of all facilities and materials related to such weapons on its territory. It also required these facilities and materials to be rendered harmless, destroyed or removed, as appropriate. An Action Team established by the IAEA visited Iraq's Al-Tuwaitha nuclear complex for the first time in May 1991. All declared nuclear material was found to be present. However, by the end of September 1991, inspectors uncovered evidence that led them to conclude that Iraq had maintained a nuclear weapons programme which was a violation of its NPT commitments, and subsequently paid many visits to Iraq to extract further information on its clandestine nuclear-weapon activities, which proved to have been extensive. Arrangements were then made to render harmless or remove, to the extent possible, the facilities and materials involved.

Democratic People's Republic of Korea

In January 1992 the Democratic People's Republic of Korea (DPRK) signed its safeguards agreement with the IAEA. The agreement was ratified by the DPRK's Parliament in April, and in May 1992 the DPRK provided the IAEA with its initial inventory of facilities and materials. This inventory included a radiochemical laboratory conducting research on the separation of uranium and plutonium. Between May and September 1992 the IAEA carried out three *ad hoc* inspections of declared DPRK facilities to verify the initial report. Analyses by the Agency and cooperating laboratories showed anomalies related to the plutonium samples given by the DPRK to the IAEA. In February 1993 the IAEA Board of Governors requested that the DPRK allow the Agency to conduct a special inspection at two facilities to clarify anomalies related to the DPRK's nuclear activities. On 12 March 1993 the DPRK announced its intention to withdraw from the NPT 'in accordance with paragraph 1 of Article X of the NPT, which jeopardizes its supreme interests'. The DPRK suspended its withdrawal from the NPT on 12 June 1993 and stated that it would continue to allow the IAEA to apply safeguards.

On 21 March 1994 the IAEA Board of Governors adopted a resolution which found the DPRK in further non-compliance with its safeguards obligations and requested that the DPRK allow the Agency's inspectors to complete their inspection activities and asked its Director General to transmit the resolution to the UN Security Council. On 31 March 1994 the President of the UN Security Council issued a statement which requested the DPRK to allow the IAEA inspectors to complete their inspection activities as a step in fulfilling its obligations under its safeguards agreement with the IAEA and in honouring the non-proliferation obligations of the Treaty. The DPRK stated on 13 June 1994 that it would withdraw immediately from the IAEA and terminated the Agency's right to conduct inspections on its territory. The next day, former president of the United States Jimmy Carter visited the DPRK and an understanding was reached whereby the DPRK would allow full transparency of its nuclear programme. In an effort to resolve the dispute over the DPRK's nuclear programme and safeguards access, the United States and the DPRK resumed their on-going bilateral dialogue in August 1994 in Geneva. On 21 October 1994, following a period of negotiation which had begun on 23 September, the two parties signed an 'Agreed Framework' which provided for a step-by-step approach to resolve all outstanding nuclear issues, including safeguards access by the IAEA. This 'Framework' was to be implemented over a period of several years. Part of the agreement provided for replacement of the DPRK's graphite-moderated reactor technology light water reactors. To implement this arrangement, a consortium, the Korean Peninsula Energy Development Organization or KEDO was established by Japan, the Republic of Korea and the United States. Other states joined subsequently.

South Africa

A safeguards agreement between the IAEA and South Africa entered into force in September 1991. In September 1992 the Director General of the Agency submitted a report to the IAEA General Conference on the completeness of the inventory of South Africa's nuclear installations and materials. The report stated that the Agency had found no evidence that the Initial Report provided by South Africa was incomplete. It was later confirmed, by President F.W. de Klerk on 24 March 1993, that South Africa had possessed six nuclear devices in 1989 but had subsequently dismantled them before acceding to the NPT. At the Agency's General Conference in September 1993, the Director General of the IAEA reported that all the high-enriched uranium in South Africa's nuclear weapons programme had been returned to South Africa's Atomic Energy Corporation and was subject to Agency safeguards. An IAEA inspection team had found no evidence to suggest that there remained any sensitive

component of the former weapons programme which had not been either dismantled or converted for peaceful use.

Latin America

In July 1991 Argentina and Brazil signed an agreement to establish the Joint System of Accounting and Control of Nuclear Materials to be overseen by ABACC. A Quadripartite Agreement between Argentina, Brazil, ABACC and the IAEA was subsequently signed in November 1991 which provides for full-scope safeguards to be applied by the IAEA in co-operation with ABACC.

In February 1992 Argentina and Brazil, and later Chile, proposed amendments to Articles 14, 15, 16, 19 and 20 of the Treaty of Tlatelolco, to facilitate its entry into force, which were designed to change the verification procedures of the Treaty so that the IAEA, rather than the Agency for the Prohibition of Nuclear Weapons in Latin America (OPANAL), would have the sole responsibility of undertaking special inspections. On 26 August 1992 a special session of OPANAL approved the amendments to the Treaty of Tlatelolco which had been proposed in February by Argentina and Brazil.

Strengthening of Safeguards and Additional Physical Protection Measures

In February 1992 the IAEA Board of Governors re-affirmed the IAEA's right: to undertake special inspections and have access to the necessary locations; to obtain early design information on new facilities and on major modifications to existing ones; and to have access to additional information from states accepting comprehensive safeguards and from other sources.

A new partnership approach between the IAEA and EURATOM concerning the implementation of safeguards in the European Community was announced in April 1992.

In late September 1992 the IAEA convened a Review Conference on the Convention on the Physical Protection of Nuclear Material in Vienna. The parties to the Convention unanimously reaffirmed that it provided:

- a sound basis for physical protection during international transport;
- an appropriate framework for co-operation between states not only in protection, but also in the recovery and return of any stolen nuclear material;
- an appropriate framework for international co-operation in the application of criminal sanctions against any person who may commit criminal acts involving nuclear material; and
- an important basis for bilateral consultations to co-ordinate parties' responsibilities under the Convention.

Other Developments

A ship, the *Akatsuki Maru*, especially designed to transport plutonium, was used in November 1992 for the first shipment of plutonium transferred by sea between France and Japan for use in the latter state's civil nuclear power programme. The ship was escorted by a ship from Japan's Maritime Safety Agency.

On 30 April 1993 a joint working group of the IAEA and the International Maritime Organization adopted a draft code for the safe carriage on board ships of irradiated nuclear fuel, plutonium and high-level radioactive waste.

On 17 June 1994, the Convention on Nuclear Safety was adopted in Vienna. The objectives of the Convention are: to achieve and maintain a high level of nuclear safety worldwide through the enhancement of national measures and international co-operation; to establish and maintain effective defences in nuclear installations against potential radiological hazards; to prevent accidents with radiological consequences; and to mitigate such consequences should they occur.

In January 1995 the IAEA issued a report summarizing its nuclear materials accounting and control procedures in the former Soviet republics, many of which lacked appropriate nuclear infrastructures following the break up of the Soviet Union. The main goal of the IAEA was to ensure that each state operated a national system of accounting and control and that it was properly maintained.

In late March 1995 the IAEA Board of Governors considered a set of proposals by the Agency's Secretariat, known as 'Programme 93+2', for a strengthened and cost-effective safeguards system. After long debate the Board endorsed the direction of 'Programme 93+2' and reached consensus on the general thrust of the proposed

new system. This was that it should provide for verification by the Agency of the 'correctness and completeness' of declarations by states party to comprehensive safeguards agreements, so that there was credible assurance of the non-diversion of nuclear material from declared facilities and of the absence of undeclared activities. The Board asked the Secretariat to submit specific proposals on the implementation of the Programme for consideration at its meeting in June 1995.

NPT Review and Extension Conference — 1995

The 1995 Review Conference did not reach a consensus Final Declaration. However, the document on *Principles and Objectives* agreed in association with the extension decision did devote several paragraphs to IAEA safeguards. In them, the States parties affirmed that the IAEA is the competent authority responsible to verify compliance of States parties to the NPT with their safeguards agreements, and asserted that 'Nothing should be done to undermine the authority of the IAEA in this regard'. It also directed that 'States parties that have concerns regarding non-compliance with the safeguards agreements of the Treaty by the States parties should direct such concerns, along with supporting evidence and information, to the IAEA to consider, investigate, draw conclusions and decide on necessary actions in accordance with its mandate'. In addition, all States parties to Treaty which had not yet concluded comprehensive safeguards agreements with the IAEA were called upon to do so, and it also recommended that nuclear fissile material transferred from military use to peaceful nuclear activities should be placed under IAEA safeguards. Finally, it observed that 'attacks or threats of attacks on nuclear facilities devoted to peaceful purposes jeopardize nuclear safety and raise serious concerns regarding the application of international law on the use of force in such cases, which could warrant appropriate action in accordance with the provision of the Charter of the United Nations'.

Safeguards and physical protection developments 1995–1997

In June 1995 the IAEA Secretariat submitted to the Board of Governors a set of proposals on the implementation of the Programme 93+2. The proposals were considered in two parts: activities with which the Secretariat believed it had the authority to proceed with (Part I), and those for which it considered it needed additional authority (Part II). Part I activities included:

- the collection of environmental samples at sites where the IAEA already had the right of access;
- the acquisition of information for which it had not previously asked, including data on parts of the fuel cycle that precede the introduction of safeguarded material into a reactor or enrichment facility, such as mining, processing and conversion plants; and
- information on past operations.

With regard to Part II of the Programme, where the Secretariat sought an extension of existing access arrangements to locations and information, the Board asked the Secretariat to present for discussion at its December 1995 meeting model legal documents through which it might acquire the necessary additional authority. Activities for which the Secretariat considered it necessary to obtain this additional authority included:

- declarations of, and physical access to, locations where activities that are 'functionally' related to fuel cycle operations, such as heavy-water production, exist;
- obtaining full access to sites, rather than just facilities, where a state has declared nuclear materials to be present, to facilitate activities such as environmental sample collection; and
- an expanded declaration giving a complete description of the nuclear fuel cycle.

On 22 September 1995 the 39th Regular Session of the IAEA General Conference adopted a resolution requesting the Director General 'to continue to develop the measures proposed under the '93+2 Programme', and requested him 'to put before the Board of Governors as soon as possible clear proposals for the measures' for which additional authority is required (Part II). On 10-14 June 1996, the Board of Governors discussed Part II of 93+2 and established a Committee to prepare a model protocol on further rights for the Agency with respect to additional information and nuclear related locations. This model protocol would provide complementary legal authority, particularly with regard to unannounced on-site inspections for any nuclear-related installation, and to nuclear and other related technological information; the use of certain sophisticated sensor technologies; and the taking of environmental samples within and outside of declared nuclear sites. On 21 April 1997 the IAEA's Committee on Strengthening the Effectiveness and Improving the Efficiency of the Safeguards System, agreed on the text of the Model Protocol to implement Part II of 93+2. This was approved by the IAEA's Board of Governors, meeting in special session, on 15 May 1997. (The Model Protocol is reproduced in Volume II of the *PPNN Briefing Book.*)

In December 1995 the United States and the European Union released a new Transatlantic Agenda, which obligates both parties to increase their coordinated programmes to prevent nuclear smuggling and enhance nuclear safety in the states of the former Soviet Union, as well as provide G-7 assistance for decommissioning the Chernobyl nuclear power facility. In April 1996 the European Commission announced that nuclear experts from the United States, the European Union and Russia had agreed to cooperate in assisting Russia secure complete control over its nuclear weapons and materials. On 19–20 April 1996 representatives of the G-7 countries met in Moscow to discuss the issues pertaining to nuclear security and safety. (The declaration from this meeting is reproduced in Volume II of the *PPNN Briefing Book*).

The Convention on Nuclear Safety, adopted in June 1994, entered into force on 24 October 1996.

On 5 September 1997, the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management was adopted. It was opened for signature on 29 September 1997.

On 10–14 November 1997, a conference on physical protection of nuclear materials was held at IAEA headquarters in Vienna and was attended by 160 participants from 41 countries.

Sixth NPT Review Conference — 2000

The 1997 session of the Preparatory Committee for the 2000 NPT Review Conference included the following text in the 'Chairman's Working Paper' under the heading 'safeguards':

> Welcome for the conclusion of negotiations on the IAEA 93+2 programme to strengthen the effectiveness and improve the efficiency of the Agency's safeguards system and expectation that IAEA will endorse that outcome at its special session in May; reaffirmation that IAEA is the competent authority responsible for verifying and assuring, in accordance with the statute of the Agency and the Agency's safeguards system, compliance with its safeguards agreements.

Chapter 8
The Peaceful Uses of Nuclear Energy

Introduction

Nuclear technology for peaceful purposes is traditionally divided into five principal areas: mining and processing of nuclear raw materials; the production of enriched uranium; the fabrication of nuclear fuel elements; the design, construction and operation of nuclear reactors; and fuel reprocessing. Apart from the use of nuclear energy to produce electricity from power reactors, it has also been used extensively in agriculture, medicine, industry, biology and hydrology.

The origins of a commitment to develop nuclear energy for peaceful purposes can be traced to President Eisenhower's 'Atoms for Peace' speech in 1953 and the subsequent establishment of the IAEA in 1956. In Treaty terms, this commitment found its most explicit formulation in preambular paragraphs 6 and 7, and Article IV of the NPT.

Article IV has two elements. The first reaffirms the inalienable right of all parties to the NPT 'to develop research, production and use of nuclear energy for peaceful purposes, without discrimination and in conformity with Articles I and II of this Treaty'. The second is a reaffirmation that 'All the Parties to the Treaty undertake to facilitate and have the right to participate in the fullest possible exchange of equipment, materials and scientific and technological information for the peaceful uses of nuclear energy...' and places an obligation on the parties to cooperate in the development of nuclear energy for peaceful purposes'...especially in the territories of non-nuclear-weapon States Party to the Treaty, with due consideration for the needs of the developing areas of the world'.

Peaceful nuclear developments 1970–1975

After INFCIRC/66 came into force the IAEA began expanding its Technical Assistance programme, which continued through the period 1970-1975. The IAEA published details of this programme annually through its reports on *Technical Assistance by the Agency*

This period also witnessed extensive debate within the IAEA over the need for equity between the availability of funding for the Technical Assistance programme and for the Agency's safeguards operations. In 1973, the IAEA initiated an annual document which estimated the total expenditure devoted to 'developing-country oriented' activities. This document included details of assistance provided by the general fund, special contributions, and the activities of the divisions of research and isotopes, operational facilities, and technical operations. This practice was discontinued in 1980.

In 1970 the IAEA received 3,600 requests for experts and equipment, of which 36.8% were approved (a total of 1,250). By 1975 this number had risen to 7,264 requests with 42.5% being granted (a total of 3,085).

First NPT Review Conference — 1975

At the First NPT Review Conference two background papers on Article IV were prepared by the UN Secretariat and the IAEA and these formed the basis for discussion. The Final Declaration, agreed by consensus in 1975, reaffirmed the two elements of the Article and recognized the growing needs of developing states for special assistance in the field of peaceful nuclear energy both 'bilaterally and through such multilateral channels as the IAEA and the United Nations Development Programme'. The Declaration also recommended that decisions on granting such assistance should 'give weight to adherence to the Treaty by recipient States'. It also recognized the potential that regional or multinational fuel cycle centres might play in the development of nuclear energy for peaceful purposes and welcomed the IAEA's studies in this area.

Peaceful nuclear developments 1975–1980

In the mid-1970s much discussion centred on assurances of nuclear fuel supply and the possibility of creating regional nuclear-fuel-cycle centres. One proposal that emerged was for an International Nuclear Fuel Authority (INFA) to be established under the auspices of the IAEA. This Authority would act as a fuel bank and guarantee the supply of nuclear fuel to states that acceded to the NPT and who also undertook to abstain from sensitive

nuclear operations, such as reprocessing or enrichment. Although INFA never materialized in an international context, the idea was later embodied within the domestic law of the United States when its Congress passed the Nuclear Non-Proliferation Act (NNPA) in 1978.

In October 1977, the International Nuclear Fuel Cycle Evaluation (INFCE) was initiated, largely as a consequence of pressures arising from the United States to strengthen the technological base of the nuclear non-proliferation regime. INFCE met between 1977 and 1980 with the objective of providing an inter-governmental assessment of the technical relationship between civil nuclear power programmes and the proliferation of nuclear weapons. The principal purpose of this assessment was to try and discover a nuclear fuel cycle that would present greater barriers to diversion for military use than those then operating. The Evaluation focused on the following aspects: an overall assessment of the nuclear fuel-cycle; measures to improve assurances of supply to developing states; spent-fuel storage; improvements to nuclear safeguards; and alternatives to an international nuclear economy based on plutonium and highly-enriched uranium.

Concern about an emerging international plutonium economy led the IAEA in 1978 to establish a Committee on International Plutonium Storage (IPS). This Group of Experts considered the possibilities for implementing such a concept using the provision in the IAEA Statute (Article XII.A.5) which calls for plutonium, surplus to national needs, to be temporarily deposited with the Agency to prevent any one state accumulating large separated plutonium stockpiles. This strategy had also been discussed in INFCE, where it was envisaged that excess plutonium would be placed under international inspection and control until it was required for use in civil nuclear power applications.

In 1978 the First UN Special Session on Disarmament (UNSSOD-1) also reaffirmed the importance of the non-proliferation of nuclear weapons and concluded that 'International cooperation in the peaceful uses of nuclear energy should be conducted under agreed and appropriate international safeguards applied on a non-discriminatory basis'.

In March 1979 the IAEA published INFCIRC/267 which revised the Agency's guiding principles and general operating rules governing the provision of technical assistance. This revision had resulted from the work of a review group established by the Director General in 1977.

In June 1980 the IAEA Committee on Assurances of Supply (CAS) was established to consider measures to ensure the reliable supply of nuclear material, equipment and technology and to determine the Agency's role in this context. The Committee's agenda included examining the economic and non-economic factors (e.g., government intervention) which influence the international nuclear market; analysing methods to increase the assurances of supply, including multinational fuel-cycle centres, a fuel bank and relief and emergency mechanisms; and assessing common approaches to nuclear cooperation.

The convening of CAS was designed to re-establish a consensus in the area of international nuclear transfers, and to establish a clear link between a commitment to non-proliferation and assured supplies of fuel, equipment and technology. It followed a period when fuel and technology suppliers had sought to impose their own constraints over nuclear trade. The discussions amongst the members of CAS were complicated by the fact that it included some states which were non-parties to the NPT.

CAS initially established two working groups to consider relevant issues. Working Group 1 was tasked with questions concerning 'principles for international co-operation in the field of nuclear energy', while Working Group 2 dealt with 'emergency and back-up mechanisms'. Later, a third working group was added to consider questions of revision mechanisms.

Second NPT Review Conference — 1980

At the Second NPT Review Conference, Main Committee II was again assigned the task of reviewing Article IV. In addition to background papers prepared by the UN Secretariat and the IAEA, Australia, Canada, Denmark, Finland, Hungary, Japan, Malaysia, New Zealand, Norway, Republic of Korea, Sweden, the Netherlands, the Philippines, the United Kingdom, the United States, and the Group of 77 (G-77) all tabled papers relevant to the review of Article IV. The work of both CAS and INFCE was commended in several of these papers, as was the importance of Article IV in enhancing economic development and the role of the IAEA in facilitating technical assistance to developing states. The work of the IAEA Group of Experts on the IPS concept was also welcomed:

> The Conference ... supports an internationally agreed effective scheme for international plutonium storage ... [and] considers that such a scheme for excess plutonium, if well designed, should not jeopardize the promotion of the peaceful uses of nuclear energy, and would make a substantial contribution to non-proliferation as well as to the improvement of the assurance of nuclear supply and the development of common approaches and generally agreed arrangements for international nuclear trade.

In the general debate at the Conference, several parties emphasized that while the promotion of the peaceful uses of nuclear energy could only occur within the framework of an effective non-proliferation regime; there was also a need for measures to more fully implement the provisions of Article IV, especially in respect of the international transfer of technology, equipment and nuclear materials to developing states.

Considerable dissatisfaction was also expressed by a number of developing non-nuclear-weapon state parties, including Ethiopia, Nigeria, the Philippines and Sri Lanka, over what they considered to be the restrictive export control policies of the nuclear suppliers and the lack of sufficient resources for technical assistance to developing states.

The Second NPT Review Conference did not achieve a consensus Final Declaration.

Peaceful nuclear developments 1980–1985

In 1980 the UN General Assembly adopted a resolution (35/112) submitted by a group of developing states to convene a United Nations Conference for the Promotion of International Cooperation in the Peaceful Uses of Nuclear Energy (UNPICPUNE). Originally, it was planned to convene UNPICPUNE in 1983 but it was postponed until 1987 due to differences over its objectives.

In 1982, the Conference on Nuclear Power Experience was held under IAEA auspices in Vienna. This Conference reviewed the operation of nuclear power reactors in the production of electricity. In May 1983 the IAEA also convened a Conference on Radioactive Waste Management in Seattle, United States. At the end of 1983, the IAEA's published details of operating nuclear reactors stated that there were 313 nuclear power units operating in 24 states, of which 12 were units in developing states.

In November 1982 the IAEA Group of Experts, which had met regularly since 1978 to discuss the IPS concept, published its Report. During the four years of discussion, serious disagreements emerged over the definition of the excess plutonium that would have to be deposited, the exact nature and location of the IPS facility, and what mechanism should be used by the IAEA to determine when plutonium might be released to a state. The latter issue led to division between three groups of opinion: those who wished for no conditions to be imposed by the IAEA; those who wanted stringent safeguards applied; and those who wished the IAEA to have the power to refuse to return/release plutonium to a state in certain circumstances.

The Group of Experts Report outlined a basis which they believed would result in a generally acceptable concept. This envisaged that an international plutonium storage scheme should:

- facilitate the development of plutonium-using fuel cycles;
- facilitate the achievement of international non-proliferation objectives;
- not discriminate between states; and
- not adversely affect national energy supplies and plans.

The Report also urged that: an IPS concept be considered as an integral component of the existing IAEA safeguards system and not a new or separate one; excess separated plutonium deposited with the IAEA should be stored at facilities designed as an IPS store within the responsible state; such stores should be located where plutonium usually would be kept, such as at reprocessing plants and mixed oxide fuel fabrication facilities; and transportation of plutonium should be kept to a minimum.

During 1983–84 the IAEA Board of Governors recommended that any system for an emergency and back-up supply mechanism for nuclear materials that had emerged from the CAS, should:

- receive, register and keep records on supplies made available for a back-up mechanism and register and keep records on the conditions for making available and drawing on such supplies;

- provide member states, upon request and to the extent possible, with such information and services as are needed for the implementation of the mechanism; and
- serve, upon request, as an intermediary between a state requesting relief from the mechanism and back-up suppliers.

Third NPT Review Conference — 1985

When the Third NPT Review Conference convened the work was divided into three Main Committees for the first time and issues related to Article IV were assigned to Main Committee III, rather than II as originally had been the case. Background papers on Article IV were prepared by the UN Secretariat and the IAEA. Other working papers were also presented by a group of Western states, Egypt, Iraq, Switzerland, and by the Non-Aligned Group. Although the Conference took place against a declining global interest in nuclear energy, the Final Declaration, agreed by consensus in 1985, did include 24 paragraphs related to Article IV. The Conference:

- urged 'that States Parties consider possible bilateral co-operation measures to further improve the implementation of Article IV' and for a report to be produced at the next review conference outlining developments in this context;
- noted the 'need for more predictable long-term supply assurances with effective assurances of non-proliferation' and commended the progress made in CAS to this end;
- acknowledged the work of the IAEA 'as the principal agent of technology transfer' and welcomed its technical assistance and cooperation programmes, particularly the establishment 'of a mechanism to permit the channelling of extra-budgetary funds to projects additional to those financed from the IAEA Technical Assistance and Co-operation Fund'; and
- recognized the growing nuclear energy needs of developing states and called for the IAEA to initiate an expert study group on mechanisms for meeting these needs including 'the establishment of a Financial Assistance Fund'.

Peaceful nuclear developments 1985–1990

In February 1986 the IAEA established a senior expert group (SEG) to study mechanisms for assisting developing states in the promotion and financing of nuclear power programmes. The SEG considered the constraints on the introduction of nuclear power in developing states and determined that the difficulty in obtaining finance was a major problem. Three main factors were identified as responsible for this: uncertainty over the credit-worthiness of the developing state; the nature of the scheme of OECD export credits which treated nuclear power plants unfavourably in comparison to fossil-fuelled ones; and the technical, political and financial uncertainties associated with nuclear power plant construction. The report of the SEG, *Promotion and Financing of Nuclear Power Programmes in Developing Countries*, released by the IAEA in 1987, recommended that the Agency take initiatives in the following areas: energy and nuclear power planning; public acceptance; project preparation and implementation; and nuclear power financing.

A review of the nuclear supply and demand situation prepared by the IAEA at the request of CAS for the period 1980–1988 concluded that:

> first, the international market has generally been a strong 'buyer's market', with ample possibilities for diversification of supplies; second, while some plant suppliers may not be able to continue to offer plants for export, new potential suppliers have appeared; third, the domestic capabilities of many buyer countries have improved, notably in fuel fabrication; fourth, there have been no major changes in suppliers' export policies, but some show flexibility in the application of constraints, notable 'prior consent rights'; fifth, there have been some cases on interruption of supplies, but these all stemmed from the period before 1980, and in most cases it has been possible to find alternative sources. In the view of most suppliers the present situation is not one of supply assurances but rather of 'demand assurances' as the lack of predictability of demand in several sectors is creating difficulties in the supplier industry.

Although CAS held 21 sessions between 1980 and 1987, it was unable to reach consensus on principles for international nuclear co-operation. The main obstacle to agreement appeared to be the lack of an internationally-binding commitment to non-proliferation. Since 1987, CAS has been in formal abeyance, though some informal consultations on the question of assured nuclear supply arrangements have occurred.

Following the Chernobyl nuclear reactor accident in the Soviet Union in April 1986, an IAEA special session on nuclear safety and radiological protection adopted two conventions: the Convention on Early Notification of a Nuclear Accident (which entered into force on 27 October 1986); and, the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (which entered into force 26 February 1987).

UNPICPUNE, first proposed in 1980, was finally held in Geneva from 23 March to 10 April 1987. The general debate reaffirmed the need for greater international co-operation in the peaceful uses of nuclear energy. Safety issues, security measures to prevent abuses of nuclear technology, and the link between assurances of non-proliferation and assurances of supply were prominent features of discussion. Several non-aligned states expressed the view that the transfer of nuclear technology for peaceful uses should be on an equitable basis and that access to this technology should be unrestricted. Other states argued that strengthening the nuclear non-proliferation regime was a prerequisite for improving international nuclear co-operation.

UNPICPUNE worked in two main committees. Main Committee I considered a non-aligned states' draft proposal to establish universally acceptable principles for international nuclear co-operation, in accordance with similarly acceptable measures for non-proliferation. Main Committee II addressed the role of nuclear energy for social and economic development, which included: nuclear energy planning and production; safety and radiological protection; spent fuel and radioactive waste management; and legal, administrative and regulatory questions. No agreement on a set of principles for international nuclear co-operation could be agreed by Main Committee I. The Conference report did, however, state that the technical reports presented at the Conference might be useful in planning national nuclear development programmes.

Fourth NPT Review Conference — 1990

Following the format in 1985, the task of reviewing Article IV was again assigned to Main Committee III, and the UN Secretariat and the IAEA both provided working papers for the Conference. The Group of Non-Aligned States also submitted a Draft Resolution on the Peaceful Uses of Nuclear Energy in relation with Preambular paragraphs 6 and 7 and Article IV of the NPT. In Main Committee III, a working paper proposing language on the review of Article IV was submitted by the following group of states: Australia, Austria, Canada, Denmark, Finland, Ireland, the Netherlands, New Zealand, Norway, and Sweden. Nigeria also tabled a working paper proposing language for the Final Declaration. Bangladesh submitted a working paper on Article IV — Peaceful Energy.

Although the Fourth NPT Review Conference did not adopt a Final Declaration, several delegations later requested that the Director General of the IAEA circulate for information the relevant sections of the Review Conference Drafting Committee document concerning Article IV. This stated that the 1990 Conference:

- confirmed that 'each country's choices and decisions in the field of peaceful uses of nuclear energy should be respected without jeopardising their respective fuel cycle policies';
- urged that in all activities to promote the peaceful uses of nuclear energy preference should be given to the non-nuclear-weapon state parties which had 'concluded the required safeguards agreement with the IAEA';
- recommended that efforts to reach agreement on universally acceptable principles for international co-operation in the peaceful uses of nuclear energy should continue and called for resumption, when appropriate, of CAS;
- commended the 1987 study by the SEG on promoting and financing nuclear power programmes in developing states and recommended that the IAEA continue to assist in securing finance for such projects from sources such as the World Bank and the United Nations Development Programme.
- underlined the importance of maintaining the highest standards in nuclear safety and radiological protection;
- affirmed the importance of the NPT as an instrument for ensuring international co-operation in nuclear safety, commended the work of the IAEA in nuclear safety, radiological protection and waste management, and called upon the industry organizations, such as the World Association of Nuclear Operators (WANO) to promote safety;
- welcomed the growth of the IAEA Technical Assistance and Co-operation Fund and 'the development of multi-year, multi-donor projects financed by extra-budgetary contributions to the IAEA';
- encouraged further growth of regional co-operative arrangements (RCAs) for research, development and training related to all aspects of nuclear science and technology, such as the Regional Co-operation Agreement for Asia and the Pacific, the Regional Co-operation Agreement for Latin America, and the African Regional Agreement;

- noted the special needs of developing states and called upon the IAEA to identify means for providing greater assistance to these states, especially in pre-project planning; and
- noted the important role played by UNPICPUNE in furthering international co-operation in the peaceful uses of nuclear energy.

Peaceful nuclear developments 1990–1995

Between 1990 and 1995, the IAEA continued implementing its programme for technology transfer via its Department of Technical Co-operation, Department of Research and Isotopes, and its Department of Nuclear Energy and Safety. Technology transfer for the IAEA's Regular Programme continued to be financed through the Regular Budget, while assistance provided by the Department of Technical Co-operation derived mainly from voluntary contributions of Member States. Technical information, covering most aspects of the peaceful uses of nuclear energy, was channelled predominantly via the IAEA's International Nuclear Information System (INIS).

The IAEA's programme of technology transfer encompassed the following areas: food and agriculture applications, such as the use of isotopic tracers in Co-ordinated Research Programmes (CRP), leading to increased efficiency of both phosphorous uptake by crops and in studying the rate of soil erosion; the application of isotopic and geochemical techniques in geothermal exploration; human health, such as in diagnosis and management of kidney disorders and tuberculosis; and nuclear power. In 1993 the IAEA established DECADES (an inter-agency project of nine international organizations) to conduct a comparative study of different energy sources for electricity generation in terms of their impact on environment and health. This resulted in a published report on *Policy Planning for Nuclear Power: An Overview of the Main Issues and Requirements*, and feasibility studies on the use of nuclear energy in the desalination of sea water;

In September 1994 Indonesia submitted a document prepared by the group of Non-Aligned and other States to the Third PrepCom for the 1995 NPT Review and Extension Conference held in Geneva. This contained two paragraphs on the peaceful uses of nuclear energy: one stated that there continued to exist 'unjustified restrictions and constraints imposed on developing NNWSs regarding full access to nuclear technology for peaceful purposes'; the other declared that the 'inalienable right of all States Parties to develop the peaceful uses of nuclear energy for economic and social development must be reaffirmed by all nuclear and advanced non-nuclear States parties' and that it was essential 'that free and unimpeded access to technology be guaranteed, without exception, for all States Parties to the Treaty who have concluded relevant safeguards agreements with the IAEA'.

NPT Review and Extension Conference — 1995

The *Principles and Objectives* decision document agreed by the conference contained six paragraphs related to peaceful uses of nuclear energy. It reaffirmed 'the inalienable right of all the parties to the Treaty to develop research, production and use of nuclear energy for peaceful purposes without discrimination and in conformity with articles I, II as well as III of the Treaty'. It also stated that 'undertakings to facilitate in the fullest possible exchange of equipment, materials, and scientific and technological information for the peaceful uses of nuclear energy should be fully implemented; and that 'preferential treatment should be given to the non-nuclear-weapon States party to the Treaty, taking the needs of developing countries particularly into account'.

The 1995 NPT Review and Extension Conference did not achieve a consensus Final Declaration.

Peaceful nuclear developments 1995–1997

The end of the Cold War and the dissolution of the USSR led to increases in stockpiles of nuclear materials as HEU and plutonium were released from nuclear weapon programmes. This led to calls for greater transparency over military and civil stockpiles, and attempts to introduce a new framework for their management. Belgium, France, Germany, Japan, Switzerland, the United Kingdom and the United States agreed in principle in January 1995 to publish annual statements of their inventories of civil-use plutonium. In addition, these states, and China and Russia, initiated discussions outside the IAEA context on a new framework agreement for the international management of plutonium. Agreement was reached in 1996 on a format for releasing information on their national stockpiles of plutonium.

On 17 June 1995, following the Nova Scotia summit of the G-7 countries, Canada announced that all states that participated in the summit, except Russia, had forbidden all nuclear reactor or technology exports to Iran, and

would also cease all nuclear cooperation with Iran if proof of a clandestine nuclear weapons programme was presented.

Sixth NPT Review Conference — 2000

The 1997 session of the Preparatory Committee for the 2000 NPT Review Conference included the following text in the 'Chairman's Working Paper' under the heading 'peaceful uses of nuclear energy':

> Reaffirmation of commitment to continue to take further steps for the full realization of the relevant provisions of the Treaty, taking into account the undertakings in the principles and objectives on the peaceful use of nuclear energy.
>
> Reaffirmation that attacks or threats of attack on nuclear facilities devoted to peaceful purposes jeopardize nuclear safety and raise serious concerns regarding the application of international law on the use of force in such cases, which could warrant appropriate action in accordance with the provisions of the Charter of the United Nations.

Chapter 9
Nuclear Export Controls

Introduction

The NPT provided the first international framework for the conduct of nuclear trade. Articles I and II contain legal commitments, made respectively by the nuclear-weapon states and the non-nuclear-weapon states, not to transfer, seek access to, or in any way assist, the spread of nuclear weapons. Article III makes provision for the IAEA to apply safeguards in non-nuclear-weapon states, with Article III.2 covering safeguards on the transfer of fissile materials to all such states. Article IV stated the inalienable right of States Party to the Treaty to the peaceful uses of nuclear energy 'without discrimination and in conformity with Articles I and II' as well as 'the right to participate in, the fullest possible exchange of equipment, materials and scientific and technological information for the peaceful uses of nuclear energy.'

Interpretation of the NPT supplier obligation

Non-nuclear-weapon states are not explicitly bound by the obligation which Article I imposes on the nuclear-weapon states parties not 'in any way to assist, encourage or induce any non-nuclear weapon State to manufacture or otherwise acquire nuclear weapons or other nuclear explosive devices'. However, the NPT's Preamble states that one of the central objectives of the Treaty is to prevent the further dissemination of nuclear weapons and therefore all states parties, including the non-nuclear-weapon states, are legally obliged to uphold this objective. Thus implicitly the non-nuclear-weapon states are bound by similar obligations over the supply of technology and materials to those explicitly accepted by the nuclear-weapon states.

Under Article III.2, suppliers are required to request safeguards on transferred items 'for peaceful purposes'. Although this could be viewed as excluding exports for military purposes designed to yield nuclear explosives, it could be held that non-explosive activities, such as providing fuel for submarine reactors, would justify transfers completely outside of safeguards. The prevailing interpretation, however, is that safeguards must be applied to the transferred item until it is introduced unambiguously into those military activities not explicitly forbidden by the Treaty.

Article III.2 also requires that only the transfer of 'equipment or material especially designed or prepared for the processing, use or production of special fissionable material' should trigger the supplier's request for safeguards. This resulted from the concerns of some industrialised non-nuclear-weapon states to protect their industries from unfair competitive disadvantages. The negative consequence, however, is that Article III.2 does not explicitly prohibit either the uncontrolled transfer of nuclear-usable technology (as opposed to material and equipment), or the export of dual-use items which may have non-nuclear applications but are also instrumental in a nuclear-weapon programme, though again the Preamble implies that they are prohibited.

Export control developments 1970-1975

The Zangger Committee

Negotiations within the Zangger Committee (named after its chairman, Claude Zangger) began in 1971. They clarified the exact meaning of Article III.2 of the NPT. These talks initially involved only Western states. In 1973 and 1974 the Soviet Union and states from Eastern Europe were included. Agreement was reached on two memoranda, published by the IAEA as INFCIRC/209 in September 1974, which established the definitional criteria for 'source and special fissionable materials' and 'equipment or material especially designed or prepared for the processing, use or production of special fissionable material'.

Memorandum A covering materials, adopted the technical definitions used in the IAEA's Statute. It also specified conditions for the export of nuclear materials. All exports were to be subject to safeguards. Material exported to non-nuclear-weapon states outside the NPT was to be covered by a non-explosive use assurance. Re-transfer of material to third parties outside the NPT was to be covered by the same conditions.

Memorandum B, covering equipment, comprised a 'trigger list' of items, the export of which 'triggers' the imposition of the same conditions attached to Memorandum A: peaceful use, safeguards, and safeguarded retransfers. The 'trigger list' contained the following items: nuclear reactors and equipment such as zirconium

tubes and coolant pumps; deuterium and heavy water (though not facilities to produce them); nuclear grade graphite; reprocessing plants; fuel fabrication plants; and uranium enrichment plants.

The Zangger Committee has continued to meet bi-annually and has published a number of amendments and additions to its initial list. These covered heavy water and deuterium production facilities and gaseous diffusion plant (1978), gas centrifuge equipment (1984), reprocessing equipment (1985) and gaseous diffusion equipment again (1990).

'Dual-use' items — goods with both civil and military applications — were not included in the Zangger list. Nor was an outright ban imposed on trade in sensitive technologies used for enrichment and reprocessing. The Zangger Committee also agreed that NPT exporters were not required to insist on full-scope safeguards (FSS) on all nuclear material within a recipient state when trading with states which had not signed the NPT.

The Nuclear Suppliers Group

The Nuclear Suppliers Group (NSG, also called the 'London Club' after the venue where it first met) was established in 1975 to seek consensus on common guidelines its members would follow in drawing-up national export controls. The stimulus for this activity was India's peaceful nuclear explosion of the previous year; the oil supply crisis of 1973 which had led to nuclear power programmes being contemplated by many states; and the consequent demand from both parties and non-parties to the NPT for the supply of nuclear reactors and other fuel-cycle equipment. One of the main purposes of the NSG was to try to prevent commercial competition stimulating the supply of proliferation-sensitive equipment to non-NPT states and to bring France, a major nuclear supplier, but not then a party to either the NPT or the Zangger Committee, into these arrangements and the wider nuclear non-proliferation regime. The Group initially involved only seven major supplier states (the United States, the Soviet Union, the United Kingdom, France, the Federal Republic of Germany, Canada and Japan).

The NSG eventually agreed that five conditions should be attached to exports of nuclear items by its members:

- the Zangger Committee conditions (peaceful use, safeguards, and the re-transfer provision) would apply to both nuclear technology and hardware;
- certain materials not defined in the IAEA Statute as 'special fissionable material', such as heavy water and the means of producing it, should also trigger safeguards;
- restraint was recommended for the export of sensitive technology and materials, such as those usable for enrichment, reprocessing, and heavy water production. This applied to exports to non-nuclear-weapon states party to the NPT, as well as to those that were not parties, thus going beyond the context of the Zangger list;
- the recipient's assurances of non-explosive use were required prior to export; and
- supplier governments had to be satisfied with the arrangements for the physical protection of nuclear materials and facilities against unauthorized use before they were to issue an export licence.

First NPT Review Conference — 1975

Although the existence of the NSG was known before this conference convened, the main debate in this area was over the interpretation of Article III.2 of the Treaty, and whether the safeguards mentioned in it were FSS on all nuclear materials within a recipient (non-NPT) state, or just on the exported items. Due to differences between western supplier states, no consensus could be reached on this point during the meeting. However, the Final Declaration in 1975 noted that:

> a number of States suppliers of nuclear material and equipment have adopted certain minimum, standard requirements for IAEA safeguards in connection with their exports of certain such items to non-nuclear weapon States not Party to the Treaty.

The Conference also urged that:

> in all achievable ways, common export requirements relating to safeguards be strengthened, in particular by extending the application of safeguards to all peaceful nuclear activities in important States not Party to the Treaty.

Export control development 1975–1980

In April 1977 the Persepolis Conference was held in Iran at which nuclear technology transfers and export controls were the principal issues. This was followed in May by the IAEA's Salzburg Conference on the nuclear fuel cycle where again export policies and conditions of nuclear supply featured heavily. At both Conferences,

many developing states expressed concern at what they considered to be unfair restrictions on nuclear exports being introduced by the nuclear suppliers.

In January 1978 the NSG notified the IAEA of their voluntary guidelines on conditions for nuclear supply and these were published in February 1978 as INFCIRC/254. By this time the NSG had attracted eight additional members (Belgium, Czechoslovakia, the German Democratic Republic, Italy, the Netherlands, Poland, Sweden, and Switzerland) bringing the total to fifteen.

In March 1978 the United States introduced the Nuclear Non-Proliferation Act (NNPA). The NNPA stated the United States would henceforth adopt unilaterally the following policy for nuclear supply:

- international initiatives would be pursued for nuclear fuel supply assurances and for more effective international controls to prevent proliferation;
- the United States would seek to confirm itself as a reliable supplier of nuclear fuels;
- universal adherence to the NPT would be encouraged; and
- all nuclear co-operation with non-nuclear-weapon states would be conditional upon the acceptance of FSS.

Second NPT Review Conference — 1980

Export controls and the practices of supplier states were major themes at the 1980 Conference, as the initiatives of the previous five years were discussed in an NPT forum for the first time. Differences between the main groupings of states on these issues were a contributory factor in the failure of the Conference to agree a Final Declaration. The Group of 77 (G-77) argued that the rights of NPT parties to the unrestricted access to nuclear technology and materials under Article IV had not been met. In particular the G-77 emphasized that: all contracts with NPT parties should be honoured, with no threat to cut-off nuclear supplies so that more stringent supply conditions could be negotiated; no unilateral supply conditions should be applied; and more effort should go towards assisting developing states party to the Treaty to obtain the benefits of the peaceful uses of nuclear energy. By contrast, the states in the Western and Socialist group argued that: commitments under Article IV were being honoured; both bilateral and multilateral technical assistance to developing states had increased considerably in the period 1975-1980; and considerable effort had been placed on improving nuclear supply.

Export control developments 1980–1985

In July 1984 a group of Western states (Australia, Belgium, Canada, the Federal Republic of Germany, France, Italy, Japan, the Netherlands, Sweden, Switzerland, the United Kingdom and the United States) convened in Luxembourg to discuss, among other non-proliferation topics, the conditions for nuclear supply and export controls. Again no consensus could be forged on making FSS a condition of supply for all nuclear transfers.

Third NPT Review Conference — 1985

The issue of FSS as a condition of nuclear supply was again prominent at the 1985 Conference. In the Final Declaration, agreed by consensus, the Conference urged:

> all non-nuclear-weapon States not party to the Treaty to make an international legally-binding commitment not to acquire nuclear weapons or other nuclear explosive devices and to accept IAEA safeguards on all their peaceful nuclear activities, both current and future, to verify that commitment.
>
> ... all States in their international nuclear co-operation and in their nuclear export policies and, specifically as a necessary basis for the transfer of relevant nuclear supplies to non-nuclear-weapon States, to take effective steps towards achieving such a commitment to non-proliferation and acceptance of such safeguards by those States.

Export control developments 1985–1990

There were no changes to the NSG guidelines during the period prior to the 1990 NPT Review Conference. The existing guidelines continued to be implemented by the adhering supplier states.

In April 1987, Canada, France, the Federal Republic of Germany, Italy, Japan, the United Kingdom and the United States announced that they would adopt a new set of export control guidelines under an arrangement known as the Missile Technology Control Regime (MTCR). These MTCR guidelines were designed to control the export of equipment and technology suitable for the construction of nuclear-capable missiles. The guidelines attempted to establish common export conditions for two categories of missile-related technologies:

- *Category 1* was concerned with technologies which could be used in the construction of missiles and for which there was a strong presumption to deny transfer. This category encompassed complete rocket systems which were capable of delivering a 500 kilogram payload to a range of 300 kilometres; and
- *Category 2* incorporated dual-use technologies which had potentially legitimate civilian uses such as, propellants, missile computers, test facilities and structural materials. Transfer restrictions were consequently less stringent for this category.

Fourth NPT Review Conference — 1990

The draft of the 1990 NPT Review Conference Final Declaration highlighted the work of the Zangger Committee:

> The Conference notes that a number of States Parties engaged in the supply of nuclear material and equipment have met regularly as an informal group which has become known as the Zangger Committee in order to coordinate their implementation of Article III. 2. To this end, these States have adopted certain requirements, including a list of items triggering IAEA safeguards for their export to non-nuclear weapon states not party to the Treaty...The Conference urges all States to adopt these requirements in connection with any nuclear cooperation with non-nuclear weapon States not Party to the Treaty. The Conference recommends that the list of items triggering IAEA safeguards and the procedures for implementation be reviewed from time to time to take into account advances in technology and changes in procurement practice. The Conference recommends the States Parties to consider further ways to improve the measures to prevent diversion of nuclear technology for nuclear weapons, other nuclear explosive purposes or nuclear weapon capabilities.

The draft document also recognized the need to go beyond the language of Article III. 2 and encompass dual-use items within its control remit:

> The Conference recognizes that there are items of equipment and materials, including tritium, not identified in NPT Article III.2 which are relevant to the proliferation of nuclear weapons and therefore to the NPT as a whole. Without prejudice to the existing principles guiding international cooperation in the peaceful uses of nuclear energy, especially Article IV of the NPT, the Conference in this regard calls for early consultations among States to ensure that their supply and export controls are appropriately coordinated.

The Conference was unable to agree a consensus Final Declaration.

Export control developments 1990–1995

After a period of more than a decade when there was little development in the area of nuclear export controls, the beginning of the 1990s witnessed a renewed interest in the subject due to both the dissolution of the USSR and the revelations that Iraq had made use of imported technology in its clandestine nuclear-weapon programme. One direct consequence of the former events was the fragmentation of the Soviet Union's over-arching export control arrangements. Efforts were subsequently made to ensure that all the republics which emerged from the Soviet Union had effective operational export control systems.

At the end of 1990 the modified Zangger Committee Trigger List was published by the IAEA as INFCIRC/209/Rev 1. This refined and consolidated the original List. It also included additional equipment for uranium enrichment by gas centrifuge and gaseous diffusion methods, and reprocessing technology.

Following discovery of an extensive clandestine nuclear weapons programme in Iraq, the NSG convened its first formal session since 1978 in March 1991 in The Hague. All 26 states then adhering to the NSG guidelines (which now included Bulgaria, Denmark, Finland, Greece, Hungary, Ireland, Luxembourg, Norway, Portugal, Rumania, and Spain) attended the meeting. Consensus decisions were taken on two substantive issues at this meeting. First, the NSG decided to establish a special working group to formulate a control arrangement to cover nuclear-related dual-use materials, equipment and technology to prevent their use in either a 'nuclear explosive activity' or an 'unsafeguarded nuclear fuel-cycle activity'. Second, it was agreed that the NSG guidelines should be amended to conform with the up-dated Zangger Committee Trigger List.

Between March 1991 and March 1993, the special working group on dual-use items met in The Hague, Brussels, Annapolis and Interlaken to draft an agreed export control arrangement to cover them. This arrangement was formally adopted at a meeting in Warsaw in March–April 1992 of an expanded 27-member NSG (Austria had joined at the end of 1991).

These new export control arrangements for dual-use and other items consisted of: a set of supply guidelines; a list of dual-use items to be submitted to licensing requirements in the future; a memorandum of understanding; and a declaration on FSS.

The supply guidelines made it obligatory for supplier states to deny transfer of dual-use items if:

- they were to be used by a non-nuclear-weapon state in a nuclear explosive activity or an unsafeguarded nuclear activity;
- when there was an unacceptable risk of diversion to such an activity; or
- when the transfers were contrary to the objective of averting the proliferation of nuclear weapons.

The dual-use list included sixty-five items. These were divided into the following eight categories:

- industrial equipment, including numerically controlled machine tools:
- materials, including beryllium, zirconium, lithium-6 and maraging steel;
- uranium separation equipment and components [this included instruments for laser enrichment for the first time and instruments for EMIS, which had been re-discovered by Iraq and had previously not been included on any list];
- heavy water production equipment extending beyond the goods already specified in the NSG guidelines;
- equipment for the development of implosion systems;
- instruments for use in explosion technology, including electronic precision circuits;
- nuclear weapon test equipment; and
- 'other' equipment, also including tritium and tritium plants.

In July 1992 the IAEA published both the guidelines and the dual-use list as INFCIRC/254/Rev.1/Part 2 and the new dual-use control arrangement became effective from January 1993.

The memorandum of understanding specified measures related to implementation, including an information exchange. It was limited initially to the 27 states which met in Warsaw. Others could only sign if they fulfilled a set of export control conditions, and there was consensus among existing members on their inclusion.

The declaration on FSS refered only to the list of items contained in the NSG's Guidelines for Nuclear Transfer (INFCIRC/254), not the items on the dual-use list. Items on the former list were only to be exported if the recipient state had accepted FSS on all fissionable materials in present and future nuclear activities. Existing supply contracts were not affected by the declaration, but all transfers had to be carried out in compliance with it as far as possible. In May 1992 the IAEA published this declaration as INFCIRC/405. It was later incorporated in an amendment to the NSG guidelines agreed in Lucerne in March-April 1993 and published by the IAEA as INFCIRC/254/Rev.1/Part 1/Mod.1.

The NSG also established a special technical working group to devise new control arrangements for uranium enrichment plants, uranium conversion facilities and coolant pumps. The group also worked on a definition of sensitive technologies.

In January 1993, the European Union (EU) introduced the Single European Market which abolished almost all trade barriers between member states in the EU. Goods listed as restricted or proscribed were not necessarily affected by this development because of provisions, related to the security interests of member states, under Article 223 of the Treaty of Rome. This Article states that:

> (a) No member state shall be obliged to supply information the disclosure of which it considers contrary to the essential interests of its security;
>
> (b) Any member state may take such measures as it considers necessary for the protection of the essential interests of its security which are connected with the production of or trade in arms, munitions and war materiel; such measures shall not adversely affect the conditions of competition in the common market regarding products which are not intended for specifically military purposes.

In March 1994 the Co-ordinating Committee for Multilateral Export Controls (COCOM) was terminated. COCOM had provided additional nuclear trade export controls between West and East since it began operating in January 1950. The COCOM guidelines were designed originally by Western states to restrict the transfer of militarily-significant and other sensitive technologies to the Soviet Union, Eastern Europe and China. COCOM

had its organizational headquarters in Paris and operated an informal system of non-enforceable export control guidelines which were divided into three separate lists: the International Munitions List; the International List (covering several dual-use items); and finally, the International Atomic Energy List, containing the items in the nuclear field for which transfers were subject to review among states participating in COCOM.

NPT Review and Extension Conference — 1995

The decision on *Principles and Objectives for Nuclear Non-Proliferation and Disarmament* reached by consensus in New York on 10 May 1995 devoted one paragraph to export controls, stating that 'transparency in nuclear-related export controls should be promoted within the framework of dialogue and cooperation among all interested States party to the Treaty, taking the needs of developing countries particularly into account'. There was no consensus Final Declaration.

Export control developments, 1995–1997

In April 1995 the NSG held its annual Plenary Meeting in Helsinki, Finland. The Group reviewed its guidelines and agreed to amendments to the export control lists. The meeting was attended by the 31 members of the NSG, and observers from the European Union and the Ukraine. The meeting was informed that the Republic of Korea has expressed its intention to adhere to the NSG guidelines.

On 17 June 1995 the Nova Scotia summit of the G-7 countries and Russia ended with Canada announcing that all states that participated in the summit, except Russia, had forbidden all nuclear reactor or technology exports to Iran.

In mid-July 1995, documents were released showing that in 1986 the US Department of Energy (DoE) redefined its guidelines for determining sensitive nuclear technology (SNT). The NNPA defined SNT as knowledge or material 'important to' nuclear fuel cycling, uranium enrichment, or heavy water production. Under DoE's revised guidelines, 'consideration of the state of the recipient country's nuclear program' also had a bearing on whether or not a given product was classified as SNT. The NNPA guidelines required the recipient nation to yield control of any by-products of SNT (such as reprocessed nuclear fuel) to the United States.

On 3 August 1995 the European Union approved a new US-Euratom nuclear cooperation treaty to replace the one that would run out in December 1995 which had guaranteed Euratom countries a supply of US-origin nuclear fuel for 35 years. France voted against the treaty and Belgium abstained.

In October 1995, following a decision taken at its plenary meeting in Madrid in April 1994, the NSG published new unified guidelines for nuclear transfers in parallel with the latest version of the guidelines for nuclear-related dual-use transfers. The new guidelines set out fundamental principles for safeguards and export controls which included, *inter alia,* a non-proliferation principle. This stated that, regardless of the type of recipient country, an export license should be denied unless a supplier was satisfied that the transfer involved would not contribute to the proliferation of nuclear weapons or other nuclear explosive devices.

In April 1996 the NSG held its plenary meeting in Buenos Aires. It was attend by representative of 24 members states; Brazil, the Republic of Korea and Ukraine attended for the first time as members. Responding to the Decision on *Principles and Objectives for Nuclear Non-Proliferation and Disarmament* adopted at the 1995 NPT Conference, the Group agreed to promote openness and transparency through further dialogue and cooperation with non-member countries. As part of this effort, an international seminar on 'The Role of Export Control in Nuclear Non-Proliferation' was held in Vienna by the NSG on 7–8 October 1997.

The Wassenaar Arrangement on Export Controls for Conventional Weapons and Dual-Use Goods and Technologies was developed from negotiations on a replacement for COCOM. Its first plenary sessions were held during 1996.

In October 1997, China attended a meeting of the Zangger Committee for the first time as a full member.

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Abbreviations and Acronyms

Items that appear in the *Glossary* are marked*

ABACC	Brazilian–Argentine Agency for Accounting and Control of Nuclear Materials
ABM	anti-ballistic missile*
ACDA	Arms Control and Disarmament Agency (US)
ALCM	air-launched cruise missile
ANF	Atlantic Nuclear Force
ASW	anti-submarine warfare
BMD	ballistic missile defence
CACNARE	Convention on Assistance in the Case of Nuclear Accident
CANDU	Canadian Deuterium-Uranium reactor
CAS	Committee on Assurances of Supply* (IAEA)
CD	Conference on Disarmament* (formerly Committee on Disarmament*)
CFE	Conventional Forces in Europe [Treaty]
CMA	continuous material accountancy
CMEA	Council for Mutual Economic Assistance (Eastern Europe)
COCOM	Coordinating Committee on Export Controls
CPPNM	Convention on the Physical Protection of Nuclear Material
CSBM	confidence- and security-building measure
CSCE	Conference on Security and Co-operation in Europe
CSNI	OECD Nuclear Energy Agency Committee on the Safety of Nuclear Installations
CTBT	Comprehensive Test Ban Treaty*
EC	European Community
ENDC	Eighteen-Nation Disarmament Committee*
EURATOM	European Atomic Energy Community
EURODIF	European Gaseous Diffusion Uranium Enrichment Consortium
FBR	Fast Breeder Reactor
FSS	full scope safeguards*
GCD	General and Complete Disarmament
GPALS	Global Protection Against Limited Strikes
GW	Gigawatt*
HEU	highly enriched uranium*
IADA	International Atomic Development Authority
IAEA	International Atomic Energy Agency*
ICBM	inter-continental ballistic missile
ICF	Inertial Confinement Fusion
IFRC	International Fusion Research Council
INF	Intermediate-range Nuclear Forces [Treaty]*
INFA	International Nuclear Fuel Agency
INFCE(P)	International Nuclear Fuel Cycle Evaluation (Programme)
INFCIRC	IAEA Information Circular*
INIS	International Nuclear Information System (IAEA)
INSAG	International Nuclear Safety Advisory Group (IAEA)
IPS	International Plutonium Storage
IRBM	intermediate-range ballistic missile
ISFS	International Spent Fuel Storage
ISIS	International Safeguards Information System
LEU	low enriched uranium*
LTBT	Limited Test Ban Treaty (also known as the Partial Test Ban Treaty)
LWR	Light Water Reactor
MBA	material balance area*
MLF	Multilateral Force
MOX	mixed oxide fuel
MTCR	Missile Technology Control Regime*
MW	Megawatt*

NAM	Non-Aligned Movement
NATO	North Atlantic Treaty Organization
NNA	Neutral and Non-Aligned countries
NNPA	United States Nuclear Non-Proliferation Act (1978)
NNWS	non-nuclear weapon states*
NPT	Non-Proliferation Treaty*
NSG	Nuclear Suppliers Group*
NWFZ	nuclear-weapon-free zone*
NWS	nuclear weapon states*
OAS	Organization of American States
OECD	Organization for Economic Co-operation and Development
OPANAL	Agency for the Prohibition of Nuclear Weapons in Latin America*
OSI	on-site inspection*
PNE	peaceful nuclear explosion
PNET	Peaceful Nuclear Explosions Treaty*
PTBT	Partial Test Ban Treaty*
PWR	Pressurized Water Reactor
SALT	Strategic Arms Limitation Talks or Treaty
SDI	Strategic Defense Initiative (US)
SLBM	submarine launched ballistic missile
SLCM	sea launched cruise missile
SNDV	Strategic Nuclear Delivery Vehicle
SNF	Short Range Nuclear Forces
SSBN	ballistic missile-equipped, nuclear-powered submarine
START	Strategic Arms Reduction Talks/Treaty*
SWU	Separative Work Unit*
TTBT	Threshold Test Ban Treaty*
UNAEC	United Nations Atomic Energy Commission
UNCPICPUNE	United Nations Conference on the Promotion of International Cooperation in the Peaceful Uses of Nuclear Energy
UNGA	United Nations General Assembly
UNSSOD	UN Special Session on Disarmament
USAEC	United States Atomic Energy Commission

Glossary

Terms defined elsewhere in the Glossary are indicated in *italic type*.

Agency for the Prevention of Nuclear Weapons in Latin America (OPANAL) Spanish title: Organismo para la Proscripción de las Armas Nucleares en la América Latina. Created by the Treaty of Tlatelolco 'to ensure compliance with the obligations of [the] Treaty'.

anti-ballistic missile (ABM) A missile designed to intercept and destroy incoming ballistic missiles. Can also be used to describe the entire defence system, as well as the missile itself. For the US and Russia, such systems are covered by the Anti-Ballistic Missile Treaty which places limits on the siting and numbers of ABM systems.

anti-tactical ballistic missile (ATBM) An *anti-ballistic missile* system designed to intercept short-range *ballistic missiles*.

atom The atom is the basic building block of matter. It is formed from a *nucleus* and electrons. The electrons, which are negatively charged, surround the positively-charged nucleus. The nucleus is formed from *protons* and *neutrons*. The number of protons in a nucleus affect the chemical properties of the atom (i.e., how it will react with other atoms) while the number of neutrons affect its physical properties (i.e., its mass and its fissile and radioactive characteristics). In an atom, the number of electrons equals the number of protons, and this number is called the atomic number. Thus, in an atom of uranium, atomic number 92, there are 92 protons in the nucleus. Atoms with the same atomic number are chemically identical and are known as elements. Nuclei of atoms of the same element/atomic number may, however, contain different numbers of neutrons. These variations of atoms of an element are called *isotopes*. Isotopes have great significance for nuclear energy because only some isotopes of some elements can undergo *fission*. For example uranium-235 (commonly written as U-235 or U^{235}) is fissile while U-238 is not. Therefore, to create *fissile material*, sufficient quantities of the fissile isotopes must be brought together.

ballistic missile (BM) A missile that gains its altitude through its source of propulsion, usually a rocket motor, rather than by aerodynamic lift with wings. A ballistic missile usually descends on its target under free-fall, following a ballistic trajectory. Long-range ballistic missiles will exit the atmosphere, before returning to earth, hence the term *re-entry vehicle* to describe the payload capsule of such a missile.

book inventory A term used in nuclear safeguards which means the algebraic sum of the most recent *physical inventory* of a *material balance area* and of all inventory changes that have occurred since that physical inventory was taken.

bulk handling facility A nuclear facility in which nuclear material is held, processed or used in a loose form, such as a liquid, gas or powder. Examples of such facilities are conversion, enrichment, fabrication and reprocessing plants.

calutron A device used in isotopic enrichment based on the principle that molecules of different masses follow different trajectories in an electro-magnetic field. Calutrons, also known as 'racetracks', are based on giant circular magnets. The molecules being separated follow a curved path within the field before being collected.

centrifuge A device used in isotopic enrichment that separates molecules of different masses by spinning them at high speed in a container leaving comparatively heavier molecules on the walls and lighter ones in the centre.

chain reaction A reaction, in a body of *fissile material*, in which additional *neutrons* from atoms undergoing *fission* are sufficient in number for the reaction to be self-sustaining. The quantity of material at which this reaction first takes place is called a *critical mass*.

challenge inspection An *on-site inspection* called at short notice in order to check compliance with a treaty obligation. Some challenge inspections are known as 'anytime, anywhere' which, as the name implies, can be carried out at sites not declared in the relevant treaty.

Committee on Assurances of Supply (CAS) [IAEA] Established by the IAEA in 1980 to consider methods to assure supplies of nuclear materials to importing states, while minimizing risks of nuclear proliferation.

Committee on Disarmament (CD) Convened in January 1979 as a replacement for the *Conference on the Committee on Disarmament* following a recommendation by the First United Nations Special Session on Disarmament. The CD was comprised of 40 states. The CD became the *Conference on Disarmament* following a recommendation by the United Nations General Assembly in 1984.

Comprehensive Test Ban Treaty (CTBT) A treaty to prohibit all nuclear testing. Negotiations concluded in the CD in 1996 and it was opened for signature in that year.

Conference of the Committee on Disarmament (CCD) Formed in 1969, when the *Eighteen-Nation Disarmament Committee* was expanded to include additional members. An expansion to 31 members was agreed in 1975. Achievements of the CCD include the 1971 Seabed Treaty and the 1972 Biological Weapons Convention. The CCD was replaced by the *Committee on Disarmament* in 1979.

Conference on Disarmament (CD) The sole multilateral arms control and disarmament negotiating forum, based in Geneva, with a United Nations-provided secretariat. It tends to operate by creating *ad hoc* committees in which discussion takes place. Treaties negotiated by it include the Chemical Weapons Convention and the *CTBT*. Until 1984 the CD was known as the *Committee on Disarmament*. In 1996 its membership was increased from 38 to 61.

critical mass The quantity of material which is the minimum required to create a *chain reaction*. This quantity varies according to the following factors: the *elements* and *isotopes* involved; the concentration of the fissile isotopes in the material; and the pressure on the material. The last of these is highly significant in the designs of some nuclear weapons, as a near-critical mass can become critical by compressing the material with explosives to increase its density. This is the basis of an implosion weapon.

cruise missile A missile that gains its altitude from aerodynamic lift. Usually continuously propelled by a jet engine.

cumulative material unaccounted for (CUMUF) A statistical analysis of the *material unaccounted for* (MUF) figures for a nuclear activity under safeguards. As individual MUF figures are subject to errors, CUMUF gives a much clearer idea of whether material is being diverted from an activity or not.

Effective kilogram (ekg) A term used in nuclear safeguards for quantifying nuclear material. The quantity in effective kilograms is obtained by taking: (a) for plutonium, its weight in kilograms; (b) for uranium with an enrichment of 0.01 (1%) and above, its weight in kilograms multiplied by the square of its enrichment; (c) for uranium with an enrichment below 0.01 (1%) and above 0.005 (0.5%), its weight in kilograms multiplied by 0.0001; and (d) for depleted uranium with an *enrichment* of 0.005 (0.5%) or below, and for thorium, its weight in kilograms multiplied by 0.00005.

Eighteen-Nation Disarmament Committee (ENDC) First convened in March 1962 following a resolution of the United Nations General Assembly in 1961. Achievements of the ENDC include assistance in the negotiation of the 1963 PTBT and completion of the NPT in 1968. In 1969 the ENDC was expanded and became the *Conference of the Committee on Disarmament*. Parties of the ENDC were: Burma; Brazil; Bulgaria; Canada; Czechoslovakia; Ethiopia; France; India; Italy; Mexico; Nigeria; Poland; Romania; Sweden; United Arab Emirates; United Kingdom; United States of America; and the Soviet Union.

enrichment The process of increasing the concentration of one material within another. Most commonly used in relation to U-235 (a fissile isotope) and U-238 (non-fissile). 'Enrichment' is a subtractive process in which unwanted material is removed. Enrichment processes and equipment include gaseous diffusion, centrifuges, calutrons and laser enrichment. The work or energy required for enrichment is given in *Separative Work Units*. Enrichment facilities are sometimes known as 'isotope separation plants'. The term enrichment is also used, when quantifying nuclear materials, to describe the ratio of the combined weight of the fissile to that of the total material in question.

European Atomic Energy Community (EURATOM) The EURATOM Treaty entered into force on 1 January 1958 and covers all areas of European Community nuclear policy, from co-ordinating nuclear energy development to operating a regional nuclear safeguards system.

fissile material Material containing atoms capable of undergoing *fission.*

fission A process by which a nucleus of an atom splits into two when struck by a neutron. This process, which only certain isotopes of certain elements can undergo, releases large amounts of energy and further neutrons. If conditions are right, these further neutrons can cause a *chain reaction.*

full-scope safeguards (FSS) Safeguards that cover all nuclear materials and installations in a state (see *safeguards (IAEA)*). The application of full-scope, sometimes termed comprehensive, safeguards to a state is often a precondition to transfers of nuclear materials and technologies.

fusion The formation of a heavier nucleus from two lighter ones. As with *fission*, fusion can only occur with particular isotopes of elements; most notably, tritium and deuterium, both isotopes of hydrogen.

gaseous diffusion An enrichment or separation technique using the property that comparatively heavier molecules travel through a fine mesh at a slower rate than lighter ones.

Gigawatt (GW) A unit of power based on the *Watt.* One Gigawatt equals 1,000,000,000 Watts.

highly enriched uranium (HEU) Uranium that has been enriched such that it contains more than 20 per cent U-233 and/or U-235.

horizontal proliferation The increase in the number of states capable of possessing, manufacturing or deploying a given weapons technology. Usually used to describe the spread of nuclear weapon or ballistic missile capabilities.

IAEA information circular (INFCIRC) For example, INFCIRC/153. Used as a shorthand way of referring to documents, such as safeguards agreements. Significant documents circulated in this way include:
INFCIRC/9 — Agreement on the Privileges and Immunities of the Agency.
INFCIRC/39 — The Agency's Inspectorate
INFCIRC/66 — The Agency's Safeguards System
INFCIRC/153 — The Structure and Content of Agreements between the Agency and States required in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons
INFCIRC/209 — Communications Received from Members Regarding the Export of Nuclear Material and of Certain Categories of Equipment and other Material
INFCIRC/225 — The Physical Protection of Nuclear Material
INFCIRC/254 — Communications Received from Certain Member States Regarding Guidelines for the Export of Nuclear Material, Equipment or Technology [London Club suppliers guidelines]
INFCIRC/540 — Model Protocol Additional to the Agreement(s) between State(s) and the International Atomic Energy Agency for the Application of Safeguards.

Intermediate-range Nuclear Forces (INF) [Treaty] This treaty between the United States and the Soviet Union covers the verified elimination of all land-based missiles with ranges between 500 and 5500 km, irrespective of warhead type. The treaty does not cover the warheads, which may be re-used on other delivery systems.

International Atomic Energy Agency (IAEA) A United Nations agency with responsibilities to implement *safeguards* on nuclear materials and promote the peaceful uses of nuclear power.

Irish Resolution A resolution concerning nuclear non-proliferation introduced to the United Nations by Ireland in 1961 and passed unanimously.

isotope See *atom*

Joule (J) A primary unit of energy, used as an international standard. See *Watt.*

laser enrichment Laser enrichment exploits the fact that different isotopes of an element have slightly different energy levels due to their different masses. By tuning lasers to wavelengths of light that correspond to particular energy levels of specific isotopes, those isotopes will absorb the extra energy and can then be separated.

low enriched uranium Uranium that has been enriched such that its concentration of U-233 and/or U-235 is greater than in natural uranium, but is less than 20 per cent.

Material Balance Area (MBA) A term used in nuclear safeguards to describe an area such that the quantity of nuclear material in each transfer into or out of it can be determined and that the *physical inventory* of nuclear material in it can be determined when necessary, in order that the material balance for safeguards purposes can be established.

Material Unaccounted For (MUF) A term used in nuclear safeguards to describe the difference between the *book inventory* and the *physical inventory* of nuclear material at a location under safeguards..

Megawatt (MW) A unit of power based on the *Watt.* One Megawatt equals 1,000,000 Watts.

Missile Technology Control Regime (MTCR) Internationally agreed guidelines on the export or transfer of ballistic missile technologies between states.

moderator A material used to lower the energy levels of *neutrons*, to help sustain a *fission* reaction. Materials used as moderators include graphite and water.

multinational technical means (MTM) Technologies and techniques used in *national technical means*, but gathered by, or shared between, a group of states.

multiple independently targetable re-entry vehicles (MIRV) A system whereby more than one target may be attacked from warheads on a single missile. (see also *re-entry vehicle*)

national technical means (NTM) Technologies and techniques used for intelligence gathering that may be useful to ascertain compliance with a treaty or agreement. NTMs include reconnaissance satellites and signals intelligence gathering.

negative security assurance[s] A form of *security assurance* whereby a *nuclear-weapon state* guarantees that it will not use or threaten to use nuclear weapons against a *non-nuclear-weapon state* under all or certain circumstances.

neutron A particle carrying no electrical charge that forms part of the *nucleus* of an *atom.* It is of approximately the same mass as a *proton.* Neutrons also exist outside of the nucleus. See also *atom.*

non-nuclear-weapon state (NNWS) A state that is not a *nuclear-weapon state.*

Nuclear Non-Proliferation Treaty (NPT) Signed on 1 July 1968, entered into force 5 March 1970. The treaty's formal title is 'Treaty on the Non-Proliferation of Nuclear Weapons'.

Nuclear Suppliers Group (NSG) A grouping of nations, also called the London Club, that have reached agreement on controls on exports of nuclear materials and technologies. These are known as the Guidelines for Nuclear Transfers.

nuclear-weapons-free zone (NWFZ) A zone, normally established by treaty, that is free of nuclear weapons. Existing NWFZs cover the Antarctic (established by the Antarctic Treaty), Latin America (Treaty of Tlatelolco), the South Pacific (Treaty of Rarotonga), Southeast Asia (Treaty of Bangkok) and Africa (Treaty of Pelindaba). There are also NWFZs on the seabed (Seabed Treaty) and in outer space (Outer Space Treaty).

nuclear-weapon state (NWS) As defined in the Non-Proliferation Treaty, this is any state that 'manufactured and exploded a nuclear weapon or other nuclear explosive device prior to 1 January 1967'. These are the Russian Federation (as successor state to the Soviet Union), the United States, the United Kingdom, China and France. India, which exploded a nuclear device in 1974, is not a nuclear-weapon state under the NPT definition.

nucleus The centre of an atom, formed from *protons* and *neutrons*. The numbers of protons in a nucleus affect the chemical properties of the atom (i.e., how it will react with other atoms) while the number of neutrons affect its physical properties (i.e., its mass and its fissile and radioactive characteristics).

on-site inspection An inspection at a site within the realm of application of a treaty or agreement. Such an inspection may be a routine, confidence-building measure or may be a *challenge inspection*.

Partial Test Ban Treaty (PTBT) The PTBT, which entered into force in 1963, bans nuclear testing by its signatories in the atmosphere, in outer space or under water. The PTBT is also known as the Limited Test Ban Treaty.

Peaceful Nuclear Explosions Treaty (PNET) A bilateral treaty between the United States of America and the Soviet Union, signed in 1976 but not ratified until 1990. The treaty aimed to ensure that any nuclear tests carried out outside of established test sites were for peaceful purposes.

physical inventory A term used in nuclear safeguards which means 'the sum of all the measured or derived estimates of batch quantities of nuclear material on hand at a given time within a *material balance area*, obtained in accordance with specified procedures.'

positive security assurances A form of security assurance whereby a *nuclear-weapon state* guarantees to take action in support of a *non-nuclear-weapon state* in the event of a threat of attack or an actual attack with nuclear weapons.

proton A particle carrying a positive electrical charge that forms part of the *nucleus* of an *atom*. It is of approximately the same mass as a *neutron*. See also *atom*.

re-entry vehicle (RV) The component of a long-range *ballistic missile* that re-enters the atmosphere, and which contains the warhead, together with any terminal guidance equipment.

reprocessing The treatment of spent reactor fuel to separate plutonium, uranium and fission products.

safeguards (IAEA) Measures applied to peaceful uses of nuclear energy by the International Atomic Energy Agency to verify that they are not used for military purposes. Safeguards agreements made under the terms of INFCIRC/66 are applied to nuclear and other materials, services, equipment, facilities and information specified in the agreement. Safeguards agreements made under the terms of INFCIRC/153 are designed for *non-nuclear-weapon state* parties to the NPT and are applied to all nuclear materials in all of the peaceful nuclear activities of the state; such safeguards come under the category *full-scope safeguards*. Other, less common, forms of IAEA safeguards include: those organized pursuant to the Tlatelolco Treaty, which are very similar to those made under the terms of INFCIRC/153; full-scope safeguards where a state is not a party to the NPT; and voluntary offer agreements by *nuclear-weapon states* in which some or all of their peaceful nuclear activities are covered by safeguards.

seal A device attached to an object designed to indicate, for example, by breakage or deformation, if that object has been interfered or tampered with in an unauthorised manner. The International Atomic Energy Agency uses seals to assist in their accounting of nuclear materials under *safeguards*.

security assurances See *negative security assurances* and *positive security assurances*.

Separative Work Unit (SWU) Unit for measuring the work required to separate different isotopes in an *enrichment* process. The formula is complex, but is related to the following factors: quantity of enriched product from the feed material required (more product=more SWUs per unit of product); quantity of feed material (more feed=fewer SWUs); level of enrichment required (more concentrated=more SWUs); concentration of required isotope in the feed material (higher concentration=fewer SWUs); and concentration of wanted material in the tails or waste (higher concentration=fewer SWUs).

Strategic Arms Reduction Treaty/Talks (START) Bilateral treaties between the United States of America and the Soviet Union (now Russian Federation). START-2 was signed in July 1991 with START-2 signed in January 1993.

tactical air-to-surface missile (TASM) A generic term covering air-to-surface missiles with ranges of a few hundred kilometres. Examples of these missiles are the Short-Range Attack Missile–Tactical (SRAM-T), recently under development by the United States; and the Air-Sol à Longue Portee (ASLP), currently under development by France.

tag A device attached to an object that makes that object individually identifiable. Tags have uses in verifying that a state has less than a certain number of items limited by a treaty or agreement by allowing accurate counting of such items. See also *seal.*

Threshold Test Ban Treaty (TTBT) A treaty between the United States and the Soviet Union that prohibits nuclear tests above 150 kilotons. First negotiated in 1976, it was not ratified by the United States until 1990.

treaty-limited equipment (TLE) Those items regulated by provisions of a treaty, such as the *Intermediate-range Nuclear Forces Treaty.* In some treaties the term *treaty-limited item* is used instead.

treaty-limited item[s] (TLI) See *treaty-limited equipment*

vertical proliferation The quantative and/or qualitative increase in the possession, manufacture or deployment of a given weapons technology by an individual state. Usually used to describe the increase of nuclear weapon or ballistic missile capabilities.

Watt (W) Primary measuring unit of power, that is energy produced or consumed in a given unit of time. 1 Watt = 1 *Joule* produced or consumed in one second. More commonly used are the units *Megawatt* (MW =1,000,000 Watts) and Kilowatt (kW =1,000 Watts). NB – the power of the heat output of the core of a nuclear reactor is measured in MW(th) — Megawatts of thermal power, but the electrical output is given as MW(e) — Megawatts of electrical power, which is always less than the MW(th) figure.

weaponization Development required to make a technology usable as a weapon.