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REPORT ON NUCLEAR NON-PROLIFERATION (Rev. 2)

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FOREWORD

At the September 30, 1999, International Nuclear Societies Council (INSC) meeting held in Vienna, Austria, development of a second revision of the Report on Nuclear Non-Proliferation was approved, and guidelines for the work of the task group to produce this revision were set. Members of the task group were appointed by INSC nuclear societies and agreement organizations.

In past years, the nuclear community has been preoccupied with implementing and strengthening the nuclear non-proliferation regime, with the ultimate aspiration for a world free of the threat of nuclear weapons.

This INSC revision addresses the current measures for strengthening the Non-Proliferation Treaty, the physical protection of nuclear materials, the prevention of illicit trafficking, the fissile materials cut-off treaty, the disarmament and dismantling of nuclear weapons, and the disposition and burning of plutonium dismantled from nuclear arsenals.

INSC hopes this report will assist policy and decision makers, the nuclear community, and the public to be aware of the benefits of the existence of an integrated global non-proliferation mechanism embracing and incorporating all available arrangements, the development of proliferation-resistant nuclear fuel technology, and above all, mutual confidence-building.

Jorge Spitalnik
Chairman, International Nuclear Societies Council

1. INTRODUCTION

1. Introduction

This report updates Chapter 5 on Nuclear Non-Proliferation in the INSC publication *Worldwide Integrated View on Main Nuclear Energy Issues* (Rev. 1) of March 1999. It summarizes the results of the 2000 Review Conference of the Treaty on the Non-Proliferation of Nuclear Weapons and the status at the end of October 2003 of the global non-proliferation regime.

An attempt is made herein to review nuclear non-proliferation from the viewpoint of a nongovernmental organization (NGO) representing the aspirations of the nuclear community for a world free of the threat of nuclear weapons.

Nuclear weapons and nuclear power are a by-product of modern civilization. As symbols of the atomic age, on one hand, they magnify mankind's concerns in terms of the possibility of total destruction, and on the other, they form the modern backdrop against which peace, prosperity, and cooperation can be forged.

In this report, we analyze the different pathways that lead to nuclear proliferation, look at the record of nuclear bomb tests, evaluate the status of weapons possessed by the so-called have-countries, and discuss the structure of the nuclear non-proliferation regime founded on the basis of multilateral and regional arrangements, International Atomic Energy Agency (IAEA) safeguards, and nuclear export control as well as the nuclear-weapons-free zones (NWFZs).

In addition, mention is made of the wherewithal of strengthening the non-proliferation measures, the physical protection of nuclear materials, the prevention of illicit trafficking, the fissile materials cut-off treaty, the disarmament and dismantling of nuclear weapons, and the disposition and burning of plutonium dismantled from nuclear arsenals.

Finally, modern approaches are described to enhance global non-proliferation through improved supplementary routine inspection by relying on a state system of accounting for and control of nuclear materials (SSAC), the establishment of an integrated global non-proliferation mechanism embracing and incorporating all the existing arrangements, the development of proliferation-resistant nuclear fuel technology, and above all, mutual confidence-building.

2. NUCLEAR WEAPONS AND NON-PROLIFERATION CONCEPT

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2.1 Introduction

Man witnessed for the first time the mighty power of nuclear energy unleashed in all its destructive form when Hiroshima and Nagasaki were bombed in 1945. These events acted as a trigger to the nuclear arms race in the years that followed as major powers armed themselves with nuclear weapons, which served as a war-deterrent force and assured greater security for themselves and their allies. Despite significant progress in nuclear arms reduction through the Strategic Arms Reduction Treaty (START)-I and -II between the two superpowers and the recent Bush-Putin summit of 2002 and despite the restrained deterrence strategy of “strict sufficiency” implemented by some nuclear weapon states (NWSs), other members of the nuclear weapons club continued to build their nuclear arsenals. The most worrisome phenomenon is nuclear weapons capability development in some threshold countries, some of which have even signed the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), which could eventually lead to horizontal proliferation.

2.2 Nuclear Fuel Cycle

The nuclear fuel cycle encompasses all nuclear fuel operations from uranium mining and refining, and enrichment and fabrication of fuel assemblies before loading into the reactor core at the front end, to the ultimate disposal after discharge from the reactor core at the back end. In general, there are three options in dealing with the back end of the nuclear fuel cycle:

1. once-through nuclear fuel cycle or direct disposal
2. recycling or chemical reprocessing of spent fuel
3. once-through fuel cycle for CANDU and graphite reactors.

After loading into the nuclear reactor, uranium in fuel assemblies undergoes fission, by which a part of ^{235}U is transformed into fission products, while a part of ^{238}U is converted into plutonium nuclides. Other transuranic elements such as neptunium, americium, curium, etc., are also formed in small quantities.

The typical composition of spent fuel for current pressurized water reactor (PWR) core management and fuel burnup, with an initial ^{235}U content of 3.5 wt%, is as follows:

1. 96% residual uranium (0.9% ^{235}U)
2. 0.6% plutonium
3. 3% fission products.

2.2.1 Once-Through Nuclear Fuel Cycle or Direct Disposal

In this option, spent fuel discharged from the nuclear reactor is considered radioactive waste, which must be managed properly and ultimately disposed of. So long as the uranium remains natural, it is free from nuclear proliferation in all nuclear fuel cycles. However, once it is enriched or burned up in a nuclear reactor, the fuel and its handling facilities are subject to safeguards and inspection. The flow of nuclear fuel in the once-through nuclear fuel cycle for light water reactors (LWRs) is shown in Fig. 1, where proliferation-prone stages or facilities are identified.

2.2.2 Recycle of Nuclear Fuel for LWRs

In this approach, spent fuel is considered an energy source that is recovered by means of chemical reprocessing, and

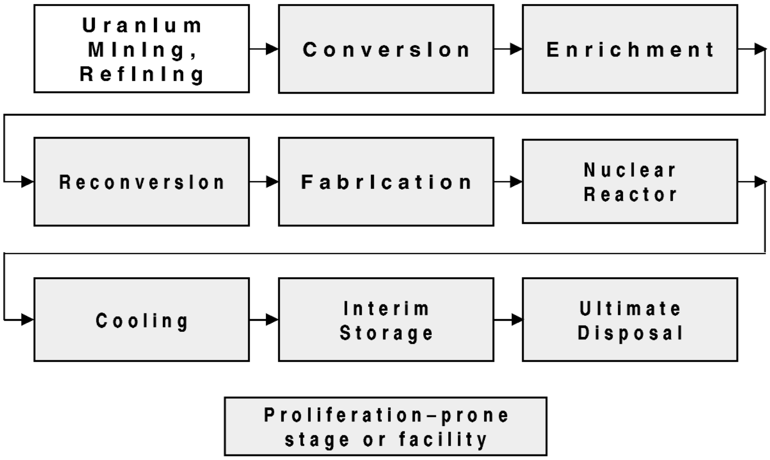

Fig. 1. Once-through nuclear fuel cycle for LWRs.

the chemical reprocessing of the spent fuel, the recycling of its plutonium content, and the conditioning by vitrification of its fission products and minor actinides content are part of a high-level long-lived waste management strategy aimed at strongly reducing both the volume and the long-term radiotoxicity of the high-level long-lived waste to be ultimately disposed of and at ensuring its long-term confinement. Spent fuel from a reactor core is stored at a cooling pond for a few years so as to be thermally and radiologically cooled down to a lower level. Then the spent fuel assemblies are transported to a chemical reprocessing plant for shearing and dissolving in nitric acid. The fissile material is then separated from the high-level waste (fission products and minor actinides) by a solvent extraction process. The recovered plutonium, which represents approximately 90% of the long-term radiotoxicity of the spent fuel, is recycled as mixed-oxide (MOX) fuel, and the high-level wastes are vitrified. Figure 2 illustrates the flow of nuclear fuel in an LWR and a fast breeder reactor (FBR), which are loaded with MOX fuel.

Both reactor types rely on chemical reprocessing for the utilization of residual ^{235}U and newly generated plutonium. Mixed-oxide fuel is less proliferation-prone than the

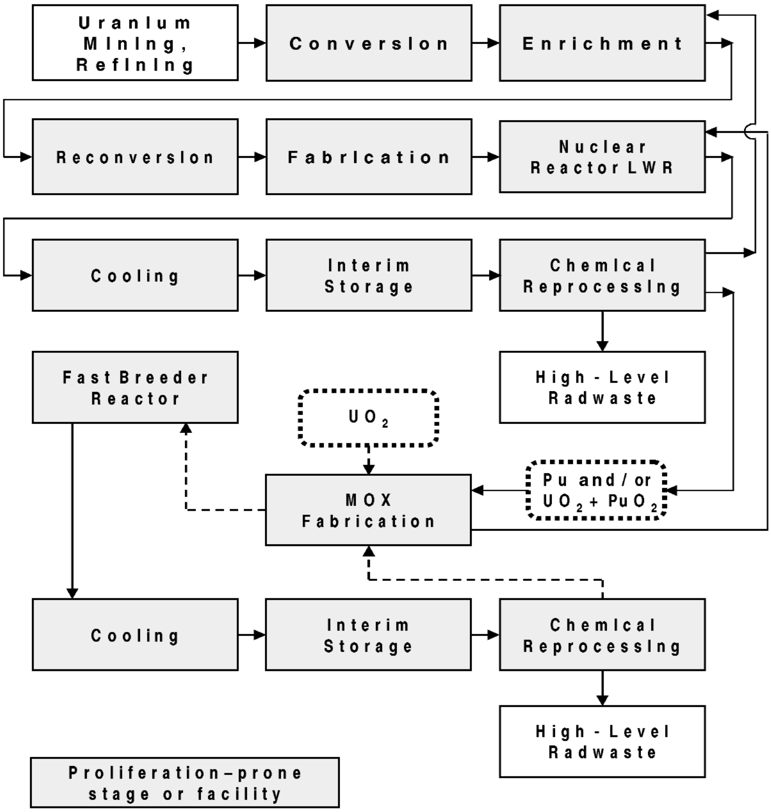

Fig. 2. Recycle of nuclear fuel for LWRs and FBRs.

separated plutonium. From the viewpoint of strengthening the non-proliferation regime, the utilization of MOX is preferable to the utilization of separated plutonium.

2.2.3 Once-Through Fuel Cycle for CANDU and Graphite Reactors

Both CANDU (heavy water reactor) and gas-cooled, graphite-moderated reactors are fueled with natural uranium fuel. In a CANDU reactor, natural uranium (with 0.71% ^{235}U content) is burned up to leave 0.2% ^{235}U, resulting in 0.3% newly formed plutonium nuclides. Because of such low contents of fissile nuclides in the spent fuel, spent fuel from CANDU and graphite reactors does not bear commercial incentives for chemical reprocessing. Nevertheless, the spent fuels discharged from these two reactor types deserve attention with respect to nuclear proliferation, because these reactor types are most apt to produce weapons-grade plutonium and because the on-line loading and unloading of their fuel make spent-fuel diversion easier. As an example, while India and Pakistan may have produced weapons-grade plutonium nuclides by means of heavy water reactors, North Korea has done the same by using a gas-cooled, graphite-moderated reactor. Figure 3 depicts the once-through fuel cycle for commercial reactors. For extracting military plutonium, spent fuel is not disposed of but is reprocessed at a chemical reprocessing plant.

Separated plutonium must be managed with extreme care and is, therefore, subject to thorough safeguards and routine inspection. Since there is a considerable amount of separated plutonium from military stockpiles resulting from dismantling nuclear warheads, immobilization and burning as MOX fuel have been proposed as means of disposing of

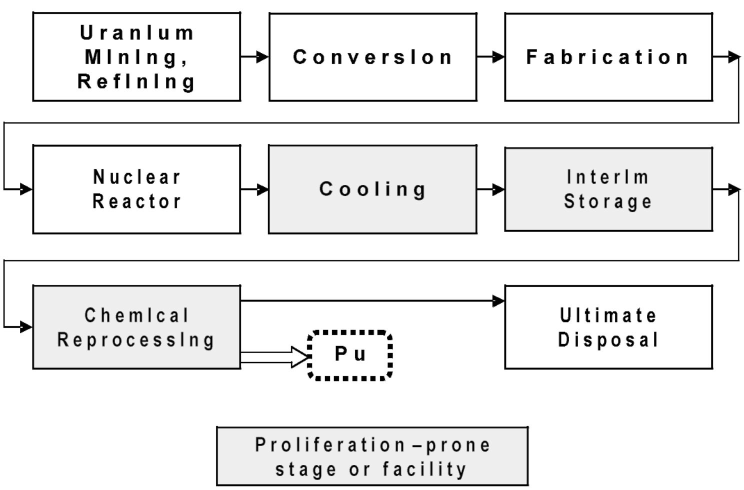

Fig. 3. Once-through nuclear fuel cycle for CANDU and graphite reactors.

excess-weapons plutonium. Only the latter option (MOX) has been retained by the United States and the Russian Federation for the disposition by each of 34 tonnes of excess-weapons plutonium under their 2000 bilateral intergovernmental agreement. Indeed, clearly, the MOX option is, among others, superior in terms of non-proliferation and disarmament because the isotopic conversion that the MOX fuel undergoes in a reactor degrades the plutonium quality to the point where it becomes far less attractive for diversion into weapons applications.

As for the dual-track approach, namely, the use of MOX in reactors as fuel on one hand and plutonium immobilization on the other, this approach can be acceptable as a temporary measure but may not be a safe and efficient strategy in long-range global energy supply terms. By comparison, the immobilization process merely encapsulates the plutonium into a radiation barrier but does not alter its isotopic composition, which means that this procedure is reversible. In short, immobilization means leaving the problematic material around for future solution.

2.3 Plutonium Disposition and MOX Fuel Technology

The events of September 11, 2001, further emphasized the need to minimize the chance of weapons-grade plutonium falling into the wrong hands. In the United States, the U.S. Department of Energy has completed two major environmental impact statements on surplus plutonium disposition of weapons-grade plutonium by fabricating the material into MOX fuel and using the fuel in commercial nuclear reactors. In Russia, the Ministry of Atomic Energy (Minatom) is developing a similar program to dispose of surplus Russian weapons-grade plutonium as MOX fuel in existing reactors. Russia is also considering the use of the surplus plutonium as fuel for future advanced reactors.

Irradiation of MOX fuel destroys much of the weapons-grade plutonium and isotopically degrades the remainder so that it is less attractive for use in nuclear weapons. In addition, spent MOX fuel assemblies are large, highly radioactive, and maintained under material and security controls. Use of MOX fuel in LWRs has been found to be fully compliant with the spent-fuel standard for plutonium disposition, while proliferation issues remain to be resolved with alternative technologies such as can-in-canister immobilization.

There are several potential technologies, including immobilization and advanced reactors, that could be used to dispose of surplus plutonium, but MOX fuel is the only such technology that has been proven on an industrial scale. MOX fuel demonstration programs began in the 1960s in the United States and Europe. In the early 1980s, use of significant quantities of MOX fuel began in European nuclear power reactors. Commercial MOX fuel fabrication has been ongoing at three facilities in Belgium and France for some time and more recently in a fourth facility in the United Kingdom. Thirty-five nuclear power reactors in Europe are currently using significant quantities of MOX fuel to produce electricity. The safety and performance record of MOX fuel is comparable to that of low-enriched uranium (LEU) fuel.

Fabricating surplus weapons plutonium into MOX fuel and using that fuel in commercial nuclear power reactors renders the material unattractive for weapons use in a number of ways:

1. Irradiation to 40 gigawatt days per tonne heavy metal (GWd/t), the nominal burnup following two 18-month cycles of operation in a PWR, leads to a net reduction of approximately 30% of the initial amount of plutonium.
2. Irradiation to 40 GWd/t degrades the isotopic composition of the plutonium: ^{240}Pu is an undesirable isotope for weapons applications; plutonium must be less than 7% ^{240}Pu to meet the definition of weapons-grade. Irradiation of MOX fuel in a reactor increases the amount of ^{240}Pu that is present, as illustrated in Table 1. The plutonium in irradiated LEU fuel and irradiated MOX fuel is classified as

Table I.
Isotopic Concentrations

Isotope	Weapons-Grade MOX Fuel Before Use (%)	Weapons-Grade MOX Fuel After 40 GWd/t Burnup (%)
^{230}Pu	93.5	51
^{240}Pu	6.5	29
^{241}Pu	—	16
^{242}Pu	—	4

Source: ANS Position Statement Nr. 47, Background Report, November 2002.

reactor-grade (i.e., containing more than 20% ^{240}Pu). Reactor-grade plutonium is not as desirable as weapons-grade plutonium for use in nuclear weapons, particularly for a rogue state or terrorist group with limited technological capabilities.

3. The plutonium in irradiated MOX fuel is encased in a matrix of highly radioactive fission products. While the chemistry for recovering plutonium from spent fuel is well known, the radiation barrier prevents easy access to the material and complicates the steps that would be required to recover it.

4. To obtain plutonium from spent fuel, it would first be necessary to divert spent fuel assemblies from their storage location. An irradiated MOX fuel assembly is large, massive, and radioactive—typical PWR fuel assemblies are more than 12 ft long, weigh more than 500 kg, and produce a very high radiation field following irradiation. Furthermore, spent fuel assemblies are stored in controlled areas (spent fuel pools or dry storage facilities), and regulations require that they be tracked and monitored.

Theft or diversion of the plutonium in spent nuclear fuel would be difficult and hazardous. Furthermore, even if the plutonium could somehow be stolen and separated from the uranium and the highly radioactive fission products in the ceramic fuel matrix, the isotopic composition of the resulting plutonium is relatively unattractive for nuclear weapons use.

2.3.1 Maturity of MOX Fuel Technology

Plutonium has long been recognized as a potential source of energy. Plutonium isotopes ^{239}Pu and ^{241}Pu are fissionable, similar to uranium isotopes ^{233}U and ^{235}U. Plutonium is produced as a by-product of nuclear power. A nuclear chain reaction involving LEU fuel produces plutonium through neutron capture in ^{238}U. After a burnup of 40 GWd/t, a PWR fuel assembly initially enriched to 4% ^{235}U will be approximately 1% plutonium. At the end of the useful life of such an initially all-uranium fuel assembly, almost half of the power generated in that assembly comes from plutonium fission.

Reactor use of LEU fuel and subsequent reprocessing of the spent fuel to chemically separate the uranium, plutonium, and fission products produced the worldwide stockpiles of plutonium. Weapons-grade plutonium was produced by reprocessing the fuel after low burnup prior to buildups of substantial quantities of the ^{240}Pu isotope, which has a high rate of spontaneous fission and is therefore undesirable for weapons applications. Reactor-grade plutonium was and is produced by reprocessing spent fuel after more extensive irradiation in a nuclear reactor.

During much of the second half of the 20th century, there were significant concerns about the availability of sufficient economically recoverable uranium from which LEU fuel for nuclear power reactors could be made. In addition, it was recognized that reprocessing spent reactor fuel, and thereby separating the uranium, plutonium, and highly radioactive fission products, offered potential benefits with respect to management of high-level radioactive waste. As a result, there was considerable worldwide nuclear technology development related to both reprocessing and reuse of the plutonium in nuclear power reactors.

Most commercial nuclear power reactors have evolved to a standard fuel type consisting of natural or low-enriched ceramic uranium oxide fuel pellets encased in tubes of zirconium-based alloy. To use plutonium as fuel in such reactors, small amounts of plutonium oxide are blended with large amounts of natural or depleted uranium oxide (MOX fuel). As the MOX fuel fabrication technology developed, it became possible to produce MOX fuel pellets that are very similar to 100% uranium oxide fuel in both physical characteristics and reactor performance.

In the United States, there was substantial development in MOX fuel technology in the 1960s and 1970s. The work culminated in a series of MOX fuel demonstration programs at five commercial nuclear power reactors: the San Onofre and Ginna PWRs, and the Dresden, Quad Cities, and Big Rock Point boiling water reactors. In each program, lead test assemblies were used for several cycles of operation to study the performance of MOX fuel rods during prototypical conditions. In all of the programs, the MOX fuel performed acceptably and in a manner similar to the co-resident uranium fuel. In the 1970s the U.S. nuclear industry was poised to begin large-scale reprocessing of spent nuclear fuel and associated reuse of the separated plutonium in commercial LWRs. However, fearing the worldwide non-proliferation consequences of separating large quantities of plutonium, the U.S. government made a policy decision against the reprocessing of spent nuclear fuel. At that time the development and deployment of MOX fuel technology in the United States came to a halt.

Other countries, however, continued their development of reprocessing and MOX fuel technologies and deployed those technologies on an industrial scale. In the early 1980s, nuclear reactors in Germany began using substantial quantities of reprocessed plutonium in the form of MOX fuel. Other European reactors have followed suit, and as of 2000, 35 nuclear power reactors in France, Germany, Belgium, and Switzerland were using MOX fuel. Reactors in Japan are also planning to use MOX fuel in the future, although no definite schedule has been established.

Three nuclear fuel fabrication facilities are currently producing MOX fuel. Belgonucléaire operates the P0 MOX fuel fabrication facility at Dessel, Belgium. Cogema operates the Cadarache and Melox MOX fuel fabrication facilities in southern France. A fourth MOX fuel fabrication facility, British

Nuclear Fuels plc's (BNFL's) Sellafield manufacturing plant, has been constructed.

MOX fuel and LEU fuel behave very similarly in reactors. Apart from the fuel pellet material, MOX and LEU fuel assemblies are essentially identical with respect to mechanical design. Both MOX fuel pellets and LEU fuel pellets consist of sintered ceramic pellets that are predominantly ^{238}U dioxide, and the respective material properties are very similar. The microstructures of the two types of fuel pellets differ somewhat in that LEU fuel is a homogeneous mixture of ^{238}U dioxide and ^{235}U dioxide, while MOX fuel is more heterogeneous, with very small plutonium-rich particles in a matrix of depleted uranium oxide. The nuclear characteristics of MOX and LEU fuel are also different due to the nuclear cross-section differences between uranium and plutonium. However, the MOX fuel assembly neutronic design can be adjusted to make the MOX fuel nuclear characteristics similar to those of co-resident LEU fuel.

The more significant differences between MOX and LEU fuel are summarized as follows:

1. The fission and overall absorption cross sections of ^{239}Pu are substantially higher than those of ^{235}U. Accordingly, for the same power level, MOX fuel has a lower thermal flux. This leads to a reduction in the worth of thermal neutron absorbers in a partial MOX fuel core, most notably soluble boron and control rods. This effect has been successfully addressed by various means, including increasing soluble boron concentration, using enriched soluble boron, adding more control rods to reactors with partial MOX fuel cores, and core design to ensure adequate shutdown margin.

2. The flux gradient between LEU fuel assemblies and MOX fuel assemblies requires PWR MOX fuel to incorporate low plutonium concentration zones on the exterior of the fuel assembly. Otherwise, those exterior MOX fuel rods would experience unacceptably high peaking due to thermal neutrons leaking in

from the adjacent LEU assemblies with higher neutron flux levels. The intra-assembly zoning for MOX fuel assemblies successfully minimizes the peaking that would otherwise be experienced in partial MOX fuel cores.

3. Fission gas release from MOX fuel at elevated burnup (greater than 40 GWd/t) is higher than the fission gas release from LEU fuel. This effect has been predominantly tied to the relatively higher power experienced by MOX fuel at high burnup. In Europe the higher fission gas release has been successfully addressed by modifying MOX fuel rod design to provide more plenum space and by establishing specific burnup limits on the MOX fuel assemblies.

4. The radionuclide inventory in spent MOX fuel differs somewhat from that of spent LEU fuel. As a result, the decay heat from MOX fuel is slightly lower than that of LEU fuel immediately following shutdown, providing a safety benefit during the time frame of most concern for analyses of postulated transients and accidents. In the longer term, the decay heat from MOX fuel exceeds that of LEU fuel, and that difference must be taken into account for spent-fuel management.

5. Spent MOX fuel contains substantially higher quantities of most actinides than does spent LEU fuel. The actinide inventories could affect the off-site doses calculated to result from hypothetical, extremely unlikely core melt accidents with containment failure. In addition, for some geologic repository designs, the actinides can have a substantial impact on the projected doses in very long (hundreds of thousands to millions of years) time frames.

Fundamentally, MOX fuel is very similar to LEU fuel, and MOX fuel has been demonstrated to perform well in commercial nuclear power reactors. Fuel assembly, core, and plant design practices effectively accommodate the differences that do exist between the fuel types.

2.3.2 Challenges for Implementing MOX Fuel Technology

The MOX fuel project is a key part of a complex, long-term program to dispose of surplus weapons plutonium in the United States and Russia. To succeed, the program will require a substantial investment of government resources, although the estimated costs are small compared to the resources that were invested in producing the weapons-usable material in the first place. The financing for the Russian plutonium disposition program is expected to derive from international sources. The governments of the industrialized nations of the world must recognize the benefit of disposing of substantial quantities of weapons-usable plutonium in Russia and the United States and invest in the plutonium disposition program accordingly.

The September 2000 United States–Russian Federation Plutonium Disposition Agreement calls for each nation to fabricate plutonium into MOX fuel and to use that fuel in existing nuclear reactors. Neither Russia nor the United States has contemporary experience making or using MOX fuel. However, facilities in Europe have been making and using MOX fuel for decades. Information and technology exchange will be essential if U.S. and Russian MOX fuel use is to begin in a timely manner.

Independent safety authorities in the United States and Russia must approve large-scale MOX fuel fabrication and subsequent use in existing nuclear reactors. This oversight must include a proper level of safeguards and physical protection for the weapons-grade plutonium during MOX fuel fabrication, transportation, and use. Fortunately, MOX fuel is a technology that has been proven on an industrial scale in European facilities. To advance the program in the United States, it is essential that the U.S. Nuclear Regulatory Commission fulfill its regulatory responsibilities in a thorough yet timely manner. The nuclear professional community can play an important role in this effort by helping to provide the government and the public with the technical facts that are pertinent to the fabrication and use of MOX fuel.

Compared to the United States, Russia has few existing LWRs available for the use of MOX fuel. In addition, Russia has contemporary experience using the BN-600 sodium-cooled fast reactor to generate power, and this reactor design is very amenable to the use of MOX fuel. Furthermore, Russia is exploring the use of future advanced reactors (including high-temperature gas-cooled reactors and sodium-cooled fast reactors) for power generation and plutonium disposition. Moreover, Canada has expressed interest in supporting a program to dispose of surplus weapons plutonium in existing CANDU heavy water reactors. Given these facts, coupled with the large and potentially growing quantities of surplus weapons plutonium needing disposition worldwide, it may ultimately be appropriate to expand the plutonium disposition program beyond using MOX fuel in existing reactors. However, it is critical from a non-proliferation perspective to initiate a plutonium disposition program in a timely and cost-effective manner. Use of surplus weapons plutonium as MOX fuel in existing nuclear power reactors offers the best opportunity to accomplish that objective.

2.4 The Concept and Objective of Nuclear Non-Proliferation

The first U.N. General Assembly resolution of January 1946 called for the elimination of nuclear weapons from state arsenals. In the same year, the United States, the first country to manufacture and use these weapons, proposed the establishment of an international authority to control all atomic energy activities but met with no success. In 1949 the Soviet Union also became a nuclear weapons power, followed in 1952 by the United Kingdom, in 1960 by France, and in 1964 by China. India made its first nuclear explosion in 1974, and India and Pakistan carried on a number of nuclear weapon tests in 1998.

In the 1960s, the realization that proliferation of nuclear weapons would pose a danger to world security resulted in the development of a non-proliferation regime that encompasses various restrictive rules as well as specialized control institutions, whose pivotal piece is the NPT. The treaty was signed in 1968 and entered into force in 1970. Thus, the need to restrain the military threat of nuclear energy has been evident from the early days of the atomic age. As a result, many organizations were established together with the conclusion of corresponding treaties and agreements, where, in particular, the IAEA, already created in 1956, fulfills an essential practical role.

The NPT is a unique document in the sense that it prohibits nuclear weapons possession by the non-nuclear weapons states (NNWSs) while recognizing the retention of such weapons by five who possessed them at the time the treaty was finalized (China, France, the United Kingdom, the United States, and Russia for the former USSR). This keeps India and Pakistan out of the nuclear weapons states (NWSs) group. Thus, the elements of this treaty are discriminatorily stipulated on the basis of the terms of the rights and obligations of those who had or had not nuclear weapons at that time.

In fact, the nuclear non-proliferation regime has allowed the five NWSs to proceed with the further development of their nuclear weapons arsenal while blocking proliferation among the other parties. Fortunately, since the end of the Cold War, development of the NWS arsenals has been largely suspended, in part from the improvement of the political relations newly established among the superpowers and from mutual cooperation of the concerned NWSs. External pressure for such mutual cooperation was applied by NNWSs through the Comprehensive Nuclear-Test Ban Treaty (CTBT) enacted at the United Nations in September 1996.

The improvement of the political relations between the two nuclear superpowers, known to possess 95% of the world's total nuclear arsenal, led to START, which initiated the process for bringing forth vertical nuclear non-proliferation. In January 1993, Russia and the United States entered into talks on the START-II Treaty, which resulted in an agreement envisaging drastic cuts in their nuclear arsenals: All MIR Ved intercontinental ballistic missiles were to be scrapped, and after completing the reductions in 2002, it was established that both sides would only retain 3000 to 3500 warheads each on 1600 launchers. After all agreements and unilateral announcements were to be implemented, the United States would have had its global arsenal reduced from a maximum of approximately 32 000 warheads in 1965 to about 5000 warheads. For Russia, the respective figures would have been approximately 34 000 in 1983 to about 3700. In November 2001, Presidents George Bush and Vladimir Putin announced reductions in their operational strategic arsenals leading to 1700 to 2200 nuclear warheads by 2012.

The nuclear non-proliferation regime relies for its implementation on such tangible measures as safeguards and the export control system and the implementation of measures of physical protection of nuclear materials and of prevention of illicit trafficking. The international nuclear non-proliferation regime consists of multilateral systems, e.g., NPT and bilateral agreements as well as independently adopted policies in specific countries. In principle, it seeks to prevent nuclear weapons proliferation. The NPT is not designed to cope with situations that arise upon failure of non-proliferation measures. This is left to the responsibility of the U.N. Security Council.

After the Persian Gulf War in 1991, the Security Council decided to impose rigorous measures on a country, in this case Iraq, attempting to acquire a nuclear weapons capability in violation of the NPT. In this context, implementation or enforcement of the nuclear non-proliferation regime rests in the hands of the highest international body dealing with compliance with U.N. principles.

Despite its discriminatory approach, the NPT has attracted a record number of adherents to an arms control agreement. It is worth stressing that NPT success came comparatively late in its history. The rush to join and to make the treaty more universal came with the end of the Cold War in the early 1990s.

The NPT is not an end in itself: The declared aim of the parties to the NPT is to use it as a transitional measure to clear the way toward eventual nuclear disarmament. The ultimate goal of the nuclear non-proliferation regime is to prevent both the proliferation of nuclear weapons and the development of nuclear arsenals. At the same time, implementation of this regime should not contribute to undermining the peaceful applications of nuclear energy. Rather, it has to be managed to activate its peaceful uses under the umbrella of the non-proliferation regime.

2.5 Record of Bomb Tests and Status of Nuclear Weapons

The total number of nuclear warheads in the hands of the five NWSs is reckoned to be of the order of tens of thousands. Of this, approximately 95% is held by the two nuclear superpowers, the U.S. and Russia. The nuclear warheads that were deployed in Ukraine, Kazakhstan, and Byelorussia during the Soviet period have been returned to Russia or are at least in Russia's custody. This being so, Russia is the only country in the CIS that is now recognized as NWS; Ukraine, Kazakhstan, and Byelorussia have joined the NPT as NNWSs. The number of nuclear warheads in the arsenal of the remaining three NWSs, China, France, and the United Kingdom, is in the range of a few hundred units each.

South Africa's first nuclear efforts are believed to have started in the early 1970s under the auspices of a peaceful nuclear explosions program to bolster South Africa's mining industry. However, former President de Klerk stated in his 1993 speech to the parliament that in 1974, the government secretly decided to develop nuclear weapons. The project soon expanded with the construction and operation of a pilot-scale uranium enrichment plant at Pelindaba and the construction of a nuclear test site in the Kalahari Desert. South Africa completed two nuclear test shafts in 1976 and 1977, respectively. A total of six nuclear devices were manufactured. The program was halted in late 1989. Beginning in July 1990, the uranium enrichment plant at

Pelindaba East was decommissioned, the six nuclear devices were dismantled, the hardware and technical documents were destroyed, the highly enriched uranium (HEU) was recast and sent back to the Atomic Energy Commission for permanent storage, and Advena, the weapons manufacturing site, was neutralized and sealed off. The entire dismantlement process was known to have been completed in early July 1991.

There have been 2045 nuclear bomb tests carried out by the five NWSs. Aside from this number (2045 events), there have been up to 13 additional test events conducted by three states that are not NWSs and that were not parties to the NPT at the time of the test. The first of these was the Indian nuclear bomb test in 1974, which India claimed as a simple nuclear explosive test for the development of peaceful uses of nuclear energy. The second is presumed to have taken place in 1979 in the South Atlantic, which, after the South African government's recognition in 1991 of having developed and then scrapped a nuclear weapons program, could have been a South African test. India conducted five nuclear bomb tests in two days, May 11 and 12, 1998, claiming they were needed to display the inherent strength of the country against threats from neighbors. Two weeks later, Pakistan also detonated five nuclear bombs, followed by one more test two days after the first one. It has to be noted that India and Pakistan are not parties of the NPT.

When it is carried out by an NNWS, a nuclear bomb test is not only contrary to NPT terms but it can also be interpreted as an implicit signal encouraging "rogue states" toward the path of nuclear weapons development and violating the NPT and discouraging states not yet parties to the NPT to join the treaty. No one knows how much plutonium and/or weapons-grade HEU has been produced or accumulated so far in one NPT-violating country (North Korea) or in the three countries that are not parties of the NPT (India, Israel, and Pakistan). But, if the record of South Africa (which voluntarily dismantled its six nuclear warheads and placed the dismantled fissile nuclear materials under IAEA's custody when it decided to join the NPT) is any guide, the amount of weapons-grade fissile materials and the number of already assembled nuclear bombs in such countries have probably reached a point where these numbers cannot be overlooked.

2.6 Nuclear Proliferation Pathways and Countermeasures

There are seven pathways to acquiring weapons-grade nuclear materials, as depicted in Fig. 4.

The five NWSs have pursued paths 1 and 2, their nuclear materials coming either from their uranium enrichment facilities or from plutonium production reactors run in conjunction with chemical reprocessing plants.

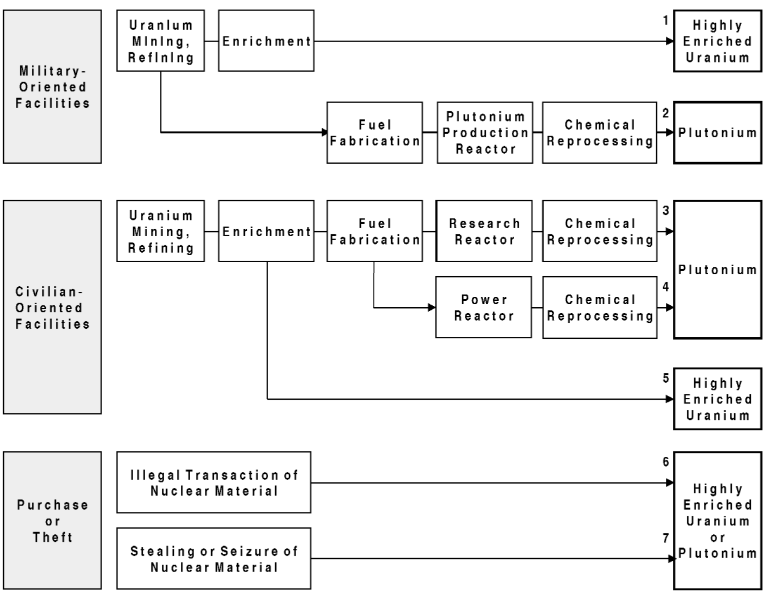

Fig. 4. Possible pathways to acquiring weapons-grade special nuclear materials.

Given the reality that civilian nuclear facilities are common, close monitoring of declared uranium enrichment facilities, nuclear reactors, reprocessing plants, and nuclear materials storage facilities is not enough to prevent nuclear proliferation.

For instance, a clandestine uranium enrichment facility, either in operation or under construction, can go on undetected for years, as was seen, all too vividly, in the aftermath of the Gulf War in Iraq, a party of the NPT, subject to IAEA's full scope of safeguards. This demonstrated that an effective non-proliferation verification regime must also focus on possible undeclared material and activities, and to this aim, the IAEA Board of Governors approved in 1997 a Model Additional Protocol to Safeguards Agreements that contains a number of provisions conferring on the IAEA the legal authority to implement further strengthening safeguards measures (see Sec. 4.3).

Paths 3, 4, and 5 in Fig. 4, which pertain to civilian facilities, are fraught with proliferation dangers. Therefore, by imposing strict safeguards on all registered civilian nuclear facilities, the IAEA is to prevent possible diversion of nuclear materials by facility operators.

Paths 6 and 7 in Fig. 4 are associated with illegal transactions of special nuclear materials in the black market and/or stealing or forcible seizure of such materials by radical or fanatic groups. The only way to prevent such transactions is with stringent enforcement of physical protection extended to special nuclear materials.

From the viewpoint of nuclear proliferation, natural uranium-fueled graphite-moderated gas-cooled reactors, heavy water reactors, and FBRs (which generate high-quality weapons-grade plutonium in bulk) are clearly more vulnerable than LWRs (with their LEU).

Strict safeguards inspections on the declared nuclear facilities and materials should be continuously implemented as countermeasures to the possible diversion of weapons-grade nuclear materials. However, undeclared nuclear facilities or materials as well as clandestine weapons development programs still remain as problematic issues in view of nuclear proliferation. The generalization of full-scope safeguards agreements and additional protocols (whose model was adopted in 1997) will provide the IAEA with the legal means to implement strengthened safeguards measures designed to adequately address these issues.

3. THE INTERNATIONAL NUCLEAR NON-PROLIFERATION REGIME

3. The International Nuclear Non-Proliferation Regime

3.1 Introduction

The nuclear non-proliferation mechanisms are of two types: multilateral arrangements and bilateral ones. A multilateral arrangement is a system in which the concerned parties, either global or regional, agree to be bound by the obligatory terms and conditions specified in a treaty or agreement. The obligation pertains to the aspects of production, assemblage, testing, inducement, transfer, deployment, etc., of nuclear weapons, their production facilities, and associated technologies. Matters of export control policy and physical protection of nuclear materials are also currently stipulated between parties to the agreement.

The goals spelled out in a multilateral arrangement can only be attained if and when a maximum possible number of parties voluntarily participates and, concomitantly, these signatories faithfully observe full compliance with the terms and conditions elucidated in the agreement. The NPT has contributed greatly to preventing, if not actually precluding, the spread of nuclear weapons. Its role will become more crucial in the years to come with the strengthening of its function and with the development of inspection techniques.

Pursuant to the NPT, the IAEA safeguards system has been applied to all declared facilities of the parties to the NPT, along with other necessary measures, such as the export control regime. The operation of a regional cooperative system like Euratom is a contributing element to the implementation of multilateral non-proliferation efforts in the respective regions. The establishment of NWFZs plays a significant role in preventive terms in the applicable regional areas.

3.2 NPT and CTBT

3.2.1 The NPT

The NPT is the central linchpin of the global nuclear non-proliferation regime. Opened for signature on July 1, 1968, it entered into force on March 5, 1970. As of December 2002, it embraced some 188 states plus Taiwan, China, more than the number of U.N. member states. Of the state parties to NPT, 50 were not IAEA members. When signed, its validity was established for a 25-year duration, up to 1995. The parties agreed at the 1995 NPT Review and Extension Conference held at the United Nations that the treaty shall continue in force indefinitely.

In the articles of the NPT, the obligations of each party are specified as follows:

1. For NWSs: not to transfer to any recipient nuclear weapons or other nuclear explosive devices and not to assist, encourage, or induce any NNWS to manufacture or otherwise acquire them.
2. For NNWSs: not to receive the transfer from any transferor of nuclear weapons or other nuclear explosive devices and not to manufacture or acquire them; for the safeguards verifications, these NNWSs are to conclude agreements with the IAEA for safeguards to be applied on all sources or special fissionable materials in all peaceful nuclear activities within the territory of such states. Such agreements are to be concluded with the IAEA individually or together with other states within 18 months after their accession to the treaty.
3. For all parties: to facilitate and participate in the exchange of equipment, materials, and scientific and technological information for the peaceful uses

> of nuclear energy; and to pursue negotiations in good faith on effective measures relating to the cessation of the nuclear arms race and to nuclear disarmament, and on a treaty on general and complete disarmament under strict and effective international control.

Other major provisions include the right of any group of states to conclude regional treaties to ensure the absence of nuclear weapons in their respective territories and the convening of review conferences every five years (review conferences have been held in 1975, 1980, 1985, 1990, 1995, and 2000).

The NPT was accompanied by Security Council Resolution 255 (1968) on security assurances to NNWSs. On April 11, 1995, the five NWSs through U.N. Security Council Resolution 984 issued harmonized security assurances for parties to the NPT.

3.2.2 The CTBT

The CTBT was opened for signature on September 24, 1996. The number of signatories is 165 state parties, and 93 state parties had ratified the CTBT as of July 2002. It will enter into force once all 44 states mentioned in its Annex A, which include India and Pakistan, have ratified it. This treaty is of unlimited duration. Each state party has the right to withdraw from the CTBT if it decides that extraordinary events related to its subject matter have jeopardized its supreme national interests.

In the decades after the first nuclear detonation, nuclear bomb tests took place on the ground, in the sea, in the air, and underground. The Partial Test Ban Treaty (PTBT) was introduced in 1963 to call off nuclear tests except for underground tests. On the other hand, CTBT is a multilateral treaty that prohibits all nuclear bomb tests, including the underground tests.

As to its structure, the treaty includes a protocol in three parts: Part I details the International Monitoring System (IMS), Part II refers to On-Site Inspections, and

Part III deals with Confidence-Building Measures. There are also two annexes to the protocol: Annex 1, detailing the location of various treaty monitoring assets associated with the IMS, and Annex 2, the parameters for screening events.

Basic obligations are such that the CTBT will ban any nuclear weapons test explosion or any other nuclear explosion (i.e., true zero yield).

The treaty established a CTBT Organization (CTBTO), located in Vienna, Austria, to ensure the implementation of its provisions, including those for international verification measures. The CTBTO includes a Conference of States Parties, an Executive Council, and a Technical Secretariat, which shall include an International Data Center. For the present interim period until the entry into force of the CTBT, a provisional Secretariat executes this work.

The most important aspects of the CTBT consist of its verification and inspections arrangements: The treaty's verification regime includes an IMS composed of seismological, radionuclide, hydro-acoustic, and infrasound monitoring; consultation and clarification; on-site inspections; and confidence-building measures. The use of national technical means, vital for the treaty's verification regime, is explicitly provided for. Requests for on-site inspections must be approved by at least 30 affirmative votes of members of the treaty's 51-member Executive Council. The Executive Council must act within 96 hours of receiving a request for an inspection.

The treaty provides for measures to redress a situation and to ensure compliance, including sanctions, and for settlement of disputes. If the Conference or Executive Council determines that a case is of particular gravity, it can bring the issue to the attention of the United Nations.

3.3 Nuclear Export Control Systems

While the threat of nuclear weapons proliferation may have declined from a political perspective, since the NPT was opened for signature, from a technological perspective it may well be said to have increased as nuclear technology has become more widespread. Particularly in the wake of events in Iraq in the 1990s, increased emphasis has been placed on controls on technology that may be important in nuclear weapons development. Note, however, that export controls are only really useful to the extent that they can be successfully implemented, and they may often serve at best (although importantly) as a delaying tactic to prevent countries attempting to develop nuclear weapons from acquiring nuclear weapons-related technology until—it is hoped—other methods can be found to dissuade the pursuit. The concern caused by the nuclear program in Iraq has led to a substantial tightening of export controls on technology of use for nuclear weapons development and their likely effectiveness as well.

Effective restrictions on exports of materials and equipment can play a direct role in limiting access to their use in potential nuclear weapons programs. Monitoring of exports can also perhaps somewhat indirectly aid other monitoring activities because procurement patterns may indicate that a particular route toward some clandestine nuclear activity is being taken. Verification resources can then be concentrated on a particular area, looking for a particular type of activity such as a centrifuge enrichment facility.

There are two main bodies that coordinate multilateral export controls on nuclear materials: the Nuclear Exporters Committee, known as the Zangger Committee, and the Nuclear Supplier's Group (NSG), or London Club, as it is sometimes known. In the past few years there have been substantial revisions to the list of items under control as well as the addition of a regime to cover dual-use items. In addition, under the auspices of the IAEA, a new universal reporting scheme on imports and exports of nuclear-related equipment has been implemented, albeit on a voluntary basis at present, which should make it possible to gain further insight into the trade patterns of the nations involved.

3.3.1 Zangger Committee

The Zangger Committee was formed in 1971, under the chairmanship of Professor Claude Zangger of Switzerland, to draft a trigger list of (a) sources or special fissionable materials and (b) equipment or materials especially designed or prepared for the processing, use, or production of special fissionable materials, which under Article III.2 of the NPT should be subject to IAEA safeguards if supplied by NPT parties to any NNWS.

Most of the 40 NSG nations are concurrently members of the Zangger Committee, consisting of 35 members plus one permanent observer—the European Commission.

The committee decided that its status was informal and that its decisions would not be legally binding upon its members. The decisions are put into legal effect by unilateral declarations of each member to other members, with subsequent letters to the Director-General of the IAEA requesting him to publish these unilateral policy declarations in IAEA Document INFCIRC/209.

The Zangger Committee arrived at a consensus on the basic guidelines, set out in two separate memoranda dated August 14, 1974. The first defined the list of sources and special fissionable materials, and the second defined the exports of equipment and non-nuclear materials. These are commonly known as the Trigger List and were published as IAEA Document INFCIRC/209 on September 3, 1974. Attached to the original Trigger List was an annex clarifying the items described in the list in some detail. Since then, additional clarification exercises, conducted on the basis of consensus and then transmitted to the IAEA, have taken place. They contained new items on plants for the production of heavy water, technological development in the field of isotope separation by the gas centrifuge process, and fuel reprocessing plants.

3.3.2 The NSG

After initial consultations in 1974 between the United Kingdom, the United States, and the USSR on the desirability of further coordinating export policy, and with increased concern over the transfer of nuclear technology resulting from the explosion of a nuclear device by India, the NSG met in 1975–78. The countries initially involved were Canada, France, the Federal Republic of Germany, Japan, the United Kingdom, the United States, and the USSR. A major reason for the group's creation was the inclusion of France, a major supplier and at the time not a party to the NPT and thus not a participant in the Zangger Committee.

An outline agreement had already been reached by 1976, at which time eight other states—Belgium, Czechoslovakia, the German Democratic Republic, Italy, the Netherlands, Poland, Sweden, and Switzerland—were also invited to participate in further consultations. In early 1978, using a procedure similar to that adopted by the Zangger Committee, all the countries involved sent letters to the Director General of the IAEA to inform that they would abide by the principles that had been agreed to in 1977. The Guidelines for the Export of Nuclear Material, Equipment or Technology (the so-called London Guidelines for Nuclear Transfers) are contained in IAEA document INFCIRC/254. These London Guidelines, which only apply to exports to NNWSs, place more stringent requirements on nuclear export than the Zangger Committee understandings, and include requirements for assurances of non-explosive use on the part of recipients, safeguards, as well as the control of retransfer.

The Zangger Trigger List in the form it had taken by the end of 1978 was incorporated into Annex A of the trigger list of the London guidelines, which also includes common criteria for technology transfers under the Guidelines. Activities and trade ban items of some equipment and materials controlled by these two main bodies are listed in Appendix A of this report. The list of specified equipment and non-nuclear material for export and import reporting is given in Appendix B.

The three basic principles of the guidelines are (a) transfer to an NNWS of items on the trigger list should be authorized only after formal assurances from the recipient government, which explicitly exclude uses that would result in a nuclear explosive device; (b) materials and facilities appearing on the trigger list should be "placed under effective physical protection to prevent unauthorized use and handling"; and (c) trigger list items should be transferred to an NNWS only when this state has entered into a full-scope safeguards agreement with the IAEA.

3.4 IAEA Safeguards

In 1963, U.S. President John F. Kennedy forecast that by the 1990s, more than 20 countries around the world would possess nuclear weapons. As a means of and in support of averting President Kennedy's nuclear nightmare, many countries began endorsing the NPT hoping to prevent the spread of nuclear weapons while promising nuclear disarmament negotiations among the five declared NWSs.

The IAEA (or simply the Agency) has been, from its outset, the instrument of governments to verify that the peaceful-use commitments made under the NPT or other agreements are faithfully observed. The IAEA's measures for this purpose are known as the safeguards system. Being a member of the U.N. family, the IAEA was mandated to accelerate and enlarge the contribution of nuclear energy to peace, health, and prosperity throughout the world, and to ensure that assistance provided by it or at its request or under its supervision or control is not used in such a way as to further any military purpose.

As of the end of 2001, 225 safeguards agreements were in force with 141 states, and as of October 2002, safeguards agreements pursuant to the NPT were concluded with 134 states. For 46 NNWS parties to NPT, there was at the time no safeguards agreement in force pursuant to the provisions of the NPT because their comprehensive safeguards agreements were signed but not in force, or were approved by the Board of Governors but not signed, or had to be concluded.

After the Gulf War in 1991, the discovery of a clandestine nuclear weapons development facility in Iraq demonstrated the limitations of the IAEA's safeguards function to detect possible undeclared nuclear activities.

IAEA's safeguards obligations in Iraq continued to be subsumed by the mandate assigned to the IAEA under the resolutions of the U.N. Security Council. The Agency sustained the implementation of its plan for monitoring and verification of Iraq's compliance with the relevant Security Council resolutions through resident inspectors of a nuclear monitoring group with the assistance and cooperation of a U.N. special commission. The implementation of this plan did not preclude the Agency's right to further investigate any aspects of Iraq's former nuclear weapons program. Newly strengthened safeguards systems were introduced to provide the international community with early warning about possible diversion or clandestine production of weapons-grade nuclear materials.

However, in December 1998, Iraq's government prohibited the continuation of the performance of IAEA inspections. After an interruption of nearly four years, the IAEA resumed in November 2002 its verification activities in Iraq. In March 2003, upon the imminence of war, the Director General decided on the withdrawal of Agency inspectors from Iraq for security reasons. By the time inspectors left Iraq, no evidence of ongoing prohibited nuclear or nuclear-related activities had been detected at the locations inspected. However, no firm conclusions could be drawn pending the completion of ongoing verification activities. As of October 2003, the Agency's mandate in Iraq under various Security Council resolutions was still standing.

As for North Korea, the IAEA had maintained a continued presence of inspectors in the Nyongbyon area since May 1994 in accordance with the request of the U.N. Security Council. The Agency carried out its monitoring activity to freeze the operation of North Korea's graphite-moderated reactor and related facilities. By the end of 1997, most of the spent fuel rods from the shutdown 5-MWe graphite reactor had been loaded into canisters for long-term storage. Little progress had been made on the issue of preservation by North Korea of information relevant to the history of her nuclear program, as required by the Agency for verification of the completeness and correctness of former reports related to her nuclear facilities and activities. Furthermore, North Korea did not enable the Agency to implement certain inspection measures, such as the measurement of plutonium content in spent fuel rods from the 5-MWe graphite reactor and monitoring of the nuclear liquid waste in two storage tanks adjacent to a “radiochemical laboratory” presumed to have been used as a reprocessing facility.

The Agency was never able to verify the completeness and correctness of the initial report of the DPRK (North Korea) under the NPT Safeguards Agreement. Since 1993 it has drawn the conclusion that the DPRK was in non-compliance with its obligations under the Agreement. In other words, the Agency has never had the complete picture regarding DPRK nuclear activities and has never been able to provide assurances regarding the peaceful character of the DPRK nuclear program. Between 1994 and 2002, an Agreed Framework signed with the United States was aimed at bringing the DPRK into compliance with its safeguards obligations. However, the reporting in October 2002 by North Korean authorities about a clandestine uranium enrichment program, the subsequent end of the “freeze” pursuant to the Agreed Framework, and the expulsion at the end of that year of the IAEA inspectors brought this phase to an end.

Another country having failed to meet its obligations under its Safeguards Agreement with the IAEA is Iran. In February 2003, Iran informed the IAEA, for the first time, of its uranium enrichment program, which was described as including two new facilities located at Natanz, namely, a pilot fuel enrichment plant nearing completion of construction and a large commercial-scale fuel enrichment plant also under construction. Iran also confirmed that a heavy water production plant was under construction in Arak. Iran acknowledged the receipt in 1991 of natural uranium, which had not been reported previously to the Agency, in the form of UF_6 (1000 kg), UF_4 (400 kg), and UO_2 (400 kg), which was now being stored at the previously undeclared

Jabr Ibn Hayan Multipurpose Laboratories located at the Tehran Nuclear Research Centre. Some of the UO_2 had also been used for isotope production experiments, including the undeclared irradiation of small amounts of the UO_2, at the Tehran Research Reactor (TRR). Another small amount of UO_2 had been used in pellets to test the chemical processes of the Molybdenum, Iodine and Xenon Radioisotope Production Facility (MIX Facility).

The Iranian authorities acknowledged that a workshop of the Kalaye Electric Company in Tehran had been used for the production of centrifuge components but stated that there had been no operations in connection with its centrifuge enrichment development program involving the use of nuclear material, either at the Kalaye Electric Company or at any other location in Iran. The pilot enrichment plant was scheduled to start operating in June 2003. More than 100 of the approximately 1000 planned centrifuge casings had already been installed at the pilot plant, and the remaining centrifuges were to be installed by the end of 2003.

In May 2003, Iran informed the Agency for the first time of its intention to construct a heavy water research reactor at Arak (the 40-MWth Iran Nuclear Research Reactor IR- 40). Iran also informed the Agency of its plan to commence construction of a fuel manufacturing plant (FMP) at Esfahan in 2003. The stated purpose of the FMP was fabrication of fuel assemblies for the IR-40 and for the Bushehr Nuclear Power Plant.

Consequently, the IAEA concluded that Iran failed to meet its obligations under its Safeguards Agreement with respect to the reporting of nuclear material, the subsequent processing and use of that material, and the declaration of facilities where the material was stored and processed. These failures can be summarized as follows:

1. failure to declare the import of natural uranium in 1991 and its subsequent transfer for further processing
2. failure to declare the activities involving the subsequent processing and use of the imported natural uranium, including the production and loss of

nuclear material, where appropriate, and the production and transfer of waste resulting therefrom

3. failure to declare the facilities where such material (including the waste) was received, stored, and processed
4. failure to provide in a timely manner updated design information for the MIX Facility and for TRR
5. failure to provide in a timely manner information on the waste storage at Esfahan and at Anarak.

3.5 Physical Protection of Nuclear Materials

Effective systems are required to protect nuclear materials and facilities from theft, seizure, and sabotage for the sake of both non-proliferation and radiation safety. The responsibility clearly rests with each state for defining and implementing proper physical protection measures at a national level. But physical protection of nuclear materials is also of international concern since incidents in one state have ramifications across borders. The international community, therefore, has a legitimate interest in the fulfillment by states of their physical protection responsibilities. The basic guidelines for physical protection systems have been developed by the IAEA (INFCIRC/225/Rev.3, Recommendations for the Physical Protection for Nuclear Materials). First published in 1972, these guidelines have been revised a number of times. They cover physical protection for nuclear materials in use, storage, and transport, both domestically and internationally. These international guidelines, which are not legally binding instruments, have proven to be of significant importance in the development of national requirements and international agreements.

For nuclear materials in international transport, the implementation of effective physical protection systems is of direct concern to shipping, receiving, and transit to or from states. The Convention on the Physical Protection of Nuclear Materials, which entered into force in 1987, requires states parties to implement specific protection measures for nuclear materials in international transport.

At the time of the negotiation of the convention, some states believed that physical protection in the domestic sphere should remain within their national responsibility and not subject to binding international standards.

The importance of having effective physical protection systems in place has been highlighted by the threat posed by well-publicized cases of illicit trafficking of small quantities of nuclear materials in the mid-1990s. These incidents pointed to the possibility of unauthorized access to direct-use materials and thus to potential weaknesses in the physical protection system of the relevant countries. The potential for the smuggling of large quantities of weapons-usable materials may be low. However, even trafficking of small quantities of such material deserves full attention in the context of non-proliferation, because quantities of nuclear materials of strategic value could be accumulated. Also, radioactive sources have been reported in illicit trafficking incidents. Although they do not pose a proliferation threat, they can cause, and have resulted in, fatal ionizing radiation exposure to individuals and therefore constitute an additional motivation to strengthen illicit trafficking prevention measures, which is beneficial to non-proliferation.

In light of these developments, the IAEA and its member states have given increased attention to activities against illicit trafficking of nuclear materials and other radioactive sources. Within its program Security of Material, the IAEA has initiated a number of activities to support member states in improving their nuclear material accountancy and physical protection systems at state and facility levels.

Following the tragic events of September 2001, the General Conference of the IAEA, in its resolution GC(45)/RES/14 B of September 21, 2001, requested the Agency to review thoroughly its activities and programs with a view to strengthening the Agency's work relevant to improving protection against acts of terrorism involving nuclear material and other radioactive materials. In March 2002, the IAEA Board approved in principle the Agency's plan of action, which covers eight areas:

1. physical protection of nuclear facilities
2. detection of malicious activities
3. strengthening of state systems for nuclear material accountancy and control
4. security of radioactive sources
5. assessment of safety and security-related vulnerabilities at nuclear facilities
6. response to malicious acts or threats thereof
7. adherence to international agreements and guidelines
8. enhancement of nuclear security-related matters.

Clearly, the first line of defense in protecting nuclear materials is an effective SSAC, through which states have an exact knowledge of the quantities and location of their nuclear materials. These systems help deter illegal activities because of the possibilities of timely detection of missing materials. For this reason, the Agency has, inter alia, focused on the development and coordination of plans for technical support to establish and improve SSACs and physical protection systems. In addition to an SSAC, a comprehensive regulatory framework with adequate operational resources is also required to detect attempts of intrusion, delay access to the materials, and activate preplanned response measures.

In general, states should compare the IAEA's recommended protection standards with their own physical protection ones. The IAEA might develop forms on which states could report each year on their efforts for their significant nuclear facilities. The purpose would be both to raise the national physical protection standards and to provide assurance to other states that protection in problem states is improving.

The Physical Protection Convention now prohibits its parties from exporting nuclear materials unless they are assured by the recipient that the materials will receive appropriate physical protection during international transport. Like the NSG, the parties to the Physical Protection

Convention might agree to adopt export controls requiring that all nuclear materials they export be subject to strengthened physical protection standards.

3.6 The NWFZ

In general, most developing countries do not possess the economic and technological means or the necessary trained manpower to engage in any significant nuclear weapons program. Horizontal proliferation in these countries could indeed cause serious security problems, particularly in a regional context, and lead to nuclear competition between rival neighboring states in sensitive regions, as was clearly demonstrated by India and Pakistan in May 1998, and have global repercussions. This led to several proposals for the denuclearization of different regions and the actual establishment of NWFZs in the world. These would serve as valuable building blocks for an eventual all-encompassing non-proliferation regime. The continued success of this approach requires full backing of the NNWSs in the respective regions and the active interest and support of the nuclear powers. A description of the existing NWFZs follows.

3.6.1 Treaty for the Prohibition of Nuclear Weapons in Latin America (Treaty of Tlatelolco, entered into force in 1968)

The main obligations of the contracting parties are as follows: no testing, use, manufacture, production, or acquisition of nuclear weapons by the parties or on behalf of anyone else; no receipt, storage, installation, or deployment of such weapons by the parties or on behalf of anyone else; and no participation elsewhere in activity designed to produce nuclear weapons.

The treaty maintains the right of the parties to conduct nuclear explosions for peaceful purposes under appropriate control.

The provisions for verification and control include the establishment of a permanent zonal supervisory organization, OPANAL, to ensure compliance with IAEA safeguards and the additional provisions of the treaty. In particular, provisions are made for "special inspections" in the case of suspect activity upon the reasoned request of one of the contracting parties and eventual engagement of the U.N. Security Council in case of violations.

3.6.2 South Pacific Nuclear-Free Zone Treaty (Treaty of Rarotonga, entered into force in 1986)

Protest of French nuclear tests on the Mururoa Atoll in the 1960s and 1970s and proposals to dump nuclear wastes in the Pacific fueled a general reaction against nuclear weapons, and at the insistence of New Zealand and Australia, most members of the South Pacific Forum established the treaty in 1986. The South Pacific Nuclear-Free Zone extends over national land territory, inland seas, and territorial waters. The treaty also prevents nuclear materials and nuclear weapons from being stationed on the South Pacific's numerous small islands.

3.6.3 Denuclearization of Africa (Signed on April 11, 1996)

In 1960, France conducted her first nuclear test explosion in the Sahara Desert. Since then, the U.N. General Assembly has adopted yearly resolutions on the denuclearization of Africa: to ban procurement of nuclear weapons by African states or assistance to them in the manufacture of such weapons. There was no action on this resolution by the African states, with the exception of repeated condemnations of South Africa for not placing its facilities under safeguards. After South Africa dismantled its nuclear arsenal in 1989 and joined the NPT in 1991, the African states agreed to sign the Pelindaba Treaty for a nuclear-free zone in Africa in 1995.

3.6.4 The Southeast Asia NWFZ (Treaty of Bangkok, entered into force in 1999)

The treaty requires each state party not to "develop, manufacture or otherwise acquire, possess or have control over nuclear weapons; station or transport nuclear weapons by any means; or test of nuclear weapons."

The treaty also outlaws the dumping of radioactive waste or materials anywhere in the zone and requires all state parties to maintain full-scope IAEA safeguards over their nuclear facilities. Each state is to decide individually whether to allow foreign ships or aircraft (which could be nuclear powered or nuclear armed) to visit or transit through their airspace or territorial waters.

The arsenals of the five NWSs (Britain, China, France, Russia, and the United States) are the subject of a treaty protocol that is open for signature by the five countries. Attached to the protocol is a pledge stating "not to use or threaten to use nuclear weapons against any State Party to the Treaty." None of the five powers has so far signed the protocol.

3.6.5 Joint Declaration for a Non-Nuclear Korean Peninsula (on February 19, 1992)

To create conditions and an environment favorable to peace and the peaceful unification of the peninsula and to contribute to the peace and security of Asia and the world at large by eliminating the danger of nuclear war through its denuclearization, South and North Korea made a declaration on January 20, 1992, with the following provisions:

1. The South and the North will not test, produce, receive, possess, store, deploy, or use nuclear weapons.
2. The South and the North will use nuclear energy solely for peaceful purposes.
3. The South and the North will not possess facilities for nuclear reprocessing and uranium enrichment.
4. To verify the denuclearization of the Korean Peninsula, the South and the North will conduct inspection of objects chosen by the other side and agreed to by both parties. Such inspection will be

implemented according to the procedures and methods prescribed by a South-North Joint Nuclear Control Committee.

5. To ensure the implementation of this joint declaration, the South and the North will organize a South-North Joint Nuclear Control Committee within one month of the coming into force of this declaration.
6. This joint declaration will enter into force the day appropriate instruments are exchanged following the completion by the South and the North of the necessary procedures to bring this declaration into effect.

Due to the noncompliance of the DPRK with the terms and conditions agreed upon and signed by both parties, this declaration remained dormant for more than 10 years until May 2003, when it was unilaterally denounced by North Korea.

4. STRENGTHENING THE NUCLEAR NON-PROLIFERATION MEASURES

4. Strengthening the Nuclear Non-Proliferation Measures

4.1 Introduction

It became evident from the discovery of a clandestine nuclear weapons development facility in Iraq after the 1991 Persian Gulf War, the recent discovery of failures by Iran to meet its NPT obligations, and the long-suspected nuclear materials diversion from an operating reactor in North Korea that simple implementation of IAEA safeguards is neither enough nor satisfactory. These three countries were parties to the NPT (though the latter withdrew from the NPT in 1993, then suspended the notice of withdrawal, and withdrew again in January 2003).

North Korea has prevented IAEA from determining whether nuclear materials have been diverted from its graphite reactor and chemical reprocessing plant and has not fully complied with its safeguards obligations. Iran failed to report on the import of nuclear material, the subsequent processing and use of that material, and the declaration of facilities where the material was stored and processed.

There exists a group of countries that have neither joined the NPT nor accepted comprehensive IAEA safeguards. This group, usually referred to as threshold states, includes India and Pakistan, which have conducted nuclear weapons tests, and, although until now there is no evidence that it carried out any such tests, presumably Israel.

In recognition of such realities, the international community began to enforce the export control regime along with implementing the IAEA safeguards system with a greater stringency and vigilance.

4.2 The Control of Dual-Use Items

The Persian Gulf War in 1991 brought another problem of the nuclear non-proliferation regime into the spotlight: the weakness of existing export controls. It was shown that in most cases, a would-be proliferating state like Iraq will still be significantly dependent on technological infusions from abroad. But the IAEA can only act effectively when it knows what is going on in a given state, e.g., what equipment, materials, and technology the state is acquiring from abroad. Iraq had made lavish imports of militarily usable goods from industrialized countries for its conventional, missile, chemical, biological, and nuclear programs. Many of the technologically advanced countries had contributed to this concentrated effort in one way or another to develop in Iraq arsenals of weapons of mass destruction. Supplier countries learned painfully that the time had come to act to close many loopholes that the existing export regulations, including international agreements such as the London Suppliers Guidelines, left open.

Thus, when the Netherlands invited, for the first time in 14 years, all members of the London Suppliers Group to a meeting in The Hague in February 1991, the response was overwhelmingly positive. The old objection of some suppliers that the industrialized exporters “ganging up” would create suspicion and alienate the developing countries had disappeared under the impact of the Persian Gulf War. Germany, one of the states traditionally reluctant to stiffen export restrictions, had become very much interested in an international agreement to reinforce export controls. France, also traditionally averse to reconvening the suppliers, was about to change its policy and was determined to demonstrate its readiness to cooperate internationally for non-proliferation purposes.

The United States submitted a preparatory paper on dual-use export controls. This had become a burning issue because of the dismantling of most Coordinating

Committee on Multilateral Export Controls restrictions. The U.S. proposals were by and large adopted: the suppliers agreed in principle to work on a list of dual-use items and, in addition, on a list of items of direct use in nuclear weapons but not related to civilian nuclear uses. This was a major change and included such materials as krytrons (for electronic switches), tritium (for boosted nuclear weapons), and beryllium (a reflector material enhancing the yield of a given amount of fissile material).

4.3 Strengthened Safeguards System

Some undesirable nuclear-related events in a few countries in recent years have significantly changed the environment and requirements of the nuclear safeguards system.

Iran and Libya[a] are NNWS parties to the NPT, but their commitment to the treaty has been under suspicion because of their demonstrated interest in acquiring nuclear arms. As for Iraq, as noted previously, a clandestine nuclear weapons development facility was being built in disrespect of that country's NPT commitments. After the 2003 war, the resumption of IAEA inspections will allow verification of whether prohibited nuclear or nuclear-related activities were carried out or not.

North Korea became a party to the treaty in 1985 but delayed more than six years before agreeing to permit IAEA inspection of its nuclear activities in April 1992. During that interval, it is presumed that it produced a quantity of plutonium that may be sufficient for one to three nuclear weapons. As of December 1998, it had not accounted for this material satisfactorily and was not in compliance with its IAEA safeguards obligations under the treaty because of its refusal to allow the IAEA to conduct a special inspection of two nuclear waste sites believed to contain information related to the production of plutonium

[a]By the end of 2003, Libya officially decided to eliminate materials, equipment, and programs leading to the production of internationally proscribed weapons, and agreed to take the necessary steps to conclude an Additional Protocol to its NPT Safeguards Agreement with IAEA.

in the past. Under an Agreed Framework signed with the United States in October 1994, North Korea agreed to resolve these issues at a future date. In the meantime, it accepted restrictions on its nuclear activities that went beyond its obligations under the NPT, including the freeze on the operation and construction of a number of sensitive facilities. North Korea withdrew from the IAEA in June 1994 but still remained a party to the NPT.

In October 2002, the DPRK acknowledged it had a "program to enrich uranium for nuclear weapons." Subsequently, the United States, Japan, and the Republic of Korea and KEDO (Korean Peninsula Energy Development Organization) concluded that the DPRK's program was a violation of the Agreed Framework, the NPT, the DPRK-IAEA Safeguards Agreement, and the North-South Joint Declaration on the Denuclearization of the Korean Peninsula. In light of those violations, the KEDO Board decided to suspend heavy oil deliveries as of the December 2002 shipment.

In November 2002, the IAEA Board of Governors recognized that the program to enrich uranium for nuclear weapons "or any other covert nuclear activities, would constitute a violation of the DPRK's international commitments, including the DPRK's safeguards agreement with the Agency pursuant to the NPT." The DPRK announced its decision to lift the freeze on its nuclear facilities as of December 13, 2002, in light of the U.S. suspension of the heavy fuel oil supply pursuant to the Agreed Framework, and on December 22, the DPRK started to cut seals and disable surveillance cameras. A week later, it ordered the IAEA inspectors to leave the country. North Korea announced its withdrawal from the NPT effective as of January 11, 2003. The IAEA Board of Governors adopted a resolution on February 12, 2003, declaring North Korea in further noncompliance with its nuclear safeguards obligations and referring the matter to the U.N. Security Council. On April 9, 2003, the U.N. Security Council expressed its "concern" over the situation in North Korea and said it would keep following developments there.

This DPRK attitude does represent a serious challenge to the nuclear non-proliferation regime because it may give a message of impunity to other would-be "proliferants." It shows that a state can be a member of the NPT and still develop nuclear weapon technologies to be put in use at the time it breaks out of the treaty. It will be of great importance to establish unequivocally, in the 2005 NPT Review Conference, that the provisions of safeguards agreements signed under NPT are to be maintained on materials, information, and facilities that were safeguarded in a given country before its withdrawal from the treaty. This was one of the main recommendations in the INSC Public Statement on North Korean Nuclear Weapons issued on September 15, 2003 (see Appendix C).

As of October 2003, the return of the DPRK to the nuclear non-proliferation regime was the subject of diplomatic negotiations taking place in Beijing, China, among six governments (China, DPRK, Japan, Republic of Korea, Russia, and the United States).

The number of failures by Iran to report the material, facilities, and activities in a timely manner as it is obliged to do pursuant to its Safeguards Agreement was considered by the IAEA Board of Governors to be a matter of concern that prompted a resolution urging Iran to provide the Agency, by the end of October 2003, with a complete and accurate declaration of all its nuclear activities. The Director General emphasized the need for the conclusion of an Additional Protocol to the Safeguards Agreement with Iran.

Before the end of the deadline set up by the IAEA, Iran announced its intention to conclude the Additional Protocol with the Agency and to provide the required information on its nuclear activities.

The Argentina-Brazil Agency for Accounting and Control (ABACC) was established under an agreement between Argentina and Brazil, which at the time did not belong to the NPT, signed at Guadalajara, Mexico, on July 18, 1991. Under this agreement, Argentina and Brazil undertook to use the nuclear materials and facilities under their jurisdiction or control exclusively for peaceful purposes; to prohibit and prevent in their territories, and to abstain from carrying out, promoting, or authorizing, directly or indirectly, or from participating in any way in the testing, manufacture, production, or acquisition by any means of any nuclear weapons; and to prohibit the receipt, storage, installation, deployment, or any other form of possession of any nuclear weapons. These two nations established a Common System of Accounting and Control of Nuclear Materials to verify that the nuclear materials in all nuclear activities of the parties are not diverted to the purposes prohibited by the agreement.

A Quadripartite Safeguards Agreement between the IAEA, Argentina, Brazil, and ABACC entered into force on March 4, 1994. Under this agreement, the IAEA would perform its safeguards activities in Brazil and Argentina with the close cooperation of ABACC. The IAEA and ABACC apply safeguards on a wide range of facilities, including enrichment plants, two LWRs, two heavy water on-load reactors, and fuel fabrication plants as well as numerous smaller facilities. After ratification of the NPT by both countries in the mid-1990s, the application of the IAEA safeguards systems made ABACC activities somehow redundant.

The formal report of the IAEA Governing Board that Iraq was in breach of its NPT obligations came after most of Iraq’s nuclear facilities had been destroyed and after the rest of the program had been tracked down by UNSCOM. This happened not as a prelude to but as a direct consequence of the U.N. action taken under Chapter 7 of the U.N. charter. The complicated situation could have dealt a major blow to the IAEA safeguards regime. However, these events provoked, in fact, a major reaction to improve the regime, and more states than ever became conscious of the increasing risks of nuclear proliferation to national, regional, and global security.

Until 1991, in NNWS parties to the NPT, the IAEA monitored only those facilities declared by the inspected country and did not seek out possible undeclared nuclear installations. After the Persian Gulf War, as it was learned that Iraq had secretly developed a network of undeclared nuclear facilities as part of an extensive nuclear weapons program, the IAEA announced in late 1991 that it would begin to exercise its previously unused authority to conduct special inspections, i.e., to demand access to undeclared sites where it suspected nuclear activities were being conducted.

The process of strengthening and improving the safeguards system has been ongoing for many years. In 1992, the right of the IAEA to use special inspections as provided for in comprehensive safeguards agreements was confirmed, and decisions were made in the same year with respect to the early provision and use of design information for facilities handling safeguarded nuclear materials. In February 1992, the IAEA Board of Governors endorsed a voluntary reporting scheme on imports and exports of specified equipment and non-nuclear materials.

Initial implementation of measures under Program 93+2 (the IAEA safeguards development program initiated in 1993 and extended two more years after that) began in June 1995 when the Board agreed to the Director General's plan to proceed immediately with the implementation of those measures deemed to be within the legal authority provided by the existing comprehensive safeguards agreements.

Safeguards have always required concerted actions by the IAEA Inspectorate, state authorities, and nuclear facility operators. The Strengthened Safeguards System places an even greater emphasis on cooperation. Increased cooperation has a number of dimensions. One dimension is a systematic evaluation, considering the interest and capabilities of individual SSACs, of ways to achieve efficiencies through enabling actions by the SSAC and through a sharing of resources and activities while preserving the IAEA requirements to come to its own independent conclusion. Measures provided for in the Additional Protocol to safeguards agreements (INFCIRC/540) approved by the IAEA Board of Governors on May 15, 1997, include many important items such as information about, and inspector access to, fuel cycle-related research and development; information on the manufacture and export of sensitive nuclear-related technologies and inspector's access to manufacturing and import locations; the collection of environmental samples beyond the declared locations when deemed necessary by the IAEA; and administrative arrangements that improve the process of designating inspectors, the issuance of multientry visas, and IAEA access to modern means of communications.

The Additional Protocol greatly adds to the value of the collection of environmental samples through increased access for inspectors. In addition to the so-called location-specific applications of environmental sampling, the Additional Protocol also provides for the future applications of environmental sampling in a monitoring or wide-area mode. Procedures to implement wide-area environmental sampling will require approval by the IAEA Board of Governors.

Traditional material accountancy safeguards have been developed through the definition of indicators of diversion or of circumstances where the possibility of diversion cannot be excluded. These indicators are constantly tested against a state's declarations of nuclear materials inventories, flows, and facility operations. A strengthened safeguards system provides for a new kind of observational vantage point comprising state declarations regarding nuclear and nuclear-related activities that constitute the whole of their nuclear program and the utilization of nuclear materials, increased inspector access, new technical measures, and broadly based analysis of information. An important development in this regard is the so-called physical model.

Just as the overall technical objective of traditional safeguards translates to the testing of the hypothesis of no diversion, the objective of strengthened safeguards is met through a country-level evaluation taken to be the testing of the hypothesis that there are no undeclared nuclear activities. It is a detailed technical evaluation of, first, the internal consistency of the state's declaration and, second, a point-by-point comparison between indications of activities from all information available to the Agency and what the state says it is doing or plans to do.

The IAEA Director General has stated that it is the aim of the Agency to achieve the optimum combination of all safeguards measures available under comprehensive safeguards agreements and additional protocols to achieve maximum effectiveness and efficiency within the available resources. This optimum combination is known as integrated safeguards. Integrated safeguards activities, when implemented fully, will usher in a smart, information-driven, nondiscriminatory system that is designed to draw conclusions regarding compliance by a state with its non-proliferation obligations.

4.4 India and Pakistan's Nuclear Tests in May 1998

India and Pakistan are neither parties to the NPT nor have ratified the CTBT. Nevertheless, both nations had been strong advocates in the international community for the worldwide settlement of the CTBT, especially during the Cold War era when the five nuclear club member countries frequently conducted nuclear tests.

Along with the suspension of nuclear detonations by the so-called have-countries as of 1996, and also the globally spread tendency for the adoption of the CTBT, the Indian stance on nuclear issues became somewhat passive. The world was relieved of the nuclear mushroom for a few decades and particularly welcomed the indefinite extension of the NPT that was terminated in 1995 after having been effective for a period of 25 years. Nuclear peace appeared to prevail in the world.

Under such circumstances, India abruptly detonated five nuclear devices on May 11 and 13, 1998. These tests reveal that India had designed an arsenal ranging from small bombs for battlefield use to hydrogen bombs. Because of detonating more than one bomb at once, the Indian authority was suspected of attempting to scramble the seismic data, making it difficult for the snoopers to interpret such data. These series of tests may have meant for India that it was able to jump up the threshold separating the “haves” and the “have-nots.” After the tests, the Indians rejoiced over their show of power and proudly said that the nuclear detonations ended India’s pushover status and claimed to be a nuclear superpower. They commented that national security considerations should override the effects of the harshest of sanctions.

The international community and the superpowers failed to either predict or prevent the Indian nuclear detonations because the reconnaissance satellites are unable to detect underground activity. In fact, placing facilities and materials underground at night or under cloud cover foils all snoopers except radar satellites, which have inferior resolution anyway. To be fully prepared for the underground nuclear tests at any time, the holes in which the nuclear devices were tested this time in the Rajastan Desert, where India’s first nuclear bomb test had taken place in 1974, had been dug as long ago as 1982.

On the other hand, Pakistan’s test was not only predicted but also publicized by its leaders as a retaliatory security measure against India’s provocation. Although the test site was pinpointed and its preparations were well detected in advance, the world leaders totally failed to preclude the tests that took place on May 28, two weeks after India’s tests. Pakistan claimed to have detonated five bombs. On May 30, she conducted another test at the same site.

India and Pakistan’s tests may become conducive to igniting chain reactions among other countries that will see them as an open invitation to acquiring this dreadful technology. For the world not to fall into a catastrophe, therefore, the global village should urge India and Pakistan not to carry out anymore tests and to sign the CTBT that mandates an end to such explosions. Despite the fact that these states, having carried out several weapons tests and boasted of their weapons capability, are unlikely to join the NPT as NNWSs, they should be encouraged and ultimately invited to commit themselves to the prevention of the spread of nuclear weapons technology to non-nuclear states, as sustained by the NPT.

The fissile material for India's nuclear test is believed to be plutonium. Pakistan alleged that its nuclear weapons technology is superior to India's know-how, hinting that the fuel for the tests was HEU.

The relationship between India and Pakistan will be maintained by the balance of mutual nuclear fear, but it appears to be fragile because it is not grounded on mutual deterrence, as it was during the successful balance of mutual nuclear fear between the former Soviet Union (FSU) and the United States, but rather on a mutual preemptive strike. The case of India and Pakistan is somewhat worrisome because of a mutual grudge resulting from three past wars. The nuclear armament by these two rivals imposes a great risk of nuclear confrontation resulting from an accident or misinformation because both countries lack adequate nuclear weapons control and reconnaissance systems. Above all, a nuclear bomb-laden missile in either country can be delivered to its opponent territory within a few minutes.

We must note, however, the positive step taken by both India and Pakistan to agree to a moratorium on further testing.

5. IS IT ENOUGH TO PREVENT THE SPREAD OF NUCLEAR WEAPONS?

5. Is it Enough to Prevent the Spread of Nuclear Weapons?

5.1 Introduction

The foregoing measures are meant to prevent diversion of materials from peaceful nuclear activities to the development of military hardware. The means for realizing this goal have been with the legal, technical, and cooperative arrangements among concerned parties. We may ask ourselves the question: Is it enough then to achieve the target objective of preventing the spread of nuclear weapons and stop there? In principle, it is absolutely desirable that all the weapons-grade nuclear materials be placed under the custody of the international safeguards system, thus ensuring total non-proliferation. In practice, however, theory sometimes comes short, and it usually serves us well to have several lines of defense instead of just one. We know that excess plutonium dismantled from nuclear arsenals is very susceptible to diversion. The same is true for HEU. Given this, fabrication of MOX fuel from excess plutonium stocks for use as nuclear fuels under the strict custody of the non-proliferation system will lessen chances of nuclear materials diversion and ultimately incinerate problematic nuclides (further lessening their proliferation potential). The MOX route is indeed a good non-proliferation solution at not too heavy financial burdens.

5.2 Prevention of Illicit Trafficking

The INSC, on October 2, 1994, delivered a position paper that stated:

"The INSC is most concerned about the apparent breakdown in security measures that has resulted in the recent uncontrolled availability of fissile materials. The Council views a correction of this problem to be of paramount urgency. It is encouraged to see the rapid reaction of involved governments and international agencies in apprehending the material. Furthermore, the INSC recognizes immediate international efforts to correct the breach of security.

The Council stresses the significance of nuclear materials control and urges governments to pay serious attention to the management of fissile materials and the importance of the responsibilities resting on the individuals involved in such management.

The Council further recommends to its member societies that they should stress to the relevant authorities the need to discourage unethical actions leading to unauthorized transfer of fissile materials."

The IAEA has diligently engaged in activities in the fields of prevention, response, training, and information exchange in support of efforts against illicit trafficking and confirmed the program for preventing and combating illicit trafficking in nuclear materials agreed to at the Moscow Nuclear Summit in April 1996.

In parallel with the attention to international verification of undertakings made by the states, non-proliferation and disarmament measures will also need more efforts to ensure that unlawful groups of individuals do not acquire weapons-grade materials. Illicit trafficking has been given a good deal of publicity in the last few years. While the primary action to prevent such trafficking rests on the governments, the IAEA has been asked to assist member states to strengthen their legislation and administrative measures to keep all nuclear materials under strict surveillance and control. The Agency is also maintaining a database in which all known cases of nuclear trafficking are registered, together with information obtained from the relevant governments.

5.3 Fissile Materials Cut-off Treaty

The negotiations of a treaty prohibiting the production of HEU or plutonium for weapons purposes have not yet begun. Such a treaty would be very desirable and might not be too difficult to implement from the standpoint of the security base of any state. In fact, it appears that the NPT NWSs have drastically reduced the production of nuclear materials for weapons purposes, and some of them, like France, have even undertaken the dismantling of their weapons-grade nuclear material production facilities. If an arrangement could be attained whereby HEU and plutonium from dismantled weapons—to start with in the United States and Russia—are stored or used for peaceful purposes under IAEA verification and if, in addition, a verified cut-off treaty is implemented, assurance could be achieved by which the global aggregate of fissile materials available for weapons use would shrink.

It has always been assumed that the verification of a nuclear materials cut-off would be a task for the IAEA. It would be a big and costly job, but the measuring techniques, as they relate to reprocessing and enrichment, already exist. Indeed, they are now applied in several NNWSs, e.g., Japan, Argentina, and Brazil.

A proposed cut-off convention on the production of fissile materials for weapons purposes is an item of the agenda of the Conference on Disarmament in Geneva. It is among the top arms control priorities of most of the industrialized nations and the NWSs.

5.4 Plutonium Management and Disposition

Plutonium disposition becomes a complicated issue, especially when it is related to nontechnical aspects.

As Glenn Seaborg once mentioned, the discovery of plutonium opened “the dawn of a new era” and marked man’s ability to control nature in a profound way, for the first time achieving mastery over the very constitution of matter itself. Actual plutonium deployment has been hampered and its economic features distorted by emotional opposition from the public and also by government policy of the U.S. Carter administration, which ultimately restricted the timeline of progress toward the closed nuclear fuel cycle based on non-proliferation concerns. The utilization of plutonium in the form of MOX fuel in commercial reactors represents a unique opportunity to burn it in power-producing machines as a reliable and long-term assured energy source.

The genuine irreversibility of nuclear arms reduction can only be achieved if current plans to retain large reserves allowing rapid increases in deployed nuclear arsenals are reversed, as well as if agreements to reduce total stockpiles of nuclear warheads and fissile materials are reached among the five NWSs. Success in these difficult endeavors will require a significant increase of high-level negotiations devoted to such critical international security problems.

In September 2000, the United States and the Russian Federation signed an intergovernmental agreement "concerning the management and disposition of plutonium designated as no longer required for defense purposes." This agreement stipulates that each party will dispose of no less than 34 tonnes of weapons-grade plutonium through either immobilization or irradiation as MOX fuel in power reactors or a combination of both disposition routes. Although they initially envisaged immobilizing approximately one-third of their 34 tonnes of plutonium, the United States finally decided in early 2002 to abandon the development of the immobilization route and, like the Russian Federation, to only keep the MOX route. A U.S. MOX fuel fabrication facility has been in the design and development phase since 1999, with the start of construction envisaged by the end of 2003. The possibility of replicating this U.S. plant in Russia is being considered for the Russian disposition program.

In this context, an optimized solution would be to have all plutonium, including that from nuclear warheads and spent fuel, burned in nuclear reactors for power generation, with no materials left over for possible diversion for weapons. This argument is a simple and straightforward one based on the fact that MOX fuel used in a reactor degrades the quality of plutonium, making it far less attractive for diversion into weapons application. On the contrary, plutonium immobilization only alters the chemical properties of plutonium, not its nuclide composition. In this way, immobilized plutonium might be recovered for future nuclear proliferation. Yet, the economics of MOX application is yet to be improved, and the handling of sensitive material in the course of its manufacture has to be closely safeguarded against diversion.

For future generations, the recycling of nuclear fuel through chemical reprocessing holds a dual virtue: the burning of plutonium in the form of MOX fuel is meant to convert the original nuclides to degrade their properties for weapons utilization and, at the same time, to greatly reduce the volume and the long-term radiotoxicity of the high-level waste inventory to be ultimately disposed of in deep geological repositories.

6. 2000 REVIEW CONFERENCE OF THE NPT

6. 2000 Review Conference of the NPT

6.1 Non-Proliferation Treaty

The Review Conference of the Treaty on the Non-Proliferation of Nuclear Weapons (New York, April 24 to May 19, 2000) reaffirmed the urgency and importance of achieving the universality of the treaty. Of the 187 state parties of the treaty, 158 attended the conference. Cuba attended as an observer, and Palestine was granted observer status.

Referring to the claims by India and Pakistan to be considered NWSs after their tests of 1998, it was reiterated that states not currently belonging to the treaty may accede to it only as NNWSs. Deploring such tests, the conference declared that such actions do not in any way confer an NWS status or any special status whatsoever.

Cuba,[a] India, Israel, and Pakistan, still not parties at the time, were urged to become NNWS members of the treaty, thereby accepting an international legally binding commitment not to acquire nuclear weapons or nuclear explosive devices and to accept IAEA safeguards in all their nuclear activities. The conference welcomed the signature by Cuba of the Additional Protocol to its safeguards agreement with the IAEA to cover the state as a whole.

Another review conference will take place in 2005.

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[a]Cuba adhered to the NPT in November 2002 and ratified the Treaty of Tlatelolco in October 2002.

6.2 Disarmament and NWSs

The conference took note of the Declaration of the Moscow Nuclear Safety and Security Summit of April 1996 on measures for the management of nuclear materials designated by each of the NWSs as no longer required for defense purposes and considered irreversibly transferred to peaceful uses. It was recommended that such materials should as soon as practicable be placed under IAEA or other relevant verification.

In the framework of the agreement between the Russian Federation and the United States to convert 500 tonnes of HEU from the Russian Federation's nuclear weapons arsenal to LEU for use in commercial reactors, more than 80 tonnes of HEU had been converted by the date of the conference. Each country expressed its intention to additionally remove some 50 tonnes of plutonium from its nuclear weapons programs and to convert it to become unfit for weapons use. However, the total number of nuclear weapons deployed and in stockpile still amounts to many thousands.

The conference stressed the need of an unequivocal undertaking by the NWSs to accomplish total elimination of their nuclear arsenals leading to nuclear disarmament, a commitment of all state parties of the NPT. Belarus, Kazakhstan, and Ukraine by voluntary withdrawal of all tactical and strategic nuclear weapons from their territories contributed to nuclear disarmament. Mongolia declared to have unilaterally adopted measures to ensure total absence of nuclear weapons in its territory, achieving therefore a nuclear-weapons-free status.

The conference referred to the early entry into force and full implementation of START-II and the conclusion of START-III, as well as the strengthening of the Limitation of the Anti-Ballistic Missile Systems (LABMS) Treaty, as cornerstones of strategic stability and as a basis for further reductions of strategic offensive weapons. The Russian Federation ratified the agreements related to LABMS signed in September 1997 by Belarus, Kazakhstan, the

Russian Federation, Ukraine, and the United States. Ratification by the other countries was still pending. Also, START-II, ratified by the Russian Federation, was still to be ratified by the United States.

6.3 Comprehensive Nuclear-Test Ban Treaty

Cessation of all nuclear-weapons-test explosions or any other nuclear explosions will contribute to the non-proliferation of nuclear weapons in all its aspects and to the process of nuclear disarmament leading to the complete elimination of nuclear weapons. The CTBT establishes commitment by the parties not to conduct such nuclear tests. The conference noted that 155 states had signed this treaty, of which 56—including 28 whose ratification is necessary for its entry into force—had ratified it. There were still 16 states whose ratification was a prerequisite for the entry into force of the treaty.

France and the United Kingdom had already ratified the treaty, and the Russian Federation had decided to proceed with the ratification. On the other hand, it had not been signed or ratified by India and Pakistan despite their pledges to do so. However, the rejection by the U.S. Congress of the ratification of the CTBT left little hope for a positive evolution of this situation.

The conference recommended a moratorium on nuclear-weapons-test explosions or any other nuclear explosions pending entry into force of the treaty. Peaceful applications of any nuclear explosions are to be interpreted in the light of the CTBT.

6.4 Nuclear Weapons-Free Zones and Regional Agreements

Bilateral or regional safeguards were considered useful in regions interested in building confidence among member states toward the non-proliferation regime. In this respect, the Declaration on the Denuclearization of the Korean Peninsula between the Republic of Korea and the Democratic People's Republic of Korea (DPRK) was welcomed.

The continuing contribution toward nuclear non-proliferation and disarmament of the Antarctic Treaty was recognized, as were the treaties of Tlatelolco, Rarotonga, Bangkok, and Pelindaba. The conference stressed the importance of the statements of the five NWSs to securing their full adherence to the treaties of Rarotonga, Pelindaba, and Bangkok.

The establishment of NWFZs where they did not exist, such as in the Middle East and South Asia, was recommended. The conference urged all parties directly concerned to consider seriously taking the practical and urgent steps required for the implementation of the proposal to establish an NWFZ in the Middle East. The initiative of the five Central Asia states to establish an NWFZ in their region was welcomed.

6.5 IAEA Safeguards

The conference reiterated the importance of the IAEA to strengthen the non-proliferation regime and provide assurance of compliance with non-proliferation undertakings. IAEA comprehensive safeguards and additional protocols should be universally applied once the complete elimination of nuclear weapons has been achieved.

The safeguards-strengthening measures in the IAEA Model Additional Protocol will provide the Agency with enhanced information about a state's nuclear activities and complimentary access to locations within a state. The application of such a protocol will introduce increased confidence about the absence of undeclared nuclear material and activities in a state as a whole. The additional protocol and the safeguards agreement between IAEA and a state party are to be read and interpreted as only one agreement. The conference stressed the need that all state parties to the NPT should accept IAEA safeguards-strengthening measures. In this respect, 51 state parties had yet to bring into force comprehensive safeguards agreements.

The fact that Cuba, a non-NPT state party, concluded signature of the additional protocol with the IAEA was welcomed, and its entry into force was urged.

6.6 Fuel and Radioactive Waste

The conference underlined the importance of managing fuel and radioactive waste that were excluded from the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management because they were within military or defense programs.

The conference encouraged all state parties to take the appropriate national, regional, and international steps to enhance and foster safety culture.

6.7 Role of NGOs

The conference agreed that a meeting should be allocated to NGOs to address each session of the preparatory committee and the review conference to the NPT. The conference was attended by 141 organizations representing research institutes and NGOs.

6.8 A Specific Country's Situation

In addition to what has been stated regarding a specific country's situation, the following issues were discussed.

6.8.1 Democratic People's Republic of Korea

IAEA continued to be unable to verify the correctness and completeness of the initial declaration of nuclear material made by the DPRK and was unable to conclude that there has been no diversion of nuclear material in that country. The conference stated that DPRK, having declared its intention to come into full compliance with its treaty safeguards agreement with IAEA, which remains binding and in force, should preserve and make available to the Agency all information needed to verify its initial declaration.

6.8.2 India and Pakistan

Considering the nuclear explosions carried out by India and Pakistan in May 1998, the conference urged India and Pakistan to accede to the NPT as NNWSs and to place all their nuclear facilities under comprehensive IAEA safeguards. Both states should also strengthen their non-proliferation export control measures over technologies, material, and equipment that can be used for the production of nuclear weapons and their delivery systems.

Both India and Pakistan declared moratoriums on further testing and stated their willingness to enter into the CTBT.

India and Pakistan expressed their wish to participate in the negotiation, in the Conference on Disarmament, of a treaty banning the production of fissile material for nuclear weapons and other nuclear explosive devices. The conference urged that pending the conclusion of a legal instrument, a moratorium on the production of such material be implemented.

6.8.3 Iraq

Since the cessation of IAEA inspections in Iraq on December 16, 1998, the Agency has not been in a position to provide any assurance of Iraq's compliance with its obligations under the NPT.

IAEA carried out an inspection in January 2000 pursuant to Iraq's safeguards agreement with IAEA, where inspectors were able only to verify the presence of the nuclear material subject to safeguards (low-enriched, natural, and depleted uranium).

7. FURTHER ACTIONS

7. Further Actions

7.1 Introduction

The notion of nuclear non-proliferation measures was first introduced to the international community in President Eisenhower's "Atoms for Peace" speech made to the U.N. General Assembly in December 1953. The celebrated speech delivered two key punches:

1. stressing the importance of the nuclear non-proliferation regime
2. enhancing the peaceful uses of nuclear energy.

Thanks to these guidelines, the spread of materials, facilities, and technologies associated with nuclear weaponry in the post-Eisenhower period has been substantially deferred. At the same time, peaceful applications of nuclear energy have been made widely available, even to developing countries with technology transfer and technical cooperation from advanced countries. As for non-proliferation, that objective has been effectively achieved, and the mechanism making that possible has been developed and upgraded over time. It is presumed that the nuclear non-proliferation regime will also be continued and strengthened with advances in legal and technical wherewithal.

Notwithstanding such success, there is no way—not enough measures—barring a complete worldwide abandonment of all nuclear materials, facilities, and technologies, including peaceful applications of nuclear energy—clearly an unrealistic scenario—to remove completely the probability of nuclear proliferation.

The best approach we can take then is to shore up the existing non-proliferation regime with step-by-step improvements over time and reinforce it with other systems such as NPT, CTBT, SSAC, etc., while working toward introducing proliferation-resistant fuels as well as wide-area environmental sampling in suspected areas for monitoring specific nuclides. Above all, mutual confidence-building among various parties will be a key ingredient in this context.

7.2 Priority Setting on Systems

Of the states considered during the past three decades to be likely nuclear-proliferating countries, most have failed to acquire nuclear weapons capability, except India and Pakistan, and presumably Israel, while several have explicitly renounced their weapons programs and accepted proper safeguards inspections. The remaining few, mostly the rogue states, have made considerably slower progress than predicted. The international nuclear non-proliferation regime is to be credited for this success.

The measures for realizing the nuclear non-proliferation regime can be achieved with legal, technical, and cooperative arrangements with the parties concerned.

When a nuclear materials cut-off treaty is put into force, the IAEA's routine inspection will have to be changed in such a way that the focal point of inspection activities could be geared mainly to the sensitive materials, associated facilities, and especially suspected spots. It has to be stressed that the implementation of integrated safeguards has, as a prerequisite, the combination of the full-scope safeguards agreement with the relevant additional protocols.

In the meantime, it would be more effective and preferable if the existing routine inspections are simplified with the help of the SSAC in each country. A new partnership approach similar to the relation between IAEA and Euratom is another concept that might receive serious consideration. Along this line, the establishment of regional cooperative organizations, following the example of Euratom and

ABACC, can enhance mutual cooperation and promote reciprocal inspection by the members of the organization and introduce confidence-building among them.

From a technical point of view, measures such as lowering the enrichment of research reactor nuclear fuel down to below 20 wt% ^{235}U, developing proliferation-resistant fuels, introducing DUPIC (direct use of PWR fuel in CANDU reactors) fuel, and making extensive use of MOX fuel are considered to contribute to nuclear non-proliferation objectives.

When the East-West confrontation was very serious in the past, and the North Atlantic Treaty Organization (NATO) was inferior to the Warsaw Treaty Organization in terms of conventional armed forces size and military hardware, such power imbalance led Western Europe to justify the deployment of nuclear weaponry on the grounds of self-defense. This acted as a stimulus to the subsequent reinforcement of armed forces along the iron curtain in the Eastern bloc, including the introduction thereby of a nuclear arsenal. In such a way, the European continent became a ground for a nuclear seesaw game. After the breakup of the Soviet Union, the military equation changed dramatically, and there is no longer justification for such a deployment. The reduction of nuclear arsenals on the European continent should be encouraged in order to achieve total nuclear non-proliferation on the planet.

7.3 Confidence-Building Measures

The international community should lend its support to confidence-building measures such as those suggested by some of regional dimension. Some of these measures may include joint declarations by neighboring countries to renounce the development or acquisition of nuclear weapons, to proceed to mutual inspections of nuclear facilities, to sign simultaneous acceptance of IAEA full-scope safeguards, to agree not to attack peaceful nuclear installations, and so on. These measures would strike at the very roots of nuclear proliferation, namely, lack of mutual trust and understanding, and thus contribute an important restraining influence on all concerned parties.

Since the motivation to go nuclear is essentially political, sometimes related to territorial issues, the desired restraint might come through a political approach. Major regional conflicts may drive certain states to seek weapons of mass destruction, including chemical, biological, and nuclear armament together with long-range missiles. This applies particularly to politically unstable and economically developing regions. The nature of the problems is well-known; the need is to find regionally acceptable solutions by which the international community can strongly influence negotiations.

7.4 Nuclear Non-Proliferation Today and Tomorrow

The political instruments of the nuclear weapons non-proliferation regime were introduced in the late 1960s and early 1970s. They reflect, as a whole, the political situation of that period, in particular, the existing proliferation risk level and the possibilities for the most developed countries, having no nuclear weapons, to create or receive this kind of weapon.

The past 30 years have witnessed gradual changes in the world's political and economic situation as well as considerable scientific and technical progress in the field of nuclear engineering and technology. The development of world nuclear power and its associated industries led to a substantial accumulation of nuclear materials in many countries. Also, a considerable number of specialists in nuclear engineering and technology have been developed throughout the world. Today, information on scientific and technical nuclear matters is widely available, and much of the special knowledge necessary for creating at least the simplest nuclear arms device is no longer confined to a few closed scientific circles. In fact, confidential information for designing and assembling a nuclear weapon, which in the past was extremely difficult to obtain, is becoming more readily accessible. All these facts have had a considerable impact on the efficacy of the existing nuclear weapons non-proliferation regime, and new approaches will be required to make its application successful in the future.

The current political situation of nuclear weapons non-proliferation is basically characterized by the following aspects:

1. Although by 2002 some 188 countries had become parties to the NPT, some states are still out of it, mainly the group of threshold countries.
2. At the same time, well-known political ambitions of some parties to the NPT unveiled their desire to acquire nuclear arms.
3. The USSR transformation into a group of independent states left some of them with a certain nuclear-weapons fabrication potential, in particular by their possession of the necessary know-how and of some nuclear materials.
4. International terrorism has spread.
5. A closer link between “horizontal” proliferation and nuclear disarmament is now being stressed.
6. Consideration of regional approaches for nuclear non-proliferation has gained greater importance.

The nuclear non-proliferation task, understood as the task of limiting the number of countries possessing nuclear weapons, is, in essence, a political task. Thus, the motivation of some countries to possess nuclear weapons can be only solved by political means.

Nevertheless, there exists a large field of activities for substantiating, adopting, and implementing the scientific and technical measures that could provide a timely discovery of a proliferation hazard to hinder and delay its implementation and, consequently, to provide the necessary time frame for the removal of the threat by political means.

As for concerns preventing the possibility of nuclear weapons acquisition by unlawful groups, this task could be solved by technical means with the help of government actions.

Nuclear technologies continuously develop, improve, and become more readily available for a large number of countries and, therefore, become more difficult to control in a cost-efficient way with traditional methods used by the international community, in particular, by the IAEA. On the other hand, the quantity of nuclear materials is steadily growing in the world and noticeably in politically unstable regions.

Nuclear science and technology can be applied for peaceful purposes in a manner that fully supports and is compatible with achieving desired non-proliferation goals. If they are applied effectively, the technical, political, and institutional factors that constitute the key elements in a global non-proliferation regime will provide continued high confidence that civil nuclear facilities and materials will not be diverted to military programs. Moreover, under appropriate circumstances, different approaches to the commercial nuclear fuel cycle—including both closed and once-through systems—can be implemented in a manner that fully supports global non-proliferation objectives.

New types of proliferation threats involving large stockpiles of weapons-grade plutonium and HEU require prompt and sustained actions on the part of the international community. In particular, numerous respected organizations and individuals have cited the grave threat posed by these nuclear materials in the FSU. Anticipated future reductions in nuclear weapons stockpiles will add to the magnitude of this challenge. Important efforts (including those now under way) to secure these materials and to transform them into more proliferation-resistant forms will require substantial resources and sustained and stable support.

Governmental and nongovernmental organizations should sponsor information exchanges among the United States, Russia, and other industrialized nations with MOX fuel expertise.

Industry and professional organizations should work to educate the public and media about the non-proliferation benefits of the MOX fuel program and the safe and successful track record of manufacturing and using MOX fuel.

It should be noted that, though political mechanisms of coordination by the countries interested in strengthening the non-proliferation regime are more or less well developed, such coordination in the technical field will require considerable enhancement. Scientific and technical experts of concerned countries should continuously cooperate among themselves on non-proliferation and control issues. Such a “horizontal” cooperation will allow for the establishment of a common knowledge base for adopting political decisions and agreements that would be mutually acceptable and feasible from both political and technical points of view.

The establishment of such a scientific and technical base could represent a useful contribution to be undertaken by the national nuclear societies acting as NGOs through the INSC. It is also important for the INSC to collaborate with other organizations of the scientific community working on nuclear non-proliferation to make use of the latest scientific developments in the nuclear non-proliferation debate. Scientific and technical cooperation of nuclear professionals in this field will lead to:

1. reaching a complete understanding of the different issues between the countries’ technical and scientific experts
2. assessing the efficacy of available technical solutions
3. contributing to the design and development of proliferation-resistant nuclear energy systems (reactors and fuel cycles)
4. developing mutually acceptable new technical solutions and assessing them in terms of their efficacy and national security

5. listing the assortment of available technical means for safeguarding nuclear non-proliferation
6. advising on problems to be foreseen when extending the functions and enhancing the efficacy of IAEA safeguards.

The results of such an appraisal could be useful to concerned countries in their nuclear non-proliferation analyses.

8. CONCLUSION

8. Conclusion

Although first developed and utilized as a military device, the peaceful uses of nuclear energy soon won wide acceptance. Efforts at confining nuclear activities within the framework of the nuclear non-proliferation regime based on treaties came belatedly but have been largely successful thanks to faithful compliance with NPT and IAEA safeguards provisions by most of the parties.

A large majority of the world's states are now members of the IAEA and parties to the NPT. To be exact, as of December 2002, 188 countries were signatories and parties to the NPT. On the other hand, some countries with sufficient technological capabilities to build nuclear weapons have not joined the NPT, nor have they accepted comprehensive IAEA safeguards, the so-called threshold states. We have witnessed that two non-NPT party threshold countries, India and Pakistan, have clearly manifested their intent of continuing to arm themselves with nuclear weapons. North Korea, an NPT signatory, recently admitted that it was pursuing the development of a nuclear weapons program, and Iran, also an NPT party state, was found lately to have not met its obligations under its IAEA Safeguards Agreement. These four countries must be made to understand that this path is self-defeating and that, instead, they should join the global non-proliferation effort.

Iraq, an NPT party, was found to have a clandestine nuclear weapons program. Following the 1991 Persian Gulf War, the U.N. Security Council asked IAEA to neutralize this program. And over the years, North Korea has prevented the IAEA from determining whether nuclear material was ever diverted from its reactor and chemical laboratory, and it has not fully complied with the safeguards obligations it accepted as a party to the NPT.

It is indeed unfortunate to realize that, after 32 years of a dormant period, the number of states having detonated nuclear weapons has increased since the onset of the NPT. However, a major favorable change following the end of the Cold War, wherein the two superpowers have actually taken steps toward reducing and dismantling nuclear weapons, has created a beneficent climate for international cooperation and accommodation. The effectuation of the CTBT is another positive step toward the non-proliferation regime. India and Pakistan as well as other threshold countries should be invited to this treaty to prevent further nuclear testing on this planet.

Diversion of nuclear materials either from civilian programs or from dismantling military arsenals should be prevented by all means through legal, technical, and cooperative arrangements. Excess plutonium recovered from dismantled nuclear arsenals of the FSU is particularly vulnerable to theft, smuggling, or forced seizure by unlawful entities, and the international community should fully support, especially by providing appropriate financing, the Russian Federation in its excess weapons plutonium disposition program.

Although it seems unrealistic in today's global conditions, it would be a great step forward for world security that all weapons-grade nuclear materials be completely and safely disposed of.

The implementation at a national level of effective physical protection measures, whose responsibility clearly rests with each state, is essential to protect nuclear materials from theft or forced seizure by unlawful entities. International guidelines for physical protection systems have been developed by the IAEA and are revised as appropriate. The international community should do its best to meet the request of those states in need of cooperation to fulfill their physical protection responsibilities, in particular states created from the breakup of the FSU.

The IAEA safeguards system remains a central instrument of the international nuclear non-proliferation regime, and the international community must make all possible endeavors toward universality with regard to the commitments subscribed to by the states so that the system can reach its full efficiency. As of September 2003, additional protocols have been signed by the IAEA with 76 states and have entered into force for 36 of those. States that have to fulfill their legal obligations under the NPT to bring safeguards agreements into force number 47, and six years after the IAEA approved the Model Additional Protocol, more than 150 countries still do not have an additional protocol in force. This situation is worrisome, and all these states should be called to conclude, as soon as possible, a full-scope agreement with the Agency.

The discovery of Iraq's clandestine nuclear weapons program, the violation of the DPRK's safeguards agreement under the NPT, and the failure of Iran to meet its obligations under its Safeguards Agreement with the IAEA demonstrated that an effective verification regime must also focus on undeclared materials and activities. The strengthening of the IAEA safeguards system resulting from the conjunction, for a state, of a full-scope safeguards agreement and an additional protocol (whose model was adopted in 1997 by the IAEA Board of Governors) is thus essential progress for the credibility of NPT verification. The international community should call all states not having yet done it to sign an additional protocol as soon as possible.

The strengthened safeguards system is based on a political commitment to support an intelligent verification system implementing an optimal combination and integration of traditional safeguards measures based on nuclear material accountancy, with the new safeguards-strengthening measures to achieve maximum effectiveness and efficiency within available Agency resources. The definition of the conceptual framework of this integrated safeguards system has now been completed, and the international community must provide its full support to the Agency for its implementation.

Regional, racial, ethnic, and territorial conflicts or economic instabilities lead to a search for quick political advantages, which may embrace the nuclear weapons temptation. Such temptations must be nipped in the bud through strict enforcement of the nuclear non-proliferation regime. The failure of preventing the nuclear tests by India and Pakistan should not interrupt the course of developing strengthened measures for nuclear non-proliferation.

The use of MOX fuel in thermal and fast reactors can serve a dual purpose: reducing the risk of nuclear materials diversion and burning up problematic nuclides. Furthermore, MOX use can serve to mitigate foreseen future fuel supply crises for energy generation. The dual-track approach regarding plutonium disposition—immobilization and use of MOX—does not seem to be the best solution in the long-term view of security, efficiency, and energy resources utilization. In this respect, it is important to note the recent renouncement by the United States of the immobilization route for the disposition of its excess-weapons plutonium and its focus, like the Russian Federation, on the MOX route only. Above all, plutonium immobilization is meant to leave unsolved the problem of the safe disposal of transuranic nuclides, because this process only alters the chemical properties of the plutonium mix, not its nuclide composition, a fact which could eventually be used in future weapons development.

Since the breakup of the Soviet Union, Russian security has been affected by the deterioration of its status, as compared with the NATO nations, in terms of military strength so that apparently Russia will try to rely more on nuclear weapons for its defense program. It is important for world peace and security to encourage the reduction of the nuclear arsenals of both sides of the European continent and, eventually, to proceed toward a nuclear-weapons-free world.

So far, the main objectives of nuclear non-proliferation measures have been largely attained. The mechanism ensuring such success has been developed, upgraded, and strengthened over time. Nevertheless, non-proliferation measures can and should be further improved and strengthened with the advancement of legal and technical wherewithal. A preferred approach at this stage is to strengthen the existing non-proliferation regime with the employment of measures such as SSAC together with the development of future generation nuclear energy generation systems (reactors and their associated fuel cycles) designed for enhanced proliferation resistance. In addition, a comprehensive regulatory framework with adequate operational resources will be required to detect attempts of intrusion, to delay access to special materials, and to activate preplanned response measures. Above all, mutual confidence-building will be a key ingredient in this context.

In recent years, the nuclear community has been preoccupied with implementing and strengthening the nuclear non-proliferation regime, and its work has been largely successful except for the cases of India, Pakistan, Iraq, DPRK, and Iran, the first two, nonparties of NPT and the last three, NPT parties. Noncompliance by NPT parties of their obligations has proved to be a matter of severe consequences representing one of the causes of military intervention, in the case of Iraq, or leading to serious diplomatic negotiations and disputes still unsolved, in the cases of DPRK and Iran.

In the years to come, efforts must be made to develop and extend the peaceful utilization of nuclear energy made possible by the nuclear non-proliferation regime. With such measures firmly in place, one can look forward to an era free from nuclear weapons, the ultimate objective of the NPT.

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APPENDIX A

Appendix A

Controlled Activities and Trade Ban on Some Equipment and Materials

Research and development, design, and manufacturing activities for the following sensitive equipment and components are classified as proliferating because such are directly conducive to nuclear weapons production. Such activities are controlled through the agreement of a protocol with the IAEA, and regular reporting and inspection for such activities are imposed on the organizations concerned.

List of Controlled Activities

1. The manufacture of centrifuge rotor tubes (thin-walled cylinders) or the assembly of gas centrifuges.
2. The manufacture of gas-diffusion barriers (thin and porous filters).
3. The manufacture or assembly of laser-based systems.
4. The manufacture or assembly of electromagnetic isotope separators.
5. The manufacture or assembly of columns or extraction equipment.
6. The manufacture of aerodynamic separation nozzles or vortex tubes.
7. The manufacture or assembly of uranium plasma generation systems.

8. The manufacture of zirconium tubes.
9. The manufacture or upgrading of heavy water or deuterium.
10. Heavy water or deuterium means deuterium, heavy water (deuterium oxide), and any other deuterium compound in which the rate of deuterium to hydrogen atoms exceeds 1:5000.
11. The manufacture of nuclear-grade graphite, which means graphite having a purity level better than 5 parts per million boron equivalent and with a density greater than 1.50 g/cm^3.
12. The manufacture of flasks for irradiated fuel, meaning a vessel for the transportation and/or storage of irradiated fuel that provides chemical, thermal, and radiological protection and that dissipates decay heat during handling, transportation, and storage.
13. The manufacture of nuclear reactor control rods.
14. The manufacture of criticality-safe tanks and vessels.
15. The manufacture of irradiated fuel element chopping machines.
16. The manufacture of hot cells. Hot cell means a cell or interconnected cells totaling at least 6 m^3 in volume with shielding equal to or greater than the equivalent of 0.5 m of concrete, with a density of 3.2 g/cm^3 or greater, outfitted with equipment for remote operations.

APPENDIX B

Appendix B

List of Specified Equipment and Non-Nuclear Material for the Reporting of Exports and Imports

The following equipment, systems, components, and materials are called trigger list items that are restricted for trade in view of nuclear non-proliferation. The export or import of those items must be duly reported to the safeguards authorities.

1. Reactors and Equipment
   - 1.1. complete nuclear reactors
   - 1.2. reactor pressure vessels
   - 1.3. reactor fuel charging and discharging machines
   - 1.4. reactor control rods
   - 1.5. reactor pressure tubes
   - 1.6. zirconium tubes
   - 1.7. primary coolant pumps

2. Non-Nuclear Materials for Reactors
   - 2.1. deuterium and heavy water
   - 2.2. nuclear-grade graphite

3. Plants for the Reprocessing of Irradiated Fuel Elements and Equipment Especially Designed or Prepared Therefor
   - 3.1. irradiated fuel element chopping machines
   - 3.2. dissolvers
   - 3.3. solvent extractors and solvent extraction equipment
   - 3.4. chemical holding or storage vessels

3.5. plutonium nitrate to oxide conversion system
3.6. plutonium oxide to metal production system

4. Plants for the Fabrication of Fuel Elements

5. Plants for the Separation of Isotopes of Uranium and Equipment, Other Than Analytical Instruments, Especially Designed or Prepared Therefor
   5.1. gas centrifuges and assemblies and components especially designed or prepared for use in gas centrifuges
      5.1.1. rotating components
      5.1.2. static components
   5.2. especially designed or prepared auxiliary systems, equipment, and components for gas centrifuge enrichment plants
      5.2.1. feed systems/product and tails withdrawal systems
      5.2.2. machine header piping systems
      5.2.3. UF_6 mass spectrometers/ion sources
      5.2.4. frequency changers
   5.3. especially designed or prepared assemblies and components for use in gaseous diffusion enrichment
      5.3.1. gaseous diffusion barriers
      5.3.2. diffuser housings
      5.3.3. compressors and gas blowers
      5.3.4. rotary shaft seals
      5.3.5. heat exchangers for cooling UF_6
   5.4. especially designed or prepared auxiliary systems equipment and components for use in gaseous diffusion enrichment
      5.4.1. feed systems/product and tails withdrawal systems
      5.4.2. header piping systems
      5.4.3. vacuum systems
      5.4.4. special shut-off and control valves
      5.4.5. UF_6 mass spectrometers/ion sources
   5.5. especially designed or prepared systems, equipment, and components for use in aerodynamic enrichment plants

- 5.5.1. separation nozzles
- 5.5.2. vortex tubes
- 5.5.3. compressors and gas blowers
- 5.5.4. rotary shaft seals
- 5.5.5. heat exchangers for gas cooling
- 5.5.6. separation element housings
- 5.5.7. feed systems/product and tails withdrawal systems
- 5.5.8. header piping systems
- 5.5.9. vacuum systems and pumps
- 5.5.10. special shut-off and control valves
- 5.5.11. UF_6 mass spectrometers/ion sources
- 5.5.12. UF_6/carrier gas separation systems.

5.6. especially designed or prepared systems, equipment, and components for use in chemical exchange or ion exchange enrichment plants

- 5.6.1. liquid-liquid exchange columns (chemical exchange)
- 5.6.2. liquid-liquid centrifugal contactors (chemical exchange)
- 5.6.3. uranium reduction systems and equipment (chemical exchange)
- 5.6.4. feed preparation systems (chemical exchange)
- 5.6.5. uranium oxidation systems (chemical exchange)
- 5.6.6. fast-reacting ion exchange resins/adsorbents (ion exchange)
- 5.6.7. ion exchange columns (ion exchange)
- 5.6.8. ion exchange reflux systems (ion exchange)

5.7. especially designed or prepared systems, equipment, and components for use in laser-based enrichment plants

- 5.7.1. uranium vaporization systems (AVLIS)
- 5.7.2. liquid uranium metal handling systems (AVLIS)
- 5.7.3. uranium metal product and tails collector assemblies (AVLIS)
- 5.7.4. separator module housings (AVLIS)

- 5.7.5. supersonic expansion nozzles (MLIS)
- 5.7.6. uranium pentafluoride product collectors (MLIS)
- 5.7.7. UF_6/carrier gas compressors (MLIS)
- 5.7.8. rotary shaft seals (MLIS)
- 5.7.9. fluorination systems (MLIS)
- 5.7.10. UF_6 mass spectrometers/ion sources (MLIS)
- 5.7.11. feed systems/product and tails withdrawal systems (MLIS)
- 5.7.12. UF_6/carrier gas separation systems (MLIS)
- 5.7.13. laser systems (AVLIS, MLIS, and CRISLA)

5.8. especially designed or prepared systems, equipment, and components for use in plasma separation enrichment plants

- 5.8.1. microwave power sources and antennas
- 5.8.2. ion excitation coils
- 5.8.3. uranium plasma generation systems
- 5.8.4. liquid uranium metal handling systems
- 5.8.5. uranium metal product and tails collector assemblies
- 5.8.6. separator module housings.

5.9 especially designed or prepared systems, equipment, and components for use in electromagnetic enrichment plants

- 5.9.1. electromagnetic isotope separators
- 5.9.2. high-voltage power supplies
- 5.9.3. magnet power supplies

6. Plants for the Production of Heavy Water, Deuterium, and Deuterium Compounds and Equipment Especially Designed or Prepared Therefor

- 6.1. water-hydrogen sulfide exchange towers
- 6.2. blowers and compressors
- 6.3. ammonia-hydrogen exchange towers

6.4. towers internals and stage pumps
6.5. ammonia crackers
6.6. infrared absorption analyzers
6.7. catalytic burners

7. Plants for the Conversion of Uranium and Equipment Especially Designed or Prepared Therefor
   7.1. especially designed or prepared systems for the conversion of uranium ore concentrates to UO_3
   7.2. especially designed or prepared systems for the conversion of UO_3 to UF_6
   7.3. especially designed or prepared systems for the conversion of UO_3 to UO_2
   7.4. especially designed or prepared systems for the conversion of UF_2 to UF_4
   7.5. especially designed or prepared systems for the conversion of UF_4 to UF_6
   7.6. especially designed or prepared systems for the conversion of UF_4 to uranium metal
   7.7. especially designed or prepared systems for the conversion of UF_6 to UO_2
   7.8. especially designed or prepared systems for the conversion of UF_6 to UF_4

APPENDIX C

Appendix C

INSC Statement on North Korean Nuclear Weapons

September 15, 2003

Whereas:

1. For more than 30 years, the NPT has proven to be an essential instrument to maintain international peace and security by preventing the spread of nuclear weapons and by avoiding the danger of nuclear warfare in conflict situations among nations of the world;
2. Adherence to the NPT includes a commitment by Nuclear Weapons States (China, France, United Kingdom, Russia, and the United States) to provide support and immediate assistance to any state that is a victim of an act, or object of a threat of aggression, in which nuclear weapons are used;
3. The DPRK indicated its intention to withdraw from the NPT, and during the three-month period before the withdrawal became effective, the NPT safeguards agreement with the IAEA remained binding and in force. Despite these legal commitments, several actions taken by the DPRK constituted non-compliance with that safeguards agreement thereby representing a unilateral refutation of obligations undertaken in the framework of international law;
4. The DPRK's withdrawal from the treaty on January 11, 2003, followed by its announcement to proceed

with the development of nuclear weapons, is particularly unsettling in the precedent it appears to establish for others to do the same without consequence, endangering an arduously attained state of worldwide restraint in the use of nuclear weapons.

Therefore:

The International Nuclear Societies Council:

1. Strongly supports the international nuclear non-proliferation regime and believes that the peaceful uses of nuclear energy, utilized under strict international safeguards, significantly serve world peace and the best interests of all nations;
2. Considers that the DPRK's actions of noncompliance with the NPT safeguards agreement need to be addressed by responsible international organizations (like the International Atomic Energy Agency and the Security Council of the United Nations) not only to reinforce the regime of international law and agreements but also to prevent other NPT parties from following their example on the basis of a precedent without penalties;
3. Emphasizes the importance for all nations to enforce their export control measures to prohibit any illegal transfer of sensitive nuclear materials and technologies to the DPRK, or other nation or organization not upholding the principles of peaceful uses of nuclear technology;
4. Recommends that its member societies stress to their respective governments that the 2005 NPT Review Conference address the issue of maintaining the provisions of the NPT safeguards agreements on those materials and facilities safeguarded before withdrawal from the NPT;
5. Supports the DPRK nuclear professionals who, acting within the legal structure of their country, uphold the regime of non-proliferation and try to encourage

policies that value the principles of the INSC Global Creed, particularly the enhancement of the peaceful uses and application of nuclear science and technology;

6. Expresses its great hope that multilateral diplomatic negotiations under way among China, DPRK, Japan, Republic of Korea, Russia, and the United States will restore the non-proliferation regime in North Korea.

ABBREVIATIONS

ABACC	Argentina-Brazilian Agency for Accounting and Control
CNTBT	Comprehensive Nuclear-Test-Ban Treaty
CTBT	Comprehensive Test Ban Treaty
CTBTO	Comprehensive Test Ban Treaty Organization
DPRK	Democratic People's Republic of Korea
FBR	Fast Breeder Reactor
FSU	Former Soviet Union
HEU	Highly Enriched Uranium
IAEA	International Atomic Energy Agency
IMS	International Monitoring System
INSC	International Nuclear Societies Council
KEDO	Korean Peninsula Energy Development Organization
LABMS	Limitation of Anti-Ballistic Missile Systems
LEU	Low-Enriched Uranium
LWR	Light Water Reactor
MOX	Mixed-Oxide
NATO	North Atlantic Treaty Organization
NFZ	Nuclear Free Zone
NGO	Non-Governmental Organization
NNWS	Non-Nuclear Weapons States
NPT	Treaty on the Non-Proliferation of Nuclear Weapons
NSG	Nuclear Supplier's Group
NWFZ	Nuclear Weapons-Free Zone
NWS	Nuclear Weapon State
PTBT	Partial Test Ban Treaty
PWR	Pressurized Water Reactor
SSAC	System of Accounting for and Control of Nuclear Materials
START	Strategic Arms Reduction Treaty
UNSCOM	United Nations Special Commission