

The Non-Proliferation Treaty: Political and Technological Prospects and Dangers in 1990

A SIPRI Research Report

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Preface

In four months the Fourth NPT Review Conference will convene. The future of international security will be greatly helped if the value of the NPT regime is thoroughly understood. Imagine if the NPT did not exist. Imagine a world in which access to the use of nuclear energy was free from all control. Although the NPT regime is far from a flawless control mechanism, international security would be considerably less stable without it. Failure to preserve it and to seek to make it less imperfect would actually amount to endangering a cornerstone of the international security system. In 1995 the NPT Extension Conference will decide whether to extend the Treaty indefinitely or for a specified period. Security and peace would not be helped unless every effort were made to preserve and improve the NPT regime. With the cold war between East and West behind us, the effort for a drastic reduction of nuclear weapons must be markedly revived, and the debate over whether security without nuclear weapons is feasible and desirable will gain new momentum. It is, however, obvious that the outcome of both hinges to no small extent on the future of the NPT regime.

This research report, made possible by a special grant from the Swedish Government, builds on contributions from authors of chapters in the *SIPRI Yearbook 1990: World Armaments and Disarmament*. For practitioners and researchers alike, it is meant to serve the overriding purpose of contributing to the preservation of the nuclear non-proliferation regime by offering an understanding of the shortcomings of the current NPT regime and ideas on how to rectify the situation.

Dr Walther Stütze
Director, SIPRI

April 1990

1. Prospects for the fourth review of the Non-Proliferation Treaty

HARALD MÜLLER

I. Introduction

The Treaty on the Non-Proliferation of Nuclear Weapons (NPT) is the most widely adhered to arms control agreement to date. It was concluded in 1968 with a view to preventing the addition of new nuclear weapon powers to the five then in existence and since its entry into force in 1970 has continued to attract new members. On the eve of the third Review Conference in 1985 there were 130 parties to the Treaty; at the beginning of 1990 the Treaty had 141 parties (for the text of the Treaty see appendix A, and for the list of parties and those with safeguards agreements see appendix B). Three nuclear weapon states, the USA, the USSR and the UK, act as depositary governments while the other two, France and China, abstain from membership but conduct, in their own words, a policy in accordance with non-proliferation goals (China) or act 'as if' party to the Treaty (France).

The fourth Review Conference of the NPT, to be held in Geneva in 1990, will set the pace for the 1995 Extension Conference which, in accordance with Article X, must decide whether to extend the Treaty indefinitely or for a specified period. It is therefore more important than its predecessors and a decisive event for the survival of the Treaty into the next millenium.

NPT review conferences present a mixed record.¹ Although the 1975 Review Conference was close to failure, under its President, Ambassador Dr Inga Thorsson, it adopted a declaration reaffirming the provisions of the Treaty (see appendix C). The second Review Conference, in 1980, failed to reach consensus, particularly over the issue of nuclear disarmament, but a Final Document was adopted recommending a third review. In 1985 the third Review Conference, presided over by Ambassador Dr Mohamed Ibrahim Shaker, produced a long, substantial document—to the surprise of many who had expected that the total lack of disarmament and arms control successes would lead the Conference to certain failure (see appendix C). The consensus was a result of minute preparation, based on a precarious balance of mutual compromises, and was uncertain until the very final

¹ Previous NPT review conferences are well documented in *SIPRI Yearbooks*. For 1975 see 'The implementation of agreements related to disarmament', SIPRI, *World Armaments and Disarmament: SIPRI Yearbook 1976* (Taylor & Francis: London, 1976), pp. 363–92, and 'Final Declaration of the Review Conference of the parties to the Treaty on the Non-Proliferation of Nuclear Weapons, 30 May 1975', appendix 9A, pp. 403–13; for 1980 see 'The Second NPT Review Conference', SIPRI, *World Armaments and Disarmament: SIPRI Yearbook 1981* (Taylor & Francis: London, 1981), chapter 10, pp. 297–338, and 'Final Document of the Second Review Conference of the parties to the Treaty on the Non-Proliferation of Nuclear Weapons', appendix 10A, pp. 339–62; for 1985 see Goldblat, J., 'The third review of the Non-Proliferation Treaty', SIPRI, *World Armaments and Disarmament: SIPRI Yearbook 1986* (Oxford University Press: Oxford, 1986), pp. 469–80, and 'Final Declaration of the third Review Conference', appendix 20A, pp. 481–94.

minutes of the meeting.² A repetition of this success in 1990, while by no means excluded, is far from assured. It will depend very much on how the NPT has developed over the past five years and how this development is perceived in the world, particularly in the developing countries.

The status of the NPT

Among the new members since 1985, the most important are Spain, Saudi Arabia and North Korea.

The Spanish decision to accede to the Treaty in 1987 broke with a time-honoured tradition and was taken despite the resistance of those in the military and the right-wing political fringe that would have preferred to keep the option open. It also attracted some leftist criticism on the grounds of the discriminatory character of the Treaty; however, it was an effective instrument to underline the self-chosen non-nuclear policy which Spain wanted to maintain *vis-à-vis* the USA in the bilateral base negotiations as well as towards NATO. It also helped to overcome difficulties created through the inequality of safeguards regimes within the *European Atomic Energy Community* (EURATOM). Spain's accession closes the last gap in the ranks of the Organization for Economic Co-operation and Development (OECD) non-nuclear weapon states and is not without meaning for deliberations in Latin America.³

The accession of Saudi Arabia in 1988 was important in several regards. First, it came in the wake of the disturbing news about the acquisition of intermediate-range missiles from China. These missiles make little military sense without a nuclear or chemical warhead since they lack the accuracy to destroy targets by conventional explosives. A second factor in the Saudi decision may have been negotiations with an FRG company, Interatom, on the acquisition of two research reactors in which FRG governmental officials tried to convince their interlocutors of the merits of full-scope safeguards. The accession silenced fears of an emerging proliferation problem in the Arabian peninsula. Second, Saudi ratification of the Treaty closed a yawning gap in NPT adherence in the centre of the Arab world. Not surprisingly, the Saudi decision was quickly followed by accessions by Qatar and Bahrain and ratification by Kuwait, which had signed in 1968. Third, because of its wealth and its oil reserves, Saudi Arabia is an important voice within the developing world, and its accession thus strengthens the group of NPT countries in the Third World.

² See Fischer, D. and Müller, H., *Nonproliferation Beyond the 1985 Review*, CEPS Papers 26 (Centre for European Policy Studies: Brussels, 1985); Shaker, M. I., 'The legacy of the 1985 Non-Proliferation Treaty Review Conference: the President's reflections', ed. J. Simpson, *Nuclear Non-Proliferation: An Agenda for the 1990s* (Cambridge University Press: Cambridge, 1987); Sanders, B., 'The Third Review Conference of the Non-Proliferation Treaty', ed. J. Kaufmann, *Conference Diplomacy*, vol. 2 (Martinus Nijhoff: Dordrecht, 1989), pp. 255-65.

³ For an analysis of the Spanish accession see Saba, K., 'Spain and the Non-Proliferation Treaty', ed. H. Müller, *A Survey of European Nuclear Policy, 1985-1987* (Macmillan: London, 1989), pp. 111-30.

The accession of North Korea in 1985, apparently the result of Soviet persuasion in connection with the planned sale of a Soviet power reactor, appeared to remove the latent threat of a nuclear arms race on the Korean peninsula; in the 1970s, reprocessing plans by South Korea had led to great nervousness in the USA, and Washington had talked the South Koreans out of these plans. North Korean accession laid the issue to rest only briefly; despite protracted negotiations Pjongjang has so far failed to comply with its obligation to conclude a safeguards agreement with the IAEA while nuclear activities are conducted on its territory.

No other state is known to have breached its NPT obligations. Rumours that Iran and Iraq are interested in revitalizing their nuclear weapon programmes with sinister intentions have remained rumours, though news on Iraq has substantiated the suspicions.

The FR Germany has suffered painful revelations of neglectful export policies which have contributed to other countries nuclear programmes; but the issue is one of neglect rather than an outright breach, and the FRG has begun to reverse the course of its nuclear exports.

The situation of the IAEA

The institutional and operational mainstay of the non-proliferation regime is the International Atomic Energy Agency (IAEA). Under Article III the NPT assigns to the IAEA the role of verifying that every non-nuclear weapon state party to the NPT meets its obligations not to divert nuclear energy from peaceful uses to nuclear weapons or other nuclear explosive devices. IAEA safeguards agreements cover all the nuclear activities of the non-nuclear weapon states parties to the NPT and are based on a model agreement drawn up by the IAEA in 1970.⁴

The Agency enhanced its standing considerably by its professional handling of the situation after the 1986 Chernobyl nuclear reactor accident. It lent technical help to the Soviet Union, created quickly and effectively an enlarged programme for nuclear safety, and presented the framework for the negotiation and conclusion of two conventions (for early notification of nuclear accidents and mutual assistance in case of such accidents) in the summer of 1986. It also installed a working group together with the OECD to work out a joint protocol for the Vienna and Paris Conventions on nuclear liability.⁵ These achievements notwithstanding, the member states have continued to hold the IAEA budget at zero growth for the seventh year in succession. The IAEA operates safeguards in 920 nuclear installations in 57

⁴ IAEA document INFCIRC/153 (corrected) (IAEA: Vienna, 1983). IAEA safeguards employ four essential methods of verification: *materials accountancy*, to determine the amount of material unaccounted for over a specific period; *containment*, to restrict access to and prevent or hamper clandestine movement of the material; *surveillance*, to detect any unreported movement or tampering with safeguarded items; and *on-site inspection*; see Fischer, D. and Szasz, P., *Safeguarding the Atom: A Critical Appraisal*, ed. J. Goldblat, SIPRI (Taylor & Francis: London, 1985), pp. 26–27.

⁵ *IAEA Newsbrief*, vol. 1, no. 1 (Oct. 1986), pp. 1–2; no. 2 (Oct. 1986), pp. 1–2; vol. 2, no. 15 (Nov. 1987), p. 4.

states with over 200 inspectors. This task is to be implemented from a safeguards budget of some \$54.5 million (1990), about one-third of the Agency's total funds of \$162.8 million.⁶ Efforts by the safeguards department to economize on current resources are now pushing against the limits of feasibility. If the safeguards system must be replaced by one of diminished rigour, criticism of the credibility of the Agency's assessments cannot but rise.

The Agency is also plagued by political problems which emerge mainly from regional conflicts outside the realm of the IAEA's activities proper. First the conflict between Iraq and Iran has led Iran, in the past, to criticize harshly what its government perceived as a lack of willingness by the Agency's leadership to help Tehran with its claims against Iraqi attacks on the Busheer nuclear construction site. This criticism reached a very shrill tone in 1986 and 1987, but has subsided since as a consequence of the cease-fire in the Gulf region. The second regional problem is the Middle East conflict. Revelations by Mordechai Vanunu concerning the advanced status of the Israeli nuclear programme⁷ have led to revived attempts by the Arab states to have Israel condemned by and possibly removed from the Agency's General Conference. The United States has threatened withdrawal and a cut-off of financial contributions should the IAEA General Conference or Board of Governors follow Arab desires. While recent legislation would exempt the IAEA safeguards system from sanctions threatened against organizations expelling Israel, it is hard to see how the IAEA as a whole would not suffer from reprisals by the USA against all activities but safeguards.

The South African issue has also loomed large in IAEA proceedings. In 1987 the Board of Governors proposed, with a majority vote, to the General Conference to suspend South Africa's right as a member. A hard-driven diplomatic campaign by the Western powers, discreetly supported by the Soviet Union and helped by a last-minute surprise announcement by then South African Prime Minister Botha to enter discussions with the depositaries on accession, helped to defer the decision by one year. The same game was played twice again, this time with more visible Soviet efforts to keep the Black Africans from pushing the issue to a vote. Further deferral, however, is not on the cards; if South Africa does not make good its promises during 1990, membership will in all likelihood be suspended. Such a decision would be a severe blow against the universality of the Agency, Israel being the next in line. The consequences to the IAEA's survival would be dire indeed, and the NPT would suffer severely from a weakening of the Agency.⁸

⁶ IAEA Newsbrief, vol. 4, no. 5 (June 1989), p. 1.

⁷ Barnaby, F., *The Invisible Bomb: The Nuclear Arms Race in the Middle East* (I. B. Tauris: London, 1989).

⁸ See Scheinman, *The International Atomic Energy Agency and World Order* (Resources for the Future: Washington, DC, 1987), pp. 211-18; *PPNN Newsbrief*, no. 1 (Mar. 1988), p. 2.

Threshold countries

As was to be expected, countries approaching the threshold of a theoretical or actual nuclear weapon capability in 1985 have since enhanced their capabilities.

South Asia

In South Asia, there is a half-open nuclear arms race under way. India is thought to have produced some 200–300 kg of plutonium outside international safeguards. Its production capacity was greatly enhanced by the completion of the unsafeguarded Drushva research reactor at the Bhaba Atomic Research Centre. This 100-MW(th)—million (thermal) watt—reactor was started up in August 1985 and reached full power in early 1986. At full capacity it may yield up to 25 kg of plutonium per year. Moreover, India operates three unsafeguarded heavy water reactors; they are indigenously built 235-MW(e)—million (electric) watt—plants based on the Canadian deuterium uranium reactor (CANDU) design. The Atomic Energy Department has several more reactors of this type under construction and plans an overall capacity of some 9000 MW(e) by the end of the 20th century.

It is reprocessing capacity rather than plutonium production that acts as a bottleneck for weapon-grade material. The pilot plant at Trombay (producing 50 Mt of spent fuel/year) was restarted in 1983 after a shut-down of about eight years. The facility at Tarapur (100 Mt/y) is put under temporary safeguards whenever spent fuel from the safeguarded US-supplied Tarapur reactors is being processed. A reprocessing plant (125 Mt/y) is under construction at Kalpakkam with a maximum annual output of 120 kg of weapon-grade plutonium (6 per cent ²⁴⁰Pu). Depending on the sophistication of design, this could yield 15–24 nuclear weapons per year. This calculation assumes full-capacity production and dedication of all the material to military purposes. Since India has an ambitious fast-breeder programme, however, it must be assumed that a considerable amount of plutonium is retained for this—civilian—purpose.

In addition to plutonium production, India is actively working on uranium enrichment, using both centrifuge and laser methods. There are indications that India is also investigating tritium production, which would enable it to produce second-generation—boosted—nuclear weapons.⁹ By removing tritium from contaminated deuterium used in research and power reactors currently operating in India the annual yield at 70 per cent capacity would be of the order of 200 g, rising to more than 1 kg by the end of the century. A pilot plant for chemical exchange and cryogenic distillation to extract tritium from heavy water was set up at the Bhaba Atomic Research Centre.

India has an advanced missile programme and has recently successfully tested the Agni intermediate-range ballistic missile (IRBM). With a range of

⁹ *Congressional Record*, vol. 135, no. 161 (16 Nov. 1989); *Nuclear Fuel*, 6 Apr. 1989, p. 11.

2500 km the Agni could give the country a base for developing inter-continental missiles. India has rented a nuclear-powered submarine from the USSR and appears to be interested in expanding research and development (R&D) for an indigenous nuclear-submarine programme. India clearly has an ambition to be the regional great power; its military spending has risen impressively, virtually negating the peaceful image the country has tried to display since the days of Mahatma Gandhi. It has a professional Army, and an Air Force endowed with a wide range of nuclear-capable aircraft such as the MiG-23, MiG-27, MiG-29, Mirage-2000, Canberra, Jaguar/GR1 and Su-7BM; the MiG-23 and MiG-27 are reportedly envisaged for modification to a nuclear role. The Navy is on the brink of a true blue-water power projection capability and has two Hermes Class aircraft carriers. This growing force is giving the civilian government the machinery to project power in the region, as in the ill-fated intervention in Sri Lanka, and the successful expedition to extract the Maldives from the hands of a mercenary *coup d'état*.¹⁰

Pakistan has continued to work on its uranium enrichment programme. There is no doubt that the centrifuge plant at Kahuta can produce highly enriched uranium (HEU), and the Prime Minister of Pakistan has indicated that the country could build nuclear weapons should it so desire. Inquiries in FR Germany reveal that tritium extraction and purification technology have been acquired by Pakistan, another disturbing sign of a serious interest in boosted weapons which could be mounted on a missile or converted to artillery shells.¹¹

Pakistan is following the Indian lead in the development of ballistic missiles. In 1989, a Pakistani device carried a 150-kg payload 640 km into space, and Pakistan also has nuclear-capable aircraft such as the F-16. Estimates of Pakistani HEU production vary; no foreign observer knows how well the Kahuta enrichment facility operates, with how many centrifuges or at what capacity. Annual output of HEU is estimated at 20–63 kg; by the end of 1990 Pakistan could have 2–15 nuclear warheads.

In the Gandhi–Zia and Gandhi–Bhutto eras, Indian–Pakistani relationships wavered between hopes for improvement and sombre tensions, but shooting incidents on the Siachen glacier in Kashmir and mutual accusations of radical irredentism gave way to *rapprochement* and apparent understanding. Once Benazir Bhutto emerged as the first freely elected Pakistani leader after the long military rule, relationships took a turn for the better; the mutual understanding not to attack each other's nuclear facilities was formalized and signed as an agreement between the states in December 1988. However, all further-reaching proposals for simultaneous ratification of the NPT, for the creation of a nuclear weapon-free zone and for bilateral

¹⁰ Based on Spector, L. S., *The Undeclared Bomb* (Ballinger: Cambridge, Mass., 1988); IISS, *The Military Balance 1989–1990* (IISS: London, 1989); ACR, Apr. 1989, p. 503.B.60; and research by Martin Kalinowski.

¹¹ Müller, H., *After the Scandals: West German Nonproliferation Policy*, PRIF Report no. 9 (Peace Research Institute: Frankfurt, Feb. 1990), pp. 6–7.

inspections have fallen on deaf ears in India. A study by the Indian Institute for Defense Studies recently pretended that no inspection scheme could create sufficient confidence that Pakistan would not cheat. Both countries appear to be poised for a nuclear arms race; it remains to be seen whether the end of the Gandhi dynasty will change things for the better.¹² Recent clashes in Kashmir give little hope that tensions will cease quickly.

The Middle East

Events in the Middle East threaten to reduce strategic stability in the region. First, the revelations by Mordechai Vanunu, a former technician at the military nuclear complex at Dimona, Israel, have changed the image of the Israeli weapon programme. Vanunu alleged, with some credibility, that Israel had more, and more sophisticated, weapons than most experts had expected. After Vanunu, it is hard not to believe that Israel has mastered the technology for boosted weapons and has developed a sophisticated arsenal of more than 100 warheads rather than a crude deterrent of last resort. These new insights make it very hard for responsible Arab statesmen to keep ignoring the Israeli nuclear capability. The smoke-screen which Israel pulled over its arsenal previously helped the Arabs to play blind and continue with their traditional defence policy. Statements by Arab delegations during the January 1989 Paris Conference on chemical arms control, that no renunciation of chemical arms was possible without simultaneously addressing the problem of Israeli nuclear weapons, indicate the change that has taken place. Now, there are even rumours that a reconsideration of NPT membership is not unthinkable in Arab capitals.

The meaning of nuclear weapons in Israel's hands is exacerbated by the progress the country has made in ballistic missile technology. The Jericho II is apparently a highly capable, 1500-km range missile which would enable Israel to target places in the USSR with a nuclear warhead. That Israel enjoys the continued delivery of the most advanced US fighter-bomber aircraft, namely F-15s and F-16s, hardly needs mention.

As a short-cut answer, the Arab states have built up a chemical weapon capability, often called 'the poor man's atom bomb'. Combined with ballistic missiles, now deployed in Syria (300-km range Scud missiles, with 400-km range Chinese M-9 missiles believed to be on order), Iraq (with the BADR 2000, estimated highly accurate at 400 km and with a maximum range of 1200 km) and Saudi Arabia (the Chinese 2700-km range CSS-2), and further developed in Libya and Egypt (both with Scuds and indigenous missile-development programmes), a new strategic threat is facing Israel. Chemical arms, delivered by missiles to air bases and mobilization assembly points at the outset of an armed conflict, threaten the two essential capabilities on which Israeli defence relies: air superiority over the battlefield, and an effective mobilization of the huge reserves in the first hour of a

¹² Spector (note 10); *Nucleonics Week*, vol. 30, no. 36 (7 Sep. 1989), p. 4; *Nucleonics Week*, vol. 30, no. 42 (19 Oct. 1989), p. 14.

war. Israel, under these circumstances, could be tempted to view its nuclear arsenal not as a last-resort weapon, but as a military stop-gap to compensate for assets lost to the Arab ballistic missile-chemical weapon threat. As a corollary, the distinction of conventional arms and weapons of mass destruction are becoming highly blurred, and dangers of pre-emption are rising.¹³

Unfortunately, the prospects for solutions remain slim as long as the USA continues to tolerate all moves by Tel Aviv in the military realm. It is clear that Israel will not be persuaded to give up its nuclear arsenal without a political solution for the region which contains some guarantee against the conventional threat the country is facing. For the Arabs to agree to a step-by-step approach towards this goal, presumably there must be a prospect that Israel's nuclear weapons will not be taboo for the negotiations. Only very strong arm twisting by the USA might convince Israel of the necessity for such a step but, so far, there is little indication that Washington can muster the will to change course in that direction.

South Africa

In South Africa, the withdrawal of Cuban troops has removed the last strategic pretence for the necessity of nuclear weapons. While the White minority perceives an internal threat, atomic bombs are of little use against the Black people in the big cities. Nevertheless, South Africa continues to operate two unsafeguarded enrichment facilities, one of laboratory size and one of a semi-commercial type which is supposed to be capable of supplying the two light water reactors at Koeberg with the necessary fuel. In combination with the laboratory-sized facility, it is also possible for South Africa to produce weapon-grade, highly enriched fuel. An annual output of 50 kg of HEU has been quoted for the pilot plant. At the end of 1990, South Africa could dispose of some 400 kg of HEU, or enough to build 16–26 nuclear warheads.

Recent allegations of South African-Israeli collaboration on missile technology indicate continued interest by the South African military in pursuing technologies which are not needed from a purely strategic point of view. However, it appears that these hawkish circles are losing ground under the de Klerk Government. The readiness of South Africa to enter serious negotiations on NPT accession is less in doubt nowadays than under President Botha. Without NPT membership, South Africa is in increasing danger of losing its last natural uranium customers, and of forgoing any chance to buy a power reactor in the second half of the 1990s.¹⁴

¹³ Jones, R. W. and Müller, H., 'Who wants a nuclear Sarajevo?', *Arms Control Today*, vol. 19, no. 1 (Jan. 1989), pp. 15–22.

¹⁴ Fischer, D., 'South Africa: an opportunity for Western Europe', eds P. Lomas and H. Müller, *Western Europe and the Future of the Nuclear Non-Proliferation Treaty* (CEPS: Brussels, 1989), pp. 85–90.

South America

It is in South America that the situation has improved most markedly, largely as a result of the political changes which installed and stabilized elected governments in both Argentina and Brazil. The nuclear capabilities of both countries have grown. Argentina has consolidated its enrichment plant and is servicing its own research and power reactors as well as research reactors in Algeria, Iran and Peru. Brazil has built an indigenous centrifuge enrichment facility and has experimented with reprocessing at laboratory scale. It has reorganized its nuclear programme in such a way that its main foreign partner, the FRG, has less control over nuclear activities in the country than previously.

Both countries have active and successful ballistic missile programmes. Argentina's Condor intermediate-range missile, developed with the active help of FRG companies, has inspired developments in the Middle East, particularly in Egypt and Iraq. Both Brazil and Argentina have also expressed an interest in nuclear-powered submarines and are actively working on such programmes—although, for financial reasons, at a slow pace.¹⁵

Accession by both countries to the NPT is as unlikely as their full and unconditional membership of the Tlatelolco Treaty. Old reservations against both legal instruments of non-proliferation remain.

The improvement, however, is a result of greatly enhanced confidence-building in the nuclear sector, initiated by President Raúl Alfonsín of Argentina and Tancredo de Almeida Neves of Brazil and continued under the present governments. The measures include high-level visits to all sensitive nuclear facilities on both sides, continued scientific and technical collaboration, including mutual visits to said facilities, interdependent nuclear activities (such as Argentina supplying enriched uranium to Brazil, and Brazil delivering heavy components for Argentinian facilities) and talks about a formal mutual inspection regime. Brazil has amended its constitution to include an article on purely peaceful objectives for its nuclear programme. Unforeseen political developments aside, it is less likely than ever that technical-economic competition in South America will degenerate into a military nuclear rivalry. While abstention by both countries from stronger non-proliferation commitments remains a source of some discomfort, a bilateral confidence-building system is better than nothing, and deserves the support it can get from abroad.¹⁶

Summary

On the eve of the fourth NPT Review Conference, the Treaty and the non-proliferation regime at large are in a state of precarious stability. The regime

¹⁵ Sanders, B. and Simpson, J., *Nuclear Submarines and Non-Proliferation: Cause for Concern*, PPNN Occasional Papers (Southampton University: Southampton, 1988).

¹⁶ Spector (note 10), pp. 229–80; *PPNN Newsbrief*, no. 3 (Nov. 1988), p. 2; *Nucleonics Week*, vol. 29, no. 13 (4 Apr. 1988); *Nucleonics Week*, vol. 30, no. 41 (12 Oct. 1989), pp. 11–12; Redick, J., *Nuclear Restraint in Latin America: Argentina and Brazil*, PPNN Occasional Papers 1 (Southampton University: Southampton, 1988).

has not been shattered profoundly in the past five years, nor have dramatic proliferation events upset the fabric of international relations. The situation in two regions has slightly deteriorated, while the status of two others has modestly improved.

Whether the NPT can weather another five years hinges largely on the degree of consensus its members can achieve on its merits for serving their own national interests. This consensus must be maintained against active attempts by non-parties to undermine the Treaty's stability. Resistance at the 1988 UN Third Special Session on Disarmament (UNSSD III) to the inclusion of a positive assessment of the Treaty in the draft resolution was a further clear sign that 'holdouts' do not necessarily plan to behave neutrally.¹⁷

With the main body of the Treaty basically intact, preparations started in 1989 for the 1990 Review Conference. The first sessions of the Preparatory Committee in 1989 went smoothly, and matters of organization and protocol have been resolved without difficulty. The chairmen of the three Preparatory Committee sessions—usually also the chairmen of the subcommittees of the Review Conference—were apportioned to the main three groups of countries and elected without ado: Ambassador Yamada, Japan, for the group of Western states; Ambassador Strulak, Poland, for the Eastern states; and Ambassador Adeyemi, Nigeria, for the developing countries. Ambassador Osvaldo de Rivero of Peru was selected as president for the Review Conference. Issues of organization and protocol have, so far, been resolved without difficulty. A proposal by Egypt to discuss a substantive paper in advance served the double purpose of claiming leadership for the large Arab country, and of sorting out the more controversial issues for the Conference itself. A 'disarmament timetable' was discussed as well as a Nigerian suggestion to draft a protocol on negative security assurances; the USA proposed to consider this suggestion, but not in the form of a protocol. Even the site of the first meeting—New York rather than Geneva—did not disturb the proceedings, as some observers had feared because of the more general-political orientation of New York UN delegations, as opposed to the more specific-technical arms control views of Geneva representatives.¹⁸

The status of implementation, problems and potential controversies facing the coming Review Conference are discussed below.

II. Status of implementation of the NPT

Article I

Article I obliges nuclear weapon states parties not to assist non-nuclear weapon states to acquire nuclear arms. By implication this obligation also applies to non-nuclear weapon states (curiously this is not part of the language of the Treaty). Have parties lived up to their obligations?

¹⁷ *Arms Control Reporter (ACR)*, July 1988, p. 602.B.148; Akashi, Y., 'Is there still life after SSOD III?', *Disarmament*, vol. 11, no. 3 (autumn 1988), p. 20.

¹⁸ *ACR*, June 1989, p. 602.B.166.

In the case of the superpowers there are indications that geostrategic and alliance interests counteract non-proliferation commitments. While direct assistance was probably absent, indirect assistance to third countries' nuclear weapon programmes is undeniable. It could also be stipulated that Article I implies not only abstaining from direct assistance but also active efforts to prevent proliferation and to persuade potential proliferators to stop undesired activities. Measured by that standard, both superpowers have failed badly.

USSR-India

Whereas no direct Soviet assistance to non-peaceful Indian nuclear activities has been registered, three factors in this co-operation are worrisome enough to deserve mention:

1. While the lease of a Soviet nuclear-powered attack submarine in 1988 to the Indian Navy did not imply delivery of nuclear weapons, it is well known that such submarines can serve as platforms for nuclear arms. They may even use highly enriched, weapon-grade uranium as fuel. This raises the question of whether it is appropriate for a depositary government of the NPT to deliver to a non-NPT country, even on a lease basis, a device which may have a place in a nuclear weapon programme and which uses fuel not subject to international safeguards. Of course, the USSR was not obliged to require safeguards on the fuel: Article 14 of the NPT model safeguards agreement¹⁹ permits the lifting of safeguards on nuclear material to be used for non-explosive military purposes, and in relationships with non-NPT parties the matter is unregulated. But it leads to questions on the commitment of the depositary government if such items are offered to a country which violently opposes the Treaty. While the letter of the NPT was not hurt, its spirit suffered from Soviet forbearance to Indian interests.²⁰ Apparently this was recognized in Moscow: it has been aired that initial plans to follow up with leasing another three ships have been scrapped.

2. The sale of two nuclear power plants to India, recently concluded under safeguards, breaks the taboo on entering major new contracts with countries conducting unsafeguarded nuclear activities. This silent agreement has, wittingly or not, governed the behaviour of nuclear suppliers in this decade. Indian stubbornness against integrating into the regime was rewarded. The Soviet decision thus provides an unfortunate precedent and has already helped France to follow suit with an agreement on a reactor sale to Pakistan. Other suppliers may follow.

3. More disturbing is the repeated supply of Soviet heavy water to India, without safeguards, through an FRG intermediary. The scheme of these deliveries was always the same: the German company bought individual batches of the material of slightly less than a ton—the amount which would

¹⁹ See note 4.

²⁰ Sanders, B. and Simpson, J., *Nuclear Submarines and Non-Proliferation: Cause for Concern*, PPNN Occasional Papers (Southampton University: Southampton, 1988).

have triggered a request for safeguards under the London Suppliers' Guidelines—allegedly for West European customers. The heavy water was then collected and shipped to India. That this was going on even after first rumours of illegal heavy water dealings had been made public makes one disbelieve in pure *naïveté* on the part of the Soviet exporters. Either a zeal for hard currency or a desire to help a highly valued strategic partner without public embarrassment lies behind Soviet behaviour. Unsafeguarded heavy water helped India considerably in stockpiling plutonium without international controls, material which can be used for whatever purpose the Indian Government decides. In this wilful neglect, Moscow came very close to a breach of its Article I obligation.²¹

USA–Pakistan

Despite growing evidence of a Pakistani nuclear weapon programme, including a breach of President Zia's commitment not to enrich uranium above 5 per cent, the US Government has continued to support Pakistan militarily. This support has included the delivery of 60 F-16 fighter-bombers to the Pakistani Air Force, capable of delivering nuclear bombs after refit. Year after year US Presidents granted a waiver on the Symington–Glenn Amendment to the Foreign Assistance Act which would have terminated all assistance to Pakistan because of its military nuclear programme. In June 1989, President George Bush informed Congress that the breach of the previous Pakistani assurance not to enrich uranium beyond the 5 per cent level was not seen as a sufficient reason to cancel military aid and would not play a role in the further US–Pakistani relationship. The decision to continue aid to Pakistan was taken despite Prime Minister Bhutto's declaration that Pakistan was in a position to build the bomb if it so desired. Washington has restricted its non-proliferation policy to regular, but mild, admonitions and has otherwise conducted business as usual.

USA–Israel

The USA keeps virtually silent on the most advanced nuclear weapon programme in a purportedly non-nuclear weapon state. While it was clearly within US power to pressure Israel towards at least a freeze on the further growth of its nuclear arsenal, even the Vanunu revelations have not stopped Washington looking the other way. Without US subsidies worth \$3 billion in fiscal year 1990 for economic assistance and foreign military sales finance, Israel would be bankrupt. In this way, the US taxpayer indirectly subsidizes Israeli expenditures for the Dimona complex. Worse still, strategic co-operation between the two states was extended to the Strategic Defense Initiative (SDI) in 1985; this includes technologies applicable to improving nuclear weapon delivery. As a consequence, the Israeli Government has become accustomed to regarding criticism from

²¹ Milhollin, G., 'Dateline New Delhi: India's nuclear cover-up', *Foreign Policy*, no. 64 (fall 1986).

Washington as not serious; even the harsh US advice to stop development of a long-range missile that could threaten the USSR appears to have gone unheeded.

South Africa

There is persistent Third World criticism of Western nuclear collaboration with South Africa. Minor nuclear technology supplies still reach South Africa, which has also been able to secure unlicensed supplies, such as a fuel fabrication measurement device illegally provided by an FRG company. However, most Western countries have visibly severed their nuclear ties to South Africa. All but the FRG and France have suspended natural uranium purchases and in 1986 the European Community (EC) Council resolved not to enter any new nuclear supply contracts with South Africa.

Policies of neglect must be added to the above politically motivated shortcomings. The USA discovered that its Department of Energy had, through lax security standards, given information on detonators, explosives and firing sites with possible nuclear applications to citizens of Argentina, India, Iran, Israel, Pakistan, South Africa, South Korea and Taiwan. While not a conscious breach of Article I, this must be seen as failure by neglect to live up to the obligations of this article.²² Other activities which may have contributed to third countries' nuclear programmes fall more clearly under Article III and are discussed in greater depth below.

It can be expected that disputes over the implementation of Article I will very much resemble those in 1985. Israel and South Africa, and their real or alleged ties to the West, will be high on the agenda, while few Third World countries will summon the courage to ask questions about India or Pakistan. Black African states will most likely be highly critical of what they view as continuation of critical Western collaboration with South Africa and may push again for including language in the final document asking NPT parties to cut nuclear ties with South Africa. Only accession to the Treaty by Pretoria would suspend such a move. In this case, Black Africans would have to decide whether they want to push the issue further, for broader political reasons, that is, out of opposition to *apartheid*, or if they would just ask for close and careful scrutiny of records and stocks in South Africa to make sure that no hidden material escapes the initial account. If they decide to continue with the boycott request, they may meet stiff resistance from some Western countries anxious to reward Pretoria for its accession. If Black African states afford *apartheid* more importance than non-proliferation in a NPT framework, there would be much room for controversy. The steps taken by the de Klerk Government towards reforms may help to overcome this problem in the future.

²² ACR, Sep. 1989, p. 602.B.167.

The Middle East

An even trickier complex of issues awaits the conferees on the Middle East. First, Israel is likely to demand observer status: this will meet the determined resistance of Arab delegations and it is not clear whether a compromise will be easily achievable. The Vanunu revelations and the fact that Israel has probably breached a peaceful-use commitment in a heavy-water supply contract with Norway affect the non-proliferation regime directly and will be used by Arab countries to argue against observer status for Israel.

Second, the status of the PLO will be a contentious issue. It is quite possible that the PLO will seek admission as observer under the label of Palestine. The USA will fight tooth and nail against such a decision. Maybe a compromise reached by the 1989 IAEA General Conference (to which the PLO was admitted as Palestine, but filed as international organization, not as a state) could remove this problem.

Third, Arab states will fight for a harsh condemnation of Israel, on the same grounds as those concerning observer status. In 1985, the USA almost walked out of the Conference over this issue. A repetition of this stubborn behaviour will open the fundamental question of US commitment to the NPT and may be the single greatest danger to the success of the Conference.

Summary

The revolutionary changes in East–West relations provide the greatest hopes that Article I can be approached in a fresh way. With the global US–Soviet contest for power subsiding, there is less reason to condone all disputable behaviour by strategic allies. Concomitantly, the risks of proliferation will rank higher on the national security agenda of major states once the central threat of a superpower nuclear war loses all probability. It is to be hoped that a reordering of priorities will persuade the governments in Moscow and Washington to put more pressure on their regional allies to freeze their latent nuclear weapon programmes or open new ones. Some change is needed in the US–Israeli relationship, even if there is no prospect to approach Israel's nuclear status straightforwardly for the time being. Three steps by the USA appear feasible as well as necessary to give minimum satisfaction to the good-willed among the Arab NPT member states: a willingness to curtail the strategic military–technical collaboration where indirect spin-offs for Israel's nuclear programme are concerned; an indication to key Arab governments that Washington is willing to address the nuclear problem in the Middle East in the framework of a peace process and to apply its influence to force Israel to at least freeze further plutonium production at Dimona; and admission of more critical language in the final document—this cannot reasonably be opposed given the news about Israel's nuclear programme since the last Review Conference.

Other Article I problems can be dealt with by a stricter and more consequential application of export controls (see also under Article III).

Article II

Article II of the NPT obliges non-nuclear weapon states parties to the Treaty to refrain from acquiring nuclear weapons. On the surface, this article has been perfectly implemented during the past five years and no NPT party is known to have acquired nuclear weapon status. Some non-nuclear weapon states parties have conducted doubtful activities, however, which give rise to concern; there has been no clear violation of Article II, but several ambiguous cases and one very disturbing development.

The nuclear programmes of Iran and Iraq suffered from the 1980–88 war. Iraq's nuclear venture at Tammuz was destroyed by an Israeli attack on the large Osiraq research reactor in 1981 and repeated Iraqi air strikes have damaged the core of Iran's once highly ambitious civilian nuclear programme, the power plant at Busheer. Both countries have made efforts to restore their nuclear programmes, so far with little apparent success. Iraq tried to acquire a substitute for its damaged reactor from France, but would not accept the French condition that a modified reactor type be supplied that did not use HEU. Allegations that Iraq was abusing the 12.5 kg of highly enriched uranium supplied by France for the destroyed reactor were proved false by IAEA inspection results. Suspicions that Iraq is actively seeking to acquire centrifuge technology for enrichment have been revived after recent reports of criminal investigations of H & H Metallform, the FRG company accused of non-licensed exports of machinery for the production of ultra-centrifuges.²³ Most recently, Iraqi nationals were detained at London's Heathrow Airport for trying to smuggle nuclear-bomb trigger technology (krytrons).²⁴ Iran has acquired 80 kg of medium-enriched fuel (19.7 per cent) from Argentina for restarting its Tehran research reactor under safeguards. There appears to be broader collaboration with Argentina. Iran has tried, with mixed success, to attract back the scientists and engineers that fled after the revolution. Iran has made unsuccessful attempts to persuade the FRG to agree to Siemens/KWU rebuilding the Busheer reactors. The FRG makes the resumption of supply contingent upon an Iran–Iraq peace treaty.²⁵ Although present Iranian capabilities give no cause for real concern, past experience of the incalculable nature of the present regime, its highly compromised position towards international law and some highly critical comments on the NPT lead many observers to view the country with circumspection. Stabilization with a moderate government would presumably remove much of this concern.

Despite Libya's status as a state party to the NPT, statements by Colonel Muammar Qadhafi indicate continued Libyan interest in nuclear weapons.²⁶ Yet there have been no obvious attempts to acquire the needed technology

²³ *Der Spiegel*, no. 51 (1989), pp. 93–94.

²⁴ *International Herald Tribune*, 29 March 1990, pp. 1, 5.

²⁵ *Nucleonics Week*, vol. 30, no. 45 (9 Nov. 1989), p. 7.

²⁶ *Spectator* (note 10), pp. 196–206.

after Libya was denied advice and technological assistance by Belgium and once ambitious plans for the purchase of Soviet power reactors were scrapped after the Chernobyl accident. Public statements contrary to existing Treaty obligations, made by the leader of a state party, must nevertheless be a cause for concern with regard to compliance with Article II.

Because it is regarded as a 'political entity' rather than a state, Taiwan is not always counted as a party although it has signed and ratified the Treaty and continues to adhere to its rules. There was thus reason to worry when it became clear that the country had embarked on a reprocessing programme. Current and prospective uranium prices make reprocessing uneconomical—it makes little sense for a country with a still small nuclear power programme—and the clandestine style of constructing the facility did not augur well for the peaceful purposes behind it. US intervention dissuaded continuation and in 1988 Taiwan agreed to dismantle the plant and to shut down a 40-MW(th) research reactor that could have become the source of spent fuel for reprocessing.²⁷

The failure of one of the Treaty's most recent accessions, North Korea, to conclude the required safeguards agreement with the IAEA is a matter of highest concern since North Korea is said to be constructing indigenously built facilities with clear military possibilities, namely, a research reactor and a reprocessing unit.²⁸ Initially, the blame for the delay was to be laid on the IAEA that apparently sent a wrong draft agreement to Pjongjang. Meanwhile, however, the impression that North Koreans are playing for time is strengthened; impossible demands, such as the withdrawal of all US nuclear arms from East Asia, are clearly presented to prevent an early conclusion of the negotiations. North Korea must be aware that the IAEA has no mandate to discuss these matters. If the situation does not change before the 1990 Review Conference North Korea will certainly be accused of being the first non-nuclear weapon state poised to breach its obligations under Article II. The matter is most dramatic because South Korea must feel itself to be in a precarious security situation if no solution is found; thus, it cannot but criticize Pjongjang during the conference. Given the considerable civilian nuclear and general technological potential of South Korea, the situation on the Korean Peninsula begins to resemble the unfortunate constellation in South Asia.

For Article II, consensus at the Review Conference is threatened by hostility between two pairs of countries. The Iran–Iraq dispute almost wrecked the 1985 Review Conference at the last minute, and mutual recriminations about alleged illegal activities could once more prove a stumbling-block. The Korean situation could be more serious. It would be difficult for the Conference not to support South Korea in a motion to condemn the North Korean failure to comply with its obligation, yet it is likely that some of North Korea's friends and potential arms customers would hurry to lend

²⁷ *Washington Post*, 24 Mar. 1988; *New York Times*, 23 Mar. 1988.

²⁸ *ACR*, Nov. 1989, pp. 602.B.20–23.

support. A division of the Conference over this issue would be a serious blow to the NPT and could well wreck any attempt to shape a consensus.

Article III

This is the most important NPT article in operational terms. Article III.1 establishes IAEA safeguards on all peaceful nuclear activities as the verification system to which all non-nuclear weapon states must subject themselves. Article III.2 obliges all nuclear exporters to require safeguards on nuclear materials, equipment and technology sold abroad.

Safeguards on peaceful nuclear activities

With the exception of North Korea all states parties to the NPT which have nuclear activities have accepted full-scope safeguards. This does not mean that the safeguards system has seen five quiet years since the third Review Conference. Safeguards have met criticism from two different sources. Anti-nuclear critics have maintained that safeguards are virtually unreliable: with evidence of the difficulty in monitoring nuclear material in large bulk-handling facilities (see below), they have denied the possibility to certify, with a sufficient degree of certainty, the absence of nuclear materials diversion. By quoting self-critical passages from the classified annual IAEA Safeguards Implementation Report (SIR), they have created the impression that the IAEA itself does not believe in the efficiency of its system. The IAEA has denied these allegations and pointed to the very high standards against which it evaluates its own achievements; even by falling short of its own safeguards objectives, as expressed in the SIR, the Agency is still satisfied that it could discover a significant diversion of weapon-grade material.²⁹

It is most unfortunate, given public uncertainty over the meaning of the safeguards system, that member states cannot resolve to follow the IAEA Secretariat's recommendation to publish the SIR in a more easily understandable form. The IAEA cannot meet its obligations under the NPT to create mutual confidence among parties by verifying compliance with their commitment if it is not permitted to present and fully explain its findings to the attentive international public.

In heavily safeguarded industrial countries tolerance for safeguards is limited. Governments tend to support the nuclear industry and the utilities in resisting demands by the IAEA safeguards department for more extensive rights of access or for redundant use of containment and surveillance instruments. It has also been difficult to agree on the use of new equipment not mentioned in the initial facility attachments, the documents which delineate the points of access, frequency of inspection and methods for safeguarding a particular plant. In some cases it has long been impossible to conclude facility attachments for a large proportion of facilities in the

²⁹ IAEA Press Releases, 2 June 1988, 10 June 1988 and 3 Aug. 1988.

country. Countries such as Belgium have a tradition of complaining about the cost of safeguards for its nuclear industry and ensuring that the IAEA confines itself to a minimum approach.

This attitude contains severe dangers because the budgetary freeze will increasingly force the IAEA to compromise on safeguards. There are growing demands from the industrialized countries to concentrate safeguards 'where it really matters'. A regional concentration on 'suspected countries' would discriminate against certain countries by applying more intrusive safeguards schemes there than elsewhere. While this may sound plausible, given different degrees of confidence in different countries' commitments, it would stretch the tolerance for discrimination within an already discriminatory Treaty beyond the limits. Alternatively, focusing safeguards on more sensitive facilities, such as reprocessing, enrichment or MOX (mixed oxides of plutonium and uranium) fuel fabrication, makes economic sense but would be a dangerous move in a political environment in which safeguards efficiency is already questioned. Any apparent relaxation of present standards would be interpreted as a capitulation of the IAEA to the demands of the 'nuclear lobby' and as a serious erosion of the credibility of the system. Risking such a public reaction while the NPT is entering its most decisive five years would not seem wise.

This is all the more true as the capability of the IAEA to implement its self-defined objectives is strained to its limits after seven years of zero budgetary growth. Expanding safeguards tasks, in the long run, requires expanded resources. Not only are more complex facilities coming on stream (see below) but, in the context of increasingly sophisticated verification schemes for recent and future arms control agreements, the impression must be avoided that IAEA safeguards are becoming old-fashioned and outdated. This requires keeping safeguards technologies up-to-date by introducing new equipment as and when available. Efforts are required which go beyond the present safeguards support programme; funding is needed for new equipment. For real as well as perceptual reasons, the zero budgetary growth policy, imposed on the Agency by the Western group of member states and accepted by most members, is increasingly dangerous for the objectives of the NPT even if no breach of the Treaty has occurred. In the same vein, the restrictions placed by many NPT countries on the designations of inspectors of 'unwanted' nationality must be curbed. They delay the timely application of safeguards unnecessarily and, given the main commitment undertaken by Treaty ratification, are a true disgrace.³⁰

New challenges to the safeguards regime emerge from new technologies entering civilian use and from new safeguarding problems on the horizon.³¹

1. Developments in laser enrichment technology are under way in a large number of industrialized states and several threshold states. The atomic

³⁰ *PPNN Newsbrief*, no. 3 (Nov. 1988), p. 3.

³¹ For this discussion see von Baeckmann, A., *Modern Nuclear Fuel Cycle Technologies: Challenges to IAEA Safeguards*, PPNN Occasional Paper 4 (Southampton University: Southampton, 1989), pp. 7-14; the author is also grateful for information from Martin Kalinowski.

vapour laser isotope separation (AVLIS) technology for uranium enrichment has reached maturity and is under development in a large number of industrialized states and several threshold states (India, Israel, Brazil). AVLIS could be employed as a relatively quick and economic way to produce 3–6 per cent enriched uranium in a single step. The product can then be fed to subsequent enrichment steps. Only the USA is known to have had a laser isotope separation plant under construction, which could be used for isotopic separation of plutonium after separation of spent fuel. (See the paper by Richard Kokoski.) A difficulty with the laser enrichment technique from the viewpoint of proliferation is that it is highly efficient and requires little space. There is no agreed list of equipment items to be monitored for the purpose of export controls, and no safeguarding system exists for these facilities.

2. Large bulk-handling facilities containing weapon-usable material, such as enrichment facilities, reprocessing plants or MOX fuel fabrication units, pose generic safeguarding problems. Material is not available in discrete units (e.g., fuel rods or assemblies) in the processing stage of these facilities. The radioactivity of the material necessitates shielded handling. Since most of the material in the processing stage of a reprocessing plant runs through pipes and vessels, real-time accounting is difficult; measurement tolerances are high enough to create significant uncertainties over a period of a few weeks. The newly developed scheme of 'campaign runs', whereby batches of isotopically slightly different material are run through the facility is helpful; it permits measurement in smaller, discrete units, but does not solve the problem of delay in accounting; nor can it deal with the material 'lost' in pipes, vessels, and so on which can only be accounted for when the whole plant is being shut down and cleaned up. Statistical bias analysis is well able to detect the systematic loss of material even in small quantities, but not in a timely enough fashion. To make up for these shortcomings, surveillance, containment and the permanent presence of inspectors are needed and practised but, of course, that implies that materials accounting cannot play the central role in bulk-handling facility safeguarding as conceptualized in INFCIRC/153.³² The IAEA LASCAR working group³³ has tried to devise a scheme for safeguarding large commercial reprocessing facilities, but its work has not yet produced a fully satisfactory approach for safeguarding large commercial reprocessing facilities.³⁴

3. A quite different problem is posed if countries renounce the recycling of spent fuel and go for direct end-storage. In this case, whether the material is stored recoverably or irrecoverably, there are considerable difficulties with the present safeguards approach. The material is highly radioactive;

³² See note 4.

³³ A forum for the exchange of information on the development of effective and efficient safeguards for large-scale reprocessing plants. Participating states are France, the FRG, Japan, the UK and the USA.

³⁴ IAEA *Newsbrief*, vol. 4, no. 6 (July/Aug. 1988), p. 2; Walker, W. and Berkhout, F., 'Safeguards and the expansion of civil reprocessing and plutonium use', paper presented to the PPNN Core Group Meeting, Baden, Austria, 18–19 Nov. 1989.

inspectors cannot be sent down to a salt dome or granite rock mine. Even in the separated plutonium stockpile in Hanau, FR Germany, physical accounting was overly risky due to the buildup of americium. In unprocessed spent fuel hazardous radiation would be higher by several orders of magnitude. Immediately after discharge of the fuel the gamma activity is dominated by fission products. After reprocessing, the gamma activity of reactor-grade plutonium can be reduced by five orders of magnitude and is then dominated by the decay of ^{241}Pu . After 10 years of storage, however, this activity will be increased again more than tenfold, as a result of the buildup of ^{241}Am . By that time, the gamma activity of the unprocessed fuel containing the same amount of plutonium will have decayed to about 2 per cent of its original value. But it would still be two orders of magnitude higher than that of plutonium 10 years after reprocessing.

There must be a pool-storage time of about 40 years before the heat production of the unprocessed fuel rods is low enough for end-storage. Diversion is theoretically possible during this time although detection would be highly probable.

The problem for safeguards concerns final storage in non-recoverable form, by implication not accessible. It is obvious that permanent materials accountancy in a 'timely-warning' manner could not be applied to direct end-storage. Yet permanent safeguards are indispensable, because over time fission products build down to stable end-stages, and radioactivity ceases to provide a natural shield against diversion. Thus, while physical protection appears to be easily feasible—by placing a guard on top of the 'plutonium mine'—safeguarding may not be feasible within the boundaries of the present safeguards philosophy.

4. Apart from fissionable materials subject to safeguards under the IAEA statute, auxiliary materials such as heavy water and materials directly used in nuclear weapons, such as beryllium and tritium, are highly critical items in international nuclear trade. Heavy water is safeguarded on an *ad hoc* basis, following the determination of the London Suppliers' Club to monitor its peaceful use.³⁵ However, no safeguards exist for beryllium, used as a neutron reflector in nuclear warheads; tritium, a heavy hydrogen isotope used to enhance the yield of fissionable material in boosted nuclear weapons, needed for neutron-enhanced weapons and for warheads with selectable yields; or lithium 6, used as lithium-deuteride in thermonuclear weapons to breed tritium during the explosion. This tritium fuses with deuterium, another heavy hydrogen isotope, to give a yield at least 100 times that of the Hiroshima bomb.

At first glance, a safeguards system for lithium and beryllium does not seem feasible for two reasons: (a) both materials are used for many civilian purposes, (b) both materials are ubiquitous and no stage in the production chain poses difficulties to clandestine operation or would facilitate verifica-

³⁵ Heavy water and heavy water production plants were added by the London Suppliers' Club to a list of items that should trigger safeguards in a set of *Guidelines for Nuclear Transfers*, INFCIRC/254, 1977 (see appendix E).

tion. The civilian demand for tritium is comparatively small and could be met by other isotopes; it does not occur naturally in exploitable amounts and must be produced in nuclear reactors or other high neutron flux sources. Tritium presents special accountancy problems because it is a gas: permeation, absorption and accidental losses are serious obstacles to a reliable accountancy system—and there are no multilateral agreements for its control. Experience is confined to facility control within the US Department of Energy (DOE) facilities (and, presumably, factories in other nuclear weapon countries), and strict controls recently installed in the Canadian Ontario Hydro commercial enterprise. A decision to introduce international safeguards on tritium would add a new burden to IAEA safeguards.

There would be two distinct verification tasks. The first concerns tritium production limits; this requires tritium accountancy, similar to present fissionable materials safeguards, with containment and surveillance as complementary measures. The second task concerns verification of non-production of tritium. This would be accomplished by non-destructive analysis of fuel rods and control to certify the absence of lithium. This approach is promising, but so far, no portable instrument for non-destructive detection of lithium has been developed.³⁶

5. The intended acquisition of nuclear submarines by Canada, planned until early 1989 and then cancelled for budgetary reasons, has opened a can of worms as far as safeguards are concerned. The trouble lies first in Article III.2 of the NPT, which demands safeguards on exports to non-nuclear weapon states for peaceful purposes only and thus theoretically permits unsafeguarded exports for non-explosive military purposes such as submarine propulsion. Another trouble lies in Article 14 of INFCIRC/153, which permits the withdrawal from safeguards of fissionable material for non-explosive military purposes, a clause which was included on the insistence of Italy (and, to a lesser degree, the Netherlands) which, at the time of the negotiations, nurtured an interest in nuclear naval propulsion long since forgotten. The clause was fortunately never invoked; lacking any specification, it left the door wide open for abuse. This became clear when the Canadian plans put the issue on the agenda. First, spokesmen for the Canadian Government pondered the idea of having a completely unsafeguarded fuel cycle, from enrichment to reprocessing and storage, under the official rationale that it was all for non-explosive military purposes. Although the IAEA expressed determination to fight this daring proposition to the end, it was certainly a position possible under the language of the document. Canada soon came to the conclusion that such a daring interpretation would obviate 20 years of faithful support of the non-proliferation regime—only to find themselves warned by the two potential suppliers, France and the UK, both of which objected to having IAEA inspectors measure and analyse the precise composition of the fuel, not to speak of their examining the reactors themselves. The French were particularly keen not to reveal the secret of

³⁶ This paragraph owes much to the advice of and various papers on tritium control by Martin Kalinowski.

their submarine reactor fuel which, uniquely, runs at various low levels of enrichment. As a consequence, it was quite unclear whether the IAEA would have access to the fuel at any point; apparently the French idea was that the fuel would be supplied by France and 'safeguarded' by Canada and France together—this would be a worst possible precedent, precluding IAEA access to sizeable amounts of fissionable materials circulating under the sovereign authority of a non-nuclear weapon state party to the NPT. The precedent was set. While Canada considered the purchase, the nuclear submarine folly had already reached Argentina, Brazil and India, three non-parties to the NPT. The USSR decided to lease a nuclear attack submarine to India—under a bilateral surveillance scheme for the fuel. Projected into the future, a world could be envisaged in which a dozen or so non-nuclear weapon states were operating nuclear submarines for the pleasure of their navies, with concomitant amounts of fuel circulating outside of all IAEA control. An unsafeguarded military nuclear fuel cycle in non-nuclear weapon states, run in parallel to and independently of safeguarded civilian nuclear activities would compromise most seriously the objectives of Article III.1, notwithstanding the ill-conceived exception clause of paragraph 14 of INFCIRC/153 (see appendix D).

Without the Canadian reversal, the Review Conference could have witnessed a confrontation between Ottawa and its previous fellows of the 'white angel' group of particularly non-proliferation-minded countries like Australia, Ireland, New Zealand and Sweden. It is to be hoped that the nuclear submarine Pandora's box remains closed among NPT parties for a long while.³⁷

6. The IAEA may confront new safeguarding requirements in the coming decade as a result of current nuclear armament negotiations. Director General Hans Blix has already offered the good services of this Agency most experienced in verification activities, and President Mikhail Gorbachev has commented his offer in an open-minded and interested tone. One possibility would be to follow the 1985 Swedish proposal³⁸ to extend the application of IAEA safeguards in nuclear weapon states from a few facilities picked from a 'voluntary offer' list to the full civilian fuel cycle. Since China signed a safeguards agreement on 20 September 1988³⁹ the IAEA may apply selective safeguards in all five nuclear weapon states parties.

What at first glance appears a waste of money and, at best, the perfection of the 'equality of misery' principle (subjecting nuclear weapon states to the same burdens as non-nuclear weapon states) can be seen as a well-considered precursor to a meaningful disarmament measure, namely, the cut-off of the production of fissile material for military purposes. To guaran-

³⁷ Sanders and Simpson (note 15).

³⁸ NPT-Conf.3-SR.2, 2 Sep. 1985, p. 24; NPT-Conf.3-47, 10 Sep. 1985; NPT-Conf.3-54, 12 Sep. 1985.

³⁹ ACR, Dec. 1988, p. 602.B.153; the 'Swedish Proposal' was repeated by the Nordic Countries Group at UNSSD III in a working paper: ACR, June 1988, p. 602.B.146; see also von Baeckmann, A., 'IAEA safeguards in nuclear weapons states: a review of objectives, purposes and achievements', *IAEA Bulletin*, vol. 30, no. 1. (1988), pp. 22–25.

tee such a cut-off would, of course, require verification at military nuclear sites. Such verification would, however, make sense only if the verifying party could be sure that no circumvention of agreements could take place by using allegedly civilian nuclear facilities for military purposes. This, logically, would make mandatory control of all nuclear facilities, civilian as well as military, in nuclear weapon states. The Swedish argument is that, rather than starting such a verification scheme from scratch, it is better to extend safeguards coverage incrementally in order to spread the inevitable cost rise over an extended period. In this way, the extension of safeguards to the military fuel cycle would only add marginally to an already sizeable safeguards burden, and opposition to such a marginal extension would not be supported by cost considerations.

Cost concerns, however, have been the greatest obstacle so far to pursuing the Swedish proposal further. Depending on the calculation, the cost increase to the safeguards burden accruing from extending Agency activities to the British, US and Soviet civil nuclear industry ranks from 200 to 400 per cent over the present budget. This opens the question of burden-sharing: cost-minded countries such as Belgium plead for nuclear weapon states to carry the full burden (indeed Belgium has argued that those privileged by the regime should pay for the whole safeguards bill in all countries). The USA and the USSR on the other hand have indicated that they would expect non-nuclear weapon states to pick up the bill if they moved towards ending their own privilege, a step they are not obliged to take under the provisions of the NPT. For these reasons it is to be feared that there is no quick solution in sight to the cut-off idea. The USSR has unilaterally declared the shut-down of several military plutonium reactors and an end to weapon-grade enrichment, but continues to produce plutonium and maintains 14 dual-purpose reactors. The USA has not followed this example even in its declaratory policy; it is closer to a shut-down in practice, however, because safety mismanagement at US military nuclear facilities forced a clean-up costing at least \$110 billion.⁴⁰ Moreover, Congress is increasingly reluctant to grant funds for the construction of new weapon-grade material production plants in a period of diminishing military and rising budgetary threats. Maybe (even if at present there is no willingness to act) all parties could be interested in an in-depth study.⁴¹

One serious possibility compromising the utility of IAEA safeguards is the trend in US policy to abandon the time-honoured strict distinction between civilian and military nuclear fuel cycles. Attempts to blur this distinction started in the mid-1980s when the Reagan Administration, for reasons of cost and convenience, considered the upgrading of civilian-produced plutonium for weapon use. The 1983 Hart-Simpson-Mitchell amendment to the Atomic Energy Act closed this route. However, a presidential order signed by President Ronald Reagan in November 1988 opens

⁴⁰ See SIPRI, *SIPRI Yearbook 1989: World Armaments and Disarmament* (Oxford University Press: Oxford, 1989), chapter 1, pp. 10-11.

the way for seizing a civilian reactor, in case of 'national technological emergency' for either plutonium or tritium production. In 1989, the DOE continued not to rule out the employment of LWRs for the production of scarce tritium.⁴² This would be a most serious blow to the present regime.

Another possible task for the IAEA is custody and civilian recycling of fissile material extracted from nuclear warheads as a consequence of disarmament. Under the INF Treaty, destruction concerns only launchers and carriers, not the nuclear material contained in the warheads. Different solutions can be envisaged for future disarmament agreements. The same scheme is apparently planned for START. Under its statute, the IAEA cannot be involved in warhead dismantling and destruction, which fall clearly within the military realm. However, once the material is extracted from nuclear warheads, the IAEA could take it into custody and assure the parties that it is not used for military purposes. Depending on the nature of the material, the language of the agreements concerned and the prevailing fuel cycle policies, the material could be either stored under IAEA control or recycled for civilian power generation. Both alternatives would serve useful symbolic political purposes: the first would set a precedent for international plutonium storage, an old thoroughly studied proposal never realized because of national sovereignty concerns but one whose time may have come again.⁴³

Plutonium recycling will be but a fraction of that envisaged 10 or 15 years ago for the last decade of the century. The bad economics of recycling pose the question of how to deal with the plutonium already separated but which the countries concerned may prefer not to transform into MOX fuel. Given the strong objections voiced in many countries to all kinds of nuclear storage, not least plutonium, internationally owned and controlled storage systems may lend some legitimacy to such badly needed facilities. As the glory and the economics of recycling and breeding fade away, the strong national, often parochial objections of some governments against international responsibility for storing plutonium may wane, too. The European Community, and, in the near future, East Asia would be ideal locations to start with such systems and to give an example to the rest of the world. The legitimacy of nationally held plutonium storage would drastically decrease under these circumstances, and the international regime and its safeguards would be greatly enriched. Such systems would greatly enhance the non-proliferation regime.

The second alternative would revitalize President Dwight D. Eisenhower's time-honoured 'atoms-for-peace' idea: the transfer of nuclear material from military to civilian purposes. Even the partial transfer of plutonium or HEU from destroyed warheads to the IAEA could counter

⁴¹ *New York Times*, 14 July 1988; *PPNN Newsbrief*, no. 4 (Jan. 1989), p. 6; *PPNN Newsbrief*, no. 5 (Apr. 1989), p. 2; *Nucleonics Week*, 1 June 1989.

⁴² *Nucleonics Week*, vol. 30, no. 29 (20 July 1989), p. 10; *PPNN Newsbrief*, no. 4 (Jan. 1989), p. 6.

⁴³ See Van Doren, C. N., *Toward an Effective International Plutonium Storage System*, Report 81-255 (Congressional Research Service: Washington, DC, 1981).

criticism by non-nuclear weapon states that superpower disarmament was not serious because the material was recycled militarily. This would have a healthy effect with regard to the divisive nature of Article VI issues.

Safeguards on exports

Article III.2 requires states parties to request safeguards on all relevant exports and, by implication, to create the necessary legal and administrative conditions needed to live up to this obligation.

The past five years have seen some breath-taking events in this context. Nuclear equipment, material and technology were transferred without safeguards by FRG companies to India (beryllium and heavy water), Pakistan (enrichment technology, maraging steel, enrichment equipment, uranium hexafluoride containers, tritium, tritium extraction and purification technology) and South Africa (fuel fabrication measurement devices). Switzerland sometimes played the role of transit stage for subsidiaries of FRG firms. Norway was the innocent supplier of heavy water to India—the Norwegian supplier was told the destination would be the FRG.⁴⁴

Parliamentary investigations revealed serious weaknesses in the export control system. The responsible agencies were understaffed and underfunded and some of the ministries charged with their supervision held a policy of export first, control second. The law left wide gaps: transit trade and activities abroad were not punishable at all. Penalties were ridiculous in comparison to the profits to be gained from perpetrations, and serious investigations were rarely launched lest companies suffer undue competitive disadvantages. While the FRG kept to the letter of the Treaty, implementation was less than sufficient and the spirit of the NPT was violated. There is some suspicion that many other industrial countries would not fare better in this regard if comparable in-depth investigations were conducted. Without adequate precautions, the creation of a unified EC market after 1992 may mean that nuclear-related goods drift freely towards those member countries with the weakest controls on trade with the outer world. While the FRG has hastened since early 1989 to close loopholes and regain lost reputation, such gaps may remain in other countries and may well be abused in the future. In some cases, NPT parties may even use such exports to collect hard currency. Romania, for example, is reported to have illegally transhipped Norwegian heavy water to Israel. Norwegian inquiries to clear the matter have not been answered by Romanian authorities.⁴⁵

Loopholes in the control systems for international trade are:

1. There is no register of 'small quantity' trade with fissionable material.
2. There are no controls on materials below given specifications. This applies to materials such as beryllium or maraging steel, defined as nuclear-usable only above a certain purity. Yet nuclear usability may exist, though at

⁴⁴ Müller (note 11).

⁴⁵ *New York Times*, 25 May 1988.

a penalty, and states or subnational groups anxious to acquire a nuclear capability may be willing to pay this penalty;

3. Transit-trade transactions—when merchandise does not touch ground in the home country of the trading company—mean that a company will not be prosecuted if such trade is not regulated by law in the home country.

4. Shipper–receiver communications are imperfect in nuclear materials not supervised by the IAEA, such as heavy water, which is usually safeguarded only on specific request by the seller in non-NPT countries. (Norway has stopped all exports of heavy water, but other suppliers stay in the market.)

5. Shipper–receiver responsibility to inform the IAEA about transactions of non-fissionable material triggering safeguards is also a source of concern. Such imports to NPT countries must be reported in good time before material is brought into such facilities. Theoretically, an NPT country could hold (or pretend to hold) a reprocessing facility idle for years, if it states that no material is processed in the plant. In trade between NPT shippers and non-NPT receivers, both sides are often in default on their reporting requirements. Recent investigations of the FRG–Brazilian nuclear deal have shown that FRG companies left it to the government to inform the IAEA, while the government was waiting for the companies to do the reporting.

6. Dual-capable technologies and items remain a ‘grey area’, with considerable scope for abuse.

7. New technologies which are clearly nuclear relevant but not yet internationally defined or regulated often lack control at national levels, too. One example is spallation neutron sources. Proton linear accelerators can be converted to a high flux neutron source by directing the proton beam on a lead target. The neutron produced by this method can be used to breed plutonium. Although no proton accelerator has yet been built which could meet the specifications required for this purpose, and although considerable engineering work has still to be done, it is not too early to start thinking about an export control and safeguards system for this technology.⁴⁶

8. There is no rule for controlling trade in tritium and lithium deuteride, two critical materials for second- and third-generation nuclear weapons.

9. Specific weapon-usable items not needed for civilian nuclear purposes but which may have civilian applications outside the nuclear sector are not listed or controlled (such as krytrons, electronic switches to co-ordinate implosion timing).

It is clear that as the sophistication of third country (or even sub-national) purchasing agencies grows, there is considerable room for improving existing international co-operation among suppliers. Such co-operation has been slow and piecemeal, one reason being that some governments were shy of offending developing countries. This fear raises one of the trickiest problems in the export-safeguards context: how to deal with those non-NPT countries which are advanced in nuclear technology and which may be able

⁴⁶ Martin Kalinowski, personal communication.

to enter (or stay in) the nuclear export business themselves. Foremost among these, Argentina has exported research reactors to Peru and Algeria and is on the verge of exporting further research reactors to Albania, Turkey and perhaps Egypt. Argentina has an ambitious programme for offering small—25 MW(e)—and medium-sized—380 MW(e)—reactors to developing countries and provides fuel services to Algeria, Brazil, Iran and Peru. Its new government is reportedly interested in opening a sales and co-operation campaign in the Middle East.⁴⁷

Despite financial difficulties, Argentina is a potent exporter. In principle the other 'threshold' states possess the same possibilities. It is feared that those new suppliers would not act with the same degree of caution and responsibility as traditional suppliers are supposed to (but do not always) apply. So far, however, new suppliers have, by and large, behaved responsibly. South Africa has said it will apply London Guidelines standards on all exports (although recent rumours of an exchange of uranium for Israeli missile technology raise some questions).⁴⁸ Argentina has declared it will demand safeguards on its nuclear trade and has so far stuck to this unilateral commitment; its sale of a research reactor to Algeria, however, does not require safeguards on eventual replications of that facility, a weaker safeguards policy than proposed by the London Guidelines. Brazil has forced China to accept, for the first time, the obligation to tolerate safeguards on possible nuclear items from Brazil, a stipulation which industrialized countries have not been able to extricate from China. The other countries have no known exports, and India is reported to have denied Colonel Qadhafi a nuclear explosive in exchange for oil exports.

In the past the one troublesome exception was China, which started in the 1960s as a strong (verbal) supporter of nuclear multipolarity. However in practice China presumably exported uranium and heavy water to Argentina and, possibly, South Africa, without safeguards. There are some indications that China—or Chinese scientists—may have helped Pakistan with weapon technology, although this has never been fully substantiated. After a long and conflict-filled negotiation with the USA on nuclear co-operation, the Chinese Prime Minister made public statements that China would not foster proliferation and would require those importing its nuclear merchandise to accept IAEA safeguards. Its recent supply understanding for a 300-MW(e) power reactor to Pakistan appears to contain such a safeguards clause.⁴⁹

The fact that the threshold countries/emerging suppliers are both targets of non-proliferation policy and players one would like to integrate presents philosophical and practical problems for a consistent export approach. Attempts to draw them closer to the regime are difficult because they feel—with some justification—that it is inappropriate for them to accept, for example, the London Guidelines as an export approach since it was

⁴⁷ *IAEA Newsbrief*, vol. 4, no. 4 (May 1989); *IAEA Bulletin*, vol. 31, no. 1 (1989), p. 57; *Nucleonics Week*, vol. 30, no. 14 (6 Apr. 1989), p. 8, and vol. 30, no. 18 (4 May 1989), p. 13.

⁴⁸ *ACR*, Nov. 1989, pp. 706.B.20–21.

⁴⁹ *Nucleonics Week*, vol. 30, no. 47 (23 Nov. 1989), p. 1.

designed to contain their own unsafeguarded nuclear developments in the first place. To abolish all export restraints towards these countries, on the other hand, opens the route to possible abuse. The transfer of knowledge and personnel from imported/safeguarded to autonomous/unsafeguarded activities is frequent, and very embarrassing to the exporter.

Aside from the manifest economic interest of nuclear exporters such as Belgium, the FRG or Switzerland, these difficulties have fuelled the hot debates on full-scope as opposed to exported-item safeguards in the past. This controversy has dominated the discussion on export policy and the meaning of Article III since the beginning of the NPT and produced the most heated dispute among the industrialized countries at the 1985 Review Conference. Under the leadership of the FRG the 'liberal exporters' compromised on language obliging parties to strive to achieve full-scope safeguards on exports—which left open a small escape (i.e., to renounce full-scope safeguards if such efforts were unsuccessful with the trading partner).⁵⁰ Since then, the only countries to enter new major export understandings with non-nuclear weapon states have been non-parties China and France (with Pakistan) and depositary USSR (with India); the Soviet sale of two 1000-MW units for soft currency, countertrade and a preferential 2.5 per cent interest loan is particularly remarkable.⁵¹

Other government-approved exports from the 'hard-nosed suppliers' concerned the implementation of past contracts and minor supplies such as spare parts and safety control equipment, but no massive sales. Under the pressure of the illegal export scandals, the FRG Government declared its intention to live up to the language of the third Review Conference Final Document and not to enter any major new contracts with countries where nuclear material was circulating free of safeguards. The past strategy of entangling non-NPT parties into the regime by co-operation was seen to be a double-edged sword. Brazil, for example, extracted considerable gains in technology and knowledge from past transfers, yet did not renounce its militarily controlled autonomous nuclear programme. Reorganization of the Brazilian nuclear establishment has deprived the FRG of residual control of sensitive activities. Together with the open transfer of German-trained personnel to the autonomous programme, these changes raise the spectre of German technology ending up in unsafeguarded facilities, a nightmare for the FRG Government and an experience contrary to the expectations of the 'entanglement-by-co-operation' strategy. A test for FRG policy will come soon. The French Government has hinted at a willingness to have the export to Pakistan conducted by NPI—the joint Framatome–Siemens venture. In this case the reactor exports would require German export licences. The FRG Government will then have to decide on export conditions, and whether it would like to go forward anyway.

Under present circumstances and with a sharpened awareness of the risks of proliferation to its own reputation if not national security, it is unlikely

⁵⁰ Fischer and Müller (note 2), pp. 18–22.

⁵¹ *Nucleonics Week*, vol. 29, no. 47 (24 Nov. 1988), pp. 3–4.

that the FRG will again take the lead of those opposed to full-scope safeguards. It is interesting to note that Switzerland has also tightened up its export legislation and regulations considerably since 1985.⁵²

Summary

The implementation of Article III by North Korea is in open doubt. Other countries which have failed to conclude their safeguards agreements with the Agency are in formal default with their obligations, but their lack of nuclear activities makes this less urgent. The recent conclusion of a safeguards agreement by Nigeria, coming on the heels of a strange statement by the country's foreign minister on the need for a Black African bomb, was a welcome event;⁵³ it demonstrated serious commitment to the NPT by the largest Black African state.

The failure of some advanced states to conclude facility attachments with the IAEA for all nuclear plants on their territory is partly a result of inattention, partly an expression of stubborn support by governments for nuclear operators' interest in minimum intrusion by inspectors in their operations, and partly an indication of serious objective difficulties in devising safeguards approaches to certain type of plant. Since safeguards are covered by far-reaching *ad hoc* inspection rights, this is not a serious concern and cannot be taken as a breach of obligation.

The negligence of some exporters, notably the FRG, in revamping their own export control policies and systems promptly after the discovery of the very first weaknesses raises serious doubts about whether Article III.2 obligations have been properly met. Urgent changes of export policy, law and administration are needed to demonstrate that there is serious willingness to live up to the Treaty commitment.

There will probably be a very tough debate on the North Korean situation, should it not be resolved by the time of the Review Conference; the divisive character of this issue is discussed above in the context of Article II. The FRG Government is expected to face critical questions on its export policy, and will have to present an impressive and convincing record of changes in its export control system to silence the voices of criticism, likely to come from the 'white angel' group of Western countries, but possibly also from the United States.

Full-scope safeguards are less likely to cause divisions, since FRG leadership of the opposition group has been weakened and Bonn's determination to fight for the matter is likely to have diminished. For the first time, it may be possible to agree on language which makes full-scope safeguards the export policy for NPT parties, with the possible exception of nuclear safety technology. This may raise problems for West German Siemens in its joint

⁵² *Nucleonics Week*, vol. 30, no. 30 (27 July 1989), pp. 4-6; *ACR*, July 1988, p. 602.B.149; *Nuclear Fuel*, vol. 4, no. 2 (17 Jan. 1986), p. 14.

⁵³ *PPNN Newsbrief*, no. 2 (July 1988), p. 2.

venture with Framatome: it is not clear which export conditions would prevail under these circumstances (see above).

International plutonium storage is likely to be back on the agenda, with some more justification and prospects than before. At least countries could be encouraged to study the matter, in co-operation with the IAEA and taking into account past work on the issue, in their regional contexts.

International co-ordination of export policy has been a controversial matter because of its exclusivity among industrialized countries. For technical reasons, it is unlikely that this constellation will change. Maybe it would help to mitigate controversy if the Conference could decide to allow exporters to conduct further co-ordination and to report to the 1995 Extension Conference. The exporters could then point to this mandate in legitimizing their further proceedings, and the non-exporters could satisfy themselves that export control co-ordination was mandated by an international body and that they would maintain a chance to review the outcome.

Article IV

Article IV requires parties to co-operate as fully as possible in the field of peaceful nuclear applications, including technology transfer, with particular attention to the needs of the developing countries. This article has been seriously affected by the Chernobyl accident and its consequences for the world nuclear industry: the accident happened at a time when nuclear energy appeared to be extricating itself slowly from the double blow of Harrisburg and high capital costs. There were clear indications of a renewed interest, even by developing countries, as clearly expressed by the mandate to the IAEA of studying possibilities of nuclear power plant financing (a proposal made by Egypt at the Third Review Conference). After the Chernobyl accident, however, the picture was reversed. In the industrial world the use or expansion of nuclear energy stopped abruptly in Belgium, the FRG, Finland, Italy, the Netherlands, Spain and Switzerland. Sweden decided to accelerate the phase-out of its current nuclear power plants (although there appear to be second thoughts on the matter). The Philippines decided to mothball their only, Westinghouse-built reactor. Mexico renounced programmes to proceed beyond the trouble-plagued Laguna Verde unit. Libya, Turkey, Egypt and Yugoslavia, previously thought to be possible markets, stepped back from purchasing plants under the double burden of financial difficulties and safety concerns. Expansion plans were scaled back and slowed down in South Korea, Japan, Taiwan, the Eastern block and even in France, so far the speediest builder of nuclear power plants. Although nuclear power has long fascinated the Third World with its glorious image as the most advanced and sophisticated energy source, the combination of very high costs and operational safety hazards nowadays leads developing countries to think twice before considering nuclear energy programmes.

The present state of affairs should not negate the importance of civilian nuclear power in the world energy picture. At present, 434 power reactors

with a combined capacity of 316 GW(e) operate in 27 countries; 100 units are under construction, including units in five countries not yet users of nuclear electricity. Nuclear power supplies about 17 per cent of the world's electricity; in 11 countries—all industrial ones—the share is above 30 per cent, but at present, interest in the Third World is confined to a handful of buyers: Indonesia, South Korea, maybe in the distant future Bangladesh among NPT parties, India and Pakistan among non-parties.⁵⁴ It is open to debate whether this decline in interest is good or bad for non-proliferation. The deceleration of nuclear expansion can be seen as good for non-proliferation, yet at the same time it weakens an important incentive to appreciate the NPT commitment. If the NPT is a bargain between the haves and the have-nots, the depreciation of nuclear technology must devalue the importance of the Treaty to those with no great interest in nuclear matters. This group is already a majority among the developing countries. If it is enlarged by those major parties which, so far, have been interested in the Treaty because of the prospects for civilian nuclear energy use, the consequences for NPT stability are not necessarily beneficial.

Prospects for reviving interest in nuclear energy in developing countries, however, are by and large dim. An IAEA study concluded that only a handful of countries would provide a market for small-scale reactors; a recent survey showed that even developing countries have not followed up the proposals of the small and medium power reactor project.⁵⁵ Interest in small power reactors has been reawakened in industrial countries, in the context of research on 'inherent safety', replacement needs in the 1990s and a preference for smaller, incremental additions rather than large-scale units.⁵⁶ Simultaneously, the most active new supplier, Argentina, has offered a small-sized power reactor for which, however, no prototype exists so far. It is too early to estimate if the interest in nuclear energy will regain momentum on the small-scale route, and if so, when this will happen. So far no visible market exists in the Third World.

An IAEA study on nuclear financing enumerated several obstacles to nuclear power development such as lack of infrastructure, of adequate legislation on radiation protection, of appropriate overall energy requirement studies and of development plans. The difficulty for private lenders to overcome concerns over construction time and constructors' reliability was duly if discreetly noted. Rather than concrete steps towards financial assistance better grounds for risk assessment were recommended. There is little chance of improving the prospects for nuclear expansion from this angle. The recent finding of the World Bank that the Angra III nuclear power plant in Brazil is

⁵⁴ *New York Times*, 7 Mar. 1989; *Nucleonics Week*, vol. 30, no. 17 (27 Apr. 1989), p. 11; *PPNN Newsbrief*, no. 4 (Jan. 1989), p. 4; *Nucleonics Week*, vol. 28, no. 12 (19 Mar. 1987), pp. 3–5.

⁵⁵ IAEA, *Small and Medium Power Reactors: Project Initiation Study, Phase I*, IAEA-Tecdoc-347 (IAEA: Vienna, 1985); IAEA, *Promotion and Financing of Nuclear Power Programmes in Developing Countries* (IAEA: Vienna, 1987), pp. 30–32.

⁵⁶ For new research into new, inherently safe reactors compare *IAEA Bulletin*, vol. 31, no. 3 (1989), pp. 5–55.

not eligible for financing because of unviability only verifies the difficulties explained in the experts' study.⁵⁷

Loss of interest by the Third World may help explain the muted negative response to two failures to achieve global consensus on the conditions for peaceful co-operation on nuclear energy—the 1987 UN Conference on the Promotion of International Cooperation for the Peaceful Uses of Nuclear Energy (PUNE) and the IAEA Committee on the Assurances of Supply (CAS). PUNE, having been prepared for seven years, due, first, to dilatory tactics by the West and, later on, by diminishing interest on part of developing countries, was first created to counter perceived nuclear suppliers' collaboration against technology 'have-nots'. While PUNE provoked many interesting technical papers it failed on the issue of conditions for peaceful co-operation. The Group of Seventy-Seven (G-77) countries, led by India, Argentina and Brazil, would have preferred a document obliging suppliers to unconditional collaboration.⁵⁸ The industrial countries, in contrast, insisted on a clear link between the degree of non-proliferation commitment and the entitlement for unimpeded access to technology. This controversy, which prevented PUNE from reaching a final consensus, was also pre-eminent in CAS, another attempt to shape such a consensus during the course of seven years. CAS agreed on some promising proposals—including a scheme for the settlement of breached contracts, a back-up system for supplies in the event of interrupted contracts, regulations for amending current contracts and a standard of regulations for interstate shipment of nuclear material—but failed on the non-proliferation commitment which would entitle recipients to enjoy the advantages of these agreements.⁵⁹ Both forums clearly showed one of the basic weaknesses of the NPT: leadership within the developing world is exerted by countries which are non-parties to the Treaty, if not its outright enemies. The domination of this group over faithful NPT adherents hinders all NPT parties from shaping consensus on these issues by themselves without the interference of outsiders.

Nuclear co-operation on non-energy applications concerns geology, medicine, agriculture, material testing, irradiation of food, and basic research. On a bilateral basis, the expansion of research reactors must be noted. Bangladesh, Indonesia and Sri Lanka have all acquired research reactors under safeguards. Saudi Arabia contracted for the supply of two research reactors with an FRG firm. While nuclear energy is stagnating, the development of nuclear research goes on. A total of 325 research reactors are in operation throughout the world, including 41 units in 22 developing countries.

Under IAEA auspices, the technical assistance and co-operation budget has reached \$45.5 million, a remarkable growth from the \$35.9 million in

⁵⁷ IAEA, *Promotion and Financing of Nuclear Power Programmes in Developing Countries* (note 55); *Nucleonics Week*, vol. 30, no. 9 (2 Mar. 1989), p. 9.

⁵⁸ 'The Group of Seventy-Seven' is a term used to denote the developing countries acting as a bloc. The group originally consisted of 77 countries; it now contains many more.

⁵⁹ *ACR*, July 1987, p. 602.B.127; *Nucleonics Week*, vol. 28, no. 12 (19 Mar. 1987), pp. 11–12.

1984. In 1988 the IAEA supported 1009 projects, including 88 regional and interregional training programmes. It assigned 2023 experts and processed 3386 equipment purchases.⁶⁰ These activities are useful but limited, producing the permanent difficulty of a balance in the IAEA's budget and expenditure. The 'gentlemen's agreement', that expenditures on safeguards and technological co-operation should be comparable, is not possible on the basis of the regular budget alone. Co-operation projects have to be financed by extrabudgetary voluntary contributions. Beyond that, developed countries sometimes pick up projects which the IAEA would like but cannot afford to fund. These 'footnote a' projects are the best way to give privilege to NPT parties.⁶¹—the IAEA by itself is not permitted to do so—and several countries, for example, the USA and Canada, have been careful in tailoring their 'footnote a' contributions towards NPT members. Yet this advantage amounts to \$2–5 million per year at maximum, no large incentive. Even with expanded funds, however, the question would remain of how much investment in nuclear research and non-energy applications the Third World can absorb.

Whereas Article IV can be said to be implemented, parties derive too little satisfaction from this fact. Objective difficulties in making Article IV benefits an effective incentive for parties to regard the Treaty as beneficial, and the subjective problem of reaching agreement between developed and developing countries in forums where the G-77 is led by non-parties, prevent its true success. Budgetary restraint policy limits the remaining possibilities.

Article IV is not expected to cause as much trouble for the Review Conference as in the past. Complaints over trade restrictions and oligopoly abounded in 1980, but were muted by 1985. It is unlikely that the developing countries as a group will put great energy into such complaints. Several individual countries may well do so, however. Iran was denied research reactor fuel by the USA and had to turn to non-NPT Argentina for supplies. Since 1984 the FRG Government has refused to grant licences for 7000 tonnes of Trigger List⁶² equipment needed to complete the Busheer power plants and has dissuaded Siemens from resuming work as long as no peace treaty is signed with Iraq. Iran's misgivings may be mitigated by the recent understanding with the USSR for the sale of two power reactors. Iran strongly criticized this attitude at the 1989 IAEA General Conference and can be expected to repeat this in 1990.⁶³

⁶⁰ *IAEA News Features*, no. 4 (Sep. 1988); *IAEA Newsbrief*, vol. 4, no. 5 (June 1989), p. 1 and vol. 4, no. 6 (July/Aug. 1989), p. 1; *IAEA Bulletin*, vol. 31, no. 2 (1989), p. 48; compare also the articles in *IAEA Bulletin*, vol. 29, no. 1 (1987), pp. 5–25 and no. 2 (1987), pp. 5–32.

⁶¹ Projects deemed worthwhile by the Agency but for which no sufficient funds are available are listed in footnote a of the annual *IAEA Technical Co-operation Budget Document*.

⁶² The Trigger List is a list of items the export of which to a non-nuclear weapon state requires the application of safeguards on the plant in which it is used or on the material or processes used. It is only relevant to export to non-NPT states in this category. The original list was agreed in 1974; it has since been expanded and forms part of the 1977 London Suppliers' Guidelines (see appendix E).

⁶³ *Nucleonics Week*, vol. 30, no. 45 (9 Nov. 1989), p. 7; vol. 27, no. 44 (30 Oct. 1986), pp. 4–5.

Iraq may complain about its failed attempt to contract for a replacement for the Osiraq reactor, but since its partner, France, was a non-party this is outside the NPT context. Libya was the victim of Soviet foot-dragging over the supply of two reactors but, in the aftermath of the Chernobyl accident, decided it was no time to start a nuclear power programme. Otherwise there were no cases of denial; on the contrary, some important NPT parties acquired research reactors for the first time. The issue of technology denial should not loom large on the agenda. This also applies to the US pressure on Taiwan to refrain from reprocessing, but Taiwan will not be represented at the Conference. The problem of restricting reprocessing as far as possible ceased to be a North-South issue with the FRG decision not to proceed with the Wackersdorf commercial reprocessing plant and the reduction if not renouncement of plutonium recycling plans in Western countries. The London Guidelines stipulation to exert 'restraint' in the export of sensitive technology stands on firmer and more defensible ground.

While substantial issues are less controversial than in the past, the complaint of insufficient technology assistance may arise. The Egyptian project of a nuclear energy fund, discussed at the 1985 Review Conference, was not supported by the IAEA expert group study. The risk of losing the benefit side of the NPT bargain will certainly be expressed, and with some reason. It is time to consider additional incentives for Third World countries to regard this Treaty as beneficial to their interests.

There is little other possibility than to expand budgetary and voluntary contributions. One useful step would be for a group of developed parties such as the EC countries to declare, at the Conference, a sizeable growth in their voluntary contributions and their 'footnote a' grants to NPT parties. The Conference should also consider the possibility of giving the IAEA a stronger mandate to pursue non-nuclear energy options, and energy/environmental impact studies, now outside its purview but which are of growing importance to the developing world. The inclusion of other energy sources as a potential recipient of IAEA technical assistance would expand considerably the absorption potential even of the smaller developing countries, and thus raise the potential benefits to be derived from membership. It goes without saying that such assistance would have to be closely co-ordinated with other lending and assisting agencies as the World Bank, the International Development Association (IDA), the United Nations Development Programme and the United Nations Environmental Programme. A declaration of expanded energy assistance—which in the IAEA context would need to be a relatively modest amount to make a difference—would be all the more high-profile in the presence of serious Third World concern about an across-the-board cut in development aid in favour of assistance to reforming Eastern Europe.

A second area where help should and could be expanded—and which should receive special attention during the Review Conference in 1990—is nuclear safety. As the appalling case of a radioactive source found in a waste-disposal site in Brazil signals, even in developing countries with an

advanced nuclear industry there are inherent problems of safety assessment and administration. As more countries enter research and non-energy application programmes, increasing assistance will be needed in this field.⁶⁴

Finally, the Conference should concern itself with regional co-operation including non-parties, which holds a potential to mitigate nuclear rivalries and mutual fear and to build some confidence even in the absence of NPT membership. The Conference could take note of this possibility and appeal to outsiders to use this opportunity in this way. The IAEA should be requested to assist such regional co-operation activities as best as it can. The present IAEA plan to expand regional and interregional projects from 15 to more than 25 per cent of the technical assistance programme is commendable in this respect.⁶⁵

Article V

Article V provides for peaceful nuclear explosion (PNE) services by the nuclear weapon states to non-nuclear weapon states under international supervision. It was the outgrowth of nuclear euphoria towards the end of the 1960s which included the purported benefits of PNEs for mining, large construction projects such as channels, secondary oil and gas production, and expanding sub-surface caverns for the storage of natural gas. The prospects for these activities heavily pushed at the time by the ambitious US Atomic Energy Commission, faded quickly. The PNE Project Plowshare was abandoned by Washington in 1972. The IAEA received initial requests for information on PNEs by Czechoslovakia, Romania and Madagascar between 1971 and 1974, but after a few years this interest died. An *ad hoc* group of experts expressed polite scepticism in a report published through the IAEA in 1977.⁶⁶ Only the USSR has conducted a few PNEs each year. Whereas in 1988 the Soviet delegate to the annual meeting of OPANAL (Agency for the Prohibition of Nuclear Weapons in Latin America) praised the merits of the PNE programme, the USSR has repeatedly declared its willingness to cease PNEs in the context of a comprehensive test ban treaty (CTBT). Although the present status of the Soviet PNE programme is unclear, given the growing protests within the USSR against the use of nuclear power and against testing,⁶⁷ it is not too risky to predict the end of Soviet PNEs in the near future, even in the absence of a CTBT. The main arguments against PNEs are cost and radiological safety concerns. If these apply in an industrial country like the USA, they weigh all the heavier in developing countries without an adequate safety infrastructure.⁶⁸

⁶⁴ Compare IAEA Press Release, 87/32, 15 Oct. 1987 and 87/40, 1 Dec. 1987.

⁶⁵ IAEA Newsbrief, vol. 3, no. 10 (Dec. 1988).

⁶⁶ Findlay, T., 'Peaceful nuclear explosions and the NPT: letting a dead letter lie', Paper presented to the PPNN Core Group Meeting, 18-19 Nov. 1989, Baden, Austria.

⁶⁷ See also Ferm, R., 'Nuclear explosions', SIPRI, *SIPRI Yearbook 1990: World Armaments and Disarmament* (Oxford University Press: Oxford, 1990), chapter 2.

⁶⁸ Findlay (note 66).

Article V is basically meaningless for the real world. It is certainly not a matter of controversy and has no impact on the forthcoming Review Conference; but while the civilian benefits of PNEs are in all likelihood a pie-in-the-sky, the existence of Article V can and has been used by non-parties (Argentina and Brazil) as an argument that PNEs are a serious option, legitimizing their refusal to renounce them. This unwelcome effect of Article V has led many people to propose that it be abandoned. However, its removal would mean setting out on the long road of Treaty amendment. Once this road is open, other amendments may be considered as well. Since the Treaty is, for legal and practical reasons, almost unamendable (see Article X below), starting this process would mean trouble and controversy which, in the end, would hurt the Treaty more than support it. Article V is certainly not worth this trouble.

Rather than removing Article V, which would open the door for further amendments, a frank discussion about the questionable value of PNEs would be preferable. A Soviet statement announcing the end of the PNE programme in the USSR would be a great help. If the Conference could resolve to declare that no benefit is to be derived from PNEs in the foreseeable future and that unwillingness to renounce PNEs is a matter of political concern, such a consensus would be more realistic and certainly more helpful politically in discussions with non-members than futile attempts to amend the Treaty.

Article VI

In Article VI all parties, nuclear as well as non-nuclear weapon states, commit themselves to faithful negotiations towards nuclear and complete and comprehensive disarmament. No issue, besides regional conflicts, has such a potential for causing controversy at the 1990 Review Conference. Lack of implementation of Article VI by the superpowers made it hard to reach consensus in 1975, wrecked the final document in 1980 and necessitated the most inventive diplomatic language—permitting parties to disagree on one point in the framework of a consensus—in 1985.⁶⁹

Non-nuclear weapon states, notably developing countries, view Article VI as the only major concession by the nuclear weapon states to compensate for the renouncement of the most powerful weapons by the non-nuclear weapon states. Article VI is part of a basic bargain: failure to realize its promise thus opens the question for many countries of whether the bargain is worth maintaining. For many Third World countries, the substance of Article VI is identical to a ban on nuclear weapon tests—an erroneous but powerful interpretation.

Basically, Article VI must be understood in the context of the Preamble to the Treaty. The Preamble poses disarmament in the context of preventing nuclear war, and of removing the causes of distrust among countries and creating confidence instead. It quotes the CTBT as the example most in the

⁶⁹ Fischer and Müller (note 2), pp. 23–29.

minds of the parties when the Treaty was negotiated, but it is not the only measure to prevent nuclear war, to dispel the causes of distrust and of arms races and to effect disarmament. Thus, the 1985 Review Conference, for example, noted stability as an important standard against which disarmament steps must be measured. A comprehensive analysis of the Preamble and Article VI show that an assessment of implementation must examine a number of aspects. How have the different aspects of disarmament been fulfilled since 1985?⁷⁰

1. *Measures to improve crisis stability and prevent nuclear escalation.* In 1987 the USA and the USSR agreed to install nuclear risk reduction centres to permit quick and undisturbed communication, the exchange of information and assessment, and independent evaluation of the other side's position.⁷¹ The mandate of these centres was soon extended to cover collaboration of nuclear-related terrorism, a potential source of 'catalytic escalation'. Since 1988 a new agreement obliges each superpower to notify the other of ballistic missile test plans, including range and direction of tested devices.⁷² An agreement to avoid incidents emerging from operations on land, including brief border operations, was added in the same year,⁷³ comparable to the highly successful 1972 US-Soviet Incidents at Sea Agreement.⁷⁴ In 1989 the exchange of information on bomber alerts and exercises was also agreed.⁷⁵ Together with measures already in place, these new steps virtually eliminate the possibility of local incidents escalating to a world-wide nuclear war.

2. *Measures to create confidence among the parties.* Confidence building is naturally served by the above measures. The main measure to achieve this goal was, however, the 1986 Stockholm Document, creating a precise advance calendar for major exercises and providing for observation and *ad hoc* inspection.⁷⁶ The heavily militarized region of Central Europe, with the greatest density of deployed nuclear weapons, has become that much more

⁷⁰ Progress on disarmament is documented in more detail in *SIPRI Yearbook 1990* (note 67): for progress towards a START treaty see chapter 11; for the implementation of the INF Treaty up to 31 December 1989 see chapter 12; for the progress of the CFE Negotiation see chapter 13; for negotiations on a chemical weapons convention see chapter 14; and for details on nuclear test talks and progress towards PNET and TTBT ratification, see chapter 15.

⁷¹ Agreement between the United States of America and the Union of Soviet Socialist Republics on the Establishment of Nuclear Risk Reduction Centers. The agreement is reproduced in SIPRI, *SIPRI Yearbook 1988: World Armaments and Disarmament* (Oxford University Press: Oxford, 1988), appendix 13E, pp. 486-89.

⁷² Agreement between the United States of America and the Union of Soviet Socialist Republics on Notifications of Launches of Intercontinental Ballistic Missiles and Submarine-Launched Ballistic Missiles, reproduced as appendix 1A in *SIPRI Yearbook 1989* (note 40), pp. 46-47.

⁷³ *International Herald Tribune*, 8 June 1989, pp. 1 and 8.

⁷⁴ Agreement between the USA and the USSR concerning the Prevention of Incidents on and over the High Seas, reproduced in Fieldhouse, R. (ed.), *SIPRI, Security at Sea: Naval Forces and Arms Control* (Oxford University Press: Oxford, 1990), appendix B, pp. 256-58.

⁷⁵ Agreement Between the Government of the Union of Soviet Socialist Republics and the Government of the United States of America on Reciprocal Advance Notification of Major Strategic Exercises; see *Department of State Bulletin*, Nov. 1989, pp. 20-21.

⁷⁶ The Stockholm Document is reproduced in SIPRI, *SIPRI Yearbook 1987: World Armaments and Disarmament* (Oxford University Press: Oxford, 1987), appendix 10A, pp. 355-69.

transparent through these measures, with the welcome corollary that the risks of nuclear escalation are reduced.

3. *Measures to remove the potential causes of armed conflict.* Hand-in-hand with these developments went the removal of possible reasons for the superpowers to go to war against each other. Mutual consultation on regional issues has been accelerated and intensified. The results are visible in the termination or scaling down of some armed conflicts in the world and the prospects of negotiated solutions in some other cases (Southern Africa, the Gulf War, South-East Asia and Afghanistan).⁷⁷ In Europe the thought of a violent clash between the blocs has become all but unthinkable after the reforms in Eastern Europe and the extreme tolerance of the USSR towards these changes.

4. *Measures to reduce nuclear arsenals.* For the first time in history, a category of nuclear weapons, intermediate-range nuclear forces, is being completely eliminated as a consequence of the 1987 INF Treaty. The complete count, including reloading missiles, spares, and training devices, comes to more than 3500 units, or about 5 per cent of world-wide arsenals. Moreover, because of the special characteristics of these weapons—forward deployment, short flight-time, high accuracy, and the capability to attack time-critical targets—they possess an inherent characteristic of crisis instability. The physical destruction of missiles and launchers is on schedule and the stipulations of the agreements are being duly observed by each side. The only shortcoming of the agreement is that the fissile material contained in the warheads, as well as guidance electronics, are free for military reuse. This inconsequence, however, should not detract from the merits of the agreement in Article VI terms; it is the first visible sign that the direction of the nuclear arms race may be reversible.

Negotiations on a START treaty have been progressing well and have been accelerated since the 1989 Malta summit meeting. A nominal reduction of 50 per cent, a real reduction by maybe 40 per cent (because of certain counting rules for bomber-carried weapons) would be a remarkable cut in warhead arsenals, eliminating as much as 8000 to 10 000 weapons. Even though a significant overkill would still remain, such reductions would be an outstanding step towards fulfilling Article VI commitments. It would also serve the goal of stability as some of the most threatening first-strike weapons, such as highly accurate MIRVed land-based missiles, would have to take a disproportionate share of the cuts. Recently, a preliminary agreement appears to be emerging on nuclear sea-launched cruise missiles. One possibility for circumventing a START agreement will thus be closed, making sure that what is eliminated in one category will not turn up in another category of nuclear weapons. There are also plans to begin talks on short-range nuclear forces (SNF) after the conclusion of a CFE agreement. Some categories of SNF platform are already indirectly included in the CFE talks: namely, artillery pieces (some of which are dual-capable) and fighter-

⁷⁷ For a report on ongoing armed conflicts in 1989, see *SIPRI Yearbook 1990* (note 67), chapter 10.

bomber aircraft. The prospect of major reductions in these categories will presumably be followed by the withdrawal of a large number of nuclear warheads; it is already virtually incredible that NATO will pursue its previous goal of modernization of the short-range Lance missile, and popular pressure in Eastern Europe will demand the removal of the respective Soviet systems.⁷⁸

5. *Measures to move towards complete and comprehensive disarmament.* The CFE Negotiation in Vienna is making rapid progress and the conclusion of a treaty is likely in 1990. A second phase, including further reductions and a restructuring towards more defensive structures, is in principle agreed upon. Negotiations on a chemical weapons convention (CWC) are making slow but steady progress; the main obstacle may not be the superpowers in this case, but some Third World states.

6. *Measures to stop nuclear testing.* The protocols to the 1974 Threshold Test Ban Treaty (TTBT) and the 1976 Peaceful Nuclear Explosions Treaty (PNET) are now being finalized and prepared for ratification. Perhaps more important were the unprecedented mutual observation and measurement activities which took place at the US and Soviet test sites in 1988.⁷⁹ These events may well be the first step towards further limits on testing, since the chances of getting adequate verification systems quickly are greatly enhanced. A lower threshold and a quantitative quota on yearly tests are possible, given greater readiness by the USA to consider such steps. A comprehensive test ban, however, is not on the cards for the time being, as the US and British governments remain firmly opposed. The small positive steps in the testing field are thus counteracted by a stagnation in the major issue.

Clearly the nuclear weapon states can present an unprecedented record on Article VI. Not even in 1975, at the height of the first *détente* period, was such an impressive array of arms control and disarmament achievements at hand. To compound this success there are prospects for further progress once the present negotiations are concluded. While the prospects for complete nuclear disarmament are not bright for the immediate future, the chance of considerable reductions is good. More important, the probability of a nuclear war is the lowest since 1945. Given the fact that the first and foremost purpose of the NPT is to contribute to the prevention of nuclear war and that all articles must be seen in this light, the progress made under Article VI is certainly the most important and significant change between 1985 and 1990. This record not only concerns the two superpowers. It involves most of their allies, which participated directly (the FRG by renouncing possession of the Pershing 1A nuclear-capable missile⁸⁰) or indirectly in the INF negotiations and are direct participants in the CFE and CSBM

⁷⁸ See *SIPRI Yearbook 1990* (note 67), chapter 18.

⁷⁹ The US-Soviet Joint Verification Experiment is discussed by Ferm, R., 'Nuclear explosions', *SIPRI Yearbook 1989* (note 40), chapter 2, pp. 52-55, and the text of the agreement is given in appendix 2B of the same volume.

⁸⁰ Risse-Kappen, T., *The Zero Option: INF, West Germany and Arms Control* (Westview Press: Boulder, Colo., 1988).

negotiations. Article VI obliges not only nuclear weapon states but all states parties to engage faithfully in negotiations, not only towards nuclear but also towards comprehensive and general disarmament.

Despite this good record the lack of serious progress towards a CTBT is a bone of contention. The CTBT was at the centre of non-nuclear weapon states' criticism of the superpowers in 1985 and remains the disarmament measure on which many minds in developing countries remain focused. There is particular embitterment because it is the only nuclear arms control measure discussed in a multilateral forum, the Geneva Conference on Disarmament (CD), and is handled disdainfully by the Western nuclear powers. Third World countries—but also some industrialized CD participants—cannot fail to note the condescension with which they are treated, despite the fact that Article VI of the NPT obliges them to participate, at least in some way, in nuclear disarmament. It is unnerving for these parties that even their efforts to install a mandate for preparing a draft treaty (which could go on for years) have amounted to nothing because of Western resistance. This constellation does not help to judge the issue of a CTBT on its own merits. The impression of disinterest by the major Western powers in multilateral disarmament has been greatly strengthened by the neglectful conduct of the USA during UNSSD III in 1988; failure to reach consensus on a final document was widely ascribed to needless US intransigence.⁸¹ However, while the connection of a CTBT to the NPT is a special one—it is the only arms control measure mentioned explicitly in the Treaty—its impact on the course of disarmament as such is limited. It is precisely for this reason that so many experts agree that it is feasible. A CTBT would impede and possibly prevent the emergence of new types of nuclear weapon, predominantly directed-energy weapons. It would also have the non-negligible side benefit of terminating the ecological risks related to continued underground testing. However, it would neither make a significant contribution to stability nor reduce the number of weapons in place; arguments by the military and the weapon designers in the USA and the UK that arsenals would decay without reliability testing are not convincing in the light of testimony and evidence to the contrary. While this evidence suggests that a CTBT is not out of reach for military reasons, it also makes it less significant as a disarmament measure. Therefore, while it is legitimate to criticize the failure to even negotiate on the matter, and to press forcefully for a CTBT, it makes little sense to hinge the fate of the Non-Proliferation Treaty on this single disarmament measure which is of some, but not of overwhelming importance to the course of disarmament.⁸² The argument cuts both ways, however. The US refusal to enter further talks on testing limitation is unjustified. If the report is correct that a high-ranking US official has indicated that the USA would cease to support the extension of the NPT after 1995 if a link were established between this extension and an

⁸¹ *PPNN Newsbrief*, no. 2 (July 1988), p. 2.

⁸² For the background to the CTBT debate see Goldblat, J. and Cox, D. (eds), *SIPRI, Nuclear Weapon Tests: Prohibition or Limitation?* (Oxford University Press: Oxford, 1988).

end to testing,⁸³ this would also set wrong priorities, given the marginal contribution of further testing to US security.

Because of this evaluation of the CTBT, Article VI contains an explosive potential for the 1990 Review Conference, compounded by the initiative of the Parliamentarians for Global Action to persuade parties to the Partial Test Ban Treaty (PTBT) to ask for an amendment conference.⁸⁴ The PTBT contains a clause opening the possibility for amendments binding all parties once a majority of parties, including the three original signatories—the USA, the USSR and the UK—take a decision. The possibility of extending the PTBT into a CTBT by amendment underlies the efforts to convene an amendment conference, a move supported by several important Third World states, including Egypt, Peru, Indonesia and Mexico, all very important NPT parties in their respective regions.

The prospects for a successful amendment conference are nil. Two of the three powers endowed with a veto right are opposed, so an amendment is impossible. It is questionable whether the intention of some of the well-meaning initiators—to have a frank discussion on all aspects of the issue with the possibility to agree on a CD mandate later on, clearing the air and steering the participants towards better mutual understanding—can be realized under these circumstances. The presence of some parties which may be tempted to use the occasion to stir trouble for the NPT bodes ill for consensus building.

Another matter for concern is the lack of attention devoted to disarmament progress in the Third World. It seems that the INF Treaty, greeted with so much relief in Europe, was almost ignored or else seen as unimportant in the Third World. The series of measures for the prevention of nuclear war were hardly noticed. The connection of confidence building and conventional arms control to the NPT, although clearly defined in the text of the Treaty, are not widely realized. It is an astonishing political reality that bilateral or bloc-to-bloc negotiations in Europe largely escape attention, let alone a correct and thorough evaluation, in other parts of the world.

Thus there is a considerable danger that there will be a clash along the North-South axis on the issue of disarmament for the single reason of the lack of a CTBT. The USSR is unlikely to side with the Third World; it will rather try to take a mediating position. Yet on the question of whether the nuclear weapon states have to present a good Article VI record, in all probability the 'Northern' world will stick together this time.

There is even some possibility of a counter-attack. US officials have grown increasingly angry at what they perceive to be hypocritical criticism of a strongly improved record and are likely to ask Third World countries what they have done to live up to their Article VI obligations. They can point to the spread of ballistic missiles, to reluctance to agree to a CWC and to the buildup of conventional arms even under conditions of a serious debt

⁸³ ACR, Nov. 1989, p. 706.B.19.

⁸⁴ Dhanapala, J., 'Article VI and the PTBT amendment proposal', Paper presented to the PPNN Core Group meeting, 18-19 Nov. 1989, Baden, Austria.

crisis in the South. There is some truth in this analysis but it would certainly not steer the Review Conference towards an agreement if the Article VI discussion were to end in a dispute over who has fared worse, North or South, on disarmament.

The conference would be greatly helped if a START treaty were already signed and if the superpowers had agreed on a framework mandate for follow-up talks on strategic arms reduction. It would also make sense, after the unforeseen changes in Eastern Europe in late 1989, to start negotiations on short-range nuclear forces immediately after the CFE. Some movement will be needed on the nuclear testing issue. If the USSR, the USA and the UK could decide to start talks not on a complete test ban, but on further constraints, this can be presented as an intermediate step towards a test ban. At the same time, it would be appropriate to give the CD a task in this context. A carefully circumscribed mandate for studying the framework of a CTBT, and for starting with the construction of a verification system, would be a compromise offer which many in the developing world would justifiably welcome. It would be particularly unhelpful if the USA continues to vote against even studying interim verification measures and the setting up of an international seismic monitoring network.⁸⁵

Such modest steps would not remove criticism of the stubborn objections to a test ban. This criticism will understandably and justifiably not cease unless a test ban comes into force, but the compromise would signal willingness on the part of the Western powers to listen to the disarmament wishes of non-nuclear weapon states and to meet them half-way. Those parties might in turn accept the good record on disarmament. It would also be great progress for the 1995 Extension Conference, if the Review Conference could open the way to a better understanding of priorities in nuclear disarmament and the (albeit limited) role a CTBT can play in this framework.

Article VII

Article VII confirms the right of parties to set up nuclear weapon-free zones in their regions. In the past NWFZ issues have been confined to a propaganda struggle between the East (pushing its various NWFZ proposals for Europe against the requirements of NATO's flexible response strategy) and the West (struggling to reject WTO proposals so as not to endanger alliance unity).⁸⁶ However, the issue is increasingly likely to open more substantial conflicts along the North-South fault line, with the Western nuclear weapon states as the main targets for criticism.

The Tlatelolco Treaty and the Rarotonga Treaty establish NWFZs in Latin America and the South Pacific, respectively.⁸⁷ The Tlatelolco Treaty is in force for 23 states, all parties to the NPT. It is not in force for four major states: Argentina, Brazil, Chile or Cuba. All the nuclear weapon states have

⁸⁵ *ACR*, Feb. 1988, p. 608.B.151.

⁸⁶ Fischer and Müller (note 2), pp. 23-24, 27.

⁸⁷ For the list of parties see appendix B.

ratified Protocol II (requesting respect for the rules of the Treaty and abstention from threats against the zone), although all but China with major qualifications. France is the only external state with territorial possessions in the region not to ratify Protocol I, which applies the nuclear-free status to territories under foreign rule; France claims constitutional difficulties in denying its Latin American territories (constitutionally part of France) the rights to security that the motherland enjoys.

The Treaty of Rarotonga is in force for 11 of 13 possible parties. Two of the three protocols to be signed by nuclear weapon states have attracted signature and ratification of only China and the USSR. France refuses to sign: it would mean the end of French nuclear tests in the region. Although the parties took great pains to meet US interests, the USA has claimed incompatibility of the Treaty's stipulation with its nuclear deterrence strategy, and the UK appears to be unwilling to sign mainly out of solidarity with the two other Western powers.⁸⁸

There have been serious talks on the creation of a NWFZ in the ASEAN (Association of South East Asian Nations) region. More conservative states, such as Singapore, have reservations about excluding US nuclear weapons from the region because of the Soviet base at Cam Ranh Bay, the proximity of China and, perhaps, India and the ambitions of Viet Nam. It remains to be seen whether this attitude will change after the announced Soviet withdrawal from Cam Ranh. Others are more willing to go ahead, and the Philippines see a good chance to get rid of US nuclear weapons in a multilateral agreement without risking a face-to-face show-down with their mighty ally. The US Government has repeatedly and strongly voiced its objections to such a zone on strategic grounds. It has made it clear to the ASEAN nations that it sees the establishment of such a zone as contrary to its national interest, and that pursuing the idea further would jeopardize US protection for the states concerned.

NWFZ proposals in areas of regional conflict where threshold countries are located have so far failed to offer a way out of the nuclear danger. In the Middle East and South Asia, the NWFZ concept has become an instrument in the ongoing propaganda war, and in Africa it has so far failed to attract South African attention. In Europe proposals for NWFZs in the northern region, in the Baltic, along the Central Front and in the Balkans have so far failed because of the different alliance strategies. As long as NATO had to plan to counter a massive conventional attack by tactical nuclear means, a NWFZ was clearly counter to its strategic concepts. With the landmark changes in Eastern Europe and the disappearance of a conventional threat through the CFE Negotiation, NATO will reconsider its own military strategy and the residual role of nuclear weapons. It may discover a genuine interest in nuclear weapon-free corridors if not zones; the strong anti-nuclear mood in FR Germany may lead the government to silent or outspoken support for such concepts; and East European states may see a good chance to

⁸⁸ ACR, July 1987, pp. 456.B.68-69; ACR, May 1987, p. 456.B.64.

reduce further Soviet presence in their territories, a goal certainly supported by some West Europeans. Some may also see in such a zone a further instrument to maintain the non-nuclear status of a united Germany. It is unlikely that this shift will come before the 1990 Review Conference, but the long-term trend may well give Article VII a higher profile in the future, and may prove quite divisive within the Western group of countries.

In 1990, however, trouble will arise from the claims of developing Tlatelolco, Rarotonga and ASEAN countries that the behaviour of Western nuclear weapon states deprives them of their rights under Article VII. It is likely that these claims will be weakest from the parties to the Tlatelolco Treaty; the loudest accusations come from Argentina, not an NPT party. The target of the accusations is the UK, reported to have introduced nuclear weapon-carrying ships during the Falklands/Malvinas War, and suspected of rotating ships carrying nuclear weapons between the homeland and the Falklands/Malvinas garrison.

Parties to the Rarotonga Treaty will complain of the refusal of the three Western nuclear weapon states to sign the Protocols. The Treaty grants transit rights and the Australian Government in particular took great pains to make the language agreeable to the USA and the UK. The objections of these two depositary states of the NPT come close to denying the countries in the region their Article VII right to establish a nuclear weapon-free zone. The same applies to those ASEAN nations interested in a NWFZ. The harsh warnings by Washington are also contrary to the Article VII prerogatives of the regional powers. Within the *Ad hoc* committee on the Indian Ocean as a zone of peace it was only the Western nuclear weapon states who objected to the nuclear-free principle. US pressures on individual countries (Palau and New Zealand) to change non-nuclear preferences, while certainly complying with strategic requirements, are not reassuring in the NPT context.⁸⁹

Two very fundamental questions must be answered:

1. What happens when the national interests of small regional states clash with the strategic interests of states with global commitments?⁹⁰ The USA and to a lesser degree the UK have maintained alliances far from their own borders and have thus been obliged to be prepared to rally to their allies' assistance over great distances. Freedom of the high seas and the unimpeded movement of armed forces have been essential for the protection of allies. Protecting the innocent, of course, is a good excuse which overrules the quietist desire of regional states to be left alone as far as nuclear weapons are concerned. When the main threat disappears, however, the ethical justification for this kind of intrusive movement is devalued and the legitimate interests of countries in 'transit regions' deserve a second hearing.

⁸⁹ ACR, Dec. 1988, p. 456.B.82; *New York Times*, 7 Aug. 1987; ACR, Sep. 1989, pp. 456.B.8, 458.B.31-32; ACR, Mar. 1989, pp. 458.B.27-28; ACR, June 1989, p. 503.B.62.

⁹⁰ See Krohn, A., *Nuklearwaffenfreie Zone: Regionales Disengagement unter der Rahmenbedingung globaler Großmachtinteressen* (Nomos: Baden-Baden, 1989); and Fieldhouse (note 74).

2. Is the operational principle of some Western navies compatible with Article VII? Denuclearization of regional zones runs contrary to the principle of nuclear-armed navies of neither confirming nor denying the presence of nuclear weapons aboard their ships and contradicts the principles of freedom of passage and transit through territorial waters which are established by international law.⁹¹ This clash became visible with New Zealand's objections to port visits by nuclear-armed ships. Rather than break with tradition and disclose which ships were not armed with nuclear weapons, the USA abandoned its defence relationship with New Zealand. The NWFZ issue puts this conflict in a broader context. By establishing NWFZs, regional powers pursue several objectives: to support the non-proliferation principle by adding a regional layer to the system, to reduce the danger of becoming a nuclear target, in some cases to diminish superpower presence, and finally to assert national sovereignty through an action of collective solidarity. These interests are as legitimate as those of a nuclear weapon state and they gain legitimacy by being applied to territory close to home. If the operational principle of Western navies makes it impossible even to consider recognition of those interests, then it must be asked whether this principle is compatible with a non-proliferation regime that contains Article VII of the NPT. Is it not this operational principle that must be changed rather than the legal rights of the countries negated? The insistence on narrow military perspectives in a world in which the main rationale for such perspectives has dramatically changed is a definite danger to the non-proliferation regime. The discriminatory character of the regime is tenable only if it remains at a minimum. Direct objections raised against the very principle of the NWFZ by the US Government⁹² leave countries in such zones—or in prospective zones—with the feeling that nuclear weapon states are not willing to sacrifice some minor privileges even where relatively small costs are involved. This connection of the NWFZ issue with the very character of the regime and the NPT will give it greater weight in 1990, and presumably in 1995, than it has possessed in the past. Finally, the direct implications of the NPT for regional interests are remote for many countries. NWFZs are a way to make the NPT more directly relevant to national security interests and thereby to create stronger support for the survival of the regime. If this attempt fails because of intransigence by the nuclear weapon states the support may be replaced by cynicism. The Western nuclear weapon states would be well advised to take the misgivings over Article VII very seriously, even though most of the countries voicing them will be among the smaller members of the family of nations.⁹³

⁹¹ Byers, R. B., 'Sea power, nuclear weapons and arms control', and Dunn, D. J., 'NATO navies and arms control', both in ed. R. B. Byers, *The Denuclearization of the Ocean* (Croom Helm: London, 1986), pp. 167–68 and 187–296, respectively.

⁹² ACR, Sep. 1988, p. 456.B.78.

⁹³ For a critical account see Fujita, E., *The Prevention of Geographical Proliferation of Nuclear Weapons: Nuclear Weapon Free Zones and Zones of Peace in the Southern Hemisphere* (UNIDIR: Geneva, Apr. 1989).

First, the USA should revoke its principle objections against the zone approach and underline the right of nations to engage in the establishment of NWFZs, depending on the merits of the approach in the respective region. Given the present plans for a retrenchment in the Pacific, based on the possibility that the US bases in the Philippines will be closed, this should be easier than in the past. Second, the USA and the UK should review their past decision not to sign the Rarotonga Treaty; this would put France in a spot, but for the time being France does not have the same obligations towards the NPT as the other two Western nuclear weapon states. In the long run it is likely that a policy of testing nuclear weapons far from one's own territory will not be tenable anyway. Third, the neither-confirm-nor-deny principle should be re-evaluated, and navy staffs should be ordered to draft operational plans under the assumption that no such principle existed; this is not equivalent to abolishing this principle at once, but it shows a degree of good will and will prove a reasonable preparation for the inevitable. Fourth, the nuclear weapon states should agree to discuss constraints on naval movements to the degree needed to respect the NWFZ.

Such decisions would be greeted with apprehension by non-nuclear weapon states pretending to keep their territory nuclear weapon-free while enjoying the nuclear umbrella provided by their alliances, but the right of countries to enact Article VII must take precedence over the luxury of conducting two contradictory policies simultaneously for the sole purpose of silencing domestic anti-nuclear opposition. As a positive side-effect, naval arms control would become much easier and the non-proliferation regime would in turn profit.

Article VIII

Article VIII of the NPT contains the rules for changing the Treaty. A purely procedural stipulation, Article VIII is of growing importance as the crucial year 1995 and the NPT Extension Conference are approached. It is thus appropriate to take a closer look at the substance of the Article.

Each party has the right to forward any proposed amendment to the depositaries who are obliged to circulate it to all parties. If so requested by at least one-third of the parties to the Treaty, the depositaries must convene an amendment conference at which the amendment must be approved by a majority of the parties to the Treaty (to include all nuclear weapon states parties and all non-nuclear weapon states parties which, at the time of circulation of the amendment, are members of the IAEA Board of Governors). The same quorum is required for ratification. In other words, the Treaty is virtually unamendable and it could be suspected that this was exactly the intention of its drafters.

If an amendment process were started by some parties, however, it would undeniably be both cumbersome and divisive. Article VIII contains no time limits for the various procedures, so it could be an enormously protracted act. The precarious balance between the various interests which the Treaty

represents makes it unlikely that a consensus could easily be formed on any change. Disputing amendments would inevitably weaken loyalty to the Treaty as it stands and lead to a dangerous erosion of Treaty support.

The basic complaints to have emerged over the past 20 years all concern implementation rather than substance. If relationships with threshold countries were unambiguous, if nuclear and other energy co-operation yielded tangible benefits to developing countries, if disarmament were going on in a steady fashion and if NWFZs were respected, there would be reason to believe that no basic changes to the Treaty would be proposed—except by non-parties for whom alleged shortcomings in the Treaty provide the excuse not to join.

If the main supporters of the Treaty want to avoid amendment debates, then they should see to it that the NPT is implemented well. Since complaints are usually voiced against the depositary powers themselves, their policy is the key to the future stability of the Treaty. This reasoning gains weight in view of 1995: there is a distinct danger that this critical date will tempt some parties to try to change the NPT.

Nigeria has already aired the idea of a protocol on negative security assurances. Such considerations will be based on quite legitimate concerns that the Treaty has not worked too well in this regard. The already difficult task of the 1995 Extension Conference will become unmanageable if it must also serve as an amendment conference. The 1990 Review Conference is thus an appropriate occasion for a double strategy: to address straightforwardly the dissatisfaction of some parties by taking them seriously and promising remedy; and by initiating a campaign against changes in the Treaty.⁹⁴

Article IX

The accession and membership issue may become a difficult one because of two regional conflicts. The first problem is connected to South Africa. South African accession to the NPT appears far more possible today than it did a few years ago. When former President P. W. Botha announced negotiations on NPT membership in 1987, this was widely perceived as a ploy to avoid expulsion from the IAEA. Under the F. W. de Klerk Government, however, the hardliners in the military have lost ground. The depositary powers are encouraged that Pretoria is seriously exploring the possibility of accession. In this case, however, South Africa would wish to be granted some advantages, such as a guarantee against suspension of IAEA membership rights and the promise of new nuclear supplies—in other words, to be treated as a normal state in the field of civilian nuclear energy. By implication, this

⁹⁴ Compare Fischer, D., 'The 1995 Nuclear Non-Proliferation Treaty Extension Conference: issues and prospects' and Müller, H., 'Smoothing the path to 1995: amending the Nuclear Non-Proliferation Treaty and enhancing the regime', in ed. J. Simpson, *Nuclear Non-Proliferation: An Agenda for the 1990s* (Cambridge University Press: Cambridge, Mass., 1987), pp. 155–64 and 123–36, respectively.

would mean the right to take a seat at the NPT Review Conference, should Pretoria deposit its instruments of ratification before that event.

The objections of Black African countries to the *apartheid* regime, however, mean that they cannot be expected to welcome South Africa at the Conference. A heavy fight over credentials can be expected, if domestic reform does not accompany accession—not an impossible, but an unlikely prospect within the time available. Denying a member the right to sit in the Conference is illegal; Western countries—perhaps also the USSR—would therefore be likely to argue for South African credentials. This would be a divisive development which could exacerbate more germane debates during the Conference.

A second problem is the status of the Palestine Liberation Organization (PLO). With the support of Arab states, the PLO has applied for full membership of different international organizations as the state of Palestine. It is quite possible that the PLO will seek admission as observer under the label of Palestine. The USA would fight vehemently against such a decision. The situation would be compounded if the PLO decided to deposit its instruments of ratification with the Soviet Union. The USSR would be trapped between its good relationship with the Arab countries and its responsibility to steer the NPT through smooth waters. If it accepted PLO ratification, the Review Conference could well arrive at a stalemate over a purely procedural issue, since the USA would never accept Palestine as a party; under present legislation, the US delegation would be forced to walk out of the Conference. If Moscow refuses acceptance, this would be the painful precedent of a prospective party being refused accession and could seriously alienate part of the Arab world. Hence, one can only hope that the situation is avoided by Arab prudence and wisdom.

There are possible solutions for both problems. For South Africa, the best situation would be to announce accession immediately before the Conference and to deposit the instruments of ratification immediately afterwards, that is, before the IAEA General Conference meets in Vienna. There would then be five years to work on reforms within South Africa that would meet Black African demands for changing the *apartheid* regime. Without progress towards domestic justice, however, South African accession will pose serious troubles for 1995: maybe more troubles than benefits would be derived from a threshold state becoming a party. The PLO problem could then perhaps be removed by a compromise recently reached during the IAEA General Conference (the PLO was admitted as Palestine, but still filed as an international organization, not as a state).

Article X

Article X contains two important stipulations. First, it permits parties to withdraw on three months' advance notice if superior national interests related to the substance matter of the Treaty force them to. This article has drawn criticism, mainly from people unfamiliar with international law

which permits under the principle of *rebus sic stantibus* the revocation of contractual commitments under extreme circumstances. Article X is rather restrictive compared with this wider principle, in that it prescribes a specific time limit and a specific connection to the Treaty's substance, as well as a specific procedure—parties must explain to other parties and the UN Security Council the factors that have precipitated the decision to withdraw.

No party has thus far used this clause to leave the Treaty and there is no immediate sign that this would occur. Yet there have been some rumours that the unfettered development of the Israeli nuclear weapon capability has compelled several Arab leaders to look very carefully at the meaning of Article X. It is a question indeed at what point the continuation of the Israeli programme would present a change compared to the status at the time of ratification or accession by major Arab countries. There is no immediate prospect of withdrawal, but the mere possibility would recommend stronger efforts by the depositaries to at least think hard about concepts and actions to remedy the situation in the Middle East. It is unlikely that five more years of passivity will prepare the ground well for Arab support for an extension of the Treaty, or continued membership, after 1995.

The Extension Conference is the second stipulation of Article X. Contrary to popular interpretations, the Treaty does not terminate in 1995. The Extension Conference has a mandate to decide on the length of extension, not on termination. Of course, a short enough extension would be the equivalent of termination. If the Conference does not reach consensus, the prevailing view among lawyers is that the Treaty would continue to be valid; but there are few who would like to see its survival dependent on non-consensus. Rather, there is general agreement that a substantial extension—another 25 years if not an indefinite extension—based on unanimity rather than on a majority vote, would be the desired outcome.

The 1990 Conference would do well to set the framework for review and extension in 1995.⁹⁵ It is not clear whether there should be (a) two conferences, one on a five-year review and one on extension; (b) one conference, devoting half of its time to each issue; or (c) a pure Extension Conference, which would take up the review procedure within its own proceedings. The 1990 Review Conference must devote some thought to these procedural questions. It is hardly conceivable to waive a review of 1990–95 when the previous four five-year periods were subjected to careful scrutiny; neither is it desirable, if it is assumed that the next five years will witness considerable progress in arms control, disarmament, and conflict management and solution, all of which would bear rather positively on a successful Extension Conference. One realistic solution could be to start with a two-week review, but without the purpose of producing a final document, to continue with a debate on the general merits and experiences of the Treaty (that is, a general review of the 25 years of its existence) and then to proceed towards producing an extension resolution.

⁹⁵ Compare Fischer, D., 'Article X and the nature of the 1995 Extension Conference', Paper presented to the PPNN Core Group Meeting, 18–19 Nov. 1989, Baden, Austria.

Three issues are likely to shape the prospects for extension and the debate in 1995: universalism, nuclear co-operation and disarmament. The Treaty is meant to cover the whole world, yet it has failed to attract a handful of important states. It cannot be ruled out that some of them may accede before 1995; even the two abstaining nuclear weapon states may reconsider their traditional position if the fate of the NPT is at stake. China is surrounded by potential threshold states; France may appreciate the high value of the NPT for the balance of power in Europe. A South African accession would enable the Black African front-line states to reverse their present position. A new, democratically elected government in Chile may see reason to break with its predecessor's refusal to accede. Still, while such accessions would certainly strengthen the Treaty, important holdouts would still remain.

Some may be tempted to argue for changing and amending the NPT. Such thoughts have been aired by scholars and officials from developing countries and India has presented the Gandhi proposal,⁹⁶ which prescribes a detailed timetable until complete disarmament is reached in 2010, as an alternative to the NPT.

If one agrees, however, that the problems in the two most difficult proliferation regions—South Asia and the Middle East—are related more to regional security issues than to questions of universal equality and justice, then the prospects of attracting these bystanders by changes in the Treaty's language are dim indeed. It is thus more reasonable to try to keep the Treaty intact and to deal with those regional issues on their own merits and in their own context, without losing sight of the positive effects a solution of these problems would have on the NPT.

By implication, this means that the Gandhi proposal should not be treated as an alternative to the NPT. This does not mean, however, that it should not be discussed. Besides outrageous features—such as asking for a safeguarded end to fissionable material production in nuclear weapon states while keeping silent on such materials in non-nuclear weapon states (i.e., India)—it contains some ideas worth considering; among these is the suggestion to create procedures and institutions for regional conflict solution without recourse to force. To set up a forum in which these proposals—and others contained in the Brandt or Palme Commission Reports—can be discussed is particularly appropriate now that the sources of conflict in Europe appear to be diminishing. It is extremely desirable for the survival of a universal treaty such as the NPT that the world not be divided into two different cultures of conflict solution—one managed by consensus and international institutions and one in which the sword and the gun still reign. To have such a forum ready before 1995 would presumably make it easier for many Third World countries to agree to an extension, because it would be a considerable sign of goodwill by the North to consider proposals from the South. At the same time, it would be made clear that the NPT is not dispensable.

⁹⁶ *PPNN Newsbrief*, 2 July 1988, p. 2.

Third World enthusiasm for a continuation of the Treaty will, to a certain degree, depend on the benefits expected from its further existence (see Article IV above). It is unlikely that nuclear technical assistance alone will offer the same prospects as it did in 1968. Disillusionment about the reality of rapid nuclear growth in the world at large, and in the developing countries in particular, is too great. It is for this reason that the industrialized world would be well advised to carefully consider the resources likely to be free for future aid and their distribution between the needs of the reforming countries in Eastern Europe and the traditional recipients in the Third World. It must be assumed that greater efforts and sacrifices will be necessary and appropriate in the rich countries to meet the needs of either alternative. From this pool of resources, a considerable share must be devoted to energy and environmental projects. If the developed countries use the period between now and 1995 to design a package of energy/environmental aid programmes, if possible in co-operation with the respective UN agencies, and present this package under the auspices of Article IV in 1995, this would certainly improve the atmosphere of the 1995 Conference.

It is stated above that prospects appear bright for unprecedented progress in disarmament in the next five years, a reversal of the Soviet situation excluded. Under these circumstances, a second START agreement is likely with further reduction of strategic nuclear arms and, perhaps, a binding commitment of the smaller nuclear weapon states not to expand their arsenals beyond a fixed number of warheads, an agreement curtailing nuclear weapons in Europe down to a few hundred, and some additional limitations on nuclear testing. Under these circumstances, it is not impossible that the total number of nuclear weapons in the world would be less in 1995 (or at least under the treaties concluded by that date) than when the NPT entered into force in 1970. While this would still not satisfy all parties, it would presumably be adequate to reach agreement on extension.

The 1990 Conference would be well advised to deal with the procedural issues foreseen for 1995. Agreement on how to proceed would relieve the preparations for 1995 from unneeded tensions on these issues. The parties should also try in 1990 to exchange views on the standards against which the issue of extension will be evaluated in 1995. Some clarity about expectations will help diplomatic preparations.

III. Conclusions

As the article-by-article review shows, there are many details which, despite the generally favourable political climate, make it likely that the 1990 Review Conference will be a difficult one for international diplomacy. Perhaps it would be easier if the shadow of the 1995 Extension Conference did not already hang over the conferees.

In the final instance, the NPT is an unfit battleground for the unresolved problems of regional conflict. It presents too precarious a balance to withstand these antagonistic interests. Success of the 1990 Review Conference

and survival of the Treaty beyond 1995 hinge either on the exclusion of regional issues and their diplomatic reverberations from the proceedings of the Conference, or on the solution of the very conflicts which disturb the non-proliferation regime in the first place. Success in 1990 appears to depend on the following factors:

1. Sober assessment by non-nuclear weapon states, particularly developing countries, of the objective merits of the NPT as a measure of world security from which they, directly or indirectly, profit.

2. A major reconsideration of US priorities: the NPT appears to be accorded less importance than previously and the obvious disdain for multilateralism displayed by the US Government is a major annoyance for the Third World, maybe without Washington fully realizing its impact. Pre-occupation with rather narrowly defined, supposed military or geostrategic interests hinders the USA from recognizing the dangers in this attitude for the future of a Treaty so essential for maintaining world order.

3. Willingness by the North, including the WTO states, to incur the material sacrifices necessary to keep the South interested in the Treaty.

4. The capability of the Third World to recognize the tremendous progress in arms control with regard to Article VI of the Treaty.

5. The ability of all actors to keep regional issues in proper perspective and not to let such issues be confused with the main body of the Treaty.

If one or more of these five factors lead to dissension, or a series of divisive motions to take majority votes (it came close to that in 1985), the consequences for 1995 would be dire. If they are all adequately dealt with, a tough but successful Conference can be expected.

2. Developments in laser isotope separation and implications for nuclear proliferation

RICHARD KOKOSKI

I. Introduction

For the past two decades research has been under way in many parts of the world to investigate the potential use of laser methods for enriching both uranium and plutonium which could then be used for the production of nuclear weapons. The impact of technological developments in the laser field on the nuclear non-proliferation regime has been a cause for concern since the processes themselves were first understood. Several important developments make it necessary to examine the potential impact of recent advances in these methods on the future of the nuclear non-proliferation regime especially with the 1990 NPT Review Conference at hand and the 1995 Extension Conference on the horizon.

In particular, many countries, several of which are not party to the 1970 Non-Proliferation Treaty, are currently investing substantial amounts of time and effort in laser isotope separation research and there are plans to deploy several facilities in this decade. As the technology associated with lasers in general becomes more widely available and its use for isotope separation rapidly reaches maturity, the possibility of its use for weapon-grade fissile material production in small, difficult-to-detect facilities becomes an ever more apparent danger. If the non-proliferation regime is adequately to deal with this challenge, a host of issues related to safeguards and export controls are sure to present themselves and will have to be addressed in the near future.

In assessing these problems it is important to examine as well the currently employed methods for uranium enrichment in order to understand the reasons why laser isotope separation is being investigated and the particular dangers which it represents as compared with other methods. In addition, although the United States has recently announced that it will no longer proceed with plans to construct a large facility for the laser separation of weapon-grade plutonium, this issue is also addressed here as it is of relevance in terms of the dangers that future decisions to deploy this type of technology by the USA or other countries could pose for the non-proliferation regime.

In addition to examining the status of current research in countries known to be involved in laser isotope separation, a discussion of the technology itself is included to bring the current situation into focus and enable the reader better to assess the possible impact of future technological developments as they may occur.

II. Overview: the dominant issues

Plutonium isotope separation: the SIS controversy

Laser isotope separation has figured prominently in a long-standing debate, recently resolved, involving the planned use of laser separation of plutonium isotopes by the United States for weapon purposes. Although the issue of plant construction in this case has been put to rest for now, the technologies applicable to plutonium and uranium isotope separation have many elements in common and there are inherent proliferation dangers associated with any future development of this process by the USA or other countries. It is thus instructive to begin with a brief discussion of the issues surrounding this recent debate.

The implementation of the 1987 INF Treaty is proceeding as scheduled, and an agreement on strategic arms reductions (START) is very likely to be concluded in 1990.¹ Possible START follow-on talks under discussion may allow for even more substantial cuts in the nuclear arsenals of the two superpowers. Given these and other very positive developments in East-West relations, the need for fissile materials for nuclear weapons would seem to be on the decline. With the exception of tritium (with a half-life of about 12 years) the important elements of nuclear weapons—plutonium-239 and uranium-235—decay extremely slowly and thus, unless a very unlikely buildup in nuclear forces takes place, can be recycled from existing or retired weapons in order to construct more modern ones if need be.

Such recycling has become common practice. Although the USA wishes to keep the warheads being withdrawn under the INF Treaty intact,² the Department of Energy (DOE) has stated that reprocessed plutonium from warheads aboard newly retired Poseidon submarines will satisfy their near-term defence requirements.³ A START treaty would make substantially more plutonium available; according to the DOE itself, a backlog in plutonium would result.⁴ At the same time, however, until late 1989 the DOE had continued to press for the creation of a new plutonium source 'technologically diverse from production reactors',⁵ and the various issues associated with them, in order to provide 'flexibility in *rapid increases* in plutonium production capacity'.⁶ For this purpose, a Special Isotope Separation (SIS) facility was planned for completion in 1995, to employ a

¹ See for example SIPRI, *SIPRI Yearbook 1990: World Armaments and Disarmament* (Oxford University Press, 1990), chapter 11.

² Hearings on National Defense Authorization Act for Fiscal Year 1989—H.R. 4264 and *Oversight of Previously Authorized Programs, DOE National Security Programs*, before the Procurement and Military Nuclear Systems Subcommittee of the Committee on Armed Services, House of Representatives, 100th Congress, 2nd Session (US Government Printing Office: Washington, DC, 1988), p. 257 (hereafter DOE-NSP/89).

³ *Energy and Water Development Appropriations for 1989*, Hearings before a Subcommittee of the Committee on Appropriations, House of Representatives, 100th Congress, 2nd Session (US Government Printing Office: Washington, DC, 1988), Part 6, p. 773 (hereafter EWDA/89).

⁴ EWDA/89 (note 3), p. 1118.

⁵ DOE-NSP/89 (note 2), p. 490.

⁶ EWDA/89 (note 3), p. 1145; emphasis added.

sophisticated laser technique to remove the unwanted isotopes from Defense Department plutonium, upgrading it to weapon-grade material.

Much concern arose over the inherent conflict in a policy which would authorize what could have amounted to several billion dollars to construct and operate a laser facility to produce material not currently needed, and which is likely to be in over-abundant supply in the not-too-distant future (if not already). In a December 1989 report, the National Academy of Sciences affirmed the adequacy of currently available plutonium to maintain a nuclear stockpile similar to the one which now exists.⁷

Further implications involved the long-standing US tenet on non-proliferation: to keep the military and civil uses of nuclear energy separate. Although the use of commercial spent fuel for weapon purposes is forbidden by the Hart-Simpson-Mitchell amendment⁸ to the Atomic Energy Act, the DOE has admitted that, while the design life of the plant is 30 years, given its planned capacity there is only enough Defense Department feed to keep it occupied for about 9 years. There had thus been concern that, once a plant was built and running, pressure would have been brought to bear on Congress to allow commercial spent fuel to be used.⁹

The purification of plutonium by the USA and perhaps other nuclear weapon states could complicate current investigations of methods of nuclear warhead verification as well.¹⁰ These rely on neutron emission from the plutonium-240 (²⁴⁰Pu) which makes up about 6 per cent of current weapon-grade plutonium. For example, the presence of ²⁴⁰Pu in a warhead has been shown to be of potential use in verification of sea-launched cruise missiles (SLCMs).¹¹

The DOE had planned to begin construction of the SIS facility in 1989,¹² and have it fully operational by 1995.¹³ The Energy Secretary, strongly backing the project earlier in 1989, began questioning its necessity by the end of the year.¹⁴ Finally, citing both the availability of plutonium from other sources and funding priorities the DOE decided in early 1990 to cancel

⁷ *New York Times*, 21 Dec. 1989.

⁸ Cochran, T. B., *et al.*, *Nuclear Weapons Databook, Vol. II, U.S. Nuclear Warhead Production* (Ballinger: Cambridge, Mass., 1987), p. 96; Palmer, G. and Bolef, D. I., 'Laser isotope separation: the plutonium connection', *Bulletin of the Atomic Scientists*, Mar. 1984, p. 30.

⁹ See also a 26 May 1989 letter from Paul Leventhal, President of the Nuclear Control Institute (NCI), to Sam Nunn, Chairman of the Senate Armed Services Committee. Co-signed by 28 leading arms control experts it recommended against SIS construction, stating that this could 'severely compromise U.S. non-proliferation objectives'. Concern was also expressed that SIS operation 'would set a precedent for the use of such plutonium purification technology in the nuclear programs of other nations, including non-nuclear weapons states'. Regarding the technologies to be employed in the plant (see below) the authors point to 'unprecedented challenges to containing the nuclear programs of emerging and advanced industrial nations to exclusively peaceful purposes' and fear the precedent-setting nature of AVLIS demonstration in increasing the risks of diversion and terrorism. (Copy courtesy Deborah Holland, NCI)

¹⁰ Letter from NCI to Sam Nunn (note 9).

¹¹ Cochran, T. B., 'Black Sea experiment: only a start', *Bulletin of the Atomic Scientists*, Nov. 1989, pp. 13-16.

¹² EWDA/89 (note 3), p. 923.

¹³ DOE-NSP/89 (note 2), pp. 235, 263; EWDA/89 (note 3), p. 1110.

¹⁴ *Washington Post*, 28 Nov. 1989, p. A6; 28 Jan. 1990, p. A4.

SIS construction. Research and development will reportedly continue, however.¹⁵

Safety concerns have temporarily halted plutonium production for weapons in the USA, and the USSR closed down three plutonium production reactors in 1989 (although it continues to produce substantial quantities in its 11 remaining dedicated reactors).¹⁶ Growing interest is now being expressed in the elimination not only of nuclear delivery vehicles, but also of nuclear warheads and fissile materials. In 1989, Soviet proposals for verifiable cut-offs in fissile material production for nuclear weapons were put forward by President Mikhail Gorbachev in May and Foreign Minister Eduard Shevardnadze in September.¹⁷ In July the US Congress passed an amendment calling on the Administration to look into the implications of a bilateral cut-off of all nuclear weapon material production.¹⁸ These are promising signs and the halt in SIS construction is expected to encourage further advances in this area.¹⁹

Uranium enrichment

The two most prevalent methods for uranium enrichment employed worldwide at the present time are gaseous diffusion and the gas centrifuge process, representing roughly 90 per cent and 10 per cent of the world enrichment market respectively.²⁰ Although no known facility produces substantial amounts of enriched uranium using laser techniques today, proliferation concerns have been raised regarding the use of these techniques for the production of highly enriched uranium (HEU) since the processes themselves were understood in the early 1970s. One of the major worries in this context is that the nature of the technology could allow for smaller and more readily concealed clandestine enrichment facilities than other methods. Also, while the USA has not produced enriched uranium for weapon purposes since 1964²¹ and the USSR announced in April 1989 that it had also halted its production,²² the potential small size of laser facilities for HEU production would also be important in assessing the verifiability of fissile material cut-off proposals.

In addition, as shown below, despite current uranium enrichment overcapacity,²³ the spread of laser enrichment technology has proceeded rapidly

¹⁵ Adams, P., 'DoE drops funds for Idaho plutonium plant', *Defense News*, vol. 5, no. 6 (5 Feb. 1990), p. 40.

¹⁶ von Hippel, F., testimony before the House Committee on Foreign Affairs, Subcommittee on Arms Control, International Security and Science, 20 June 1989, mimeo, p. 3; Lanouette, W., 'Plutonium—no supply, no demand?', *Bulletin of the Atomic Scientists*, Dec. 1989, p. 45.

¹⁷ Hibbs, M. and MacLachlan, A., 'Soviet official pessimistic about IAEA role in verifying Pu production cutoff', *Nuclear Fuel*, vol. 14, no. 21 (16 Oct. 1989), p. 2; Lanouette (note 16), p. 45.

¹⁸ *Congressional Record*, vol. 135, no. 103 (27 July 1989), H4361.

¹⁹ *New York Times*, 27 Jan. 1990, p. 13.

²⁰ Erkens, J. W., 'CRISLA aims to reduce costs', *Nuclear Engineering International*, vol. 34, no. 419 (June 1989), p. 48.

²¹ EWDA/89 (note 3), pp. 1034–35.

²² *Arms Control Today*, May 1989, p. 25.

²³ Clark, R. G. and Addington-Lee, F., 'Overcapacity leaves buyers in the driving seat', *Nuclear Engineering International*, vol. 34, no. 419 (June 1989), p. 42.

in the past decade, with many countries—including many not party to the NPT—investing substantial amounts of time and effort in research and development. These developments may be hastened as nuclear power is re-examined in the light of growing evidence for a greenhouse effect. New and supposedly safer reactors²⁴ may use uranium more highly enriched than that prevalent today, heightening proliferation concerns. Laser processes, now forecast to be capable of more economical uranium enrichment, will doubtless become the focus of much greater attention should such trends materialize.

The choice of enrichment technology depends on the relative importance of several aspects of the processes concerned. These technical and economic factors are of course weighted differently when a decision is made to employ a given method. Depending on whether, for example, a relatively small amount of HEU is required for a few nuclear weapons or large amounts of inexpensively produced fuel for a light water reactor (LWR), very dissimilar approaches may be chosen. In order to understand how such trade-offs are made and gain insight into the level of scientific expertise necessary for the various methods, a cursory look at diffusion and centrifuge techniques,²⁵ with subsequent explication of the technology involved in the laser methods, is first provided.

III. The technology

Uranium enrichment

Natural uranium (containing only 0.7 per cent ²³⁵U, with ²³⁸U making up the rest) can be used in heavy water reactors, but ²³⁵U must be enriched to 2–4 per cent to fuel the more prevalent light water reactors. Uranium is enriched to more than 90 per cent ²³⁵U for weapon purposes and to about 93–97 per cent for many nuclear submarine and research reactors (however, the USSR has recently revealed that its naval reactors use uranium enriched to only 10 per cent ²³⁵U²⁶). In all the techniques described below for enriching uranium the process involves the separation of the input or ‘feed’ stream of material into two streams: a ‘product’ stream in which the ²³⁵U is enriched and a ‘tails’ stream in which ²³⁵U is depleted.²⁷

²⁴ Broad, W. H, ‘Now, a meltdown-proof reactor’, *International Herald Tribune*, 17 Nov. 1988.

²⁵ An earlier and very thorough examination of enrichment techniques can be found in Krass *et al.*, SIPRI, *Uranium Enrichment and Nuclear Weapon Proliferation* (Taylor & Francis: London, 1983), which also examines the relationship with non-proliferation issues. For a good earlier overview of the more technical aspects see Villani, S. (ed.), *Topics in Applied Physics, Vol. 35, Uranium Enrichment* (Springer-Verlag: West Berlin, 1979).

²⁶ *Nuclear Fuel*, vol. 14, no. 15 (24 July. 1989), p. 12.

²⁷ See, e.g., *Advanced Uranium Enrichment Technologies*, Hearing before the Subcommittee on Energy Research and Production of the Committee on Science and Technology, US House of Representatives, 96th Congress, 1st Session (US Government Printing Office: Washington, DC, 1979), p. 86 (hereafter HR-AUET).

Gaseous diffusion

This is the most prevalent means of enriching uranium today. The method involves separating molecules of uranium hexafluoride (UF_6) containing ^{235}U from those containing ^{238}U . Since some laser methods also are designed to use UF_6 as feed material, this has important implications for the ease with which they might be introduced into the enrichment cycle now in use. The diffusion method depends on the fact that lighter molecules in a gas will move with a greater average velocity. In a gaseous diffusion unit UF_6 under high pressure is allowed to diffuse through a porous barrier, the higher speed of the molecules containing ^{235}U allowing for more collisions with the barrier and hence more of a chance for them to escape through one of the holes (typically 10 millionths of a millimetre in diameter.)²⁸ The emerging gas is thus slightly enriched in UF_6 molecules containing the desired ^{235}U atom.

The gas centrifuge

This is a more advanced technique which allows higher separation factors²⁹ than gaseous diffusion while still providing a reasonable (though smaller) throughput³⁰ This method uses centrifugal acceleration created in a cylinder rotating at very high speed. UF_6 gas is fed into the rotating cylinder and acceleration of rotation increases the concentration of UF_6 molecules containing ^{235}U closer to the centre of the cylinder for collection.³¹ The high rate of rotation necessary to obtain useful enrichment factors is more effectively achieved using high-strength lightweight materials in cylinder construction and by operation in a vacuum container.³²

Principles of laser enrichment

Perhaps surprisingly, photoselecting isotopes dates from experiments in the 1930s with mercury. The separation of uranium by selective photochemistry was also considered at the time of the Manhattan project.³³ With the advent of the laser these methods were re-examined, and relatively efficient techniques have been found to separate both plutonium and uranium isotopes. The laser's ability to produce collimated light of a very precise frequency allows it to be used to deposit exact amounts of energy to given atoms or molecules—a fact which can be exploited in the isotopic separation process. Laser isotope separation has been discussed widely since the late 1960s,³⁴ and the fact that advanced lasers are useful for many other

²⁸ *Nuclear Weapons Databook Vol. II* (note 8), p. 129.

²⁹ The separation factor is defined as the percentage of ^{235}U in the product stream divided by the percentage in the tails stream.

³⁰ *Nuclear Weapons Databook Vol. II* (note 8), p. 130.

³¹ Soubbaramayer, 'Centrifugation', in Villani (note 25), p. 186.

³² Krass (note 25), pp. 130–32.

³³ Villani (note 25), p. 269.

³⁴ 'Uranium enrichment: rumors of Israeli progress with lasers', *News and Comment, Science*, vol. 183 (22 Mar. 1974), p. 1174.

applications³⁵ ensures their continued development and increasing availability. Since some laser methods also use UF₆ as feed material, this has implications for the ease with which they might be introduced into the enrichment processes now in use.

Most of the details concerning the research and development of these advanced laser isotope separation processes remain classified, and therefore some of the information presented below is, of necessity, lacking in detail in some specific areas.

Generic principles

A general laser enrichment process is most readily conceptualized as occurring in three stages.³⁶

1. Source preparation: the uranium or plutonium is put into a form which is amenable to the processing which will subsequently occur, such as UF₆ or uranium, depending on the particular process.

2. Excitation: the preferential modification of the source material associated with one of the isotopes (in most cases ²³⁵U for uranium enrichment or ²⁴⁰Pu for plutonium purification) through the use of one or more laser types.

3. Extraction: removal of the component which has been thus modified.

Atomic Vapor Laser Isotope Separation

To illustrate the technology involved, the particular process in which the United States has invested most of its efforts is described. The Atomic Vapor Laser Isotope Separation (AVLIS) process is being developed at the Lawrence Livermore National Laboratory (LLNL) with support from the Oak Ridge National Laboratory³⁷ and is similar to processes being developed in several other countries. In the AVLIS process, the feed material is uranium metal, heated by bombarding it with a beam from an electron gun to produce a stream of uranium vapour.³⁸ This vapour contains both ²³⁵U and ²³⁸U atoms. The difference in size of the two respective nuclei (and to a lesser extent the difference in mass and other characteristics)³⁹ affects the specific wavelengths of light which produce allowable transitions between electron energy levels. These differences are very small, but with finely tuned lasers it is possible selectively to produce transitions leading to ionization in the ²³⁵U atoms alone. Once thus positively charged, the ²³⁵U atoms are selectively extracted from the vapour stream by attraction to

³⁵ For example, atomic spectroscopy, chemical reaction research—see for instance Casper, B. M., 'Laser enrichment: a new path to proliferation?', *Bulletin of the Atomic Scientists*, Jan. 1977, p. 31, 41.

³⁶ HR-AUET (note 27) p. 70.

³⁷ 'DOE extends Martin Marietta contracts', *Nuclear Fuel*, vol. 13, no. 26 (26 Dec. 1988), p. 11.

³⁸ HR-AUET (note 27), p. 72; *Nuclear Weapons Databook Vol. II* (note 8), p. 132.

³⁹ Krass, A. S., 'Laser enrichment of uranium: the proliferation connection', *Science*, vol. 196, no. 4291 (13 May 1977), p. 723.

negatively charged plates, leaving the uncharged ^{238}U atoms to continue on their path relatively unimpeded.

In the laser system itself copper-vapour lasers⁴⁰ 'pump' (provide excitation energy for) dye lasers⁴¹ that are tuned to the particular red-orange wavelengths that ^{235}U absorbs.⁴² Four different laser frequencies are used: three to excite the ^{235}U atoms and a fourth to allow ionization. This complex procedure uses the part of the spectrum where the dye lasers are more efficient⁴³ and enhances the selection of ^{235}U since each frequency takes advantage of a separate electron energy level difference.⁴⁴

Molecular Laser Isotope Separation (MLIS)

The chemical properties of molecules formed from different isotopes of the same element (UF_6 composed of six fluorine atoms and either one ^{235}U or one ^{238}U atom, for example) are basically identical. Chemical separation of the molecules is therefore correspondingly difficult. Lasers can be used, however, to impart energy to molecules containing only one of the isotopic forms, enabling the chemical changes needed for subsequent chemical separation. These changes are principally of two types—photodissociation and photoreaction.⁴⁵ Both have been investigated in some detail and an example of each is discussed below.

1. *Photodissociative separation.* In a general photodissociative process the laser energy is used to *break chemical bonds* selectively—that is, in molecules made from one particular isotope. This process uses a laser to remove a fluorine atom from only those UF_6 molecules containing ^{235}U . The use of UF_6 was favoured not only because its high vapour pressure allows for high densities in the gaseous phase but also because of the substantial experience already gained in its production and handling for uranium separation using gas diffusion and centrifuge techniques.⁴⁶ The most advanced research in this method has been carried out in the FRG by a consortium led by Uranit (Uran-Isotopentrennungs-Gesellschaft mbH).⁴⁷ In the process, gas containing UF_6 is first cooled by expansion through a nozzle. Light from an infra-red laser is then used to excite molecular vibrations in the UF_6 molecules containing ^{235}U , leaving those containing ^{238}U unaffected. Subsequently, further irradiation by either an infra-red or ultraviolet laser then dissociates only the excited molecules into uranium

⁴⁰ See, e.g., Svelto, O., *Principles of Lasers*, 2nd edn (Plenum: New York, 1982), p. 210.

⁴¹ See, e.g., Svelto (note 40), p. 239.

⁴² Thurston, C., 'AVLIS program to gear up to full-scale 1-million SWU/yr module test by 1988', *Nuclear Fuel*, vol. 10, no. 15 (29 July 1985), pp. 3-5.

⁴³ 'Laser enrichment process called proliferation resistant', *Physics Today*, July 1979, p. 18.

⁴⁴ *Nuclear Weapons Databook Vol. II* (note 8), p. 132.

⁴⁵ Robinson, C. P. and Jensen, R. J., 'Laser methods of uranium isotope separation', in Villani (note 25), p. 280.

⁴⁶ Villani (note 25), p. 281.

⁴⁷ Hibbs, M., 'Laser team of West Germany's Uranit "fights for survival" of MLIS R&D', *Nuclear Fuel*, vol. 13, no. 19 (19 Sep. 1988), p. 4.

pentafluoride (UF₅) and a fluorine atom. The desired UF₅ quickly condenses into a powdered form ('laser snow') which can be easily collected.⁴⁸

2. *Photoreactive separation.* The US-based firm Isotopes Technologies (IT, headed by a former DOE Deputy Assistant Secretary for Uranium Enrichment) believes it can have a laser enrichment plant operating in 1994 at a cost of under \$50 million using a specific type of photoreactive laser separation described here.⁴⁹ Employing 'off-the-shelf' modular technology,⁵⁰ the process has been called CRISLA (Chemical Reaction by Isotope Selective Laser Activation). As in photodissociative separation, UF₆ molecules containing ²³⁵U are first preferentially excited by a laser (carbon monoxide in this case). The process then makes use of the fact that when a mixture of UF₆ and a proprietary reagent (called RX) is irradiated by the laser, the rate of reaction of the excited UF₆ molecules with RX is over 10 000 times⁵¹ that of the unexcited molecules. The product of the reaction (called URX) is therefore enriched in ²³⁵U and, being chemically and physically distinct from UF₆, is easily separated by standard techniques. The power of the lasers in this process is potentially lower than in the other methods described since the laser is used only for excitation and not for ionization or dissociation. Such techniques are sometimes referred to as 'laser-assisted' processes, and their number is continually growing.⁵²

Comparison of uranium enrichment technology

In addition to scientific feasibility the important features of any enrichment technology include: (a) the separation factor, (b) the throughput, (c) inventory requirements, (d) energy requirements, (e) the capital cost and (f) operating cost elements (including reliability).⁵³

An advantage of diffusion and to some extent the gas centrifuge is that they involve to varying degrees tried and true technology. However, since the separation factor is so small for each stage, diffusion requires a 1200-stage 'cascade' (each stage enriching the uranium slightly more) in order to produce 3 per cent ²³⁵U reactor-grade uranium from natural uranium.⁵⁴ Weapon-grade uranium requires about 4000 stages. In the case of the gas centrifuge only about 10 stages are required for reactor-grade and about 35 for weapon-grade material. On the other hand the capacity of a given gas-centrifuge cascade is very small, and many thousands of individual centrifuges are required to produce substantial quantities of enriched

⁴⁸ Krass (note 25), p. 170.

⁴⁹ 'Longenecker to head Isotope Technologies', *Nuclear Fuel*, vol. 14, no. 13 (26 June 1989), pp. 1-2.

⁵⁰ Lindeman, E., 'Isotope technologies marketing SWU on small scale to U.S. utilities', *Nuclear Fuel*, vol. 14, no. 4 (20 Feb. 1989), p. 4.

⁵¹ Erkens (note 20), p. 48.

⁵² Krass (note 25), pp. 171-72.

⁵³ HR-AUET (note 27), pp. 69, 87.

⁵⁴ HR-AUET (note 27), p. 10.

product.⁵⁵ With lasers, however, the AVLIS process is expected to be able to enrich natural uranium to 3–5 per cent in a single stage⁵⁶ and ‘possibly could be developed to produce HEU’.⁵⁷

In addition, laser isotope separation of uranium can remove most of the ²³⁵U from the uranium ore, whereas gaseous diffusion can leave more than a quarter of the ²³⁵U. Lasers could also be used to remove the remaining ²³⁵U from wastes of other types of separation.⁵⁸ Laser techniques can be more selective in their enrichment capability than either gaseous diffusion or centrifuges. Unwanted and potentially dangerous ²³²U, ²³⁴U and ²³⁶U are not enriched by laser processes. Decay products of ²³²U emit gamma radiation and are a major health and materials handling problem; ²³⁴U raises concerns about inhalation and internal dosage rates; ²³⁶U is a neutron absorber and unwanted in a nuclear reactor.⁵⁹ On the other hand, laser facilities are expected to require more frequent replacement of worn parts than gaseous diffusion equipment.⁶⁰ Comparing the advanced gas centrifuge to the AVLIS process for uranium enrichment, the DOE’s then Deputy Assistant Secretary for Uranium Enrichment stated in 1986: ‘The AVLIS technology is less capital intensive, requires significantly less investment prior to a decision to deploy, has a lower estimated (operating) cost, has greater potential for cost reductions through technology improvements, and is more adaptable to deployment in increments that can match the evolving needs of the enrichment marketplace’.⁶¹

Further insight into the relative merits of laser enrichment in general and the different specific laser technologies can be gained by looking at the vigour of current research, the planned facilities and the choices made by individual countries or companies and (where possible) the reasons for making them. These are discussed below.

Plutonium isotope separation

The ²³⁹Pu used in nuclear weapon construction does not occur in nature, but can be produced from ²³⁸U atoms in nuclear reactors. Depending on how the reactor is configured and run, other isotopes of plutonium are produced to varying degrees. US nuclear weapons, for example, are designed to operate

⁵⁵ Casper (note 35), p. 30.

⁵⁶ Lindeman, E., ‘Less feed, fewer SWU, lower assay needed to enrich REPU with AVLIS, DOE says’, *Nuclear Fuel*, vol. 12, no. 12 (15 June 1987), p. 9.

⁵⁷ *Fiscal Year 1989 Arms Control Impact Statements* (US Government Printing Office: Washington, DC, 1988), p. 145.

⁵⁸ Palmer and Bolef (note 8), p. 26.

⁵⁹ *Nuclear Fuel*, vol. 14, no. 6 (21 Mar. 1989), p. 4. The gas diffusion and centrifuge processes, which discriminate among isotopes based on their mass, enrich ²³²U, ²³⁴U and ²³⁶U by factors of about 8, 5 and 10 times respectively as they enrich 0.8% ²³⁵U to 3.2% ²³⁵U (see *Nuclear Fuel*, vol. 12, no. 12 (15 June 1987), p. 9).

⁶⁰ MacLachlan, A., ‘Sales increase for Franc’s Pechiney’, *Nuclear Fuel*, vol. 13, no. 11 (30 May 1988), p. 13.

⁶¹ *Fiscal Year 1987 Department of Energy Authorization*, Hearings before the Subcommittee on Energy Research and Production of the Committee on Science and Technology, House of Representatives, 99th Congress, 2nd Session (US Government Printing Office: Washington, DC, 1986), Vol. 1, pp. 26–27 (hereafter DOE-CST/87).

with 'weapon-grade' plutonium composed of 6 per cent ^{240}Pu or less, the rest composed of ^{239}Pu (with very small amounts of the other isotopes).⁶² It is possible to produce such plutonium in reactors, although this results in less than optimal power output. Commercial reactors discharge plutonium which is still mainly ^{239}Pu but also contains typically about 25 per cent ^{240}Pu and significant amounts of the other isotopes.⁶³ Chemical methods are then used to extract the plutonium and uranium separately.

In 1986 the USA selected the AVLIS process to convert fuel-grade ^{240}Pu (7–19 per cent)⁶⁴ owned by the Defense Department to weapon-grade plutonium.⁶⁵ Technologically there is considerable overlap in the uranium and plutonium AVLIS processes. In the LLNL facility most of this overlap has been in the laser systems. Copper vapour and dye lasers have been used for both, although tuned to slightly different frequencies.⁶⁶ In fact the laser hardware in the LLNL's Laser Demonstration Facility has been used to supply laser light for both the plutonium and uranium separation programmes.⁶⁷ There are differences in the operation and design of the production processes, however, primarily in the separator technology and with materials handling.⁶⁸ Although not as much is known (other than regarding the US programme) about the state of development of plutonium laser separation methods world-wide, the similarity in US AVLIS approaches to separating different isotopes of plutonium and uranium indicates the possibilities available for countries developing such techniques for uranium enrichment.

IV. Research and development: today and tomorrow

NPT parties

The USA

Of the NPT signatories, the USA in 1982 selected the AVLIS process in preference to two other advanced uranium enrichment techniques for further development. In 1985 the AVLIS process was again selected for future US enrichment needs, this time in preference to the advanced gas centrifuge.⁶⁹ Former US Energy Secretary Harrington has called AVLIS the 'technology

⁶² EWDA/89 (note 3), pp. 1117, 1144.

⁶³ Lovins, A.B., 'Nuclear weapons and power-reactor plutonium', *Nature*, vol. 283 (28 Feb. 1980), p. 818.

⁶⁴ DOE-NSP/89 (note 2), p. 314.

⁶⁵ 'DOE selects AVLIS for Pu production also', *Nuclear Fuel*, vol. 11, no. 9 (5 May 1986), p. 13; EWDA/89 (note 3), p. 733; 'Laser technology', *Energy and Technology Review*, July/Aug. 1989, p. 20.

⁶⁶ DOE-CST/87 (note 61), p. 71.

⁶⁷ 'Special isotope separation program', *Energy and Technology Review*, July/Aug. 1989, p. 24.

⁶⁸ DOE selects AVLIS for Pu production also', *Nuclear Fuel*, vol. 11, no. 9 (5 May 1986), p. 13.

⁶⁹ *DOE Uranium Enrichment Program*, Hearing before the Subcommittee on Energy Conservation and Power of the Committee on Energy and Commerce, US House of Representatives, 99th Congress, 2nd Session (US Government Printing Office: Washington, DC, 1986), p. 18 (Hereafter DOE-UEP); *Nuclear Weapons Databook Vol. II* (note 8), p. 132.

of the future, the uranium enrichment process of the 21st Century'.⁷⁰ In its comparison study, the US Department of Energy evaluation board report stated that the advanced gas centrifuge would necessitate the 'development of machines that are at the upper limit of present technology in terms of materials components, design and manufacturing capabilities'.⁷¹ At the time, LLNL's then associate director for lasers contrasted this to the AVLIS programme stating 'we have taken relatively unsophisticated material and produced a sophisticated system.'⁷²

The stated reasons for using AVLIS for uranium enrichment in the USA are to remain competitive in the future and to 'assure the country has the military security that it requires for its Naval Propulsion Program and other programs'.⁷³ Congress appropriated over \$500 million towards the development of AVLIS from 1973 to 1987.⁷⁴ Funding for fiscal year 1990 has been set at \$134 million with the House-Senate Conference directing the DOE to accelerate completion of the AVLIS technology and ensure the development has an industrial perspective.⁷⁵ The DOE is requesting \$154.5 million for fiscal year 1991 with plans to select a contractor in March 1990 to commercialize the AVLIS technology.⁷⁶

In its annual report for 1987, the DOE announced the successful demonstration of laser enrichment technology at one-half plant scale.⁷⁷ The DOE is committed to complete a production demonstration by the end of 1991,⁷⁸ and the DOE's contractors are known to favour having an AVLIS plant in operation by 1996.⁷⁹ Current plans are for deployment in the late 1990s.⁸⁰

The USSR

Although information is rather sparse, research into uranium laser isotope separation has been carried out in the USSR at the Institute of Spectroscopy and the Kurchatov Institute.⁸¹ The head of the development of laser uranium enrichment in the USSR reportedly stated in 1985 that the process had already been 'turned . . . over to industry' and they are thought to have made

⁷⁰ DOE-CST/87 (note 61), p. 48.

⁷¹ Uranium Enrichment Technology Evaluation and Assessment, DOE Process Evaluation Board Report, 15 May 1985, p. 6 (reprinted in *Nuclear Fuel*, vol. 10, no. 12 (17 June 1985), p. 19).

⁷² Note 42, p. 4.

⁷³ DOE-CST/87 (note 61), pp. 8, 36.

⁷⁴ 'Senate would require DOE to study putting AVLIS at idle enrichment plant', *Nuclear Fuel*, vol. 12, no. 25 (14 Dec. 1987), p. 3.

⁷⁵ 'Funding bill would allow DOE to buy uranium from West German stockpile', *Nuclear Fuel*, vol. 14, no. 19 (18 Sep. 1989), p. 9.

⁷⁶ *Nuclear Engineering International*, Mar. 1990, p. 4

⁷⁷ 'DOE reports '87 net loss of \$385-million; SWU sales total nearly 1.13-billion', *Nuclear Fuel*, vol. 13, no. 12 (13 June 1988), p. 4.

⁷⁸ 'Enrichment budget sent to Congress', *Nuclear Fuel*, vol. 14, no. 2 (23 Jan. 1989), p. 12.

⁷⁹ 'DOE's contractors pushing strategy for early AVLIS plant construction', *Nuclear Fuel*, vol. 14, no. 5 (6 Mar. 1989), p. 9.

⁸⁰ Note 57, p. 161.

⁸¹ Central Intelligence Agency, *USSR Energy Atlas* (US Government Printing Office: Washington, DC, 1985), p. 43, cited in *Nuclear Weapons Data Book, Vol. IV, Soviet Nuclear Weapons* (Ballinger: Cambridge, Mass., 1989), p. 94; Robinson, C. P. and Jensen, R. J., 'Laser methods of uranium isotope separation', in Villani (note 25), p. 272.

a great deal of progress.⁸² However, a recent report indicates that the USSR does not have plans to build additional enrichment capacity.⁸³

Japan

The Japan Atomic Energy Research Institute (JAERI) has been researching the AVLIS process since 1976. The Laser Atomic Separation Engineering Research Association (LASER) of Japan was formed in 1987⁸⁴ by nine commercial utilities, the Japan Atomic Power Co. (JAPCO) and the Central Research Institute of the Electrical Power Industry (CRIEPI).⁸⁵ Mitsubishi, Hitachi and Toshiba have also joined LASER. Annual spending on AVLIS has risen from \$5 million a year to about \$65 million a year.⁸⁶ It was expected that LASER would conduct a small-scale test by 1990 and, given good results, become commercial early in the 21st century.⁸⁷ The MLIS process is being developed by the Institute of Physical & Chemical Research (IPCR) which in 1988 reported achieving a separation factor of 4.7 (a separation factor of about 4.3 is required to enrich natural uranium to 3 per cent reactor-grade ²³⁵U). The process employed is a variant of the photodissociative process and quantities of 'laser snow' (solid UF₅ enriched in ²³⁵U) measured in hundreds of milligrams were obtained.⁸⁸ Should laser enrichment prove reliable and economical it is possible that some of the new enrichment capacity which the Japan Nuclear Fuel Industries Co. (JNFI) is planning may also use this technology.⁸⁹ Further, the Industrial Research Institute (IRI) is reportedly evaluating the CRISLA process.⁹⁰

The FRG

The Federal Republic of Germany, now thought to have developed the most advanced MLIS technology, has chosen to concentrate on this method, believing it to be superior to the atomic laser process at least in part since it uses UF₆—not requiring high temperature or 'highly aggressive' uranium vapour.⁹¹ The leader of MLIS research in the FRG is Uranit, the FRG shareholder in Urenco, owned by Nukem GmbH, Preussenelektrika AG and

⁸² DOE-CST/87 (note 61), p. 44.

⁸³ 'European enrichers say they are hurt by Soviet/Chinese aggressiveness', *Nuclear Fuel*, vol. 14, no. 1 (9 Jan. 1989), p. 7.

⁸⁴ Usui, N., 'Japan's PNC commissions centrifuge enrichment demonstration plant', *Nuclear Fuel*, vol. 13, no. 9 (2 May 1988), p. 6.

⁸⁵ Usui, N., 'Japanese set up AVLIS research group', *Nuclear Fuel*, vol. 12, no. 3 (9 Feb. 1987), p. 12.

⁸⁶ Hiruo, E., 'U.S. share of enrichment market said to hinge on AVLIS operation date', *Nuclear Fuel*, vol. 13, no. 6 (21 Mar. 1988), p. 5.

⁸⁷ MacLachlan, A. and Usui, N., 'Urenco using REPU enrichment as lure for Japanese business', *Nuclear Fuel*, vol. 12, no. 11 (1 June 1987), p. 7.

⁸⁸ Usui, N., 'Japan's IPCR reports breakthrough using MLIS enrichment process', *Nuclear Fuel*, vol. 13, no. 8 (18 Apr. 1988), p. 7.

⁸⁹ 'NRC receives first license application to export U to Japan for enrichment', *Nuclear Fuel*, vol. 12, no. 12 (15 June 1987), p. 12.

⁹⁰ Ushio, S., 'Japanese move forward with AVLIS plans', *Nuclear Fuel*, vol. 11, no. 12 (16 June 1986), p. 8.

⁹¹ Hibbs, M., 'Laser team of West Germany's Uranit "fights for survival" of MLIS R&D', *Nuclear Fuel*, vol. 13, no. 19 (19 Sep. 1988), pp. 4-5.

Hoechst AG.⁹² Funding for 1988 was approximately DM 13 million (\$6.8 million). A separation factor of 15 has recently been achieved on a laboratory scale, putting this effort well ahead of the Japanese MLIS (and of the US, British and French efforts, all of which abandoned MLIS after only achieving a separation factor of approximately 2.5). Current Uranit planning involves a 1/100-scale pilot plant costing about DM 120 million (\$63 million), which it is hoped will be operational by 1996, and a 1/10-scale follow-up pilot to be completed sometime in the next century.⁹³

The UK

The United Kingdom Atomic Energy Authority (UKAEA), having originally concentrated on molecular laser separation, in 1984 decided in favour of the atomic separation process. British Nuclear Fuels plc (BNFL) initiated a laser isotope separation programme in 1982 and by 1986 felt it would be in a position to consider plant installation in the late 1990s.⁹⁴ Development work in conjunction with the UKAEA is proceeding, and a small-scale demonstration is planned for the mid-1990s. In the UK it is believed that centrifuge technology will be viable for some time in the future and that by 1992 it should be clear whether laser separation will be competitive with advanced centrifuge technology.⁹⁵

Others

Aspects of both MLIS and AVLIS are being investigated in *the Netherlands*. In *Canada*, Atomic Energy Canada Ltd (AECL) has recently expanded its activities in laser separation research, and research has reportedly also been conducted in *Australia*.⁹⁶

Non-NPT parties

Brazil

Of the non-signatories to the NPT, work on laser enrichment of uranium is under way in Brazil at the Institute for Energy and Nuclear Research (IPEN) as well as at the Air Force's Aerospace Technology Center (CTA) in São José dos Campos, the principal site of Brazil's rocket research programme. However, it has been judged highly unlikely that the technique is close to

⁹² Hibbs, M., 'Late funding effort may save German laser enrichment project', *Nuclear Fuel*, vol. 13, no. 21 (17 Oct. 1988), p. 3.

⁹³ Note 91, p. 5.

⁹⁴ 'Enrichers discuss prospects for laser SWU', *Nuclear Fuel*, vol. 11, no. 18 (8 Sep. 1986), p. 5.

⁹⁵ Marshall, P., 'BNFL says operating profit is up while export earnings drop 12%', *Nuclear Fuel*, vol. 13, no. 23 (14 Nov. 1988), p. 5; *Atom*, no. 389 (Mar. 1989), p. 46.

⁹⁶ Silver, R., 'Canadian officials looking at advances for fuel cycle, including enrichment', *Nuclear Fuel*, vol. 13, no. 13 (27 June 1988) p. 6; Casper (note 35), p. 40; Krass (note 25), p. 235.

being mastered⁹⁷ and, as far as the CTA effort is concerned, it has recently been reported that it is now de-emphasized.⁹⁸

Israel

As early as 1974 a physicist with the Ministry of Defence of Israel stated that Israel had demonstrated the feasibility of laser enrichment.⁹⁹ In 1986 Mordechai Vanunu told of the existence of an Israeli laser separation facility at the Dimona Centre which can be used to enrich uranium and purify plutonium.¹⁰⁰ According to Vanunu, in 1981 Israeli scientists began actually to use lasers to separate uranium isotopes, expanding the unit to production scale when he left Dimona in 1985.¹⁰¹ A recent US report has stated however that 'Israel has no known [uranium] enrichment capability, but it has been working to develop laser isotope separation that if successful could provide a new source of weapons materials'¹⁰². An LLNL source has reported that Israel has been investigating the AVLIS process¹⁰³

France

In France, laser enrichment technology development is being pursued by the CEA (Commissariat à l'Energie Atomique) although, as far as a commercial plant is concerned, its subsidiary Cogema will ultimately be the beneficiary.¹⁰⁴ Although believed to be behind the USA in laser enrichment development,¹⁰⁵ the French are also pursuing AVLIS ('SILVA' in French) and evaluated and abandoned centrifuge technology even before a similar decision was taken by the USA.¹⁰⁶ At the CEA's Saclay centre a pre-industrial SILVA process plant began operating several years ago; full results are expected in 1990, when plans call for beginning construction of a pilot plant with the target date for full industrial-scale plant operation set at around 2000.¹⁰⁷

China

Begun in the early 1970s, research in China into laser isotope separation has involved both the molecular and atomic processes, but since 1985 con-

⁹⁷ Spector, L. S., *The Undeclared Bomb* (Ballinger: Cambridge, Mass., 1988), pp. 259-60.

⁹⁸ Hibbs, M., 'Bonn: there is "no military background" to Brazil's unsafeguarded program', *Nuclear Fuel*, vol. 14, no. 16 (7 Aug. 1989), p. 13.

⁹⁹ Quoted in *Science*, vol. 183 (note 34), p. 1172.

¹⁰⁰ Barnaby, F., *The Invisible Bomb: The Nuclear Arms Race in the Middle East* (I. B. Tauris: London, 1989), pp. 25-26.

¹⁰¹ Barnaby (note 100), p. 40.

¹⁰² Donnelly, W. H., 'Israel and nuclear weapons', Congressional Research Service Issue Brief, IB87079, 17 Nov. 1989, p. 3.

¹⁰³ Thurston (note 42), p. 5.

¹⁰⁴ MacLachlan, A., 'French 'sages' could advise linking R&D, nuclear industry', *Nucleonics Week*, vol. 30, no. 16 (20 Apr. 1989), p. 15.

¹⁰⁵ Thurston (note 42), p. 5.

¹⁰⁶ DOE-CST/87 (note 61), p. 44.

¹⁰⁷ MacLachlan, A., 'French find chemical enrichment is a pleasant economic surprise', *Nuclear Fuel*, vol. 12, no. 2 (26 Jan. 1987), p. 2; Capron, J-P., 'Nuclear electricity, the answer to energy

centration has focused on the atomic process. A pilot plant may be installed in the early 1990s.¹⁰⁸ Gas centrifuge technology is also being investigated, and China hopes to decide on an enrichment priority by the turn of the century.¹⁰⁹ At Fudan University a replica of CRISLA developed by the US-based Isotope Technologies firm has been constructed (though not yet duplicating the IT results) using published data.¹¹⁰

India

India is also reportedly conducting research into laser enrichment techniques at the Bhabha Atomic Research Centre.¹¹¹

Co-operative efforts

Co-operative efforts involve Eurodif, a multinational uranium enrichment company, which is reported to be actively pursuing an AVLIS capability. It is planning plant demonstrations of the process in the early 1990s in Pierrelatte.¹¹²

In a recent joint statement¹¹³ the UK and the FRG have expressed their receptivity to the proposal that laser enrichment technology be included in their co-operation in Urenco. Until the mid-1990s, however, Urenco is planning to introduce in a modular fashion improved centrifuge designs with which laser technology will have to compete. In its 1988 annual report Urenco stated that it was unlikely that significant, commercial-scale laser technology would be introduced before the next century.¹¹⁴

It has also recently been stated that any future collaboration on enrichment between France and the FRG will involve laser methods.¹¹⁵

V. Proliferation and uranium laser enrichment

Clandestine deployment

Unlike weapon-grade plutonium which can be produced in a small nuclear reactor, the production of substantial quantities of HEU has, until now, required a large dedicated effort. It has been said that 'one of the hardest

challenges', *Atom*, no. 388 (Feb. 1989), p. 34; MacLachlan, A., 'Cogema will not deploy AVLIS for reprocessed U until after 2000', *Nuclear Fuel*, vol. 13, no. 10 (16 May 1988), p. 4.

¹⁰⁸ 'China has been selling enriched uranium commercially since 1981, official says', *Nuclear Fuel*, vol. 13, no. 20 (3 Oct. 1988), p. 12.

¹⁰⁹ Lindeman, E., MacLachlan, A. and Hibbs, M., 'Nuclear fuel survey: views differ on market impact of Soviet, Chinese U/SWU', *Nuclear Fuel*, vol. 14, no. 1 (9 Jan. 1989), p. 7.

¹¹⁰ Knapik, M., 'Looking ahead to the enrichment marketplace of the 1990s', *Nuclear Fuel*, vol. 14, no. 13 (26 June 1989), p. 2.

¹¹¹ Spector, L. S., *The New Nuclear Nations* (Vintage: New York, 1985), p. 101.

¹¹² Hiruo (note 86), p. 5.

¹¹³ Joint Declaration Between the UK and West Germany on the Peaceful Use of Nuclear Energy, signed in Bonn, 25 July 1989, reprinted in *Nuclear Fuel*, vol. 14, no. 16 (7 Aug. 1989), p. 5.

¹¹⁴ 1988 Urenco Annual Report quoted in *Nuclear Fuel*, vol. 14, no. 7 (3 Apr. 1989), p. 5.

¹¹⁵ MacLachlan, A., 'Potential French-German enrichment cooperation will be in lasers', *Nuclear Fuel*, vol. 14, no. 13 (26 June 1989), p. 4.

things on earth to hide is a gaseous diffusion plant; its mere presence on the landscape, easily detected by satellites, is a dead give-away of a nation's intentions'.¹¹⁶ It is believed that the fewer stages necessary and the subsequent smaller size of gas-centrifuge uranium enrichment plants means that their appearance is not as distinctive as diffusion plants but that the effort required for their construction would still permit identification. Laser enrichment plants need less uranium for processing and can be smaller still, which would contribute to the difficulty in detecting and monitoring them.¹¹⁷ If these plants were large enough to produce substantial quantities (5 tonnes p.a.) it has been judged¹¹⁸ that they would likely be detected by the 'larger intelligence effort' including analysis of human intelligence and communications intercepts, for example. Facilities capable of producing much smaller, but for many countries still militarily significant quantities of uranium would, however, be substantially harder to find in a timely fashion. Given the data in section IV on the number of states *known* to be involved in research and active planning of deployment of laser enrichment facilities, a primary and increasing concern regarding the proliferation of nuclear weapon capabilities is thus the possible construction of clandestine laser enrichment facilities.

The CRISLA process

In this context, one prominent cause for concern, should its developers' claims be borne out, is the CRISLA process. The apparatus size, about 7 m in length, its modular design, and the fact that it reportedly employs less complex technology than AVLIS¹¹⁹ carry obvious proliferation concerns. The fact that the Chinese have used published drawings to construct a model of the same design demonstrates this inherent proliferation danger. This particular example illustrates that, although almost two decades of US research on AVLIS have not yet resulted in plant construction, it must be emphasized that the stated purpose of the LLNL uranium enrichment programme in the USA is 'to prove, by *large-scale* technology demonstrations, the *economic viability* of uranium enrichment for commercial reactor fuel'¹²⁰—considerations which may not be very important for other potential developers, in particular countries planning to produce a few nuclear weapons.

This point is further illustrated by the fact that workers at Avco-Everett, an earlier developer of the AVLIS-type laser process, 'had produced a small quantity of 50 percent enriched uranium in one pass through their apparatus'¹²¹ within four months of filing a patent application in 1970. Also, in 1979, before R&D was moved to the Livermore government laboratories,

¹¹⁶ *Science*, vol. 183 (note 34), pp. 1172–73.

¹¹⁷ EWDA/89 (note 3), p. 1196; DOE-UEP (note 69), p. 192.

¹¹⁸ von Hippel, F., Albright, D.H., Levi, B.G., 'Stopping the production of fissile materials for weapons', *Scientific American*, vol. 253, no. 3 (Sep. 1985), pp. 32–33.

¹¹⁹ Note 50, p. 4.

¹²⁰ 'Laser technology', *Energy and Technology Review*, July/Aug. 1989, p. 20; emphasis added.

¹²¹ Palmer and Bolef (note 8), p. 26.

Standard Oil of New Jersey (now the Exxon corporation) had joined with Avco to form Jersey Nuclear-Avco Isotopes (JNAI) which felt that construction of a demonstration plant, if begun in 1981, could be completed by 1983. The US Government wanted to continue to do more research first and these plans never came to fruition, but they illustrate that there are likely to be more rapid routes to a deployed laser enrichment facility than that taken by large government projects—routes which would be more tempting for countries interested in a relatively small, but nonetheless significant capability.

Further concerns

It has been predicted that AVLIS, because of its projected lower cost, will possibly force world enrichment prices down in the future. In addition, developers of the process are predicting that, because the feed and product material is quite different from the UF_6 gas used in most of today's separation, AVLIS will change the nuclear fuel cycle.¹²² Thus should the AVLIS approach gain a foothold there will be potential economic and logistical incentives likely to further the spread of this laser enrichment technology to other nations interested in a share of the world uranium market. A danger from the proliferation standpoint then arises that laser technology could lead to the production of HEU and its subsequent mixing with depleted tails or natural uranium for LWR fuel, creating the danger of diversion to weapon production. (Of course, if this HEU were being produced for reactors utilizing HEU, there is a diversion potential independent of the materials source.)¹²³ The DOE does, in fact, acknowledge proliferation to be a primary concern in connection with laser enrichment and has stated a desire to focus much attention on this, as they have tried to do with diffusion and the gas centrifuge.¹²⁴

Safeguards

Employing AVLIS for uranium enrichment will require the development of new safeguards methods and devices, a fact which has been acknowledged by the USA.¹²⁵ A former divisional director in the IAEA Department of Safeguards sees no difficulty in developing safeguards for uranium enrichment plants using laser methods and expects them to progress as the technology itself matures.¹²⁶ The inventory at any one time would be relatively small and the sensitive enrichment technology is confined to one step. The

¹²² Hiruo, E., '10-year enrichment services pacts may be outdated, ex-DOE official says', *Nuclear Fuel*, vol. 13, no. 10 (16 May 1988), p. 11.

¹²³ Greenwood, T., Rathjens, G. W. and Ruina, J., 'Nuclear power and weapons proliferation', *Adelphi Paper*, no. 130 (IISS: London, 1977), p. 28.

¹²⁴ DOE-CST/87 (note 61), p. 36

¹²⁵ EWDA/89 (note 3), p. 1229

¹²⁶ Seneviratne, G., 'Former IAEA official warns of problems ahead for IAEA safeguards regime', *Nuclear Fuel*, vol. 12, no. 2 (26 Jan. 1987), p. 10.

major safeguards problem is believed to be the above-mentioned construction of small clandestine HEU production facilities.¹²⁷

On the other hand, a senior Western safeguards official believes that the laser upgrading of plutonium, by blurring the civilian–military distinction in relation to nuclear energy, would ‘pose a major challenge to the international safeguards regime’.¹²⁸ Facilities like the proposed SIS plant would require substantial new efforts on the part of the IAEA, as safeguards would be needed for the large amounts of ²⁴⁰Pu and ²⁴¹Pu which would be produced in addition to the ²³⁹Pu.¹²⁹

The question of the development of export controls for critical elements of laser isotope separation is also important. A recent US Government report has stated that while ‘equipment for economic production of LEU or HEU is readily distinguishable from that needed for most other applications . . . it could be difficult to detect and hence control the export of equipment suitable for AVLIS smaller scale experimentation’.¹³⁰ Clearly this issue merits further investigation, and with the advent of newer approaches employing less sophisticated technology, such as CRISLA, the problem could become more acute.

VI. Outlook

The 1990s will undoubtedly see many important developments in laser enrichment technology. The cancellation of SIS construction must be seen as a positive development, opening new possibilities for bilateral fissile material cut-off proposals. However, regarding uranium laser enrichment, the developments of the past two decades have shown the technology to be advanced to the point at which some countries are on the verge of making decisions on full-scale laser enrichment plant construction and many others are considering deployment of demonstration or prototype facilities. The precedent-setting nature of developments in more technologically advanced nations, coupled with new potentially more accessible methods of laser isotope separation, is a combination which gives particular cause for concern with regard to nuclear weapon proliferation.

Clearly these issues merit further attention as the 1990 NPT Review Conference approaches and, perhaps more importantly, in the analysis and discussion preceding the 1995 NPT Extension Conference—a crucial juncture for the NPT regime.

¹²⁷ von Baeckmann, A., ‘Modern fuel cycle technologies: challenges to IAEA safeguards?’, in *New Technology, the NPT and the IAEA Safeguards System, Programme for Promoting Nuclear Non-Proliferation*, Occasional Paper 4 (Centre for International Policy Studies: Southampton, Oct. 1989), p. 9.

¹²⁸ Hibbs, M. and MacLachlan, A., ‘Soviet Union postpones completion of Siberian reprocessing plant’, *Nuclear Fuel*, vol. 14, no. 21 (16 Oct. 1989), p. 2.

¹²⁹ Letter of NCI to Sam Nunn (note 9), p. 2.

¹³⁰ Note 57, p. 165.

Appendix A. Treaty on the Non-Proliferation of Nuclear Weapons

*Signed at London, Moscow and
Washington on 1 July 1968
Entered into force on 5 March 1970
Depositaries: UK, UK and Soviet
governments*

The States concluding this Treaty, hereinafter referred to as the 'Parties to the Treaty',

Considering the devastation that would be visited upon all mankind by a nuclear war and the consequent need to make every effort to avert the danger of such a war and to take measures to safeguard the security of peoples,

Believing that the proliferation of nuclear weapons would seriously enhance the danger of nuclear war,

In conformity with resolutions of the United Nations General Assembly calling for the conclusion of an agreement on the prevention of wider dissemination of nuclear weapons,

Undertaking to co-operate in facilitating the application of International Atomic Energy Agency safeguards on peaceful nuclear activities,

Expressing their support for research, development and other efforts to further the application, within the framework of the International Atomic Energy Agency safeguards system, of the principle of safeguarding effectively the flow of source and special fissionable materials by use of instruments and other techniques at certain strategic points,

Affirming the principle that the benefits of peaceful applications of nuclear technology, including any technological by-products which may be derived by nuclear-weapon States from the development of nuclear explosive devices, should be available for peaceful purposes to all Parties to the Treaty, whether nuclear-weapon or non-nuclear-weapon States,

Convinced that, in furtherance of this principle, all Parties to the Treaty are entitled to participate in the fullest possible exchange of scientific information for, and to contribute alone or in co-operation with other States to, the further development of the applications of atomic energy for peaceful purposes,

Declaring their intention to achieve at the earliest possible date the cessation of the nuclear arms race and to undertake effective measures in the direction of nuclear disarmament,

Urging the co-operation of all States in the attainment of this objective,

Recalling the determination expressed by the Parties to the 1963 Treaty banning nuclear weapon tests in the atmosphere, in outer space and under water in its Preamble to seek to achieve the discontinuance of all test explosions of nuclear weapons for all time and to continue negotiations to this end,

Desiring to further the easing of international tension and the strengthening of trust between States in order to facilitate the cessation of the manufacture of nuclear weapons, the liquidation of all their existing stockpiles, and the elimination from national arsenals of nuclear weapons and the means of their delivery pursuant to a Treaty on general and complete disarmament under strict and effective international control,

Recalling that, in accordance with the Charter of the United Nations, States must refrain in their international relations from the threat or use of force against the territorial integrity or political independence of any State, or in any other manner inconsistent with the Purposes of the United Nations, and that the establishment and maintenance of international peace and security are to be promoted with the least diversion for armaments of the world's human and economic resources,

Have agreed as follows:

Article I

Each nuclear-weapon State Party to the Treaty undertakes not to transfer to any recipient whatsoever nuclear weapons or other nuclear explosive devices or control over such weapons or explosive devices directly, or indirectly; and not in any way to assist, encourage, or induce any non-nuclear-weapon State to manufacture or otherwise acquire nuclear weapons or other nuclear explosive devices, or control over such weapons or explosive devices.

Article II

Each non-nuclear-weapon State Party to the Treaty undertakes not to receive the transfer from any transferor whatsoever of nuclear weapons or other nuclear explosive devices or of control over such weapons or explosive devices directly, or indirectly; not to manufacture or otherwise acquire nuclear weapons or other nuclear explosive devices; and not to seek or receive any assistance in the manufacture of nuclear weapons or other nuclear explosive devices.

Article III

1. Each non-nuclear-weapon State Party to the Treaty undertakes to accept the safeguards, as set forth in an agreement to be negotiated and concluded with the International Atomic Energy Agency in accordance with the Statute of the International Atomic Energy Agency and the Agency's safeguards system, for the exclusive purpose of verification of the fulfilment of its obligations assumed under this Treaty with a view to preventing diversion of nuclear energy from peaceful uses to nuclear weapons or other nuclear explosive devices. Procedures for the safeguards required by this Article shall be followed with respect to source or special fissionable material whether it is being produced, processed or used in any principal nuclear facility or is outside any such facility. The safeguards required by this Article shall be applied on all source or special fissionable material in all peaceful nuclear activities within the territory of such State, under its jurisdiction, or carried out under its control anywhere.

2. Each State Party to the Treaty undertakes not to provide: (a) source or special fissionable material; or (b) equipment or material especially designed or prepared for the processing, use or production of special fissionable material, to any non-nuclear-weapon State for peaceful purposes, unless the source or special fissionable material shall be subject to the safeguards required by this Article.

3. The safeguards required by this Article shall be implemented in a manner designed to comply with Article IV of this Treaty, and to avoid hampering the economic or technological development of the Parties or international co-operation in the field of peaceful nuclear activities, including the international exchange of nuclear material and equipment for the processing,

use or production of nuclear material for peaceful purposes in accordance with the provisions of this Article and the principle of safeguarding set forth in the Preamble of the Treaty.

4. Non-nuclear-weapon States Party to the Treaty shall conclude agreements with the International Atomic Energy Agency to meet the requirements of this Article either individually or together with other States in accordance with the Statute of the International Atomic Energy Agency. Negotiation of such agreements shall commence within 180 days from the original entry into force of this Treaty. For States depositing their instruments of ratification or accession after the 180-day period, negotiation of such agreements shall commence not later than the date of such deposit. Such agreements shall enter into force not later than eighteen months after the date of initiation of negotiations.

Article IV

1. Nothing in this Treaty shall be interpreted as affecting the inalienable right of all the Parties to the Treaty to develop research, production and use of nuclear energy for peaceful purposes without discrimination and in conformity with Articles I and II of this Treaty.

2. All the Parties to the Treaty undertake to facilitate, and have the right to participate in, the fullest possible exchange of equipment, materials and scientific and technological information for the peaceful uses of nuclear energy. Parties to the Treaty in a position to do so shall also cooperate in contributing alone or together with other States or international organizations to the further development of the application of nuclear energy for peaceful purposes, especially in the territories of non-nuclear-weapon States Party to the Treaty, with due consideration for the needs of the developing areas of the world.

Article V

Each Party to the Treaty undertakes to take appropriate measures to ensure that, in accordance with this Treaty, under appropriate international observation and through appropriate international procedures, potential benefits from any peaceful applications of nuclear explosions will be made available to non-nuclear weapon States Party to the Treaty on a non-discriminatory basis and that the charge to such Parties for the explosive devices used will be as low as possible and exclude any

charge for research and development. Non-nuclear-weapon States Party to the Treaty shall be able to obtain such benefits, pursuant to a special international agreement or agreements, through an appropriate international body with adequate representation of non-nuclear-weapon States. Negotiations on this subject shall commence as soon as possible after the Treaty enters into force. Non-nuclear-weapon States Party to the Treaty so desiring may also obtain such benefits pursuant to bilateral agreements.

Article VI

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

Article VII

Nothing in this Treaty affects the right of any group of States to conclude regional treaties in order to assure the total absence of nuclear weapons in their respective territories.

Article VIII

1. Any Party to the Treaty may propose amendments to this Treaty. The text of any proposed amendment shall be submitted to the Depositary Governments which shall circulate it to all Parties to the Treaty. Thereupon, if requested to do so by one-third or more of the Parties to the Treaty, the Depositary Governments shall convene a conference, to which they shall invite all the Parties to the Treaty, to consider such an amendment.

2. Any amendment to this Treaty must be approved by a majority of the votes of all the Parties to the Treaty, including the votes of all nuclear-weapon States Party to the Treaty and all other Parties which, on the date the amendment is circulated, are members of the Board of Governors of the International Atomic Energy Agency. The amendment shall enter into force for each Party that deposits its instrument of ratification of the amendment upon the deposit of such instruments of ratification by a majority of all the Parties, including the instruments of ratification of all nuclear-weapon States Party to the Treaty and all other Parties which, on the date the amendment is circulated, are members of the Board of Governors of the International

Atomic Energy Agency. Thereafter, it shall enter into force for any other Party upon the deposit of its instrument of ratification of the amendment.

3. Five years after the entry into force of this Treaty, a conference of Parties to the Treaty shall be held in Geneva, Switzerland, in order to review the operation of this Treaty with a view to assuring that the purposes of the Preamble and the provisions of the Treaty are being realised. At intervals of five years thereafter, a majority of the Parties to the Treaty may obtain, by submitting a proposal to this effect to the Depositary Governments, the convening of further conferences with the same objective of reviewing the operation of the Treaty.

Article IX

1. This Treaty shall be open to all States for signature. Any State which does not sign the Treaty before its entry into force in accordance with paragraph 3 of this Article may accede to it at any time.

2. This Treaty shall be subject to ratification by signatory States. Instruments of ratification and instruments of accession shall be deposited with the Governments of the United Kingdom of Great Britain and Northern Ireland, the Union of Soviet Socialist Republics and the United States of America, which are hereby designated the Depositary Governments.

3. This treaty shall enter into force after its ratification by the States, the Governments of which are designated Depositaries of the Treaty, and forty other States signatory to this Treaty and the deposit of their instruments of ratification. For the purposes of this Treaty, a nuclear-weapon State is one which has manufactured and exploded a nuclear weapon or other nuclear explosive device prior to 1 January, 1967.

4. For States whose instruments of ratification or accession are deposited subsequent to the entry into force of this Treaty, it shall enter into force on the date of the deposit of their instruments of ratification or accession.

5. The Depositary Governments shall promptly inform all signatory and acceding States of the date of each signature, the date of deposit of each instrument of ratification or of accession, the date of the entry into force of this Treaty, and the date of receipt of any requests for convening a conference or other notices.

6. This Treaty shall be registered by the Depositary Governments pursuant to Article 102 of the Charter of the United Nations.

Article X

1. Each Party shall in exercising its national sovereignty have the right to withdraw from the Treaty if it decides that extraordinary events, related to the subject matter of this Treaty, have jeopardized the supreme interests of its country. It shall give notice of such withdrawal to all other Parties to the Treaty and to the United Nations Security Council three months in advance. Such notice shall include a statement of the extraordinary events it regards as having jeopardized its supreme interests.

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

Article XI

This Treaty, the English, Russian, French, Spanish and Chinese texts of which are equally authentic, shall be deposited in the archives of the Depositary Governments. Duly certified copies of this Treaty shall be transmitted by the Depositary Governments to the Governments of the signatory and acceding States.

Source: Treaty Series, Vol. 729 (United Nations, New York).

For the list of states which have signed, ratified, acceded or succeeded to the NPT, see appendix B.

Appendix B. Implementation of the Non-Proliferation Treaty, the Treaty of Tlatelolco and the Treaty of Rarotonga

RAGNHILD FERM

For the full text of the NPT, see appendix A; for the texts of the Treaties of Tlatelolco and Rarotonga, see Goldblat, J., SIPRI, *Agreements for Arms Control: A Critical Survey* (Taylor & Francis: London, 1982).

I. Summaries of the agreements

Treaty on the non-proliferation of nuclear weapons (NPT)

Signed at London, Moscow and Washington on 1 July 1968; entered into force on 5 March 1970.

Prohibits the transfer by nuclear weapon states, to any recipient whatsoever, of nuclear weapons or other nuclear explosive devices or of control over them, as well as the assistance, encouragement or inducement of any non-nuclear weapon state to manufacture or otherwise acquire such weapons or devices. Prohibits the receipt by non-nuclear weapon states from any transferor whatsoever, as well as the manufacture or other acquisition by those states of nuclear weapons or other nuclear explosive devices.

Non-nuclear weapon states undertake to conclude safeguard agreements with the International Atomic Energy Agency (IAEA) with a view to preventing diversion of nuclear energy from peaceful uses to nuclear weapons or other nuclear explosive devices.

The parties undertake to facilitate the exchange of equipment, materials and scientific and technological information for the peaceful uses of nuclear energy and to ensure that potential benefits from peaceful applications of nuclear explosions will be made available to non-nuclear weapon parties to the Treaty. They also undertake to pursue negotiations in good faith on effective measures relating to cessation of the nuclear arms race at an early date and to nuclear disarmament, and on a treaty on general and complete disarmament.

Twenty-five years after the entry into force of the Treaty (1995), a conference shall be convened to decide whether the Treaty shall continue in force indefinitely or shall be extended for an additional fixed period or periods.

Treaty for the prohibition of nuclear weapons in Latin America (Treaty of Tlatelolco)

Signed at Mexico City on 14 February 1967; entered into force on 22 April 1968.

Prohibits the testing, use, manufacture, production or acquisition by any means, as well as the receipt, storage, installation, deployment and any form of possession of any nuclear weapons by Latin American countries.

The parties should conclude agreements with the IAEA for the application of safeguards to their nuclear activities.

Under *Additional Protocol I* the extra-continental or continental states which, *de jure* or *de facto*, are internationally responsible for territories lying within the limits of the geographical zone established by the Treaty (France, the Netherlands, the UK and the USA) undertake to apply the statute of military denuclearization, as defined in the Treaty, to such territories.

Under *Additional Protocol II* the nuclear weapon states undertake to respect the statute of military denuclearization of Latin America, as defined and delimited in the Treaty, and not to contribute to acts involving a violation of the Treaty, nor to use or threaten to use nuclear weapons against the parties to the Treaty.

South Pacific Nuclear Free Zone Treaty (Treaty of Rarotonga)

Signed at Rarotonga, Cook Islands, on 6 August 1985; entered into force on 11 December 1986.

Prohibits the manufacture or acquisition by other means of any nuclear explosive device, as well as possession or control over such device by the parties anywhere inside or outside the zone area described in an annex. The parties also undertake not to supply nuclear material or equipment unless subject to IAEA safeguards; and to prevent in their territories the stationing as well as the testing of any nuclear explosive device. Each party remains free to allow visits, as well as transit, by foreign ships and aircraft.

Under Protocol 1, France, the UK and the USA would undertake to apply the treaty prohibitions relating to the manufacture, stationing and testing of nuclear explosive devices in the territories situated within the zone, for which they are internationally responsible.

Under Protocol 2, China, France, the UK, the USA and the USSR would undertake not to use or threaten to use a nuclear explosive device against the parties to the treaty or against any territory within the zone for which a party to Protocol 1 is internationally responsible.

Under Protocol 3, China, France, the UK, the USA and the USSR would undertake not to test any nuclear explosive device anywhere within the zone.

II. Status of the implementation, as of 1 January 1990

Number of parties

| | |
|---|-----|
| Non-Proliferation Treaty | 141 |
| NPT safeguards agreements (non-nuclear weapon states) | 82 |
| Treaty of Tlatelolco | 23 |
| Additional Protocol I | 3 |
| Additional Protocol II | 5 |
| Treaty of Rarotonga | 11 |
| Protocol 1 | 0 |
| Protocol 2 | 2 |
| Protocol 3 | 2 |

Notes

1. The table records year of ratification, accession or succession.

2. The Non-Proliferation Treaty provides for three depositaries—the governments of the UK, the USA and the USSR. The dates given for these agreements are the earliest date on which countries deposited their instruments of ratification, accession or succession—whether in London, Washington or Moscow.

3. The Non-Proliferation Treaty is open for all states for signature.

The Treaty of Tlatelolco is open for signature by all the Latin American republics; all other sovereign states situated in their entirety south of latitude 35° north in the western hemisphere; and (except for a political entity the territory of which is the subject of an international dispute) all such states which become sovereign, when they have been admitted by the General Conference; Additional Protocol I—by 'all extra-continental or continental states having *de jure* or *de facto* international responsibility for territories situated in the zone of application of the Treaty'; Additional Protocol II—by 'all powers possessing nuclear weapons', that is, the USA, the USSR, the UK, France and China.

The Treaty of Rarotonga is open for signature by members of the South Pacific Forum; Protocol 1—by France, the UK and the USA; Protocol 2—by France, China, the USSR, the UK and the USA; Protocol 3—by France, China, the USSR, the UK and the USA.

4. Key to abbreviations used in the table:

S: Signature without further action

PI, PII: Additional Protocols to the Treaty of Tlatelolco

P1, P2, P3: Protocols to the Treaty of Rarotonga

SA: Nuclear safeguards agreement in force with the International Atomic Energy Agency as required by the Non-Proliferation Treaty or the Treaty of Tlatelolco, or concluded by a nuclear weapon state on a voluntary basis.

5. Footnotes to the table are on pp. 86–91.

THE NPT: PROSPECTS AND DANGERS IN 1990 79

| State | Non-Proliferation Treaty | Treaty of Tlatelolco | Treaty of Rarotonga |
|---------------------|--------------------------|----------------------|---------------------|
| Afghanistan | 1970 SA | | |
| Antigua and Barbuda | 1985 ¹ | 1983 ² | |
| Argentina | | S ¹ | |
| Australia | 1973 SA | | 1986 |
| Austria | 1969 SA | | |
| Bahamas | 1976 ¹ | 1977 ² | |
| Bahrain | 1988 ² | | |
| Bangladesh | 1979 SA | | |
| Barbados | 1980 | 1969 ² | |
| Belgium | 1975 SA | | |
| Belize | 1985 ¹ | | |
| Benin | 1972 | | |
| Bhutan | 1985 SA | | |
| Bolivia | 1970 | 1969 ² | |
| Botswana | 1969 | | |
| Brazil | | 1968 ¹ | |
| Brunei Darussalam | 1985 SA | | |
| Bulgaria | 1969 SA | | |
| Burkina Faso | 1970 | | |
| Burundi | 1971 | | |
| Cameroon | 1969 | | |

80 THE NPT: PROSPECTS AND DANGERS IN 1990

| State | Non-Proliferation Treaty | Treaty of Tlatelolco | Treaty of Rarotonga |
|--------------------------|--------------------------|---------------------------------------|--|
| Canada | 1969 SA | | |
| Cape Verde | 1979 | | |
| Central African Republic | 1970 | | |
| Chad | 1971 | | |
| Chile | | 1974 ¹ | |
| China | | PII: 1974 ⁵ | P2: 1989 ¹ P3: 1989 ¹ |
| Colombia | 1986 | 1972 ² SA | |
| Congo | 1978 | | |
| Cook Islands | | | 1985 |
| Costa Rica | 1970 SA | 1969 ² SA ¹⁶ | |
| Côte d'Ivoire | 1973 SA | | |
| Cyprus | 1970 SA | | |
| Czechoslovakia | 1969 SA | | |
| Denmark | 1969 SA | | |
| Dominica | 1984 ¹ | S | |
| Dominican Republic | 1971 SA | 1968 ² SA ¹⁶ | |
| Ecuador | 1969 SA | 1969 ² SA ¹⁶ | |
| Egypt | 1981 ³ SA | | |
| El Salvador | 1972 SA | 1968 ² SA ¹⁶ | |

THE NPT: PROSPECTS AND DANGERS IN 1990 81

| State | Non-Proliferation Treaty | Treaty of Tlatelolco | Treaty of Rarotonga |
|----------------------------|--------------------------|--|---------------------|
| Equatorial Guinea | 1984 | | |
| Ethiopia | 1970 SA | | |
| Fiji | 1972 ¹ SA | | 1985 |
| Finland | 1969 SA | | |
| France | * | PI: S ⁶ PII: 1974 ⁷ | |
| Gabon | 1974 | | |
| Gambia | 1975 SA | | |
| German Democratic Republic | 1969 SA | | |
| FR Germany | 1975 ³ SA | | |
| Ghana | 1970 SA | | |
| Greece | 1970 SA | | |
| Grenada | 1975 ¹ | 1975 ² | |
| Guatemala | 1970 SA | 1970 ² SA ¹⁶ | |
| Guinea | 1985 | | |
| Guinea-Bissau | 1976 | | |
| Haiti | 1970 | 1969 ² | |
| Holy See (Vatican City) | 1971 ⁶ SA | | |
| Honduras | 1973 SA | 1968 ² SA ¹⁶ | |
| Hungary | 1969 SA | | |

82 THE NPT: PROSPECTS AND DANGERS IN 1990

| State | Non-Proliferation Treaty | Treaty of Tlatelolco | Treaty of Rarotonga |
|--|------------------------------|---------------------------------------|---------------------|
| Iceland | 1969 SA | | |
| Indonesia | 1979 ⁷ SA | | |
| Iran | 1970 SA | | |
| Iraq | 1969 SA | | |
| Ireland | 1968 SA | | |
| Italy | 1975 ⁸ SA | | |
| Jamaica | 1970 SA | 1969 ² SA ¹⁶ | |
| Japan | 1976 ⁹ SA | | |
| Jordan | 1970 SA | | |
| Kampuchea (Cambodia) | 1972 | | |
| Kenya | 1970 | | |
| Kiribati | 1985 ¹ | | 1986 |
| Korea, Dem. People's Rep. of (North) | 1985 | | |
| Korea, Republic of (South) | 1975 ^{10, 11} SA | | |
| Kuwait | 1989 ¹² | | |
| Lao People's Dem. Republic | 1970 | | |
| Lebanon | 1970 SA | | |
| Lesotho | 1970 SA | | |

THE NPT: PROSPECTS AND DANGERS IN 1990 83

| State | Non-Proliferation Treaty | Treaty of Tlatelolco | Treaty of Rarotonga |
|---------------|--------------------------|---|---------------------|
| Liberia | 1970 | | |
| Libya | 1975 SA | | |
| Liechtenstein | 1978 ¹³ SA | | |
| Luxembourg | 1975 SA | | |
| Madagascar | 1970 SA | | |
| Malawi | 1986 | | |
| Malaysia | 1970 SA | | |
| Maldives | 1970 SA | | |
| Mali | 1970 | | |
| Malta | 1970 | | |
| Mauritius | 1969 SA | | |
| Mexico | 1969 ¹⁴ SA | 1967 ^{2, 8} SA | |
| Mongolia | 1969 SA | | |
| Morocco | 1970 SA | | |
| Nauru | 1982 SA | | 1987 |
| Nepal | 1970 SA | | |
| Netherlands | 1975 SA | PI: 1971 ⁹ SA ¹⁷ | |
| New Zealand | 1969 SA | | 1986 |
| Nicaragua | 1973 SA | 1968 ^{2, 10} SA ¹⁶ | |

84 THE NPT: PROSPECTS AND DANGERS IN 1990

| State | Non-Proliferation Treaty | Treaty of Tlatelolco | Treaty of Rarotonga |
|----------------------------------|--------------------------|---------------------------------------|---------------------|
| Nigeria | 1968 SA | | |
| Niue | | | 1986 |
| Norway | 1969 SA | | |
| Panama | 1977 | 1971 ² SA | |
| Papua New Guinea | 1982 SA | | 1989 |
| Paraguay | 1970 SA | 1969 ² SA ¹⁶ | |
| Peru | 1970 SA | 1969 ² SA ¹⁶ | |
| Philippines | 1972 SA | | |
| Poland | 1969 SA | | |
| Portugal | 1977 SA | | |
| Qatar | 1989 | | |
| Romania | 1970 SA | | |
| Rwanda | 1975 | | |
| Saint Lucia | 1979 ¹ | | |
| Saint Vincent and the Grenadines | 1984 ¹ | | |
| Samoa, Western | 1975 SA | | 1986 |
| San Marino | 1970 ¹⁰ | | |
| Sao Tome and Principe | 1983 | | |
| Saudi Arabia | 1988 | | |

| State | Non-Proliferation Treaty | Treaty of Tlatelolco | Treaty of Rarotonga |
|---------------------|--------------------------|---------------------------------------|---------------------|
| Senegal | 1970 SA | | |
| Seychelles | 1985 | | |
| Sierra Leone | 1975 | | |
| Singapore | 1976 SA | | |
| Solomon Islands | 1981 ¹ | | 1989 |
| Somalia | 1970 | | |
| Spain | 1987 SA | | |
| Sri Lanka | 1979 SA | | |
| Sudan | 1973 SA | | |
| Suriname | 1976 ¹ SA | 1977 ² SA ¹⁶ | |
| Swaziland | 1969 SA | | |
| Sweden | 1970 SA | | |
| Switzerland | 1977 ¹³ SA | | |
| Syria | 1969 ¹⁰ | | |
| Taiwan | 1970 | | |
| Thailand | 1972 SA | | |
| Togo | 1970 | | |
| Tonga | 1971 ¹ | | |
| Trinidad and Tobago | 1986 | 1970 ² | |
| Tunisia | 1970 | | |

| State | Non-Proliferation Treaty | Treaty of Tlatelolco | Treaty of Rarotonga |
|------------------------------|--|---|--|
| Turkey | 1980 ¹⁵ SA | | |
| Tuvalu | 1979 ¹ | | 1986 |
| Uganda | 1982 | | |
| UK | 1968 ¹⁶ SA ¹⁷ | PI: 1969 ¹¹ PII: 1969 ¹¹ | |
| Uruguay | 1970 SA | 1968 ² SA ¹⁶ | |
| USA | 1970 SA ¹⁸ | PI: 1981 ¹² PII: 1971 ¹³ SA ¹⁷ | |
| USSR | 1970 SA ¹⁹ | PII: 1979 ¹⁴ | P2: 1988 ² P3: 1988 ² |
| Venezuela | 1975 SA | 1970 ^{2, 15} SA ¹⁶ | |
| Viet Nam | 1982 | | |
| Yemen Arab Republic | 1986 | | |
| Yemen, People's Dem. Rep. of | 1979 | | |
| Yugoslavia | 1970 ²⁰ SA | | |
| Zaire | 1970 SA | | |

The Non-Proliferation Treaty

¹ Notification of succession.

² Bahrain declared that its accession to the Treaty shall in no way constitute recognition of Israel or be a cause of establishment of any relations of any kind therewith.

³ On the occasion of the deposit of the instrument of ratification, Egypt stated that since it was embarking on the construction of nuclear power reactors, it expected assistance and support from industrialized nations with a developed nuclear industry. It called upon nuclear weapon states to promote research and development of peaceful applications of nuclear explosions in order to overcome all the difficulties at present involved therein. Egypt also appealed to these states to exert their efforts to conclude an agreement prohibiting the use or threat of use of nuclear weapons against any state, and expressed the view that the Middle East should remain completely free of nuclear weapons.

⁴ France, not party to the Treaty, declared that it would behave like a state adhering to the Treaty and that it would follow a policy of strengthening appropriate safeguards relating to nuclear equipment, material and technology. On 12 Sep. 1981 an agreement between France, the European Atomic Energy Community (Euratom) and the IAEA for the application of safeguards in France

entered into force. The agreement covers nuclear material and facilities notified to the IAEA by France.

⁵ On depositing the instrument of ratification, FR Germany reiterated the declaration made at the time of signing: it reaffirmed its expectation that the nuclear weapon states would intensify their efforts in accordance with the undertakings under Article VI of the Treaty, as well as its understanding that the security of FR Germany continued to be ensured by NATO; it stated that no provision of the Treaty may be interpreted in such a way as to hamper further development of European unification; that research, development and use of nuclear energy for peaceful purposes, as well as international and multinational co-operation in this field, must not be prejudiced by the Treaty; that the application of the Treaty, including the implementation of safeguards, must not lead to discrimination of the nuclear industry of FR Germany in international competition; and that it attached vital importance to the undertaking given by the USA and the UK concerning the application of safeguards to their peaceful nuclear facilities, hoping that other nuclear weapon states would assume similar obligations.

In a separate note, FR Germany declared that the Treaty will also apply to Berlin (West) without affecting Allied rights and responsibilities, including those relating to demilitarization. In notes of 24 July, 19 Aug. and 25 Nov. 1975, respectively, addressed to the US Department of State, Czechoslovakia, the USSR and the GDR stated that this declaration by FR Germany had no legal effect.

⁶ On acceding to the Treaty, the Holy See stated, *inter alia*, that the Treaty will attain in full the objectives of security and peace and justify the limitations to which the states party to the Treaty submit, only if it is fully executed in every clause and with all its implications. This concerns not only the obligations to be applied immediately but also those which envisage a process of ulterior commitments. Among the latter, the Holy See considers it suitable to point out the following: (a) The adoption of appropriate measures to ensure, on a basis of equality, that all non-nuclear weapon states party to the Treaty will have available to them the benefits deriving from peaceful applications of nuclear technology. (b) The pursuit of negotiations in good faith of effective measures relating to cessation of the nuclear arms race at an early date and to nuclear disarmament, and on a treaty on general and complete disarmament under strict and effective control.

⁷ On signing the Treaty, Indonesia stated, *inter alia*, that it attaches great importance to the declarations of the USA, the UK and the USSR affirming their intention to provide immediate assistance to any non-nuclear weapon state party to the Treaty that is a victim of an act of aggression in which nuclear weapons are used. Of utmost importance, however, is not the action *after* a nuclear attack has been committed but the guarantees to prevent such an attack. Indonesia trusts that the nuclear weapon states will study further this question of effective measures to ensure the security of the non-nuclear weapon states. On depositing the instrument of ratification, Indonesia expressed the hope that the nuclear countries would be prepared to co-operate with non-nuclear countries in the use of nuclear energy for peaceful purposes and implement the provisions of Article IV of the Treaty without discrimination. It also stated the view that the nuclear weapon states would observe the provisions of Article VI of the Treaty relating to the cessation of the nuclear arms race.

⁸ Italy stated that in its belief nothing in the Treaty was an obstacle to the unification of the countries of Western Europe; it noted full compatibility of the Treaty with the existing security agreements; it noted further that when technological progress would allow the development of peaceful explosive devices different from nuclear weapons, the prohibition relating to their manufacture and use shall no longer apply; it interpreted the provisions of Article IX, paragraph 3 of the Treaty, concerning the definition of a nuclear weapon state, in the sense that it referred exclusively to the five countries which had manufactured and exploded a nuclear weapon or other nuclear explosive device prior to 1 Jan. 1967, and stressed that under no circumstance would a claim of pertaining to such category be recognized by Italy for any other state.

⁹ On depositing the instrument of ratification, Japan expressed the hope that France and China would accede to the Treaty; it urged a reduction of nuclear armaments and a comprehensive ban on nuclear testing; appealed to all states to refrain from the threat or use of force involving either nuclear or non-nuclear weapons; expressed the view that peaceful nuclear activities in non-nuclear weapon states party to the Treaty should not be hampered and that Japan should not be discriminated against in favour of other parties in any aspect of such activities. It also urged all nuclear weapon states to accept IAEA safeguards on their peaceful nuclear activities.

¹⁰ A statement was made containing a disclaimer regarding the recognition of states party to the Treaty.

¹¹ On depositing the instrument of ratification, the Republic of Korea took note of the fact that the depositary governments of the three nuclear weapon states had made declarations in June 1968 to take immediate and effective measures to safeguard any non-nuclear weapon state which is a victim of an act or an object of a threat of aggression in which nuclear weapons are used. It recalled that the UN Security Council adopted a resolution to the same effect on 19 June 1968.

¹² On depositing the instruments of ratification, Kuwait declared that the ratification of the Treaty does not mean in any way a recognition of Israel. No treaty relation will arise between Kuwait and Israel.

¹³ On depositing the instruments of accession and ratification, Liechtenstein and Switzerland stated that activities not prohibited under Articles I and II of the Treaty include, in particular, the whole field of energy production and related operations, research and technology concerning future generations of nuclear reactors based on fission or fusion, as well as production of isotopes. Liechtenstein and Switzerland define the term 'source or special fissionable material' in Article III of the Treaty as being in accordance with Article XX of the IAEA Statute, and a modification of this interpretation requires their formal consent; they will accept only such interpretations and definitions of the terms 'equipment or material especially designed or prepared for the processing, use or production of special fissionable material', as mentioned in Article III of the Treaty, that they will expressly approve; and they understand that the application of the Treaty, especially of the control measures, will not lead to discrimination of their industry in international competition.

¹⁴ On signing the Treaty, Mexico stated, *inter alia*, that none of the provisions of the Treaty shall be interpreted as affecting in any way whatsoever the rights and obligations of Mexico as a state party to the Treaty of Tlatelolco.

It is the understanding of Mexico that at the present time any nuclear explosive device is capable of being used as a nuclear weapon and that there is no indication that in the near future it will be possible to manufacture nuclear explosive devices that are not potentially nuclear weapons. However, if technological advances modify this situation, it will be necessary to amend the relevant provisions of the Treaty in accordance with the procedure established therein.

¹⁵ The ratification was accompanied by a statement in which Turkey underlined the non-proliferation obligations of the nuclear weapon states, adding that measures must be taken to meet adequately the security requirements of non-nuclear weapon states. Turkey also stated that measures developed or to be developed at national and international levels to ensure the non-proliferation of nuclear weapons should in no case restrict the non-nuclear weapon states in their option for the application of nuclear energy for peaceful purposes.

¹⁶ The UK recalled its view that if a regime is not recognized as the government of a state, neither signature nor the deposit of any instrument by it, nor notification of any of those acts, will bring about recognition of that regime by any other state.

¹⁷ This agreement, signed by the UK, Euratom and the IAEA, provides for the submission of British non-military nuclear installations to safeguards under IAEA supervision.

¹⁸ This agreement provides for safeguards on fissionable material in all facilities within the USA, excluding those associated with activities of direct national security significance.

¹⁹ The agreement provides for the application of IAEA safeguards in Soviet peaceful nuclear facilities designated by the USSR.

²⁰ In connection with the ratification of the Treaty, Yugoslavia stated, *inter alia*, that it considered a ban on the development, manufacture and use of nuclear weapons and the destruction of all stockpiles of these weapons to be indispensable for the maintenance of a stable peace and international security; it held the view that the chief responsibility for progress in this direction rested with the nuclear weapon powers, and expected these powers to undertake not to use nuclear weapons against the countries which have renounced them as well as against non-nuclear weapon states in general, and to refrain from the threat to use them. It also emphasized the significance it attached to the universality of the efforts relating to the realization of the Non-Proliferation Treaty.

The Treaty of Tlatelolco

¹ On signing the Treaty, Argentina stated that it understands Article 18 as recognizing the rights of parties to carry out, by their own means or in association with third parties, explosions of nuclear devices for peaceful purposes, including explosions which involve devices similar to those used in nuclear weapons.

² The Treaty is in force for this country due to a declaration, annexed to the instrument of ratification in accordance with Article 28, paragraph 2, which waived the requirements for the entry into force of the Treaty, specified in paragraph 1 of that Article: namely, that all states in the region deposit the instruments of ratification; that Protocol I and Protocol II be signed and ratified by those states to which they apply; and that agreements on safeguards be concluded with the IAEA. (Colombia made this declaration subsequent to the deposit of ratification, as did Nicaragua and Trinidad and Tobago.)

³ On signing the Treaty, Brazil stated that, according to its interpretation, Article 18 of the Treaty gives the signatories the right to carry out, by their own means or in association with third parties, nuclear explosions for peaceful purposes, including explosions which involve devices similar to those used in nuclear weapons. This statement was reiterated at the ratification. Brazil also stated that it did

not waive the requirements for the entry into force of the Treaty laid down in Article 28. *The Treaty is therefore not yet in force for Brazil.*

⁴ Chile has not waived the requirements for the entry into force of the Treaty laid down in Article 28. *The Treaty is therefore not yet in force for Chile.*

⁵ On signing Protocol II, China stated, *inter alia*: China will never use or threaten to use nuclear weapons against non-nuclear Latin American countries and the Latin American nuclear weapon-free zone; nor will China test, manufacture, produce, stockpile, install or deploy nuclear weapons in these countries or in this zone, or send its means of transportation and delivery carrying nuclear weapons to cross the territory, territorial sea or airspace of Latin American countries. The signing of the Protocol does not imply any change whatsoever in China's stand on the disarmament and nuclear weapon issue and, in particular, does not affect its stand against the Non-Proliferation Treaty and the Partial Test Ban Treaty.

China holds that, in order that Latin America may truly become a nuclear weapon-free zone, all nuclear countries, and particularly the superpowers, must undertake not to use or threaten to use nuclear weapons against the Latin American countries and the Latin American nuclear weapon-free zone, and implement the following undertakings: (1) dismantle all foreign military bases in Latin America and refrain from establishing new bases there, and (2) prohibit the passage of any means of transportation and delivery carrying nuclear weapons through Latin American territory, territorial sea or airspace.

⁶ On signing Protocol I, France made the following reservations and interpretative statements: The Protocol, as well as the provisions of the Treaty to which it refers, will not affect the right of self-defence under Article 51 of the UN Charter; the application of the legislation referred to in Article 3 of the Treaty relates to legislation which is consistent with international law; the obligations under the Protocol shall not apply to transit across the territories of the French Republic situated in the zone of the Treaty, and destined to other territories of the French Republic; the Protocol shall not limit, in any way, the participation of the populations of the French territories in the activities mentioned in Article 1 of the Treaty, and in efforts connected with the national defence of France; the provisions of Articles 1 and 2 of the Protocol apply to the text of the Treaty as it stands at the time when the Protocol is signed by France, and consequently no amendment to the Treaty that might come into force under Article 29 thereof would be binding on the government of France without the latter's express consent.

⁷ On signing Protocol II, France stated that it interprets the undertaking contained in Article 3 of the Protocol to mean that it presents no obstacle to the full exercise of the right of self-defence enshrined in Article 51 of the UN Charter; it takes note of the interpretation of the Treaty given by the Preparatory Commission for the Denuclearization of Latin America and reproduced in the Final Act according to which the Treaty does not apply to transit, the granting or denying of which lies within the exclusive competence of each state party in accordance with the pertinent principles and rules of international law; it considers that the application of the legislation referred to in Article 3 of the Treaty relates to legislation which is consistent with international law. The provisions of Articles 1 and 2 of the Protocol apply to the text of the Treaty as it stands at the time when the Protocol is signed by France. Consequently, no amendment to the Treaty that might come into force under the provision of Article 29 would be binding on the government of France without the latter's express consent. This declaration of interpretation is contested in part or in whole by one or more contracting parties to the Treaty or to Protocol II, these instruments would be null and void as far as relations between France and the contesting state or states are concerned. On depositing its instrument of ratification of Protocol II, France stated that it did so subject to the statement made on signing the Protocol. On 1 Apr. 1974, France made a supplementary statement to the effect that it was prepared to consider obligations under Protocol II as applying not only to the signatories of the Treaty, but also to territories for which the statute of denuclearization was in force in conformity with Article 1 of Protocol I.

⁸ On signing the Treaty, Mexico said that if technological progress makes it possible to differentiate between nuclear weapons and nuclear devices for peaceful purposes, it will be necessary to amend the relevant provisions of the Treaty, according to the procedures established therein.

⁹ The Netherlands stated that Protocol I shall not be interpreted as prejudicing the position of the Netherlands as regards its recognition or non-recognition of the rights or of claims to sovereignty over the parties to the Treaty, or of the grounds on which such claims are made.

¹⁰ Nicaragua stated that it reserved the right to use nuclear energy for peaceful purposes such as the removal of earth for the construction of canals, irrigation works, power plants, and so on, as well as to allow the transit of atomic material through its territory.

¹¹ When signing and ratifying Protocol I and Protocol II, the UK made the following declaration of understanding: In connection with Article 3 of the Treaty, defining the term 'territory' as including the territorial sea, airspace and any other space over which the state exercises sovereignty in accordance with 'its own legislation', the UK does not regard its signing or ratification of the

Protocols as implying recognition of any legislation which does not, in its view, comply with the relevant rules of international law.

The Treaty does not permit the parties to carry out explosions of nuclear devices for peaceful purposes unless and until advances in technology have made possible the development of devices for such explosions which are not capable of being used for weapon purposes.

The signing and ratification by the UK could not be regarded as affecting in any way the legal status of any territory for the international relations of which the UK is responsible, lying within the limits of the geographical zone established by the Treaty.

Should any party to the Treaty carry out any act of aggression with the support of a nuclear weapon state, the UK would be free to reconsider the extent to which it could be regarded as committed by the provisions of Protocol II.

In addition, the UK declared that its undertaking under Article 3 of Protocol II not to use or threaten to use nuclear weapons against the parties to the Treaty extends also to territories in respect of which the undertaking under Article I of Protocol I becomes effective.

¹² The USA ratified Protocol I with the following understandings: The provisions of the Treaty made applicable by this Protocol do not affect the exclusive power and legal competence under international law of a state adhering to this Protocol to grant or deny transit and transport privileges to its own or any other vessels or aircraft irrespective of cargo or armaments; the provisions of the Treaty made applicable by this Protocol do not affect rights under international law of a state adhering to this Protocol regarding the exercise of the freedom of the seas, or regarding passage through or over waters subject to the sovereignty of a state, and the declarations attached by the United States to its ratification of Protocol II apply also to its ratification of Protocol I.

¹³ The USA signed and ratified Protocol II with the following declarations and understandings: In connection with Article 3 of the Treaty, defining the term 'territory' as including the territorial sea, airspace and any other space over which the state exercises sovereignty in accordance with 'its own legislation', the ratification of the Protocol could not be regarded as implying recognition of any legislation which does not, in the view of the USA, comply with the relevant rules of international law.

Each of the parties retains exclusive power and legal competence, unaffected by the terms of the Treaty, to grant or deny non-parties transit and transport privileges.

As regards the undertaking not to use or threaten to use nuclear weapons against the parties, the USA would consider that an armed attack by a party, in which it was assisted by a nuclear weapon state, would be incompatible with the party's obligations under Article 1 of the Treaty.

The definition contained in Article 5 of the Treaty is understood as encompassing all nuclear explosive devices; Articles 1 and 5 of the Treaty restrict accordingly the activities of the parties under paragraph 1 of Article 18.

Article 18, paragraph 4 permits, and US adherence to Protocol II will not prevent, collaboration by the USA with the parties to the Treaty for the purpose of carrying out explosions of nuclear devices for peaceful purposes in a manner consistent with a policy of not contributing to the proliferation of nuclear weapon capabilities.

The USA will act with respect to such territories of Protocol I adherents, as are within the geographical area defined in Article 4, paragraph 2 of the Treaty, in the same manner as Protocol II requires it to act with respect to the territories of the Parties.

¹⁴ The USSR signed and ratified Protocol II with the following statement:

The USSR proceeds from the assumption that the effect of Article 1 of the Treaty extends, as specified in Article 5 of the Treaty, to any nuclear explosive device and that, accordingly, the carrying out by any party to the Treaty of explosions of nuclear devices for peaceful purposes would be a violation of its obligations under Article 1 and would be incompatible with its non-nuclear status. For states parties to the Treaty, a solution to the problem of peaceful nuclear explosions can be found in accordance with the provisions of Article V of the Non-Proliferation Treaty and within the framework of the international procedures of the IAEA. The signing of the Protocol by the USSR does not in any way signify recognition of the possibility of the force of the Treaty being extended beyond the territories of the states parties to the Treaty, including airspace and territorial waters as defined in accordance with international law. With regard to the reference in Article 3 of the Treaty to 'its own legislation' in connection with the territorial waters, airspace and any other space over which the states parties to the Treaty exercise sovereignty, the signing of the Protocol by the USSR does not signify recognition of their claims to the exercise of sovereignty which are contrary to generally accepted standards of international law. The USSR takes note of the interpretation of the Treaty given in the Final Act of the Preparatory Commission for the Denuclearization of Latin America to the effect that the transport of nuclear weapons by the parties to the Treaty is covered by the prohibitions in Article 1 of the Treaty. The USSR reaffirms its position that authorizing the transit of nuclear weapons in any form would be contrary to the objectives of the Treaty, according to which, as specially mentioned in the preamble, Latin America must be completely free from nuclear weapons, and that it would be incompatible with the non-nuclear status of the states parties to the Treaty and with their obligations as laid down in Article 1 thereof.

Any actions undertaken by a state or states parties to the Treaty which are not compatible with their non-nuclear status, and also the commission by one or more states parties to the Treaty of an act of aggression with the support of a state which is in possession of nuclear weapons or together with such a state, will be regarded by the USSR as incompatible with the obligations of those countries under the Treaty. In such cases the USSR reserves the right to reconsider its obligations under Protocol II. It further reserves the right to reconsider its attitude to this Protocol in the event of any actions on the part of other states possessing nuclear weapons which are incompatible with their obligations under the said Protocol. The provisions of the articles of Protocol II are applicable to the text of the Treaty of Tlatelolco in the wording of the Treaty at the time of the signing of the Protocol by the Soviet Union, due account being taken of the position of the USSR as set out in the present statement. Any amendment to the Treaty entering into force in accordance with the provisions of Articles 29 and 6 of the Treaty without the clearly expressed approval of the USSR shall have no force as far as the USSR is concerned.

In addition, the USSR proceeds from the assumption that the obligations under Protocol II also apply to the territories for which the status of the denuclearized zone is in force in conformity with Protocol I of the Treaty.

¹⁵ Venezuela stated that in view of the existing controversy between Venezuela on the one hand and the UK and Guyana on the other, Article 25, paragraph 2 of the Treaty should apply to Guyana. This paragraph provides that no political entity should be admitted, part or all of whose territory is the subject of a dispute or claim between an extra-continental country and one or more Latin American states, so long as the dispute has not been settled by peaceful means.

¹⁶ Safeguards agreements under the Non-Proliferation Treaty cover the Treaty of Tlatelolco.

¹⁷ Safeguards agreements under Protocol I.

The Treaty of Rarotonga

¹ In signing Protocols 2 and 3 China declared that it respected the status of the South Pacific nuclear-free zone and would neither use nor threaten to use nuclear weapons against the zone nor test nuclear weapons in the region. However, China reserved its right to reconsider its obligations under the Protocols if other nuclear weapon states or the contracting Parties to the Treaty took any action in 'gross' violation of the Treaty and the Protocols, thus changing the status of the zone and endangering the security interests of China.

² In signing Protocols 2 and 3 the USSR stated the view that admission of transit of nuclear weapons or other nuclear explosive devices by any means, as well as of visits by foreign military ships and aircraft with nuclear explosive devices on board, to the ports and airfields within the nuclear-free zone would contradict the aims of the Treaty of Rarotonga and would be inconsistent with the status of the zone. It also warned that in case of action taken by a party or parties violating their major commitments connected with the nuclear-free status of the zone, as well as in case of aggression committed by one or several parties to the Treaty, supported by a nuclear-weapon state, or together with it, with the use by such a state of the territory, airspace, territorial sea or archipelagic waters of the parties for visits by nuclear weapon-carrying ships and aircraft or for transit of nuclear weapons, the USSR will have the right to consider itself free of its non-use commitments assumed under Protocol 2.

The Soviet Union ratified Protocols 2 and 3 to the Treaty without reference to the conditions included in its statement made at the time of signature. It expressed the hope that all states members of the South Pacific Forum would join the Treaty, and called upon the nuclear powers, which had not done so, to sign and ratify the relevant Protocols.

Appendix C. Final Declarations of the 1975 and 1985 NPT Review Conferences

Final Declaration of the first NPT Review Conference, 1975

Preamble

The States Party to the Treaty on the Non-Proliferation of Nuclear Weapons, which met in Geneva in May 1975, in accordance with the Treaty, to review the operation of the Treaty with a view to assuring that the purposes of the Preamble and the provisions of the Treaty are being realized,

Recognizing the continuing importance of the objectives of the Treaty,

Affirming the belief that universal adherence to the Treaty would greatly strengthen international peace and enhance the security of all States,

Firmly convinced that, in order to achieve this aim, it is essential to maintain, in the implementation of the Treaty, an acceptable balance of mutual responsibilities and obligations of all States Party to the Treaty, nuclear-weapon and non-nuclear-weapon States,

Recognizing that the danger of nuclear warfare remains a grave threat to the survival of mankind,

Convinced that the prevention of any further proliferation of nuclear weapons or other nuclear explosive devices remains a vital element in efforts to avert nuclear warfare, and that the promotion of this objective will be furthered by more rapid progress towards the cessation of the nuclear arms race and the limitation and reduction of existing nuclear weapons, with a view to the eventual elimination from national arsenals of nuclear weapons, pursuant to a Treaty on general and complete disarmament under strict and effective international control,

Recalling the determination expressed by the Parties to seek to achieve the discontinuance of all test explosions of nuclear weapons for all time,

Considering that the trend towards *détente* in relations between States provides a favourable climate within which more significant progress should be possible towards the cessation of the nuclear arms race,

Noting the important role which nuclear energy can, particularly in changing economic circumstances, play in power production and in contributing to the progressive elimination of the economic and technological gap between developing and developed States,

Recognizing that the accelerated spread and development of peaceful applications of nuclear energy will, in the absence of effective safeguards, contribute to further proliferation of nuclear explosive capability,

Recognizing the continuing necessity of full cooperation in the application and improvement of International Atomic Energy Agency (IAEA) safeguards on peaceful nuclear activities,

Recalling that all Parties to the Treaty are entitled to participate in the fullest possible exchange of scientific information for, and to contribute alone or in co-operation with other States to, the further development of the applications of atomic energy for peaceful purposes,

Reaffirming the principle that the benefits of peaceful applications of nuclear technology, including any technological by-products which may be derived by nuclear-weapon States from the development of nuclear explosive devices, should be available for peaceful purposes to all Parties to the Treaty, and

Recognizing that all States Parties have a duty to strive for the adoption of tangible and effective measures to attain the objectives of the Treaty,

Declares as follows:

Purposes

The States Party to the Treaty reaffirm their strong common interest in averting the further proliferation of nuclear weapons. They reaffirm their strong support for the Treaty, their continued dedication to its principles and objectives, and their commitment to implement fully and more effectively its provisions.

They reaffirm the vital role of the Treaty in international efforts

— to avert further proliferation of nuclear weapons,

— to achieve the cessation of the nuclear arms race and to undertake effective measures in the direction of nuclear disarmament, and

— to promote co-operation in the peaceful uses of nuclear energy under adequate safeguards.

Review of Articles I and II

The review undertaken by the Conference confirms that the obligations undertaken under Articles I and II of the Treaty have been faithfully observed by all Parties. The Conference is convinced that the continued strict observance of these Articles remains central to the shared objective of averting the further proliferation of nuclear weapons.

Review of Article III

The Conference notes that the verification activities of the IAEA under Article III of the Treaty respect the sovereign rights of States and do not hamper the economic, scientific or technological development of the Parties to the Treaty or international co-operation in peaceful nuclear activities. It urges that this situation be maintained. The Conference attaches considerable importance to the continued application of safeguards under Article III, 1, on a non-discriminatory basis, for the equal benefit of all States Party to the Treaty.

The Conference notes the importance of systems of accounting for and control of nuclear material, from the standpoints both of the responsibilities of States Party to the Treaty and of co-operation with the IAEA in order to facilitate the implementation of the safeguards provided for in Article III, 1. The Conference expresses the hope that all States having peaceful nuclear activities will establish and maintain effective accounting and control systems and welcomes the readiness of the IAEA to assist States in so doing.

The Conference expresses its strong support for effective IAEA safeguards. In this context it recommends that intensified efforts be made towards the standardization and the universality of application of IAEA safeguards, while ensuring that safeguards agreements with non-nuclear-weapon States not Party to the Treaty are of adequate duration, preclude diversion to any nuclear explosive devices and contain appropriate provisions for the continuance of the application of safeguards upon re-export.

The Conference recommends that more attention and fuller support be given to the improvement of safeguards techniques, instru-

mentation, data-handling and implementation in order, among other things, to ensure optimum cost-effectiveness. It notes with satisfaction the establishment by the Director-General of the IAEA of a standing advisory group on safeguards implementation.

The Conference emphasizes the necessity for the States Party to the Treaty that have not yet done so to conclude as soon as possible safeguards agreements with the IAEA.

With regard to the implementation of Article III, 2, of the Treaty, the Conference notes that a number of States suppliers of nuclear material or equipment have adopted certain minimum, standard requirements for IAEA safeguards in connexion with their exports of certain such items to non-nuclear-weapon States not Party to the Treaty (IAEA document INFCIRC/209 and addenda). The Conference attaches particular importance to the condition, established by those States, of an undertaking of non-diversion to nuclear weapons or other nuclear explosive devices, as included in the said requirements.

The Conference urges that:

(a) in all achievable ways, common export requirements relating to safeguards be strengthened, in particular by extending the application of safeguards to all peaceful nuclear activities in importing States not Party to the Treaty;

(b) such common requirements be accorded the widest possible measure of acceptance among all suppliers and recipients;

(c) all Parties to the Treaty should actively pursue their efforts to these ends.

The Conference takes note of:

(a) the considered view of many Parties to the Treaty that the safeguards required under Article III, 2, should extend to all peaceful nuclear activities in importing States;

(b) (i) the suggestion that it is desirable to arrange for common safeguards requirements in respect of nuclear material processed, used or produced by the use of scientific and technological information transferred in tangible form to non-nuclear-weapon States not Party to the Treaty;

(ii) the hope that this aspect of safeguards could be further examined.

The Conference recommends that, during the review of the arrangements relating to the financing of safeguards in the IAEA which is to be undertaken by its Board of Governors at an appropriate time after 1975, the less favourable financial situation of the developing countries be fully taken into account. It recommends further that, on that occasion, the Parties to the Treaty concerned seek measures that would restrict within appropriate limits the respective shares of developing countries in safeguards costs.

The Conference attaches considerable

importance, so far as safeguards inspectors are concerned, to adherence by the IAEA to Article VII.D of its Statute, prescribing, among other things, that "due regard shall be paid . . . to the importance of recruiting the staff on as wide a geographical basis as possible"; it also recommends that safeguards training be made available to personnel from all geographic regions.

The Conference, convinced that nuclear materials should be effectively protected at all times, urges that action be pursued to elaborate further, within the IAEA, concrete recommendations for the physical protection of nuclear material in use, storage and transit, including principles relating to the responsibility of States, with a view to ensuring a uniform, minimum level of effective protection for such material.

It calls upon all States engaging in peaceful nuclear activities (i) to enter into such international agreements and arrangements as may be necessary to ensure such protection; and (ii) in the framework of their respective physical protection systems, to give the earliest possible effective application to the IAEA's recommendations.

Review of Article IV

The Conference reaffirms, in the framework of Article IV, 1, that nothing in the Treaty shall be interpreted as affecting, and notes with satisfaction that nothing in the Treaty has been identified as affecting, the inalienable right of all the Parties to the Treaty to develop research, production and use of nuclear energy for peaceful purposes without discrimination and in conformity with Articles I and II of the Treaty.

The Conference reaffirms, in the framework of Article IV, 2, the undertaking by all Parties to the Treaty to facilitate the fullest possible exchange of equipment, materials and scientific and technological information for the peaceful uses of nuclear energy and the right of all Parties to the Treaty to participate in such exchange and welcomes the efforts made towards that end. Noting that the Treaty constitutes a favourable framework for broadening international co-operation in the peaceful uses of nuclear energy, the Conference is convinced that on this basis, and in conformity with the Treaty, further efforts should be made to ensure that the benefits of peaceful applications of nuclear technology should be available to all Parties to the Treaty.

The Conference recognizes that there continues to be a need for the fullest possible exchange of nuclear materials, equipment and technology, including up-to-date developments, consistent with the objectives and safeguards requirements of the Treaty. The Conference reaffirms the undertaking of the Parties to the Treaty in a position to do so to co-

operate in contributing, alone or together with other States or international organizations, to the further development of the applications of nuclear energy for peaceful purposes, especially in the territories of non-nuclear-weapon States Party to the Treaty, with due consideration for the needs of the developing areas of the world. Recognizing, in the context of Article IV, 2, those growing needs of developing States, the Conference considers it necessary to continue and increase assistance to them in this field bilaterally and through such multilateral channels as the IAEA and the United Nations Development Programme.

The Conference is of the view that, in order to implement as fully as possible Article IV of the Treaty, developed States Party to the Treaty should consider taking measures, making contributions and establishing programmes, as soon as possible, for the provision of special assistance in the peaceful uses of nuclear energy for developing States Party to the Treaty.

The Conference recommends that, in reaching decisions on the provision of equipment, materials, services and scientific and technological information for the peaceful uses of nuclear energy, on concessional and other appropriate financial arrangements and on the furnishing of technical assistance in the nuclear field, including co-operation related to the continuous operation of peaceful nuclear facilities, States Party to the Treaty should give weight to adherence to the Treaty by recipient States. The Conference recommends, in this connexion, that any special measures of co-operation to meet the growing needs of developing States Party to the Treaty might include increased and supplemental voluntary aid provided bilaterally or through multilateral channels such as the IAEA's facilities for administering funds-in-trust and gifts-in-kind.

The Conference further recommends that States Party to the Treaty in a position to do so, meet, to the fullest extent possible, "technically sound" requests for technical assistance, submitted to the IAEA by developing States Party to the Treaty, which the IAEA is unable to finance from its own resources, as well as such "technically sound" requests as may be made by developing States Party to the Treaty which are not members of the IAEA.

The Conference recognizes that regional or multinational nuclear-fuel-cycle centres may be an advantageous way to satisfy, safely and economically, the needs of many States in the course of initiating or expanding nuclear power programmes, while at the same time facilitating physical protection and the application of IAEA safeguards, and contributing to the goals of the Treaty.

The Conference welcomes the IAEA's studies in this area, and recommends that they be continued as expeditiously as possible. It considers that such studies should include, among other aspects, identification of the complex practical

and organizational difficulties which will need to be dealt with in connexion with such projects.

The Conference urges all Parties to the Treaty in a position to do so to co-operate in these studies, particularly by providing to the IAEA where possible economic data concerning construction and operation of facilities such as chemical reprocessing plants, plutonium fuel fabrication plants, waste management installations, and longer-term spent-fuel storage, and by assistance to the IAEA to enable it to undertake feasibility studies concerning the establishment of regional nuclear-fuel-cycle centres in specific geographic regions.

The Conference hopes that, if these studies lead to positive findings, and if the establishment of regional or multinational nuclear-fuel-cycle centres is undertaken, Parties to the Treaty in a position to do so, will co-operate in, and provide assistance for, the elaboration and realization of such projects.

Review of Article V

The Conference reaffirms the obligation of Parties to the Treaty to take appropriate measures to ensure that potential benefits from any peaceful applications of nuclear explosions are made available to non-nuclear-weapon States Party to the Treaty in full accordance with the provisions of Article V and other applicable international obligations. In this connexion, the Conference also reaffirms that such services should be provided to non-nuclear-weapon States Party to the Treaty on a non-discriminatory basis and that the charge to such Parties for the explosive devices used should be as low as possible and exclude any charge for research and development.

The Conference notes that any potential benefits could be made available to non-nuclear-weapon States not Party to the Treaty by way of nuclear explosion services provided by nuclear-weapon States, as defined by the Treaty, and conducted under the appropriate international observation and international procedures called for in Article V and in accordance with other applicable international obligations. The Conference considers it imperative that access to potential benefits of nuclear explosions for peaceful purposes not lead to any proliferation of nuclear explosive capability.

The Conference considers the IAEA to be the appropriate international body, referred to in Article V of the Treaty, through which potential benefits from peaceful applications of nuclear explosions could be made available to any non-nuclear-weapon State. Accordingly, the Conference urges the IAEA to expedite work on identifying and examining the important legal issues involved in, and to commence consideration of, the structure and content of the special international agreement or agreements

contemplated in Article V of the Treaty, taking into account the views of the Conference of the Committee on Disarmament (CCD) and the United Nations General Assembly and enabling States Party to the Treaty but not members of the IAEA which would wish to do so to participate in such work.

The Conference notes that the technology of nuclear explosions for peaceful purposes is still at the stage of development and study and that there are a number of interrelated international legal and other aspects of such explosions which still need to be investigated.

The Conference commends the work in this field that has been carried out within the IAEA and looks forward to the continuance of such work pursuant to United Nations General Assembly resolution 3261 D (XXIX). It emphasizes that the IAEA should play the central role in matters relating to the provision of services for the application of nuclear explosions for peaceful purposes. It believes that the IAEA should broaden its consideration of this subject to encompass, within its area of competence, all aspects and implications of the practical applications of nuclear explosions for peaceful purposes. To this end it urges the IAEA to set up appropriate machinery within which intergovernmental discussion can take place and through which advice can be given on the Agency's work in this field.

The Conference attaches considerable importance to the consideration by the CCD, pursuant to United Nations General Assembly resolution 3261 D (XXIX) and taking due account of the views of the IAEA, of the arms control implications of nuclear explosions for peaceful purposes.

The Conference notes that the thirtieth session of the United Nations General Assembly will receive reports pursuant to United Nations General Assembly resolution 3261 D (XXIX) and will provide an opportunity for States to discuss questions related to the application of nuclear explosions for peaceful purposes. The Conference further notes that the results of discussion in the United Nations General Assembly at its thirtieth session will be available to be taken into account by the IAEA and the CCD for their further consideration.

Review of Article VI

The Conference recalls the provisions of Article VI of the Treaty under which all Parties undertook to pursue negotiations in good faith on effective measures relating

- to the cessation of the nuclear arms race at an early date and
- to nuclear disarmament and
- to a treaty on general and complete disarmament under strict and effective international control.

While welcoming the various agreements on

arms limitation and disarmament elaborated and concluded over the last few years as steps contributing to the implementation of Article VI of the Treaty, the Conference expresses its serious concern that the arms race, in particular the nuclear arms race, is continuing unabated.

The Conference therefore urges constant and resolute efforts by each of the Parties to the Treaty, in particular by the nuclear-weapon States, to achieve an early and effective implementation of Article VI of the Treaty.

The Conference affirms the determination expressed in the preamble to the 1963 Partial Test-Ban Treaty and reiterated in the preamble to the Non-Proliferation Treaty to achieve the discontinuance of all test explosions of nuclear weapons for all time. The Conference expresses the view that the conclusion of a treaty banning all nuclear weapons tests is one of the most important measures to halt the nuclear arms race. It expresses the hope that the nuclear-weapon States Party to the Treaty will take the lead in reaching an early solution of the technical and political difficulties on this issue. It appeals to these States to make every effort to reach agreement on the conclusion of an effective comprehensive test ban. To this end, the desire was expressed by a considerable number of delegations at the Conference that the nuclear-weapon States Party to the Treaty should as soon as possible enter into an agreement, open to all States and containing appropriate provisions to ensure its effectiveness, to halt all nuclear weapons tests of adhering States for a specified time, whereupon the terms of such an agreement would be reviewed in the light of the opportunity, at that time, to achieve a universal and permanent cessation of all nuclear weapons tests. The Conference calls upon the nuclear-weapon States signatories of the Treaty on the Limitation of Underground Nuclear Weapons Tests, meanwhile, to limit the number of their underground nuclear weapons tests to a minimum. The Conference believes that such steps would constitute an incentive of particular value to negotiations for the conclusion of a treaty banning all nuclear weapons test explosions for all time.

The Conference appeals to the nuclear-weapon States Parties to the negotiations on the limitation of strategic arms to endeavour to conclude at the earliest possible date the new agreement that was outlined by their leaders in November 1974. The Conference looks forward to the commencement of follow-on negotiations on further limitations of, and significant reductions in, their nuclear weapons systems as soon as possible following the conclusion of such an agreement.

The Conference notes that, notwithstanding earlier progress, the CCD has recently been unable to reach agreement on new substantive measures to advance the objectives of Article VI of the Treaty. It urges, therefore, all members of the CCD Party to the Treaty, in

particular the nuclear-weapon States Party, to increase their efforts to achieve effective disarmament agreements on all subjects on the agenda of the CCD.

The Conference expresses the hope that all States Party to the Treaty, through the United Nations and the CCD and other negotiations in which they participate, will work with determination towards the conclusion of arms limitation and disarmament agreements which will contribute to the goal of general and complete disarmament under strict and effective international control.

The Conference expresses the view that, disarmament being a matter of general concern, the provision of information to all Governments and peoples on the situation in the field of the arms race and disarmament is of great importance for the attainment of the aims of Article VI. The Conference therefore invites the United Nations to consider ways and means of improving its existing facilities for collection, compilation and dissemination of information on disarmament issues, in order to keep all Governments as well as world public opinion properly informed on progress achieved in the realization of the provisions of Article VI of the Treaty.

Review of Article VII and the security of non-nuclear-weapon States

Recognizing that all States have need to ensure their independence, territorial integrity and sovereignty, the Conference emphasizes the particular importance of assuring and strengthening the security of non-nuclear-weapon States Parties which have renounced the acquisition of nuclear weapons. It acknowledges that States parties find themselves in different security situations and therefore that various appropriate means are necessary to meet the security concerns of States Parties.

The Conference underlines the importance of adherence to the Treaty by non-nuclear-weapon States as the best means of reassuring one another of their renunciation of nuclear weapons and as one of the effective means of strengthening their mutual security.

The Conference takes note of the continued determination of the Depositary States to honour their statements, which were welcomed by the United Nations Security Council in resolution 255(1968), that, to ensure the security of the non-nuclear-weapon States Party to the Treaty, they will provide or support immediate assistance, in accordance with the Charter, to any non-nuclear-weapon State Party to the Treaty which is a victim of an act or an object of a threat of aggression in which nuclear weapons are used.

The Conference, bearing in mind Article VII of the Treaty, considers that the establishment of internationally recognized nuclear-weapon-

free zones on the initiative and with the agreement of the directly concerned States of the zone, represents an effective means of curbing the spread of nuclear weapons, and could contribute significantly to the security of those States. It welcomes the steps which have been taken towards the establishment of such zones.

The Conference recognizes that for the maximum effectiveness of any Treaty arrangements for establishing a nuclear-weapon-free zone the co-operation of the nuclear-weapon States is necessary. At the Conference it was urged by a considerable number of delegations that nuclear-weapon States should provide, in an appropriate manner, binding security assurances to those States which become fully bound by the provisions of such regional arrangements.

At the Conference it was also urged that determined efforts must be made, especially by the nuclear-weapon States Party to the Treaty, to ensure the security of all non-nuclear-weapon States Parties. To this end the Conference urges all States, both nuclear-weapon States and non-nuclear-weapon States to refrain, in accordance with the Charter of the United Nations, from the threat or the use of force in relations between States, involving either nuclear or non-nuclear weapons. Additionally, it stresses the responsibility of all Parties to the Treaty and especially the nuclear-weapon States, to take effective steps to strengthen the security of non-nuclear-weapon States and to promote in all appropriate fora the consideration of all practical means to this end, taking into account the views expressed at this Conference.

Review of Article VIII

The Conference invites States Party to the Treaty which are Members of the United Nations to request the Secretary-General of the United Nations to include the following item in the provisional agenda of the thirty-first session of the General Assembly: "Implementation of the conclusions of the first Review Conference of the Parties to the Treaty on the Non-Proliferation of Nuclear Weapons."

The States Party to the Treaty participating in the Conference propose to the Depositary Governments that a second conference to review the operation of the Treaty be convened in 1980.

The Conference accordingly invites States Party to the Treaty which are members of the United Nations to request the Secretary-General of the United Nations to include the following item in the provisional agenda of the thirty-third session of the General Assembly: "Implementation of the conclusions of the first Review Conference of the Parties to the Treaty on the Non-Proliferation of Nuclear Weapons and establishment of a preparatory committee for the second Conference."

Review of Article IX

The five years that have passed since the entry into force of the Treaty have demonstrated its wide international acceptance. The Conference welcomes the recent progress towards achieving wider adherence. At the same time, the Conference notes with concern that the Treaty has not as yet achieved universal adherence. Therefore, the Conference expresses the hope that States that have not already joined the Treaty should do so at the earliest possible date.

Source: *Yearbook of the United Nations 1975*, Vol. 29 (UN Office of Public Information, New York, 1975).

Final Declaration of the third NPT Review Conference, 1985

THE STATES PARTY TO THE TREATY ON THE NON-PROLIFERATION OF NUCLEAR WEAPONS WHICH MET IN GENEVA FROM 27 AUGUST TO 21 SEPTEMBER 1985 TO REVIEW THE OPERATION OF THE TREATY SOLEMNLY DECLARE:

- their conviction that the Treaty is essential to international peace and security,
- their continued support for the objectives of the Treaty which are:
 - the prevention of proliferation of nuclear weapons or other nuclear explosive devices;
 - the cessation of the nuclear arms race, nuclear disarmament and a Treaty on general and complete disarmament;
 - the promotion of co-operation between States Parties in the field of the peaceful uses of nuclear energy,
- the reaffirmation of their firm commitment to the purposes of the Preamble and the provisions of the Treaty,
- their determination to enhance the implementation of the Treaty and to further strengthen its authority.

Review of the Operation of the Treaty and Recommendations

Articles I and II and preambular paragraphs 1-3

The Conference noted the concerns and convictions expressed in preambular paragraphs 1 to 3 and agreed that they remain valid. The States Party to the Treaty remain resolved in their belief in the need to avoid the devastation that a nuclear war would bring. The Conference remains convinced that any proliferation of nuclear weapons would seriously increase the danger of a nuclear war.

The Conference agreed that the strict observance of the terms of Articles I and II remains central to achieving the shared objectives of preventing under any circumstances the further proliferation of nuclear weapons and preserving the Treaty's vital

contribution to peace and security, including to the peace and security of non-Parties.

The Conference acknowledged the declaration by nuclear-weapons States Party to the Treaty that they have fulfilled their obligations under Article I. The Conference further acknowledged the declarations that non-nuclear-weapons States Party to the Treaty had fulfilled their obligations under Article II. The Conference was of the view therefore that one of the primary objectives of the Treaty had been achieved in the period under review.

The Conference also expressed deep concern that the national nuclear programmes of some States non-Party to the Treaty may lead them to obtain a nuclear weapon capability. States Party to the Treaty stated that any further detonation of a nuclear explosive device by any non-nuclear-weapon State would constitute a most serious breach of the non-proliferation objective.

The Conference noted the great and serious concerns expressed about the nuclear capability of South Africa and Israel. The Conference further noted the calls on all States for the total and complete prohibition of the transfer of all nuclear facilities, resources or devices to South Africa and Israel and to stop all exploitation of Namibian uranium, natural or enriched, until the attainment of Namibian independence.

Article III and preambular paragraphs 4 and 5

1. The Conference affirms its determination to strengthen further the barriers against the proliferation of nuclear weapons and other nuclear explosive devices to additional States. The spread of nuclear explosive capabilities would add immeasurably to regional and international tensions and suspicions. It would increase the risk of nuclear war and lessen the security of all States. The Parties remain convinced that universal adherence to the Non-Proliferation Treaty is the best way to strengthen the barriers against proliferation and they urge all States not party to the Treaty to accede to it. The Treaty and the régime of non-proliferation it supports play a central role in promoting

regional and international peace and security, *inter alia*, by helping to prevent the spread of nuclear explosives. The non-proliferation and safeguards commitments in the Treaty are essential also for peaceful nuclear commerce and co-operation.

2. The Conference expresses the conviction that IAEA safeguards provide assurance that States are complying with their undertakings and assist States in demonstrating this compliance. They thereby promote further confidence among States and, being a fundamental element of the Treaty, help to strengthen their collective security. IAEA safeguards play a key role in preventing the proliferation of nuclear weapons and other nuclear explosive devices. Unsafeguarded nuclear activities in non-nuclear-weapon States pose serious proliferation dangers.

3. The Conference declares that the commitment to non-proliferation by nuclear-weapon States Party to the Treaty pursuant to Article I, by non-nuclear-weapon States Party to the Treaty pursuant to Article II, and by the acceptance of IAEA safeguards on all peaceful nuclear activities within non-nuclear-weapon States Party to the Treaty pursuant to Article III is a major contribution by those States to regional and international security. The Conference notes with satisfaction that the commitments in Articles I-III have been met and have greatly helped prevent the spread of nuclear explosives.

4. The Conference therefore specifically urges all non-nuclear-weapon States not party to the Treaty to make an international legally-binding commitment not to acquire nuclear weapons or other nuclear explosive devices and to accept IAEA safeguards on all their peaceful nuclear activities, both current and future, to verify that commitment. The Conference further urges all States in their international nuclear co-operation and in their nuclear export policies and, specifically as a necessary basis for the transfer of relevant nuclear supplies to non-nuclear-weapon States, to take effective steps towards achieving such a commitment to non-proliferation and acceptance of such safeguards by those States. The Conference expresses its view that accession to the Non-Proliferation Treaty is the best way to achieve that objective.

5. The Conference expresses its satisfaction that four of the five nuclear-weapon States have voluntarily concluded safeguards agreements with the IAEA, covering all or

part of their peaceful nuclear activities. The Conference regards those agreements as further strengthening the non-proliferation régime and increasing the authority of IAEA and the effectiveness of its safeguards system. The Conference calls on the nuclear-weapon States to continue to co-operate fully with the IAEA in the implementation of these agreements and calls on IAEA to take full advantage of this co-operation. The Conference urges the People's Republic of China similarly to conclude a safeguards agreement with IAEA. The Conference recommends the continued pursuit of the principle of universal application of IAEA safeguards to all peaceful nuclear activities in all States. To this end, the Conference recognizes the value of voluntary offers and recommends further evaluation of the economic and practical possibility of extending application of safeguards to additional civil facilities in the nuclear-weapon States as and when IAEA resources permit and consideration of separation of the civil and military facilities in the nuclear-weapon States. Such an extending of safeguards will enable the further development and application of an effective régime in both nuclear-weapon States and non-nuclear-weapon States.

6. The Conference also affirms the great value to the non-proliferation régime of commitments by the nuclear-weapon States that nuclear supplies provided for peaceful use will not be used for nuclear weapons or other nuclear explosive purposes. Safeguards in nuclear-weapon States pursuant to their safeguards agreements with IAEA can verify observance of those commitments.

7. The Conference notes with satisfaction the adherence of further Parties to the Treaty and the conclusion of further safeguards agreements in compliance with the undertaking of the Treaty and recommends that:

(a) The non-nuclear-weapon States Party to the Treaty that have not concluded the agreements required under Article III(4) conclude such agreements with IAEA as soon as possible;

(b) The Director-General of IAEA intensify his initiative of submitting to States concerned draft agreements to facilitate the conclusion of corresponding safeguards agreements, and that Parties to the Treaty, in particular Depositary Parties, should actively support these initiatives;

(c) All States Party to the Treaty make strenuous individual and collective efforts to make the Treaty truly universal.

8. The Conference notes with satisfaction that IAEA in carrying out its safeguards activities has not detected any diversion of a significant amount of safeguarded material to the production of nuclear weapons, other nuclear explosive devices or to purposes unknown.

9. The Conference notes that IAEA safeguards activities have not hampered the economic, scientific or technological development of the Parties to the Treaty, or international co-operation in peaceful nuclear activities and it urges that this situation be maintained.

10. The Conference commends IAEA on its implementation of safeguards pursuant to this Treaty and urges it to continue to ensure the maximum technical and cost effectiveness and efficiency of its operations, while maintaining consistency with the economic and safe conduct of nuclear activities.

11. The Conference notes with satisfaction the improvement of IAEA safeguards which has enabled it to continue to apply safeguards effectively during a period of rapid growth in the number of safeguarded facilities. It also notes that IAEA safeguards approaches are capable of adequately dealing with facilities under safeguards. In this regard, the recent conclusion of the project to design a safeguards régime for centrifuge enrichment plants and its implementation is welcomed. This project allows the application of an effective régime to all plants of this type in the territories both of nuclear-weapon States and non-nuclear-weapon States Parties to the Treaty.

12. The Conference emphasizes the importance of continued improvements in the effectiveness and efficiency of IAEA safeguards, for example, but not limited to:

(a) Uniform and non-discriminatory implementation of safeguards;

(b) The expeditious implementation of new instruments and techniques;

(c) The further development of methods for evaluation of safeguards effectiveness in combination with safeguards information;

(d) Continued increases in the efficiency of the use of human and financial resources and of equipment.

13. The Conference believes that further improvement of the list of materials and equipment which, in accordance with

Article III(2) of the Treaty, calls for the application of IAEA safeguards should take account of advances in technology.

14. The Conference recommends that IAEA establish an internationally agreed effective system of international plutonium storage in accordance with Article XII(A)5 of its statute.

15. The Conference welcomes the significant contributions made by States Parties in facilitating the application of IAEA safeguards and in supporting research, development and other supports to further the application of effective and efficient safeguards. The Conference urges that such co-operation and support be continued and that other States Parties provide similar support.

16. The Conference calls upon all States to take IAEA safeguards requirements fully into account while planning, designing and constructing new nuclear fuel cycle facilities and while modifying existing nuclear fuel cycle facilities.

17. The Conference also calls on States Parties to the Treaty to assist IAEA in applying its safeguards, *inter alia*, through the efficient operation of State systems of accounting for and control of nuclear material, and including compliance with all notification requirements in accordance with safeguards agreements.

18. The Conference welcomes the Agency's endeavours to recruit and train staff of the highest professional standards for safeguards implementation with due regard to the widest possible geographical distribution, in accordance with Article VII D of the IAEA Statute. It calls upon States to exercise their right regarding proposals of designation of IAEA inspectors in such a way as to facilitate the most effective use of safeguards manpower.

19. The Conference also commends to all States Parties the merits of establishment of international fuel cycle facilities, including multination participation, as a positive contribution to reassurance of the peaceful use and non-diversion of nuclear materials. While primarily a national responsibility, the Conference sees advantages in international co-operation concerning spent fuel storage and nuclear waste storage.

20. The Conference calls upon States Parties to continue their political, technical and financial support of the IAEA safeguards system.

21. The Conference underlines the need for IAEA to be provided with the necessary financial and human resources to ensure that the Agency is able to continue to meet effectively its safeguards responsibilities.

22. The Conference urges all States that have not done so to adhere to the Convention on the physical protection of nuclear material at the earliest possible date.

Article IV and preambular paragraphs 6 and 7

1. The Conference affirms that the NPT fosters the world-wide peaceful use of nuclear energy and reaffirms that nothing in the Treaty shall be interpreted as affecting the inalienable right of any Party to the Treaty to develop research, production and use of nuclear energy for peaceful purposes without discrimination and in conformity with Articles I and II.

2. The Conference reaffirms the undertaking by all Parties to the Treaty, in accordance with Article IV and preambular paragraphs 6 and 7, to facilitate the fullest possible exchange of equipment, materials and scientific and technological information for the peaceful uses of nuclear energy and the right of all Parties to the Treaty to participate in such exchange. In this context, the Conference recognizes the importance of services. This can contribute to progress in general and to the elimination of technological and economic gaps between the developed and developing countries.

3. The Conference reaffirms the undertaking of the Parties to the Treaty in a position to do so to co-operate in contributing, alone or together with other States or international organizations, to the further development of the applications of nuclear energy for peaceful purposes, especially in the territories of the non-nuclear-weapon States Party to the Treaty, with due consideration for the needs of the developing areas of the world. In this context the Conference recognizes the particular needs of the least developed countries.

4. The Conference requests that States Parties consider possible bilateral co-operation measures to further improve the implementation of Article IV. To this end, States Parties are requested to give in written form their experiences in this area in the form of national contributions to be pre-

sented in a report to the next Review Conference.

5. The Conference recognizes the need for more predictable long-term supply assurances with effective assurances of non-proliferation.

6. The Conference commends the recent progress which the IAEA's Committee on Assurances of Supply (CAS) has made towards agreeing a set of principles related to this matter, and expresses the hope that the Committee will complete this work soon. The Conference further notes with satisfaction the measures which CAS has recommended to the IAEA Board of Governors for alleviating technical and administrative problems in international shipments of nuclear items, emergency and back-up mechanisms, and mechanisms for the revision of international nuclear co-operation agreements and calls for the early completion of the work of CAS and the implementation of its recommendations.

7. The Conference reaffirms that in accordance with international law and applicable treaty obligations, States should fulfil their obligations under agreements in the nuclear field, and any modification of such agreements, if required, should be made only by mutual consent of the parties concerned.

8. The Conference confirms that each country's choices and decisions in the field of peaceful uses of nuclear energy should be respected without jeopardizing their respective fuel cycle policies. International co-operation in this area, including international transfer and subsequent operations should be governed by effective assurances of non-proliferation and predictable long-term supply assurances. The issuance of related licences and authorization involved should take place in a timely fashion.

9. While recognizing that the operation and management of the back-end of the fuel cycle including nuclear waste storage are primarily a national responsibility, the Conference acknowledges the importance for the peaceful uses of nuclear energy of international and multilateral collaboration for arrangements in this area.

10. The Conference expresses its profound concern about the Israeli military attack on Iraq's safeguarded nuclear reactor on 7 June 1981. The Conference recalls Security Council Resolution 487 of 1981, strongly condemning the military attack by Israel which was unanimously adopted by the

Council and which considered that the said attack constituted a serious threat to the entire IAEA safeguards régime which is the foundation of the Non-Proliferation Treaty. The Conference also takes note of the decisions and resolutions adopted by the United Nations General Assembly and the International Atomic Energy Agency on this attack, including Resolution 425 of 1984 adopted by the General Conference of the IAEA.

11. The Conference recognizes that an armed attack on a safeguarded nuclear facility, or threat of attack, would create a situation in which the Security Council would have to act immediately in accordance with provisions of the United Nations Charter. The Conference further emphasizes the responsibilities of the Depositaries of NPT in their capacity as permanent members of the Security Council to endeavour, in consultation with the other members of the Security Council, to give full consideration to all appropriate measures to be undertaken by the Security Council to deal with the situation, including measures under Chapter VII of the United Nations Charter.

12. The Conference encourages Parties to be ready to provide immediate peaceful assistance in accordance with international law to any Party to the NPT, if it so requests, whose safeguarded nuclear facilities have been subject to an armed attack, and calls upon all States to abide by any decisions taken by the Security Council in accordance with the United Nations Charter in relation to the attacking State.

13. The Conference considers that such attacks could involve grave dangers due to the release of radioactivity and that such attacks or threats of attack jeopardize the development of the peaceful uses of nuclear energy. The Conference also acknowledges that the matter is under consideration by the Conference on Disarmament and urges co-operation of all States for its speedy conclusion.

14. The Conference acknowledges the importance of the work of the International Atomic Energy Agency (IAEA) as the principal agent for technology transfer amongst the international organizations referred to in Article IV(2) and welcomes the successful operation of the Agency's technical assistance and co-operation programmes. The Conference records with appreciation that projects supported from

these programmes covered a wide spectrum of applications, related both to power and non-power uses of nuclear energy notably in agriculture, medicine, industry and hydrology. The Conference notes that the Agency's assistance to the developing States Party to the Treaty has been chiefly in the non-power uses of nuclear energy.

15. The Conference welcomes the establishment by the IAEA, following a recommendation of the First Review Conference of the Parties to the Treaty, of a mechanism to permit the channelling of extra-budgetary funds to projects additional to those financed from the IAEA Technical Assistance and Co-operation Fund. The Conference notes that this channel has been used to make additional resources available for a wide variety of projects in developing States Party to the Treaty.

16. In this context, the Conference proposes the following measures for consideration by the IAEA:

(i) IAEA assistance to developing countries in siting, construction, operation and safety of nuclear power projects and the associated trained manpower provision to be strengthened.

(ii) To provide, upon request, assistance in securing financing from outside sources for nuclear power projects in developing countries, and in particular the least developed countries.

(iii) IAEA assistance in nuclear planning systems for developing countries to be strengthened in order to help such countries draw up their own nuclear development plans.

(iv) IAEA assistance on country-specific nuclear development strategies to be further developed, with a view to identifying the application of nuclear technology that can be expected to contribute most to the development both of individual sectors and developing economies as a whole.

(v) Greater support for regional co-operative agreements, promoting regional projects based on regionally agreed priorities and using inputs from regional countries.

(vi) Exploration of the scope for multi-year, multi-donor projects financed from the extra-budgetary resources of the IAEA.

(vii) The IAEA's technical co-operation evaluation activity to be further developed, so as to enhance the Agency's effectiveness in providing technical assistance.

17. The Conference underlines the need for the provision to the IAEA of the necessary financial and human resources to ensure that the Agency is able to continue to meet effectively its responsibilities.

18. The Conference notes the appreciable level of bilateral co-operation in the peaceful uses of nuclear energy, and urges that States in a position to do so should continue and where possible increase the level of their co-operation in these fields.

19. The Conference urges that preferential treatment should be given to the non-nuclear-weapon States Party to the Treaty in access to or transfer of equipment, materials, services and scientific and technological information for the peaceful uses of nuclear energy, taking particularly into account needs of developing countries.

20. Great and serious concerns were expressed at the Conference about the nuclear capability of South Africa and Israel and that the development of such a capability by South Africa and Israel would undermine the credibility and stability of the non-proliferation Treaty régime. The Conference noted the demands made on all States to suspend any co-operation which would contribute to the nuclear programme of South Africa and Israel. The Conference further noted the demands made on South Africa and Israel to accede to the NPT, to accept IAEA safeguards on all their nuclear facilities and to pledge themselves not to manufacture or acquire nuclear weapons or other nuclear explosive devices.

21. The Conference recognizes the growing nuclear energy needs of the developing countries as well as the difficulties which the developing countries face in this regard, particularly with respect to financing their nuclear power programmes. The Conference calls upon States Party to the Treaty to promote the establishment of favourable conditions in national, regional and international financial institutions for financing of nuclear energy projects including nuclear power programmes in developing countries. Furthermore, the Conference calls upon the IAEA to initiate and the Parties to the Treaty to support the work of an expert group study on mechanisms to assist developing countries in the promotion of their nuclear power programmes, including the establishment of a Financial Assistance Fund.

22. The Conference recognizes that further IAEA assistance in the preparation of

feasibility studies and infrastructure development might enhance the prospects for developing countries for obtaining finance, and recommends such countries as are members of the Agency to apply for such help under the Agency's technical assistance and co-operation programmes. The Conference also acknowledges that further support for the IAEA's Small and Medium Power Reactor (SMPR) Study could help the development of nuclear reactors more suited to the needs of some of the developing countries.

23. The Conference expresses its satisfaction at the progress in the preparations for the United Nations Conference for the Promotion of International Co-operation in the Peaceful Uses of Nuclear Energy (UNCPICPUNE) and its conviction that UNCPICPUNE will fully realize its goals in accordance with the objectives of resolution 32/50 and relevant subsequent resolutions of the General Assembly for the development of national programmes of peaceful uses of nuclear energy for economic and social development, especially in the developing countries.

24. The Conference considers that all proposals related to the promotion and strengthening of international co-operation in the peaceful uses of nuclear energy which have been produced by the Third Review Conference of the NPT, be transmitted to the Preparatory Committee of the UNCPICPUNE.

Article V

1. The Conference reaffirms the obligation of Parties to the Treaty to take appropriate measures to ensure that potential benefits from any peaceful applications of nuclear explosions are made available to non-nuclear weapon States Party to the Treaty in full accordance with the provisions of article V and other applicable international obligations, that such services should be provided to non-nuclear weapon States Party to the Treaty on a non-discriminatory basis and that the charge to such Parties for the explosive devices used should be as low as possible and exclude any charge for research and development.

2. The Conference confirms that the IAEA would be the appropriate international body through which any potential benefits of the

peaceful applications of nuclear explosions could be made available to non-nuclear weapon States under the terms of Article V of the Treaty.

3. The Conference notes that the potential benefits of the peaceful applications of nuclear explosions have not been demonstrated and that no requests for services related to the peaceful applications of nuclear explosions have been received by the IAEA since the Second NPT Review Conference.

Article VI and preambular paragraphs 8-12

A.

1. The Conference recalled that under the provisions of Article VI all parties have undertaken to pursue negotiations in good faith:

- on effective measure relating to cessation of the nuclear arms race at an early date;
- on effective measures relating to nuclear disarmament;
- on a Treaty on general and complete disarmament under strict and effective international control.

2. The Conference undertook an evaluation of the achievements in respect of each aspect of the article in the period under review, and paragraphs 8 to 12 of the preamble, and in particular with regard to the goals set out in preambular paragraph 10 which recalls the determination expressed by the parties to the Partial Test Ban Treaty to:

- continue negotiations to achieve the discontinuance of all test explosions of nuclear weapons for all time.

3. The Conference recalled the declared intention of the parties to the Treaty to achieve at the earliest possible date the cessation of the nuclear arms race and to undertake effective measures in the direction of nuclear disarmament and their urging made to all States parties to co-operate in the attainment of this objective. The Conference also recalled the determination expressed by the parties to the 1963 Treaty banning nuclear weapons tests in the atmosphere, in outer space and under water in its preamble to seek to achieve the discontinuance of all test explosions on nuclear weapons for all time and the desire to further the easing of

international tension and the strengthening of trust between States in order to facilitate the cessation of the manufacture of nuclear weapons, the liquidation of all existing stockpiles, and the elimination from national arsenals of nuclear weapons and the means of their delivery.

4. The Conference notes that the Tenth Special Session of the General Assembly of the United Nations concluded, in paragraph 50 of its Final Document, that the achievement of nuclear disarmament will require urgent negotiations of agreements at appropriate stages and with adequate measures of verification satisfactory to the States concerned for:

(a) Cessation of the qualitative improvement and development of nuclear-weapon systems;

(b) Cessation of the production of all types of nuclear weapons and their means of delivery, and of the production of fissionable material for weapons purposes;

(c) A comprehensive, phased programme with agreed time-tables whenever feasible, for progressive and balanced reduction of stockpiles of nuclear weapons and their means of delivery, leading to their ultimate and complete elimination at the earliest possible time.

5. The Conference also recalled that in the Final Declaration of the First Review Conference, the parties expressed the view that the conclusion of a treaty banning all nuclear-weapon tests was one of the most important measures to halt the nuclear arms race and expressed the hope that the nuclear-weapon States party to the Treaty would take the lead in reaching an early solution of the technical and political difficulties of this issue.

6. The Conference examined developments relating to the cessation of the nuclear arms race, in the period under review and noted in particular that the destructive potentials of the nuclear arsenals of nuclear-weapon States parties, were undergoing continuing development, including a growing research and development component in military spending, continued nuclear testing, development of new delivery systems and their deployment.

7. The Conference noted the concerns expressed regarding developments with far reaching implications and the potential of a new environment, space, being drawn into the arms race. In that regard the Conference

also noted the fact that the United States of America and the Union of Soviet Socialist Republics are pursuing bilateral negotiations on a broad complex of questions concerning space and nuclear arms, with a view to achieving effective agreements aimed at preventing an arms race in space and terminating it on Earth.

8. The Conference noted with regret that the development and deployment of nuclear weapon systems had continued during the period of review.

9. The Conference also took note of numerous proposals and actions, multilateral and unilateral, advanced during the period under review by many States with the aim of making progress towards the cessation of the nuclear arms race and nuclear disarmament.

10. The Conference examined the existing situation in the light of the undertaking assumed by the parties in Article VI to pursue negotiations in good faith on effective measures relating to cessation of the nuclear arms race at an early date and to nuclear disarmament. The Conference recalled that a stage of negotiations on the Strategic Arms Limitations Talks (SALT II) had been concluded in 1979, by the signing of the Treaty which had remained unratified. The Conference noted that both the Union of Soviet Socialist Republics and the United States of America have declared that they are abiding by the provisions of SALT II.

11. The Conference recalled that the bilateral negotiations between the Union of Soviet Socialist Republics and the United States of America which were held between 1981 and 1983 were discontinued without any concrete results.

12. The Conference noted that bilateral negotiations between the Union of Soviet Socialist Republics and the United States of America had been held in 1985 to consider questions concerning space and nuclear arms, both strategic and intermediate-range, with all the questions considered and resolved in their interrelationship. No agreement has emerged so far. These negotiations are continuing.

13. The Conference evaluated the progress made in multilateral nuclear disarmament negotiations in the period of the Review.

14. The Conference recalled that the trilateral negotiations on a comprehensive test ban treaty, begun in 1977 between the Union of Soviet Socialist Republics, the United Kingdom of Great Britain and

Northern Ireland and the United States of America, had not continued after 1980, that the Committee on Disarmament and later the Conference on Disarmament had been called upon by the General Assembly of the United Nations in successive years to begin negotiations on such a Treaty, and noted that such negotiations had not been initiated, despite the submission of draft treaties and different proposals to the Conference on Disarmament in this regard.

15. The Conference noted the lack of progress on relevant items of the agenda of the Conference on Disarmament, in particular those relating to the cessation of the nuclear arms race and nuclear disarmament, the prevention of nuclear war including all related matters and effective international arrangements to assure non-nuclear-weapon States against the use or threat of use of nuclear weapons.

16. The Conference noted that two Review Conferences had taken place since 1980, one on the Sea-bed Treaty and one on the Environmental Modification Treaty and three General Conferences of the Agency for the Prohibition of Nuclear Weapons in Latin America. In 1982, a Special United Nations General Assembly Session on Disarmament took place without any results in matters directly linked to nuclear disarmament.

17. The Conference also noted that the last five years had thus not given any results concerning negotiations on effective measures relating to cessation of the nuclear arms race and to nuclear disarmament.

B

1. The Conference concluded that, since no agreements had been reached in the period under review on effective measures relating to the cessation of an arms race at an early date, on nuclear disarmament and on a Treaty on general and complete disarmament under strict and effective international control, the aspirations contained in preambular paragraphs 8 to 12 had still not been met, and the objectives under Article VI had not yet been achieved.

2. The Conference reiterated that the implementation of Article VI is essential to the maintenance and strengthening of the Treaty, reaffirmed the commitment of all States Parties to the implementation of this Article and called upon the States Parties to

intensify their efforts to achieve fully the objectives of the Article. The Conference addressed a call to the nuclear-weapon States Parties in particular to demonstrate this commitment.

3. The Conference welcomes the fact that the United States of America and the Union of Soviet Socialist Republics are conducting bilateral negotiations on a complex of questions concerning space and nuclear arms—both strategic and intermediate-range—with all these questions considered and resolved in their interrelationship. It hopes that these negotiations will lead to early and effective agreements aimed at preventing an arms race in space and terminating it on Earth, at limiting and reducing nuclear arms, and at strengthening strategic stability. Such agreements will complement and ensure the positive outcome of multilateral negotiations on disarmament, and would lead to the reduction of international tensions and the promotion of international peace and security. The Conference recalls that the two sides believe that ultimately the bilateral negotiations, just as efforts in general to limit and reduce arms, should lead to the complete elimination of nuclear arms everywhere.

4. The Conference urges the Conference on Disarmament, as appropriate, to proceed to early multilateral negotiations on nuclear disarmament in pursuance of paragraph 50 of the Final Document of the First Special Session of the General Assembly of the United Nations devoted to disarmament.

5. The Conference reaffirms the determination expressed in the preamble of the 1963 Partial Test Ban Treaty, confirmed in Article I(b) of the said Treaty and reiterated in preambular paragraph 10 of the Non-Proliferation Treaty, to achieve the discontinuance of all test explosions of nuclear weapons for all time.

6. The Conference also recalls that in the Final Document of the First Review Conference, the Parties expressed the view that the conclusion of a Treaty banning all nuclear weapons tests was one of the most important measures to halt the nuclear arms race. The Conference stresses the important contribution that such a treaty would make toward strengthening and extending the international barriers against the proliferation of nuclear weapons; it further stresses that adherence to such a treaty by all States would contribute substantially to the full

achievement of the non-proliferation objective.

7. The Conference also took note of the appeals contained in five successive United Nations General Assembly resolutions since 1981 for a moratorium on nuclear weapons testing pending the conclusion of a comprehensive test ban Treaty, and of similar calls made at this Conference. It also took note of the measure announced by the Union of Soviet Socialist Republics for a unilateral moratorium on all nuclear explosions from 6 August 1985 until 1 January 1986, which would continue beyond that date if the United States of America, for its part, refrained from carrying out nuclear explosions. The Union of Soviet Socialist Republics suggested that this would provide an example for other nuclear-weapon States and would create favourable conditions for the conclusion of a Comprehensive Test Ban Treaty and the promotion of the fuller implementation of the Non-Proliferation Treaty.

8. The Conference took note of the unconditional invitation extended by the United States of America to the Union of Soviet Socialist Republics to send observers, who may bring any equipment they deem necessary, to measure a United States of America nuclear test in order to begin a process which in the view of the United States of America would help to ensure effective verification of limitations on under-ground nuclear testing.

9. The Conference also took note of the appeals contained in five United Nations General Assembly resolutions since 1982 for a freeze on all nuclear weapons in quantitative and qualitative terms, which should be taken by all nuclear-weapon States or, in the first instance and simultaneously, by the Union of Soviet Socialist Republics and the United States of America on the understanding that the other nuclear-weapon States would follow their example, and of similar calls made at this Conference.

10. The Conference took note of proposals by the Union of Soviet Socialist Republics and the United States of America for the reduction of nuclear weapons.

11. The Conference took note of proposals submitted by States Parties on a number of related issues relevant to achieving the purposes of Article VI and set out in Annex I to this document and in the statements made in the General Debate of the Conference.

12. The Conference reiterated its conviction that the objectives of Article VI remained unfulfilled and concluded that the nuclear-weapon States should make greater efforts to ensure effective measures for the cessation of the nuclear arms race at an early date, for nuclear disarmament and for a Treaty on general and complete disarmament under strict and effective international control.

The Conference expressed the hope for rapid progress in the United States-USSR bilateral negotiations.

The Conference except for certain States whose views are reflected in the following subparagraph deeply regretted that a comprehensive multilateral Nuclear Test Ban Treaty banning all nuclear tests by all States in all environments for all time had not been concluded so far and, therefore, called on the nuclear weapon States Party to the Treaty to resume trilateral negotiations in 1985 and called on all the nuclear-weapon States to participate in the urgent negotiation and conclusion of such a Treaty as a matter of the highest priority in the Conference on Disarmament.

At the same time, the Conference noted that certain States Party to the Treaty, while committed to the goal of an effectively verifiable comprehensive Nuclear Test Ban Treaty, considered deep and verifiable reductions in existing arsenals of nuclear weapons as the highest priority in the process of pursuing the objectives of Article VI.

The Conference also noted the statement of the USSR, as one of the nuclear weapon States Party to the Treaty, recalling its repeatedly expressed readiness to proceed forthwith to negotiations, trilateral and multilateral, with the aim of concluding a comprehensive Nuclear Test Ban Treaty and the submission by it of a draft Treaty proposal to this end.

Article VII and the Security of Non-Nuclear-Weapon States

1. The Conference observes the growing interest in utilizing the provisions of Article VII of the Non-Proliferation Treaty, which recognizes the right of any group of States to conclude regional treaties in order to assure the absence of nuclear weapons in their respective territories.

2. The Conference considers that the establishment of nuclear-weapon-free zones on the basis of arrangements freely arrived at among the States of the region concerned constitutes an important disarmament measure and therefore the process of establishing such zones in different parts of the world should be encouraged with the ultimate objective of achieving a world entirely free of nuclear weapons. In the process of establishing such zones, the characteristics of each region should be taken into account.

3. The Conference emphasizes the importance of concluding nuclear-weapon-free zone arrangements in harmony with internationally recognized principles, as stated in the Final Document of the First Special Session of the United Nations devoted to disarmament.

4. The Conference holds the view that, under appropriate conditions, progress towards the establishment of nuclear-weapon-free zones will create conditions more conducive to the establishment of zones of peace in certain regions of the world.

5. The Conference expresses its belief that concrete measures of nuclear disarmament would significantly contribute to creating favourable conditions for the establishment of nuclear-weapon-free zones.

6. The Conference expresses its satisfaction at the continued successful operation of the Treaty for the Prohibition of Nuclear Weapons in Latin America (Treaty of Tlatelolco). It reaffirms the repeated exhortations of the General Assembly to France, which is already a signatory of Additional Protocol I, to ratify it, and calls upon the Latin American States that are eligible to become parties to the treaty do so. The Conference welcomes the signature and ratification of Additional Protocol II to this Treaty by all nuclear-weapon States.

7. The Conference also notes the continued existence of the Antarctic Treaty.

8. The Conference notes the endorsement of the South Pacific Nuclear Free Zone Treaty by the South-Pacific Forum on 6 August 1985 at Rarotonga and welcomes this achievement as consistent with Article VII of the Non-Proliferation Treaty. The Conference also takes note of the draft Protocols to the South Pacific Nuclear Free Zone Treaty and further notes the agreement at the South Pacific Forum that consultations

on the Protocols should be held between members of the Forum and the nuclear-weapon States eligible to sign them.

9. The Conference takes note of the existing proposals and the ongoing regional efforts to achieve nuclear-weapon-free zones in different areas of the world.

10. The Conference recognizes that for the maximum effectiveness of any treaty arrangements for establishing a nuclear-weapon-free zone the co-operation of the nuclear-weapon States is necessary. In this connection, the nuclear-weapon States are invited to assist the efforts of States to create nuclear-weapon-free zones, and to enter into binding undertakings to respect strictly the status of such a zone and to refrain from the use or threat of use of nuclear weapons against the States of the zone.

11. The Conference welcomes the consensus reached by the United Nations General Assembly at its thirty-fifth session that the establishment of a nuclear-weapon-free zone in the region of the Middle East would greatly enhance international peace and security, and urges all parties directly concerned to consider seriously taking the practical and urgent steps required for the implementation of the proposal to establish a nuclear-weapon-free zone in the region of the Middle East.

12. The Conference also invites the nuclear-weapon States and all other States to render their assistance in the establishment of the zone and at the same time to refrain from any action that runs counter to the letter and spirit of United Nations General Assembly resolution 39/54.

13. The Conference considers that acceding to the Non-Proliferation Treaty and acceptance of IAEA safeguards by all States in the region of the Middle East will greatly facilitate the creation of a nuclear-weapon-free zone in the region and will enhance the credibility of the Treaty.

14. The Conference considers that the development of a nuclear weapon capability by South Africa at any time frustrates the implementation of the Declaration on the Denuclearization of Africa and that collaboration with South Africa in this area would undermine the credibility and the stability of the Non-Proliferation Treaty régime. South Africa is called upon to submit all its nuclear installations and facilities to IAEA safeguards and to accede to the Non-Proliferation Treaty. All States Parties

directly concerned are urged to consider seriously taking the practical and urgent steps required for the implementation of the proposal to establish a nuclear-weapon-free zone in Africa. The nuclear-weapon States are invited to assist the efforts of States to create a nuclear-weapon-free zone in Africa, and to enter into binding undertakings to respect strictly the status of such a zone and to refrain from the use or threat of use of nuclear weapons against the States of the zone.

15. The Conference considers that the most effective guarantee against the possible use of nuclear weapons and the danger of nuclear war is nuclear disarmament and the complete elimination of nuclear weapons. Pending the achievement of this goal on a universal basis and recognizing the need for all States to ensure their independence, territorial integrity and sovereignty, the Conference reaffirms the particular importance of assuring and strengthening the security of non-nuclear-weapon States Parties which have renounced the acquisition of nuclear weapons. The Conference recognizes that different approaches may be required to strengthen the security of non-nuclear-weapon States Parties to the Treaty.

16. The Conference underlines again the importance of adherence to the Treaty by non-nuclear-weapon States as the best means of reassuring one another of their renunciation of nuclear weapons and as one of the effective means of strengthening their mutual security.

17. The Conference takes note of the continued determination of the Depositary States to honour their statements, which were welcomed by the United Nations Security Council in resolution 255 (1968), that, to ensure the security of the non-nuclear-weapon States Parties to the Treaty, they will provide or support immediate assistance, in accordance with the Charter, to any non-nuclear-weapon State Party to the Treaty which is a victim of an act or an object of a threat of aggression in which nuclear weapons are used.

18. The Conference reiterates its conviction that, in the interest of promoting the objectives of the Treaty, including the strengthening of the security of non-nuclear-weapon States Parties, all States, both nuclear-weapon and non-nuclear-weapon States, should refrain, in accordance with the Charter of the United Nations, from the

threat or the use of force in relations between States, involving either nuclear or non-nuclear weapons.

19. The Conference recalls that the Tenth Special Session of the General Assembly in paragraph 59 of the Final Document took note of the declarations made by the nuclear-weapon States regarding the assurance of non-nuclear-weapon States against the use or threat of use of nuclear weapons and urged them to pursue efforts to conclude, as appropriate, effective arrangements to assure non-nuclear-weapon States against the use or threat of use of nuclear weapons.

20. Being aware of the consultations and negotiations on effective international arrangements to assure non-nuclear-weapon States against the use or threat of use of nuclear weapons, which have been under way in the Conference on Disarmament for several years, the Conference regrets that the search for a common approach which could be included in an international legally binding instrument, has been unsuccessful. The Conference takes note of the repeatedly expressed intention of the Conference on Disarmament to continue to explore ways and means to overcome the difficulties encountered in its work and to carry out negotiations on the question of effective international arrangements to assure non-nuclear-weapon States against the use or threat of use of nuclear weapons. In this connection, the Conference calls upon all States, particularly the nuclear-weapon States, to continue the negotiations in the Conference on Disarmament devoted to the search for a common approach acceptable to all, which could be included in an international instrument of a legally binding character.

Article VIII

The States Party to the Treaty participating in the Conference propose to the Depositary Governments that a fourth Conference to review the operation of the Treaty be convened in 1990.

The Conference accordingly invites States Party to the Treaty which are Members of the United Nations to request the Secretary-General of the United Nations to include the following item in the provisional agenda of the forty-third session of the General Assembly:

'Implementation of the conclusions of the third Review Conference of the Parties to the Treaty on the Non-Proliferation of Nuclear Weapons and establishment of a Preparatory Committee for the fourth Conference.'

Article IX

The Conference, having expressed great satisfaction that the overwhelming majority of States have acceded to the Treaty on the Non-Proliferation of Nuclear Weapons and having recognized the urgent need for further ensuring the universality of the Treaty, appeals to all States, particularly the nuclear-weapon States and other States advanced in nuclear technology, which have not yet done so, to adhere to the Treaty at the earliest possible date.

Source: *Final Document, Review Conference of the Parties to the Treaty on the non-proliferation of nuclear weapons, NPT/CONF.III/64/I, Annex I.*

Appendix D. The IAEA model NPT safeguards agreement, 1971

THE STRUCTURE AND CONTENT OF AGREEMENTS BETWEEN THE AGENCY AND STATES REQUIRED IN CONNECTION WITH THE TREATY ON THE NON-PROLIFERATION OF NUCLEAR WEAPONS

Agreed at Vienna on 10 March 1971

On 20 April 1971, the IAEA Board of Governors authorized the Director General to use the material reproduced below as the basis for negotiating safeguards agreements between the IAEA and non-nuclear weapon states parties to the NPT

PART I

Basic undertaking

1. The Agreement should contain, in accordance with Article III.1 of the Treaty on the Non-Proliferation of Nuclear Weapons, an undertaking by the State to accept safeguards, in accordance with the terms of the Agreement, on all source or special fissionable material in all peaceful nuclear activities within its territory, under its jurisdiction or carried out under its control anywhere, for the exclusive purpose of verifying that such material is not diverted to nuclear weapons or other nuclear explosive devices.

Application of safeguards

2. The Agreement should provide for the Agency's right and obligation to ensure that safeguards will be applied, in accordance with the terms of the Agreement, on all source or special fissionable material in all peaceful nuclear activities within the territory of the State, under its jurisdiction or carried out under its control anywhere, for the exclusive purpose of verifying that such material is not diverted to nuclear weapons or other nuclear explosive devices.

Co-operation between the Agency and the State

3. The Agreement should provide that the Agency and the State shall co-operate to facilitate the implementation of the safeguards provided for therein.

Implementation of safeguards

4. The Agreement should provide that safeguards shall be implemented in a manner designed:

- (a) To avoid hampering the economic and technological development of the State or international co-operation in the field of peaceful nuclear activities, including international exchange of *nuclear material*;
- (b) To avoid undue interference in the

State's peaceful nuclear activities, and in particular in the operation of *facilities*; and

(c) To be consistent with prudent management practices required for the economic and safe conduct of nuclear activities.

5. The Agreement should provide that the Agency shall take every precaution to protect commercial and industrial secrets and other confidential information coming to its knowledge in the implementation of the Agreement. The Agency shall not publish or communicate to any State, organization or person any information obtained by it in connection with the implementation of the Agreement, except that specific information relating to such implementation in the State may be given to the Board of Governors and to such Agency staff members as require such knowledge by reason of their official duties in connection with safeguards, but only to the extent necessary for the Agency to fulfil its responsibilities in implementing the Agreement. Summarized information on *nuclear material* being safeguarded by the Agency under the Agreement may be published upon decision of the Board if the States directly concerned agree.

6. The Agreement should provide that in implementing safeguards pursuant thereto the Agency shall take full account of technological developments in the field of safeguards, and shall make every effort to ensure optimum cost-effectiveness and the application of the principle of safeguarding effectively the flow of *nuclear material* subject to safeguards under the Agreement by use of instruments and other techniques at certain *strategic points* to the extent that present or future technology permits. In order to ensure optimum cost-effectiveness, use should be made, for example, of such means as:

- (a) Containment as a means of defining *material balance areas* for accounting purposes;

(b) Statistical techniques and random sampling in evaluating the flow of *nuclear material*; and

(c) Concentration of verification procedures on those stages in the nuclear fuel cycle involving the production, processing, use or storage of *nuclear material* from which nuclear weapons or other nuclear explosive devices could readily be made, and minimization of verification procedures in respect of other *nuclear material*, on condition that this does not hamper the Agency in applying safeguards under the Agreement.

National system of accounting for and control of nuclear material

7. The Agreement should provide that the State shall establish and maintain a system of accounting for and control of all *nuclear material* subject to safeguards under the Agreement, and that such safeguards shall be applied in such a manner as to enable the Agency to verify, in ascertaining that there has been no diversion of *nuclear material* from peaceful uses to nuclear weapons or other nuclear explosive devices, findings of the State's system. The Agency's verification shall include, inter alia, independent measurements and observations conducted by the Agency in accordance with the procedures specified in Part II below. The Agency, in its verification, shall take due account of the technical effectiveness of the State's system.

Provisions of information to the Agency

8. The Agreement should provide that to ensure the effective implementation of safeguards thereunder the Agency shall be provided, in accordance with the provisions set out in Part II below, with information concerning *nuclear material* subject to safeguards under the Agreement and the features of *facilities* relevant to safeguarding such material. The Agency shall require only the minimum amount of information and data consistent with carrying out its responsibilities under the Agreement. Information pertaining to *facilities* shall be the minimum necessary for safeguarding *nuclear material* subject to safeguards under the Agreement. In examining design information, the Agency shall, at the request of the State, be prepared to examine on premises of the State design information which the State regards as being of particular sensitivity. Such information would not have to be physically transmitted to the Agency provided that it remained available for ready further examination by the Agency on premises of the State.

Agency inspectors

9. The Agreement should provide that the State shall take the necessary steps to ensure that Agency inspectors can effectively dis-

charge their functions under the Agreement. The Agency shall secure the consent of the State to the designation of Agency inspectors to that State. If the State, either upon proposal of a designation or at any other time after a designation has been made, objects to the designation, the Agency shall propose to the State an alternative designation or designations. The repeated refusal of a State to accept the designation of Agency inspectors which would impede the inspections conducted under the Agreement would be considered by the Board upon referral by the Director General with a view to appropriate action. The visits and activities of Agency inspectors shall be so arranged as to reduce to a minimum the possible inconvenience and disturbance to the State and to the peaceful nuclear activities inspected, as well as to ensure protection of industrial secrets or any other confidential information coming to the inspectors' knowledge.

Privileges and immunities

10. The Agreement should specify the privileges and immunities which shall be granted to the Agency and its staff in respect of their functions under the Agreement. In the case of a State party to the Agreement on the Privileges and Immunities of the Agency, the provisions thereof, as in force for such State, shall apply. In the case of other States, the privileges and immunities granted should be such as to ensure that:

(a) The Agency and its staff will be in a position to discharge their functions under the Agreement effectively; and

(b) No such State will be placed thereby in a more favourable position than States party to the Agreement on the Privileges and Immunities of the Agency.

Termination of safeguards

Consumption or dilution of nuclear material

11. The Agreement should provide that safeguards shall terminate on *nuclear material* subject to safeguards thereunder upon determination by the Agency that it has been consumed, or has been diluted in such a way that it is no longer usable for any nuclear activity relevant from the point of view of safeguards, or has become practicably irrecoverable.

Transfer of nuclear material out of the State

12. The Agreement should provide, with respect to *nuclear material* subject to safeguards thereunder, for notification of transfers of such material out of the State, in accordance with the provisions set out in paragraphs 92-94 below. The Agency shall terminate safeguards under the Agreement on *nuclear material* when the recipient State has assumed responsibility therefor, as provided

for in paragraph 91. The Agency shall maintain records indicating each transfer and, where applicable, the re-application of safeguards to the transferred *nuclear material*.

Provisions relating to nuclear material to be used in non-nuclear activities

13. The Agreement should provide that if the State wishes to use *nuclear material* subject to safeguards thereunder in non-nuclear activities, such as the production of alloys or ceramics, it shall agree with the Agency on the circumstances under which the safeguards on such *nuclear material* may be terminated.

Non-application of safeguards to nuclear material to be used in non-peaceful activities

14. The Agreement should provide that if the State intends to exercise its discretion to use *nuclear material* which is required to be safeguarded thereunder in a nuclear activity which does not require the application of safeguards under the Agreement, the following procedures will apply:

(a) The State shall inform the Agency of the activity, making it clear:

(i) That the use of the *nuclear material* in a non-proscribed military activity will not be in conflict with an undertaking the State may have given and in respect of which Agency safeguards apply, that the *nuclear material* will be used only in a peaceful nuclear activity; and

(ii) That during the period of non-application of safeguards the *nuclear material* will not be used for the production of nuclear weapons or other nuclear explosive devices;

(b) The Agency and the State shall make an arrangement so that, only while the *nuclear material* is in such an activity, the safeguards provided for in the Agreement will not be applied. The arrangement shall identify, to the extent possible, the period or circumstances during which safeguards will not be applied. In any event, the safeguards provided for in the Agreement shall again apply as soon as the *nuclear material* is re-introduced into a peaceful nuclear activity. The Agency shall be kept informed of the total quantity and composition of such unsafeguarded *nuclear material* in the State and of any exports of such material; and

(c) Each arrangement shall be made in agreement with the Agency. The Agency's agreement shall be given as promptly as possible; it shall only relate to the temporal and procedural provisions, reporting arrangements, etc., but shall not involve any approval or classified knowledge of the military activity or relate to the use of the *nuclear material* therein.

Finance

15. The Agreement should contain one of

the following sets of provisions:

(a) An agreement with a Member of the Agency should provide that each party thereto shall bear the expenses it incurs in implementing its responsibilities thereunder. However, if the State or persons under its jurisdiction incur extraordinary expenses as a result of a specific request by the Agency, the Agency shall reimburse such expenses provided that it has agreed in advance to do so. In any case the Agency shall bear the cost of any additional measuring or sampling which inspectors may request; or

(b) An agreement with a party not a Member of the Agency should in application of the provisions of Article XIV.C of the Statute, provide that the party shall reimburse fully to the Agency the safeguards expenses the Agency incurs thereunder. However, if the party or persons under its jurisdiction incur extraordinary expenses as a result of a specific request by the Agency, the Agency shall reimburse such expenses provided that it has agreed in advance to do so.

Third party liability for nuclear damage

16. The Agreement should provide that the State shall ensure that any protection against third party liability in respect of nuclear damage, including any insurance or other financial security, which may be available under its laws or regulations shall apply to the Agency and its officials for the purpose of the implementation of the Agreement, in the same way as that protection applies to nationals of the State.

International responsibility

17. The Agreement should provide that any claim by one party thereto against the other in respect of any damage, other than damage arising out of a nuclear incident, resulting from the implementation of safeguards under the Agreement, shall be settled in accordance with international law.

Measures in relation to verification of non-diversion

18. The Agreement should provide that if the Board, upon report of the Director General, decides that an action by the State is essential and urgent in order to ensure verification that *nuclear material* subject to safeguards under the Agreement is not diverted to nuclear weapons or other nuclear explosive devices the Board shall be able to call upon the State to take the required action without delay, irrespective of whether procedures for the settlement of a dispute have been invoked.

19. The Agreement should provide that if the Board upon examination of relevant information reported to it by the Director General finds that the Agency is not able to

verify that there has been no diversion of *nuclear material* required to be safeguarded under the Agreements to nuclear weapons or other nuclear explosive devices, it may make the reports provided for in paragraph C of Article XII of the Statute and may also take, where applicable, the other measures provided for in that paragraph. In taking such action the Board shall take account of the degree of assurance provided by the safeguards measures that have been applied and shall afford the State every reasonable opportunity to furnish the Board with any necessary reassurance.

Interpretation and application of the Agreement and settlement of disputes

20. The Agreement should provide that the parties thereto shall, at the request of either, consult about any question arising out of the interpretation or application thereof.

21. The Agreement should provide that the State shall have the right to request that any question arising out of the interpretation or application thereof be considered by the Board; and that the State shall be invited by the Board to participate in the discussion of any such question by the Board.

22. The Agreement should provide that any dispute arising out of the interpretation or application thereof except a dispute with regard to a finding by the Board under paragraph 19 above or an action taken by the Board pursuant to such a finding which is not settled by negotiation or another procedure agreed to by the parties should, on the request of either party, be submitted to an arbitral tribunal composed as follows: each party would designate one arbitrator, and the two arbitrators so designated would elect a third, who would be the Chairman. If, within 30 days of the request for arbitration, either party has not designated an arbitrator, either party to the dispute may request the President of the International Court of Justice to appoint an arbitrator. The same procedure would apply if, within 30 days of the designation or appointment of the second arbitrator, the third arbitrator had not been elected. A majority of the members of the arbitral tribunal would constitute a quorum, and all decisions would require the concurrence of two arbitrators. The arbitral procedure would be fixed by the tribunal. The decisions of the tribunal would be binding on both parties.

Final clauses

Amendment of the Agreement

23. The Agreement should provide that the parties thereto shall, at the request of either of them, consult each other on amendment of the Agreement. All amendments shall require the agreement of both parties. It might additionally be provided, if convenient

to the State, that the agreement of the parties on amendments to Part II of the Agreement could be achieved by recourse to a simplified procedure. The Director General shall promptly inform all Member States of any amendment to the Agreement.

Suspension of application of Agency safeguards under other agreements

24. Where applicable and where the State desires such a provision to appear, the Agreement should provide that the application of Agency safeguards in the State under other safeguards agreements with the Agency shall be suspended while the Agreement is in force. If the State has received assistance from the Agency for a project, the State's undertaking in the Project Agreement not to use items subject thereto in such a way as to further any military purpose shall continue to apply.

Entry into force and duration

25. The Agreement should provide that it shall enter into force on the date on which the Agency receives from the State written notification that the statutory and constitutional requirements for entry into force have been met. The Director General shall promptly inform all Member States of the entry into force.

26. The Agreement should provide for it to remain in force as long as the State is party to the Treaty on the Non-Proliferation of Nuclear Weapons.

PART II

Introduction

27. The Agreement should provide that the purpose of Part II thereof is to specify the procedures to be applied for the implementation of the safeguards provisions of Part I.

Objective of safeguards

28. The Agreement should provide that the objective of safeguards is the timely detection of diversion of significant quantities of *nuclear material* from peaceful nuclear activities to the manufacture of nuclear weapons or of other nuclear explosive devices or for purposes unknown, and deterrence of such diversion by the risk of early detection.

29. To this end the Agreement should provide for the use of material accountancy as a safeguards measure of fundamental importance, with containment and surveillance as important complementary measures.

30. The Agreement should provide that the technical conclusion of the Agency's verification activities shall be a statement, in respect of each *material balance area*, of the amount of *material unaccounted for* over a

specific period, giving the limits of accuracy of the amounts stated.

National system of accounting for and control of nuclear material

31. The Agreement should provide that pursuant to paragraph 7 above the Agency, in carrying out its verification activities, shall make full use of the State's system of accounting for and control of all *nuclear material* subject to safeguards under the Agreement, and shall avoid unnecessary duplication of the State's accounting and control activities.

32. The Agreement should provide that the State's system of accounting for and control of all *nuclear material* subject to safeguards under the Agreement shall be based on a structure of material balance areas, and shall make provision as appropriate and specified in the Subsidiary Arrangements for the establishment of such measures as:

(a) A measurement system for the determination of the quantities of *nuclear material* received, produced, shipped, lost or otherwise removed from inventory, and the quantities on inventory;

(b) The evaluation of precision and accuracy of measurements and the estimation of measurement uncertainty;

(c) Procedures for identifying, reviewing and evaluating differences in shipper/receiver measurements;

(d) Procedures for taking a *physical inventory*;

(e) Procedures for the evaluation of accumulations of unmeasured inventory and unmeasured losses;

(f) A system of records and reports showing, for each *material balance area*, the inventory of *nuclear material* and the changes in that inventory including receipts into and transfers out of the *material balance area*;

(g) Provisions to ensure that the accounting procedures and arrangements are being operated correctly; and

(h) Procedures for the provisions of reports to the Agency in accordance with paragraphs 59-69 below.

Starting point of safeguards

33. The Agreement should provide that safeguards shall not apply thereunder to material in mining or ore processing activities.

34. The Agreement should provide that:

(a) When any material containing uranium or thorium which has not reached the stage of the nuclear fuel cycle described in subparagraph (c) below is directly or indirectly exported to a non-nuclear-weapon State, the State shall inform the Agency of its quantity, composition and destination, unless the material is exported for specifically non-nuclear purposes;

(b) When any material containing uranium or thorium which has not reached the stage of the nuclear fuel cycle described in subparagraph (c) below is imported, the State shall inform the Agency of its quantity and composition, unless the material is imported for specifically non-nuclear purposes; and

(c) When any *nuclear material* of a composition and purity suitable for fuel fabrication or for being isotopically enriched leaves the plant or the process stage in which it has been produced, or when such *nuclear material*, or any other *nuclear material* produced at a later stage in the nuclear fuel cycle, is imported into the State, the *nuclear material* shall become subject to the other safeguards procedures specified in the Agreement.

Termination of safeguards

35. The Agreement should provide that safeguards shall terminate on *nuclear material* subject to safeguards thereunder under the conditions set forth in paragraph 11 above. Where the conditions of that paragraph are not met, but the State considers that the recovery of safeguarded *nuclear material* from residues is not for the time being practicable or desirable, the Agency and the State shall consult on the appropriate safeguards measures to be applied. It should further be provided that safeguards shall terminate on *nuclear material* subject to safeguards under the Agreement under the conditions set forth in paragraph 13 above, provided that the State and the Agency agree that such *nuclear material* is practicably irrecoverable.

Exemptions from safeguards

36. The Agreement should provide that the Agency shall, at the request of the State, exempt *nuclear material* from safeguards, as follows:

(a) Special fissionable material, when it is used in gram quantities or less as a sensing component in instruments;

(b) *Nuclear material*, when it is used in non-nuclear activities in accordance with paragraph 13 above, if such *nuclear material* is recoverable; and

(c) Plutonium with an isotopic concentration of plutonium-238 exceeding 80%.

37. The Agreement should provide that *nuclear material* that would otherwise be subject to safeguards shall be exempted from safeguards at the request of the State, provided that *nuclear material* so exempted in the State may not at any time exceed:

(a) One kilogram in total of special fissionable material, which may consist of one or more of the following:

(i) Plutonium;

(ii) Uranium with an *enrichment* of 0.2 (20%) and above, taken account of by

multiplying its weight by its *enrichment*; and

(iii) Uranium with an *enrichment* below 0.2 (20%) and above that of natural uranium, taken account of by multiplying its weight by five times the square of its *enrichment*;

(b) Ten metric tons in total of natural uranium and depleted uranium with an *enrichment* above 0.005 (0.5%);

(c) Twenty metric tons of depleted uranium with an *enrichment* of 0.005 (0.5%) or below; and

(d) Twenty metric tons of thorium; or such greater amounts as may be specified by the Board of Governors for uniform application.

38. The Agreement should provide that if exempted *nuclear material* is to be processed or stored together with safeguarded *nuclear material*, provision should be made for the reapplication of safeguards thereto.

Subsidiary arrangements

39. The Agreement should provide that the Agency and the State shall make Subsidiary Arrangements which shall specify in detail, to the extent necessary to permit the Agency to fulfil its responsibilities under the Agreement in an effective and efficient manner, how the procedures laid down in the Agreement are to be applied. Provision should be made for the possibility of an extension or change of the Subsidiary Arrangements by agreement between the Agency and the State without amendment of the Agreement.

40. It should be provided that the Subsidiary Arrangements shall enter into force at the same time as, or as soon as possible after, the entry into force of the Agreement. The State and the Agency shall make every effort to achieve their entry into force within 90 days of the entry into force of the Agreement, a later date being acceptable only with the agreement of both parties. The State shall provide the Agency promptly with the information required for completing the Subsidiary Arrangements. The Agreement should also provide that, upon its entry into force, the Agency shall be entitled to apply the procedures laid down therein in respect of the *nuclear material* listed in the inventory provided for in paragraph 41 below.

Inventory

41. The Agreement should provide that, on the basis of the initial report referred to in paragraph 62 below, the Agency shall establish a unified inventory of all *nuclear material* in the State subject to safeguards under the Agreement, irrespective of its origin, and maintain this inventory on the

basis of subsequent reports and of the results of its verification activities. Copies of the inventory shall be made available to the State at agreed intervals.

Design information

General

42. Pursuant to paragraph 8 above, the Agreement should stipulate that design information in respect of existing *facilities* shall be provided to the Agency during the discussion of the Subsidiary Arrangements, and that the time limits for the provision of such information in respect of new *facilities* shall be specified in the Subsidiary Arrangements. It should further be stipulated that such information shall be provided as early as possible before *nuclear material* is introduced into a new *facility*.

43. The Agreement should specify that the design information in respect of each *facility* to be made available to the Agency shall include, when applicable:

(a) The identification of the *facility*, stating its general character, purpose, nominal capacity and geographic location, and the name and address to be used for routine business purposes;

(b) A description of the general arrangement of the *facility* with reference, to the extent feasible, to the form, location and flow of *nuclear material* and to the general layout of important items of equipment which use, produce or process *nuclear material*;

(c) A description of features of the *facility* relating to material accountancy, containment and surveillance; and

(d) A description of the existing and proposed procedures at the *facility* for *nuclear material* accountancy and control, with special reference to *material balance areas* established by the operator, measurements of flow and procedures for *physical inventory* taking.

44. The Agreement should further provide that other information relevant to the application of safeguards shall be made available to the Agency in respect of each *facility*, in particular on organizational responsibility for material accountancy and control. It should also be provided that the State shall make available to the Agency supplementary information on the health and safety procedures which the Agency shall observe and with which the inspectors shall comply at the *facility*.

45. The Agreement should stipulate that design information in respect of a modification relevant for safeguards purposes shall be provided for examination sufficiently in advance for the safeguards procedures to be adjusted when necessary.

Purposes of examination of design information

46. The Agreement should provide that

the design information made available to the Agency shall be used for the following purposes:

(a) To identify the features of *facilities* and *nuclear material* relevant to the application of safeguards to *nuclear material* in sufficient detail to facilitate verification;

(b) To determine *material balance areas* to be used for Agency accounting purposes and to select those *strategic points* which are *key measurement points* and which will be used to determine the *nuclear material* flows and inventories; in determining such *material balance areas* the Agency shall, inter alia, use the following criteria:

(i) The size of the *material balance area* should be related to the accuracy with which the material balance can be established;

(ii) In determining the *material balance area* advantage should be taken of any opportunity to use containment and surveillance to help ensure the completeness of flow measurements and thereby simplify the application of safeguards and concentrate measurement efforts at *key measurement points*;

(iii) A number of *material balance areas* in use at a *facility* or at distinct sites may be combined in one *material balance area* to be used for Agency accounting purposes when the Agency determines that this is consistent with its verification requirements; and

(iv) If the State so requests, a special *material balance area* around a process step involving commercially sensitive information may be established;

(c) To establish the nominal timing and procedures for taking of *physical inventory* for Agency accounting purposes;

(d) To establish the records and reports requirements and records evaluation procedures;

(e) To establish requirements and procedures for verification of the quantity and location of *nuclear material*; and

(f) To select appropriate combinations of containment and surveillance methods and techniques and the *strategic points* at which they are to be applied.

It should further be provided that the results of the examination of the design information shall be included in the Subsidiary Arrangements.

Re-examination of design information

47. The Agreement should provide that design information shall be re-examined in the light of changes in operating conditions, of developments in safeguards technology or of experience in the application of verification procedures, with a view to modifying the action the Agency has taken pursuant to paragraph 46 above.

Verification of design information

48. The Agreement should provide that the Agency, in co-operation with the State, may send inspectors to *facilities* to verify the design information provided to the Agency pursuant to paragraphs 42-45 above for the purposes stated in paragraph 46.

Information in respect of nuclear material outside facilities

49. The Agreement should provide that the following information concerning *nuclear material* customarily used outside *facilities* shall be provided as applicable to the Agency:

(a) A general description of the use of the *nuclear material*, its geographic location, and the user's name and address for routine business purposes; and

(b) A general description of the existing and proposed procedures for *nuclear material* accountancy and control, including organizational responsibility for material accountancy and control.

The Agreement should further provide that the Agency shall be informed on a timely basis of any change in the information provided to it under this paragraph.

50. The Agreement should provide that the information made available to the Agency in respect of *nuclear material* customarily used outside *facilities* may be used, to the extent relevant, for the purposes set out in sub-paragraphs 46(b)-(f) above.

Records system

General

51. The Agreement should provide that in establishing a national system of accounting for and control of *nuclear material* as referred to in paragraph 7 above, the State shall arrange that records are kept in respect of each *material balance area*. Provision should also be made that the Subsidiary Arrangements shall describe the records to be kept in respect of each *material balance area*.

52. The Agreement should provide that the State shall make arrangements to facilitate the examination of records by inspectors, particularly if the records are not kept in English, French, Russian or Spanish.

53. The Agreement should provide that the records shall be retained for at least five years.

54. The Agreement should provide that the records shall consist, as appropriate, of:

(a) Accounting records of all *nuclear material* subject to safeguards under the Agreement; and

(b) Operating records for *facilities* containing such *nuclear material*.

55. The Agreement should provide that the system of measurements on which the records used for the preparation of reports are based shall either conform to the latest

international standards or be equivalent in quality to such standards.

Accounting records

56. The Agreement should provide that the accounting records shall set forth the following in respect of each *material balance area*:

(a) All *inventory changes*, so as to permit a determination of the *book inventory* at any time;

(b) All measurement results that are used for determination of the *physical inventory*; and

(c) All *adjustments* and *corrections* that have been made in respect of *inventory changes*, *book inventories* and *physical inventories*.

57. The Agreement should provide that for all *inventory changes* and *physical inventories* the records shall show, in respect of each *batch* of *nuclear material*: material identification, *batch data* and *source data*. Provision should further be included that records shall account for uranium, thorium and plutonium separately in each *batch* of *nuclear material*. Furthermore, the date of the *inventory change* and, when appropriate, the originating *material balance area* and the receiving *material balance area* or the recipient, shall be indicated for each *inventory change*.

Operating records

58. The Agreement should provide that the operating records shall set forth as appropriate in respect of each *material balance area*:

(a) Those operating data which are used to establish changes in the quantities and composition of *nuclear material*;

(b) The data obtained from the calibration of tanks and instruments and from sampling and analyses, the procedures to control the quality of measurements and the derived estimates of random and systematic error;

(c) A description of the sequence of the actions taken in preparing for, and in taking, a *physical inventory*, in order to ensure that it is correct and complete; and

(d) A description of the actions taken in order to ascertain the cause and magnitude of any accidental or unmeasured loss that might occur.

Reports system

General

59. The Agreement should specify that the State shall provide the Agency with reports as detailed in paragraphs 60-69 below in respect of *nuclear material* subject to safeguards thereunder.

60. The Agreement should provide that reports shall be made in English, French,

Russian or Spanish, except as otherwise specified in the Subsidiary Arrangements.

61. The Agreement should provide that reports shall be based on the records kept in accordance with paragraphs 51-58 above and shall consist, as appropriate, of accounting reports and special reports.

Accounting reports

62. The Agreement should stipulate that the Agency shall be provided with an initial report on all *nuclear material* which is to be subject to safeguards thereunder. It should also be provided that the initial report shall be dispatched by the State to the Agency within 30 days of the last day of the calendar month in which the Agreement enters into force, and shall reflect the situation as of the last day of that month.

63. The Agreement should stipulate that for each *material balance area* the State shall provide the Agency with the following accounting reports:

(a) *Inventory change* reports showing changes in the inventory of *nuclear material*. The reports shall be dispatched as soon as possible and in any event within 30 days after the end of the month in which the *inventory changes* occurred or were established; and

(b) Material balance reports showing the material balance based on a *physical inventory* of *nuclear material* actually present in the *material balance area*. The reports shall be dispatched as soon as possible and in any event within 30 days after the *physical inventory* has been taken.

The reports shall be based on data available as of the date of reporting and may be corrected at a later date as required.

64. The Agreement should provide that *inventory change* reports shall specify identification and *batch data* for each *batch* of *nuclear material*, the date of the *inventory change* and, as appropriate, the originating *material balance area* and the receiving *material balance area* or the recipient. These reports shall be accompanied by concise notes:

(a) Explaining the *inventory changes*, on the basis of the operating data contained in the operating records provided for under subparagraph 58(a) above; and

(b) Describing, as specified in the Subsidiary Arrangements, the anticipated operational programme, particularly the taking of a *physical inventory*.

65. The Agreement should provide that the State shall report each *inventory change*, *adjustment* and *correction* either periodically in a consolidated list or individually. The *inventory changes* shall be reported in terms of *batches*; small amounts, such as analytical samples, as specified in the Subsidiary Arrangements, may be combined and reported as one *inventory change*.

66. The Agreement should stipulate that the Agency shall provide the State with semi-annual statements of *book inventory* of *nuclear material* subject to safeguards, for each *material balance area*, as based on the *inventory change* reports for the period covered by each such statement.

67. The Agreement should specify that the material balance reports shall include the following entries, unless otherwise agreed by the Agency and the State:

- (a) Beginning *physical inventory*;
- (b) *Inventory changes* (first increases, then decreases);
- (c) Ending *book inventory*;
- (d) *Shipper/receiver differences*;
- (e) Adjusted ending *book inventory*;
- (f) Ending *physical inventory*; and
- (g) *Material unaccounted for*.

A statement of the *physical inventory*, listing all *batches* separately and specifying material identification and *batch data* for each *batch*, shall be attached to each material balance report.

Special reports

68. The Agreement should provide that the State shall make special reports without delay:

- (a) If any unusual incident or circumstances lead the State to believe that there is or may have been loss of *nuclear material* that exceeds the limits to be specified for this purpose in the Subsidiary Arrangements; or
- (b) If the containment has unexpectedly changed from that specified in the Subsidiary Arrangements to the extent that unauthorized removal of *nuclear material* has become possible.

Amplification and clarification of reports

69. The Agreement should provide that at the Agency's request the State shall supply amplifications or clarifications of any report, in so far as relevant for the purpose of safeguards.

Inspections

General

70. The Agreement should stipulate that the Agency shall have the right to make inspections as provided for in paragraphs 71-82 below.

Purposes of inspections

71. The Agreement should provide that the Agency may make ad hoc inspections in order to:

- (a) Verify the information contained in the initial report on the *nuclear material* subject to safeguards under the Agreement;
- (b) Identify and verify changes in the situation which have occurred since the date of the initial report; and

- (c) Identify, and if possible verify the quantity and composition of, *nuclear material* in accordance with paragraphs 93 and 96 below, before its transfer out of or upon its transfer into the State.

72. The Agreement should provide that the Agency may make routine inspections in order to:

- (a) Verify that reports are consistent with records;
- (b) Verify the location, identity, quantity and composition of all *nuclear material* subject to safeguards under the Agreement; and
- (c) Verify information on the possible causes of *material unaccounted for*, *shipper/receiver differences* and uncertainties in the *book inventory*.

73. The Agreement should provide that the Agency may make special inspections subject to the procedures laid down in paragraph 77 below;

- (a) In order to verify the information contained in special reports; or
- (b) If the Agency considers that information made available by the State, including explanations from the State and information obtained from routine inspections, is not adequate for the Agency to fulfil its responsibilities under the Agreement.

An inspection shall be deemed to be special when it is either additional to the routine inspection effort provided for in paragraphs 78-82 below, or involves access to information or locations in addition to the access specified in paragraph 76 for ad hoc and routine inspections, or both.

Scope of inspections

74. The Agreement should provide that for the purposes stated in paragraphs 71-73 above the Agency may:

- (a) Examine the records kept pursuant to paragraphs 51-58;
- (b) Make independent measurements of all *nuclear material* subject to safeguards under the Agreement;
- (c) Verify the functioning and calibration of instruments and other measuring and control equipment;
- (d) Apply and make use of surveillance and containment measures; and
- (e) Use other objective methods which have been demonstrated to be technically feasible.

75. It should further be provided that within the scope of paragraph 74 above the Agency shall be enabled:

- (a) To observe that samples at *key measurement points* for material balance accounting are taken in accordance with procedures which produce representative samples, to observe the treatment and analysis of the samples and to obtain duplicates of such samples;
- (b) To observe that the measurements of

nuclear material at key measurement points for material balance accounting are representative, and to observe the calibration of the instruments and equipment involved;

(c) To make arrangements with the State that, if necessary:

(i) Additional measurements are made and additional samples taken for the Agency's use;

(ii) The Agency's standard analytical samples are analysed;

(iii) Appropriate absolute standards are used in calibrating instruments and other equipment; and

(iv) Other calibrations are carried out;

(d) To arrange to use its own equipment for independent measurement and surveillance, and if so agreed and specified in the Subsidiary Arrangements, to arrange to install such equipment;

(e) To apply its seals and other identifying and tamper-indicating devices to containments, if so agreed and specified in the Subsidiary Arrangements; and

(f) To make arrangements with the State for the shipping of samples taken for the Agency's use.

Access for inspections

76. The Agreement should provide that:

(a) For the purposes specified in subparagraphs 71(a) and (b) above and until such time as the *strategic points* have been specified in the Subsidiary Arrangements, the Agency's inspectors shall have access to any location where the initial report or any inspections carried out in connection with it indicate that *nuclear material* is present;

(b) For the purposes specified in subparagraph 71(c) above the inspectors shall have access to any location of which the Agency has been notified in accordance with subparagraphs 92(c) or 95(c) below;

(c) For the purposes specified in paragraph 72 above the Agency's inspectors shall have access only to the *strategic points* specified in the Subsidiary Arrangements and to the records maintained pursuant to paragraphs 51-58; and

(d) In the event of the State concluding that any unusual circumstances require extended limitations on access by the Agency, the State and the Agency shall promptly make arrangements with a view to enabling the Agency to discharge its safeguards responsibilities in the light of these limitations. The Director General shall report each such arrangement to the Board.

77. The Agreement should provide that in circumstances which may lead to special inspections for the purposes specified in paragraph 73 above the State and the Agency shall consult forthwith. As a result of such consultations the Agency may make inspections in addition to the routine inspection effort

provided for in paragraphs 78-82 below, and may obtain access in agreement with the State to information or locations in addition to the access specified in paragraph 76 above for ad hoc and routine inspections. Any disagreement concerning the need for additional access shall be resolved in accordance with paragraphs 21 and 22; in case action by the State is essential and urgent, paragraph 18 above shall apply.

Frequency and intensity of routine inspections

78. The Agreement should provide that the number, intensity, duration and timing of routine inspections shall be kept to the minimum consistent with the effective implementation of the safeguards procedures set forth therein, and that the Agency shall make the optimum and most economical use of available inspection resources.

79. The Agreement should provide that in the case of *facilities* and *material balance areas* outside *facilities* with a content or *annual throughput*, whichever is greater, of *nuclear material* not exceeding five *effective kilograms*, routine inspections shall not exceed one per year. For other *facilities* the number, intensity, duration, timing and mode of inspections shall be determined on the basis that in the maximum or limiting case the inspection régime shall be no more intensive than is necessary and sufficient to maintain continuity of knowledge of the flow and inventory of *nuclear material*.

80. The Agreement should provide that the maximum routine inspection effort in respect of *facilities* with a content or *annual throughput* of *nuclear material* exceeding five *effective kilograms* shall be determined as follows:

(a) For reactors and sealed stores, the maximum total of routine inspection per year shall be determined by allowing one sixth of a *man-year of inspection* for each such *facility* in the State;

(b) For other *facilities* involving plutonium or uranium enriched to more than 5%, the maximum total of routine inspection per year shall be determined by allowing for each such *facility* $30 \times \sqrt{E}$ man-days of inspection per year, where E is the inventory or *annual throughput* of *nuclear material*, whichever is greater, expressed in *effective kilograms*. The maximum established for any such *facility* shall not, however, be less than 1.5 *man-years of inspection*; and

(c) For all other *facilities*, the maximum total of routine inspection per year shall be determined by allowing for each such *facility* one third of a *man-year of inspection* plus $0.4 \times E$ man-days of inspection per year, where E is the inventory or *annual throughput* of *nuclear material*, whichever is greater, expressed in *effective kilograms*.

The Agreement should further provide that the Agency and the State may agree to amend the maximum figures specified in this paragraph upon determination by the Board that such amendment is reasonable.

81. Subject to paragraphs 78-80 above the criteria to be used for determining the actual number, intensity, duration, timing and mode of routine inspections of any *facility* shall include:

(a) The form of *nuclear material*, in particular, whether the material is in bulk form or contained in a number of separate items; its chemical composition and, in the case of uranium, whether it is of low or high *enrichment*; and its accessibility;

(b) The effectiveness of the State's accounting and control system, including the extent to which the operators of *facilities* are functionally independent of the State's accounting and control system; the extent to which the measures specified in paragraph 32 above have been implemented by the State; the promptness of reports submitted to the Agency; their consistency with the Agency's independent verification; and the amount and accuracy of the *material unaccounted for*, as verified by the Agency;

(c) Characteristics of the State's nuclear fuel cycle, in particular, the number and types of *facilities* containing *nuclear material* subject to safeguards, the characteristics of such *facilities* relevant to safeguards, notably the degree of containment; the extent to which the design of such *facilities* facilitates verification of the flow and inventory of *nuclear material*; and the extent to which information from different *material balance areas* can be correlated;

(d) International interdependence, in particular, the extent to which *nuclear material* is received from or sent to other States for use or processing; any verification activity by the Agency in connection therewith; and the extent to which the State's nuclear activities are interrelated with those of other States; and

(e) Technical developments in the field of safeguards, including the use of statistical techniques and random sampling in evaluating the flow of *nuclear material*.

82. The Agreement should provide for consultation between the Agency and the State if the latter considers that the inspection effort is being deployed with undue concentration on particular *facilities*.

Notice of inspections

83. The Agreement should provide that the Agency shall give advance notice to the State before arrival of inspectors at *facilities* or *material balance areas* outside *facilities*, as follows:

(a) For ad hoc inspections pursuant to sub-paragraph 71(c) above, at least 24 hours, for

those pursuant to sub-paragraphs 71(a) and (b), as well as the activities provided for in paragraph 48, at least one week;

(b) For special inspections pursuant to paragraph 73 above, as promptly as possible after the Agency and the State have consulted as provided for in paragraph 77, it being understood that notification of arrival normally will constitute part of the consultations; and

(c) For routine inspections pursuant to paragraph 72 above, at least 24 hours in respect of the *facilities* referred to in sub-paragraph 80(b) and sealed stores containing plutonium or uranium enriched to more than 5%, and one week in all other cases.

Such notice of inspections shall include the names of the inspectors and shall indicate the *facilities* and the *material balance areas* outside *facilities* to be visited and the periods during which they will be visited. If the inspectors are to arrive from outside the State the Agency shall also give advance notice of the place and time of their arrival in the State.

84. However, the Agreement should also provide that, as a supplementary measure, the Agency may carry out without advance notification a portion of the routine inspections pursuant to paragraph 80 above in accordance with the principle of random sampling. In performing any unannounced inspections, the Agency shall fully take into account any operational programme provided by the State pursuant to paragraph 64(b). Moreover, whenever practicable, and on the basis of the operational programme, it shall advise the State periodically of its general programme of announced and unannounced inspections, specifying the general periods when inspections are foreseen. In carrying out any unannounced inspections, the Agency shall make every effort to minimize any practical difficulties for *facility* operators and the State, bearing in mind the relevant provisions of paragraphs 44 above and 89 below. Similarly the State shall make every effort to facilitate the task of the inspectors.

Designation of inspectors

85. The Agreement should provide that:

(a) The Director General shall inform the State in writing of the name, qualifications, nationality, grade and such other particulars as may be relevant, of each Agency official he proposes for designation as an inspector for the State;

(b) The State shall inform the Director General within 30 days of the receipt of such a proposal whether it accepts the proposal;

(c) The Director General may designate each official who has been accepted by the State as one of the inspectors for the State, and shall inform the State of such designations; and

(d) The Director General, acting in response to a request by the State or on his own initiative, shall immediately inform the State of the withdrawal of the designation of any official as an inspector for the State.

The Agreement should also provide, however, that in respect of inspectors needed for the purposes stated in paragraph 48 above and to carry out ad hoc inspections pursuant to sub-paragraphs 71(a) and (b) the designation procedures shall be completed if possible within 30 days after the entry into force of the Agreement. If such designation appears impossible within this time limit, inspectors for such purposes shall be designated on a temporary basis.

86. The Agreement should provide that the State shall grant or renew as quickly as possible appropriate visas, where required, for each inspector designated for the State.

Conduct and visits of inspectors

87. The Agreement should provide that inspectors, in exercising their functions under paragraphs 48 and 71-75 above, shall carry out their activities in a manner designed to avoid hampering or delaying the construction, commissioning or operation of facilities, or affecting their safety. In particular inspectors shall not operate any facility themselves or direct the staff of a facility to carry out any operation. If inspectors consider that in pursuance of paragraphs 74 and 75, particular operations in a facility should be carried out by the operator, they shall make a request therefor.

88. When inspectors require services available in the State, including the use of equipment, in connection with the performance of inspections, the State shall facilitate the procurement of such services and the use of such equipment by inspectors.

89. The Agreement should provide that the State shall have the right to have inspectors accompanied during their inspections by representatives of the State, provided that inspectors shall not thereby be delayed or otherwise impeded in the exercise of their functions.

Statements on the Agency's verification activities

90. The Agreement should provide that the Agency shall inform the State of:

(a) The results of inspections, at intervals to be specified in the Subsidiary Arrangements; and

(b) The conclusions it has drawn from its verification activities in the State, in particular by means of statements in respect of each material balance area, which shall be made as soon as possible after a physical inventory has been taken and verified by the Agency and a material balance has been struck.

International transfers

General

91. The Agreement should provide that nuclear material subject or required to be subject to safeguards thereunder which is transferred internationally shall, for purposes of the Agreement, be regarded as being the responsibility of the State:

(a) In the case of import, from the time that such responsibility ceases to lie with the exporting State, and no later than the time at which the nuclear material reaches its destination; and

(b) In the case of export, up to the time at which the recipient State assumes such responsibility, and no later than the time at which the nuclear material reaches its destination.

The Agreement should provide that the States concerned shall make suitable arrangements to determine the point at which the transfer of responsibility will take place. No State shall be deemed to have such responsibility for nuclear material merely by reason of the fact that the nuclear material is in transit on or over its territory or territorial waters, or that it is being transported under its flag or in its aircraft.

Transfers out of the State

92. The Agreement should provide that any intended transfer out of the State of safeguarded nuclear material in an amount exceeding one effective kilogram, or by successive shipments to the same State within a period of three months each of less than one effective kilogram but exceeding in total one effective kilogram, shall be notified to the Agency after the conclusion of the contractual arrangements leading to the transfer and normally at least two weeks before the nuclear material is to be prepared for shipping. The Agency and the State may agree on different procedures for advance notification. The notification shall specify:

(a) The identification and, if possible, the expected quantity and composition of the nuclear material to be transferred, and the material balance area from which it will come;

(b) The State for which the nuclear material is destined;

(c) The dates on and locations at which the nuclear material is to be prepared for shipping;

(d) The approximate dates of dispatch and arrival of the nuclear material; and

(e) At what point of the transfer the recipient State will assume responsibility for the nuclear material, and the probable date on which this point will be reached.

93. The Agreement should further provide that the purpose of this notification shall be to enable the Agency if necessary to identify,

and if possible verify the quantity and composition of, *nuclear material* subject to safeguards under the Agreement before it is transferred out of the State and, if the agency so wishes or the State so requests, to affix seals to the *nuclear material* when it has been prepared for shipping. However, the transfer of the *nuclear material* shall not be delayed in any way by any action taken or contemplated by the Agency pursuant to this notification.

94. The Agreement should provide that, if the *nuclear material* will not be subject to Agency safeguards in the recipient State, the exporting State shall make arrangements for the Agency to receive, within three months of the time when the recipient State accepts responsibility for the *nuclear material* from the exporting State, confirmation by the recipient State of the transfer.

Transfers into the State

95. The Agreement should provide that the expected transfer into the State of *nuclear material* required to be subject to safeguards in an amount greater than one *effective kilogram*, or by successive shipments from the same State within a period of three months each of less than one *effective kilogram* but exceeding in total one *effective kilogram*, shall be notified to the Agency as much in advance as possible of the expected arrival of the *nuclear material*, and in any case not later than the date on which the recipient State assumes responsibility therefor. The Agency and the State may agree on different procedures for advance notification. The notification shall specify:

(a) The identification and, if possible, the expected quantity and composition of the *nuclear material*;

(b) At what point of the transfer responsibility for the *nuclear material* will be assumed by the State for the purposes of the Agreement, and the probable date on which this point will be reached; and

(c) The expected date of arrival, the location to which the *nuclear material* is to be delivered and the date on which it is intended that the *nuclear material* should be unpacked.

96. The Agreement should provide that the purpose of this notification shall be to enable the Agency if necessary to identify, and if possible verify the quantity and composition of, *nuclear material* subject to safeguards which has been transferred into the State, by means of inspection of the consignment at the time it is unpacked. However, unpacking shall not be delayed by any action taken or contemplated by the Agency pursuant to this notification.

Special reports

97. The Agreement should provide that in the case of international transfers a special report as envisaged in paragraph 68 above

shall be made if any unusual incident or circumstances lead the State to believe that there is or may have been loss of *nuclear material*, including the occurrence of significant delay during the transfer.

Definitions

98. "Adjustment" means an entry into an accounting record or a report showing a *shipper/receiver difference* or *material unaccounted for*.

99. "Annual throughput" means, for the purposes of paragraphs 79 and 80 above, the amount of *nuclear material* transferred annually out of a *facility* working at nominal capacity.

100. "Batch" means a portion of *nuclear material* handled as a unit for accounting purposes at a *key measurement point* and for which the composition and quantity are defined by a single set of specifications or measurements. The *nuclear material* may be in bulk form or contained in a number of separate items.

101. "Batch data" means the total weight of each element of *nuclear material* and, in the case of plutonium and uranium, the isotopic composition when appropriate. The units of account shall be as follows:

(a) Grams of contained plutonium;

(b) Grams of total uranium and grams of contained uranium-235 plus uranium-233 for uranium enriched in these isotopes; and

(c) Kilograms of contained thorium, natural uranium or depleted uranium.

For reporting purposes the weights of individual items in the *batch* shall be added together before rounding to the nearest unit.

102. "Book inventory" of a *material balance area* means the algebraic sum of the most recent *physical inventory* of that *material balance area* and of all *inventory changes* that have occurred since that *physical inventory* was taken.

103. "Correction" means an entry into an accounting record or a report to rectify an identified mistake or to reflect an improved measurement of a quantity previously entered into the record or report. Each correction must identify the entry to which it pertains.

104. "Effective kilogram" means a special unit used in safeguarding *nuclear material*. The quantity in "effective kilograms" is obtained by taking:

(a) For plutonium, its weight in kilograms;

(b) For uranium with an *enrichment* of 0.01 (1%) and above, its weight in kilograms multiplied by the square of its *enrichment*;

(c) For uranium with an *enrichment* below 0.01 (1%) and above 0.005 (0.5%), its weight in kilograms multiplied by 0.0001; and

(d) For depleted uranium with an *enrichment* of 0.005 (0.5%) or below, and for thorium, its weight in kilograms multiplied by 0.00005.

105. "Enrichment" means the ratio of the combined weight of the isotopes uranium-233 and uranium-235 to that of the total uranium in question.

106. "Facility" means:

(a) A reactor, a critical facility, a conversion plant, a fabrication plant, a reprocessing plant, an isotope separation plant or a separate storage installation; or

(b) Any location where *nuclear material* in amounts greater than one *effective kilogram* is customarily used.

107. "Inventory change" means an increase or decrease, in terms of *batches*, of *nuclear material* in a *material balance area*; such a change shall involve one of the following:

(a) Increases:

(i) Import;

(ii) Domestic receipt: receipts from other *material balance areas*, receipts from a non-safeguarded (non-peaceful) activity or receipts at the starting point of safeguards;

(iii) Nuclear production: production of special fissionable material in a reactor; and

(iv) De-exemption: reapplication of safeguards on *nuclear material* previously exempted therefrom on account of its use or quantity.

(b) Decreases:

(i) Export;

(ii) Domestic shipment: shipments to other *material balance areas* or shipments for a non-safeguarded (non-peaceful) activity;

(iii) Nuclear loss: loss of *nuclear material* due to its transformation into other element(s) or isotope(s) as a result of nuclear reactions;

(iv) Measured discard: *nuclear material* which has been measured, or estimated on the basis of measurements and disposed of in such a way that it is not suitable for further nuclear use;

(v) Retained waste: *nuclear material* generated from processing or from an operational accident, which is deemed to be unrecoverable for the time being but which is stored;

(vi) Exemption: exemption of *nuclear material* from safeguards on account of its use or quantity; and

(vii) Other loss: for example, accidental loss (that is, irretrievable and inadvertent loss of *nuclear material* as the result of an operational accident) or theft.

108. "Key measurement point" means location where *nuclear material* appears in such a form that it may be measured to determine material flow or inventory. "Key measurement points" thus include, but are not limited to, the inputs and outputs (including measured discards) and storages in *material balance areas*.

109. "Man-year of inspection" means, for the purposes of paragraph 80 above, 300 man-days of inspection, a man-day being a day during which a single inspector has access to a *facility* at any time for a total of not more than eight hours.

110. "Material balance area" means an area in or outside of a *facility* such that:

(a) The quantity of *nuclear material* in each transfer into or out of each "material balance area" can be determined; and

(b) The *physical inventory of nuclear material* in each "material balance area" can be determined when necessary, in accordance with specified procedures, in order that the material balance for Agency safeguards purposes can be established.

111. "Material unaccounted for" means the difference between *book inventory* and *physical inventory*.

112. "Nuclear material" means any source or any special fissionable material as defined in Article XX of the Statute. The term source material shall not be interpreted as applying to ore or ore residue. Any determination by the Board under Article XX of the Statute after the entry into force of this Agreement which adds to the materials considered to be source material or special fissionable material shall have effect under this Agreement only upon acceptance by the State.

113. "Physical inventory" means the sum of all the measured or derived estimates of *batch* quantities of *nuclear material* on hand at a given time within a *material balance area*, obtained in accordance with specified procedures.

114. "Shipper/receiver difference" means the difference between the quantity of *nuclear material* in a *batch* as stated by the shipping *material balance area* and as measured at the receiving *material balance area*.

115. "Source data" means those data, recorded during measurement or calibration or used to derive empirical relationships, which identify *nuclear material* and provide *batch data*. "Source data" may include, for example, weight of compounds, conversion factors to determine weight of element, specific gravity, element concentration, isotopic ratios, relationship between volume and manometer readings and relationship between plutonium produced and power generated.

116. "Strategic point" means a location selected during examination of design information where, under normal conditions and when combined with the information from all "strategic points" taken together, the information necessary and sufficient for the implementation of safeguards measures is obtained and verified; a "strategic point" may include any location where key measurements related to material balance account-

ancy are made and where containment and surveillance measures are executed.

Source: IAEA document INFCIRC/153 (Corrected)
(IAEA, Vienna, 1983)

Appendix E. The London Suppliers' Guidelines for nuclear transfers, 1977

Agreed at London on 21 September 1977 by the Nuclear Supplier Group, and attached to communications addressed on 11 January 1978 to the Director General of the IAEA

1. The following fundamental principles for safeguards and export controls should apply to nuclear transfers to any non-nuclear-weapon State for peaceful purposes. In this connection, suppliers have defined an export trigger list and agreed on common criteria for technology transfers.

Prohibition on nuclear explosives

2. Suppliers should authorize transfer of items identified in the trigger list only upon formal governmental assurances from recipients explicitly excluding uses which would result in any nuclear explosive device.

Physical protection

3. (a) All nuclear materials and facilities identified by the agreed trigger list should be placed under effective physical protection to prevent unauthorized use and handling. The levels of physical protection to be ensured in relation to the type of materials, equipment and facilities, have been agreed by suppliers, taking account of international recommendations.

(b) The implementation of measures of physical protection in the recipient country is the responsibility of the Government of that country. However, in order to implement the terms agreed upon amongst suppliers, the levels of physical protection on which these measures have to be based should be the subject of an agreement between supplier and recipient.

(c) In each case special arrangements should be made for a clear definition of responsibilities for the transport of trigger list items.

Safeguards

4. Suppliers should transfer trigger list items only when covered by IAEA safeguards, with duration and coverage provisions in conformance with the GOV/1621 guidelines.* Exceptions should be made only

after consultation with the parties to this understanding.

5. Suppliers will jointly reconsider their common safeguards requirements, whenever appropriate.

Safeguards triggered by the transfer of certain technology

6. (a) The requirements of paragraphs 2, 3 and 4 above should also apply to facilities for reprocessing, enrichment, or heavy-water production, utilizing technology directly transferred by the supplier or derived from transferred facilities, or major critical components thereof.

(b) The transfer of such facilities, or major critical components thereof, or related technology, should require an undertaking (1) that IAEA safeguards apply to any facilities of the same type (i.e. if the design, construction or operating processes are based on the same or similar physical or chemical processes, as defined in the trigger list) constructed during an agreed period in the recipient country and (2) that there should at all times be in effect a safeguards agreement permitting the IAEA to apply Agency safeguards with respect to such facilities identified by the recipient, or by the supplier in consultation with the recipient, as using transferred technology.

Special controls on sensitive exports

7. Suppliers should exercise restraint in the transfer of sensitive facilities, technology and weapons-usable materials. If enrichment or reprocessing facilities, equipment or technology are to be transferred, suppliers should encourage recipients to accept, as an alternative to national plants, supplier involvement and/or other appropriate multinational participation in resulting facilities. Suppliers should also promote international (including IAEA) activities concerned with multinational regional fuel cycle centres.

Special controls on export of enrichment facilities, equipment and technology

8. For a transfer of an enrichment facility, or technology therefor, the recipient nation should agree that neither the transferred facility, nor any facility based on such technology, will be designed or operated for the production of greater than 20% enriched uranium without the consent of the supplier nation, of which the IAEA should be advised.

Controls on supplied or derived weapons-usable material

9. Suppliers recognize the importance, in order to advance the objectives of these Guidelines and to provide opportunities further to reduce the risks of proliferation, of including in agreements on supply of nuclear materials or of facilities which produce weapons-usable material, provisions calling for mutual agreement between the supplier and the recipient on arrangements for reprocessing, storage, alteration, use, transfer or retransfer of any weapons-usable material involved. Suppliers should endeavour to include such provisions whenever appropriate and practicable.

Controls on retransfer

10. (a) Suppliers should transfer trigger list items, including technology defined under paragraph 6, only upon the recipient's assurance that in the case of:

(1) retransfer of such items,

or

(2) transfer of trigger list items derived from facilities originally transferred by the supplier, or with the help of equipment or technology originally transferred by the supplier;

the recipient of the retransfer or transfer will have provided the same assurances as those required by the supplier for the original transfer.

(b) In addition the supplier's consent should be required for: (1) any retransfer of the facilities, major critical components, or technology described in paragraph 6; (2) any transfer of facilities or major critical components derived from those items; (3) any retransfer of heavy water or weapons-usable material.

Supporting activities

Physical security

11. Suppliers should promote international co-operation on the exchange of physical security information, protection of nuclear materials in transit, and recovery of stolen nuclear materials and equipment.

Support for effective IAEA safeguards

12. Suppliers should make special efforts

in support of effective implementation of IAEA safeguards. Suppliers should also support the Agency's efforts to assist Member States in the improvement of their national systems of accounting and control of nuclear material and to increase the technical effectiveness of safeguards.

Similarly, they should make every effort to support the IAEA in increasing further the adequacy of safeguards in the light of technical developments and the rapidly growing number of nuclear facilities, and to support appropriate initiatives aimed at improving the effectiveness of IAEA safeguards.

Sensitive plant design features

13. Suppliers should encourage the designers and makers of sensitive equipment to construct it in such a way as to facilitate the application of safeguards.

Consultations

14. (a) Suppliers should maintain contact and consult through regular channels on matters connected with the implementation of these Guidelines.

(b) Suppliers should consult, as each deems appropriate, with other Governments concerned on specific sensitive cases, to ensure that any transfer does not contribute to risks of conflict or instability.

(c) In the event that one or more suppliers believe that there has been a violation of supplier/recipient understandings resulting from these Guidelines, particularly in the case of an explosion of a nuclear device, or illegal termination or violation of IAEA safeguards by a recipient, suppliers should consult promptly through diplomatic channels in order to determine and assess the reality and extent of the alleged violation.

Pending the early outcome of such consultations, suppliers will not act in a manner that could prejudice any measure that may be adopted by other suppliers concerning their current contacts with that recipient.

Upon the findings of such consultations, the suppliers, bearing in mind Article XII of the IAEA Statute, should agree on an appropriate response and possible action which could include the termination of nuclear transfers to that recipient.

15. In considering transfers, each supplier should exercise prudence having regard to all the circumstances of each case, including any risk that technology transfers not covered by paragraph 6, or subsequent retransfers, might result in unsafeguarded nuclear materials.

16. Unanimous consent is required for any changes in these Guidelines, including any which might result from the reconsideration mentioned in paragraph 5.

• This is a reference to an IAEA document of 20 August 1973, entitled "The formulation of certain provisions in agreements under the Agency's safeguards system (1965, as provisionally extended in 1966 and 1968)", which recommends that the following two concepts should be reflected in the agreements: (a) that the duration of the agreement should be related to the period of actual use of the items in the recipient State; and (b) that the provisions for terminating the agreement should be formulated in such a way that the rights and obligations of the parties continue to apply in connection with supplied nuclear material and with special fissionable material produced, processed or used in or in connection with supplied nuclear material, equipment, facilities or non-nuclear material, until such time as the Agency has terminated the application of safeguards thereto.

ANNEX A. TRIGGER LIST REFERRED TO IN GUIDELINES

PART A. Material and equipment

1. Source or special fissionable material as defined in Article XX of the Statute of the International Atomic Energy Agency; provided that items specified in subparagraph (a) below, and exports of source or special fissionable material to a given recipient country, within a period of 12 months, below the limits specified in subparagraph (b) below, shall not be included:

(a) Plutonium with an isotopic concentration of plutonium-238 exceeding 80%.

Special fissionable material when used in gram quantities or less as a sensing component in instruments; and

Source material which the Government is satisfied is to be used only in non-nuclear activities, such as the production of alloys or ceramics;

(b) Special fissionable material

| |
|-----------------------------------|
| 50 effective grams; |
| Natural uranium 500 kilograms; |
| Depleted uranium 1 000 kilograms; |
| and |
| Thorium 1 000 kilograms. |

2.1. Reactors and equipment therefor:

2.1.1. Nuclear reactors capable of operation so as to maintain a controlled self-sustaining fission chain reaction, excluding zero energy reactors, the latter being defined as reactors with a designed maximum rate of production of plutonium not exceeding 100 grams per year.

2.1.2. Reactor pressure vessels: Metal vessels, as complete units or as major shop-fabricated parts therefor, which are especially designed or prepared to contain the core of a nuclear reactor as defined in paragraph 2.1.1. above and are capable of withstanding the operating pressure of the primary coolant.

2.1.3. Reactor fuel charging and discharging machines: Manipulative equipment especially designed or prepared for inserting or removing fuel in a nuclear reactor as defined in paragraph 2.1.1. above capable of on-load operation or employing technically sophisticated positioning or alignment features to allow complex off-load fuelling operations such as those in which direct viewing of or access to the fuel is not normally available.

2.1.4. Reactor control rods:

Rods especially designed or prepared for the control of the reaction rate in a nuclear reactor as defined in paragraph 2.1.1 above.

2.1.5. Reactor pressure tubes:

Tubes which are especially designed or prepared to contain fuel elements and the primary coolant in a reactor as defined in paragraph 2.1.1 above at an operating pressure in excess of 50 atmospheres.

2.1.6. Zirconium tubes:

Zirconium metal and alloys in the form of tubes or assemblies of tubes, and in quantities exceeding 500 kg per year, especially designed or prepared for use in a reactor as defined in paragraph 2.1.1 above, and in which the relationship of hafnium to zirconium is less than 1:500 parts by weight.

2.1.7. Primary coolant pumps:

Pumps especially designed or prepared for circulating liquid metal as primary coolant for nuclear reactors as defined in paragraph 2.1.1 above.

2.2. Non-nuclear materials for reactors:

2.2.1. Deuterium and heavy water:

Deuterium and any deuterium compound in which the ratio of deuterium to hydrogen exceeds 1:5 000 for use in a nuclear reactor as defined in paragraph 2.1.1 above in quantities exceeding 200 kg of deuterium atoms for any one recipient country in any period of 12 months.

2.2.2. Nuclear grade graphite:

Graphite having a purity level better than 5 parts per million boron equivalent and with a density greater than 1.50 grams per cubic centimetre in quantities exceeding 30 metric tons for any one recipient country in any period of 12 months.

2.3.1. Plants for the reprocessing of irradiated fuel elements, and equipment especially designed or prepared therefor.

2.4.1. Plants for the fabrication of fuel elements.

2.5.1. Equipment, other than analytical instruments, especially designed or prepared for the separation of isotopes of uranium.

2.6.1. Plants for the production of heavy water, deuterium and deuterium compounds and equipment especially designed or prepared therefor.

Clarifications of certain of the items on the above list are annexed.

PART B. Common criteria for technology transfers under paragraph 6 of the Guidelines

1. "Technology" means technical data in physical form designated by the supplying country as important to the design, construction, operation, or maintenance of enrichment, reprocessing, or heavy water production facilities or major critical components thereof, but excluding data available to the public, for example, in published books and periodicals, or that which has been made available internationally without restrictions upon its further dissemination.

2. "Major critical components" are:

- (a) in the case of an isotope separation plant of the gaseous diffusion type: *diffusion barrier*;
- (b) in the case of an isotope separation plant of the gas centrifuge type: *gas centrifuge assemblies, corrosion-resistant to UF₆*;
- (c) in the case of an isotope separation plant of the jet nozzle type: *the nozzle units*;
- (d) in the case of an isotope plant of the vortex type: *the vortex units*.

3. For facilities covered by paragraph 6 of the Guidelines for which no major critical component is described in paragraph 2 above, if a supplier nation should transfer in the aggregate a significant fraction of the items essential to the operation of such a facility, together with the knowhow for construction and operation of that facility, that transfer should be deemed to be a transfer of "facilities or major critical components thereof".

4. The definitions in the preceding paragraphs are solely for the purposes of paragraph 6 of the Guidelines and this Part B, which differ from those applicable to Part A of this trigger list, which should not be interpreted as limited by such definition.

5. For the purposes of implementing paragraph 6 of the Guidelines, the following facilities should be deemed to be "of the same type (i.e. if their design, construction or operating processes are based on the same or similar physical or chemical processes)":

Where the technology transferred is such as to make possible the construction in the recipient State of a facility of the following type, or major critical components thereof:

- (a) an isotope separation plant of the gaseous diffusion type

The following will be deemed to be facilities of the same type:

- any other isotope separation plant using the gaseous diffusion process.

- (b) an isotope separation plant of the gas centrifuge type

any other isotope separation plant using the gas centrifuge process.

- (c) an isotope separation plant of the jet nozzle type.....

any other isotope separation plant using the jet nozzle process.

- (d) an isotope separation plant of the vortex type.....

any other isotope separation plant using the vortex process.

- (e) a fuel reprocessing plant using the solvent extraction process

any other fuel reprocessing plant using the solvent extraction process.

- (f) a heavy water plant using the exchange process.....

any other heavy water plant using the exchange process.

- (g) a heavy water plant using the electrolytic process

any other heavy water plant using the electrolytic process.

- (h) a heavy water plant using the hydrogen distillation process.....

any other heavy water plant using the hydrogen distillation process.

Note: In the case of reprocessing, enrichment, and heavy water facilities whose design, construction, or operation processes are based on physical or chemical processes other than those enumerated above, a similar approach would be applied to define facilities "of the same type", and a need to define major critical components of such facilities might arise.

6. The reference in paragraph 6(b) of the Guidelines to "any facilities of the same type constructed during an agreed period in the recipient's country" is understood to refer to such facilities (or major critical components thereof), the first operation of which commences within a period of at least 20 years from the date of the first operation of (1) a facility which has been transferred or incorporates transferred major critical components or of (2) a facility of the same type built

after the transfer of technology. It is understood that during that period there would be a conclusive presumption that any facility of the same type utilized transferred technology. But the agreed period is not intended to limit the duration of the safeguards imposed or the duration of the right to identify facilities as being constructed or operated on the basis of or by the use of transferred technology in accordance with paragraph 6(b) (2) of the Guidelines.

Annex.

Clarifications of items on the trigger list

A. Complete nuclear reactors

(Item 2.1.1 of the trigger list)

1. A "nuclear reactor" basically includes the items within or attached directly to the reactor vessel, the equipment which controls the level of power in the core, and the components which normally contain or come in direct contact with or control the primary coolant of the reactor core.

2. The export of the whole set of major items within this boundary will take place only in accordance with the procedures of the Guidelines. Those individual items within this functionally defined boundary which will be exported only in accordance with the procedures of the Guidelines are listed in paragraphs 2.1.1 to 2.1.5.

The Government reserves to itself the right to apply the procedures of the Guidelines to other items within the functionally defined boundary.

3. It is not intended to exclude reactors which could reasonably be capable of modification to produce significantly more than 100 grams of plutonium per year. Reactors designed for sustained operation at significant power levels, regardless of their capacity for plutonium production, are not considered as "zero energy reactors".

B. Pressure vessels

(Item 2.1.2. of the trigger list)

4. A top plate for a reactor pressure vessel is covered by item 2.1.1 as a major shop-fabricated part of a pressure vessel.

5. Reactor internals (e.g. support columns and plates for the core and other vessel internals, control rod guide tubes, thermal shields, baffles, core grid plates, diffuser plates, etc.) are normally supplied by the reactor supplier. In some cases, certain internal support components are included in the fabrication of the pressure vessel. These items are sufficiently critical to the safety and reliability of the operation of the reactor (and, therefore, to the guarantees and liability of the reactor supplier), so that their supply, outside the basic supply arrangement for the

reactor itself, would not be common practice. Therefore, although the separate supply of these unique, especially designed and prepared, critical, large and expensive items would not necessarily be considered as falling outside the area of concern, such a mode of supply is considered unlikely.

C. Reactor control rods

(Item 2.1.4 of the trigger list)

6. This item includes, in addition to the neutron absorbing part, the support or suspension structures therefor if supplied separately.

D. Fuel reprocessing plants

(Item 2.3.1 of the trigger list)

7. A "plant for the reprocessing of irradiated fuel elements" includes the equipment and components which normally come in direct contact with and directly control the irradiated fuel and the major nuclear material and fission product processing streams. The export of the whole set of major items within this boundary will take place only in accordance with the procedures of the Guidelines. In the present state of technology, the following items of equipment are considered to fall within the meaning of the phrase "and equipment especially designed or prepared therefor":

(a) Irradiated fuel element chopping machines: remotely operated equipment especially designed or prepared for use in a reprocessing plant as identified above and intended to cut, chop or shear irradiated nuclear fuel assemblies, bundles or rods; and

(b) Critically safe tanks (e.g. small diameter, annular or slab tanks) especially designed or prepared for use in a reprocessing plant as identified above, intended for dissolution of irradiated nuclear fuel and which are capable of withstanding hot, highly corrosive liquid, and which can be remotely loaded and maintained;

8. The Government reserves to itself the right to apply the procedures of the Guidelines to other items within the functionally defined boundary.

E. Fuel fabrication plants

(Item 2.4.1 of the trigger list)

9. A "plant for the fabrication of fuel elements" includes the equipment:

(a) Which normally comes in direct contact with, or directly processes, or controls, the production flow of nuclear material, or

(b) Which seals the nuclear material within the cladding.

10. The export of the whole set of items for the foregoing operations will take place only in accordance with the procedures of the Guidelines. The Government will also give consideration to application of the pro-

of protection to be ensured in relation to the type of materials, and equipment and facilities containing these materials, taking account of international recommendations.

2. Paragraph 3(b) of the Guidelines document states that implementation of measures of physical protection in the recipient country is the responsibility of the Government of that country. However, the levels of physical protection on which these measures have to be based should be the subject of an agreement between supplier and recipient. In this context these requirements should apply to all States.

3. The document INFCIRC/225 of the International Atomic Energy Agency entitled "The Physical Protection of Nuclear Material" and similar documents which from time to time are prepared by international groups of experts and updated as appropriate to account for changes in the state of the art and state of knowledge with regard to physical protection of nuclear material are a useful basis for guiding recipient States in designing a system of physical protection measures and procedures.

4. The categorization of nuclear material presented in the attached table or as it may be updated from time to time by mutual agreement of suppliers shall serve as the agreed basis for designating specific levels of physical protection in relation to the type of materials, and equipment and facilities containing these materials, pursuant to paragraph 3(a) and 3(b) of the Guidelines document.

5. The agreed levels of physical protection to be ensured by the competent national authorities in the use, storage and transportation of the materials listed in the attached table shall as a minimum include protection characteristics as follows:

Category III

Use and Storage within an area to which access is controlled.

Transportation under special precautions including prior arrangements among sender, recipient and carrier, and prior agreement between entities subject to the jurisdiction and regulation of supplier and recipient States, respectively, in case of international transport specifying time, place and procedures for transferring transport responsibility.

Category II

Use and Storage within a protected area to which access is controlled, i.e. an area under constant surveillance by guards or electronic devices, surrounded by a physical barrier with a limited number of points of entry under appropriate control, or any area with an equivalent level of physical protection.

Transportation under special precautions including prior arrangements among sender,

recipient and carrier, and prior agreement between entities subject to the jurisdiction and regulation of supplier and recipient States, respectively, in case of international transport, specifying time, place and procedures for transferring transport responsibility.

Category I

Materials in this Category shall be protected with highly reliable systems against unauthorized use as follows:

Use and Storage within a highly protected area, i.e. a protected area as defined for Category II above, to which, in addition, access is restricted to persons whose trustworthiness has been determined, and which is under surveillance by guards who are in close communication with appropriate response forces. Specific measures taken in this context should have as their objective the detection and prevention of any assault, unauthorized access or unauthorized removal of material.

Transportation under special precautions as identified above for transportation of Category II and III materials and, in addition, under constant surveillance by escorts and under conditions which assure close communication with appropriate response forces.

6. Suppliers should request identification by recipients of those agencies or authorities having responsibility for ensuring that levels of protection are adequately met and having responsibility for internally co-ordinating response/recovery operations in the event of unauthorized use or handling of protected materials. Suppliers and recipients should also designate points of contact within their national authorities to co-operate on matters of out-of-country transportation and other matters of mutual concern.

Source: IAEA document INFCIRC/254, Appendix (IAEA, Vienna, 1978).

The Guidelines were agreed upon by the members of the Nuclear Supplier Group, the so-called London Club: Belgium, Canada, Czechoslovakia, France, German Democratic Republic, FR Germany, Italy, Japan, Netherlands, Poland, Sweden, Switzerland, UK, USA, USSR.

Appendix F. Statistics on IAEA safeguards and the Regular Budget of the IAEA, and list of IAEA member states

1. Nuclear power and the scale of IAEA safeguards activities, 1980-88

| | 1980 | 1985 | 1986 | 1987 | 1988 |
|---|---------|---------|---------|-----------|--------|
| World total installed nuclear power generating capacity in GW(e) | 136 | 250 | 273.3 | 297.9 | 311 |
| Nuclear power plants in operation | 253 | 374 | 397 | 417 | 429 |
| No. of inspections | 1 100 | 1 980 | 2 054 | 2 133 | 2 128 |
| Man/person-days of inspection | 104* | 7 750 | 8 292 | 9 556 | 9 379 |
| Installations inspected | 500 | 514 | 595 | 631 | n.a. |
| Automatic photo and television surveillance systems operated in the field | n.a. | 290 | 325 | 320 | n.a. |
| No. of seals applied to nuclear material and detached for verification | 3 000 | 9 000 | 10 300 | 12 500 | 15 500 |
| No. of plutonium and uranium samples analysed | 780 | 1 270 | 1 030 | 1 340 | 1 170 |
| Analytical results reported | 1 862 | 3 250 | 2 840 | 3 600 | 3 040 |
| Data entries for accounting and safeguards | 400 000 | 561 000 | 876 000 | 1 146 000 | n.a. |
| Discrepancies or anomalies encountered (all accounted for) | 200 | 150 | 270 | 290 | n.a. |

* man-years

n.a. not available

Source: IAEA, *The Annual Report*, various years.

2. Installations in non-nuclear weapon states under IAEA safeguards or containing safeguarded material, 1980-88

| | 1980 | 1985 | 1986 | 1987 | 1988 |
|---|------------|------------|------------|------------|------------|
| Power reactors | 127 | 172 | 178 | 188 | 188 |
| Research reactors and critical assemblies | 175 | 177 | 176 | 173 | 172 |
| Conversion plants | 4 | 6 | 6 | 7 | 7 |
| Fuel fabrication plants | 38 | 37 | 36 | 41 | 41 |
| Reprocessing plants | 7 | 6 | 6 | 6 | 6 |
| Enrichment plants | 4 | 5 | 6 | 7 | 7 |
| Separate storage facilities | 21 | 30 | 34 | 37 | 41 |
| Other facilities | 40 | 41 | 43 | 46 | 49 |
| Sub-total | 416 | 474 | 485 | 505 | 511 |
| Other locations | 358 | 413 | 414 | 406 | 407 |
| Non-nuclear installations | - | 2 | 2 | 2 | 2 |
| Total | 774 | 889 | 901 | 913 | 920 |

Source: IAEA, *The Annual Report*, various years.

3. Extracts from the Regular Budget of the IAEA, 1984-88

Figures are in US\$ m.

| | Actual expenditure | | | | | 1989 Budget | 1990 with price increase |
|---------------------------------------|--------------------|-------------|--------------|--------------|--------------|----------------|--------------------------------|
| | 1984 | 1985 | 1986 | 1987 | 1988 | | |
| Technical Assistance and Co-operation | 3.9 | 4.5 | 6.3 | 7.1 | 7.6 | 8.5 | 9.4 |
| Safeguards | 27.3 | 31.0 | 39.9 | 43.8 | 45.9 | 52.9 | 54.5 |
| Total budget | 84.1 | 92.5 | 120.6 | 133.3 | 142.1 | 157.5 | 162.8 |

Source: IAEA, *The Agency's Budget*, various years.

4. IAEA member states, as of September 1989

| | | |
|----------------------------|-------------------------------|---------------------------------|
| Afghanistan | Hungary | Nigeria |
| Albania | Iceland | Norway |
| Algeria | India | Pakistan |
| Argentina | Indonesia | Panama |
| Australia | Iran | Paraguay |
| Austria | Iraq | Peru |
| Bangladesh | Ireland | Philippines |
| Belgium | Israel | Poland |
| Bolivia | Italy | Portugal |
| Brazil | <i>Ivory Coast (see Côte</i> | Qatar |
| Bulgaria | <i>d'Ivoire)</i> | Romania |
| <i>Burma (see Myanmar)</i> | Jamaica | Saudi Arabia |
| Byelorussia | Japan | Senegal |
| Cameroon | Jordan | Sierra Leone |
| Canada | Kampuchea (<i>Cambodia</i>) | Singapore |
| Chile | Kenya | South Africa |
| China | Korea, Democratic | Spain |
| Colombia | People's Republic of | Sri Lanka |
| Costa Rica | Korea, Republic of | Sudan |
| Côte d'Ivoire | Kuwait | Sweden |
| Cuba | Lebanon | Switzerland |
| Cyprus | Liberia | Syria |
| Czechoslovakia | Libya | Tanzania |
| Denmark | Liechtenstein | Thailand |
| Dominican Republic | Luxembourg | Tunisia |
| Ecuador | Madagascar | Turkey |
| Egypt | Malaysia | Uganda |
| El Salvador | Mali | UK |
| Ethiopia | Mauritius | Ukraine |
| Finland | Mexico | United Arab Emirates |
| France | Monaco | Uruguay |
| Gabon | Mongolia | USA |
| German Democratic | Morocco | USSR |
| Republic | <i>Myanmar (formerly</i> | Venezuela |
| FR Germany | <i>Burma)</i> | Viet Nam |
| Ghana | Namibia | Yugoslavia |
| Greece | Netherlands | Zaire |
| Guatemala | New Zealand | Zambia |
| Haiti | Nicaragua | Zimbabwe |
| Holy See (Vatican City) | Niger | Total: 113 member states |

Glossary

- Bulk handling facility (BHF)** A plant or store that handles nuclear material in bulk (e.g., in the form of liquid, gas, powder, pellets, 'pebbles', wire or sheets) as distinct from a plant in which the material is in separate (discrete) and identifiable components. Typical BHF's are reprocessing and enrichment plants, plants for fabricating fuel elements, and plants for converting uranium oxide into the gas uranium hexafluoride (UF_6) to be fed into an enrichment plant or for converting uranium oxide into uranium metal.
- CANDU** Canadian deuterium uranium reactor, a *heavy water reactor*, fuelled with natural uranium and cooled and moderated by *heavy water*. The large Canadian research reactors (known as the NRX-type) are also HWRs but of a somewhat different design.
- Containment and surveillance** Containment is the use of the physical features of a plant or store to restrict access to it (e.g., by sealing it off) and thus prevent the clandestine movement of nuclear material into or out of it. Surveillance means chiefly the use of instruments to detect any unreported movement of or tampering with safeguarded items.
- EC** The European Community or Common Market, which now comprises Belgium, Denmark, France, the FRG, Greece, Ireland, Italy, Luxembourg, the Netherlands and the UK. Portugal and Spain joined on 1 January 1986, but EC legislation will apply to them entirely only after a transitional period.
- Enriched uranium** Natural uranium, as found in nature, contains 0.7 per cent of the fissile isotope ^{235}U ; the remainder is composed of the fertile (i.e., convertible into plutonium) isotope ^{238}U and traces of other isotopes. By various means (e.g., by passing it in gaseous form through the membranes of a *gaseous diffusion plant* or rotating it in a *gas ultracentrifuge*) the proportion of ^{235}U to ^{238}U is increased. When the percentage of ^{235}U reaches 20 per cent, the material is termed 'highly enriched uranium' although the charge of a nuclear explosive is much more highly enriched (90 per cent). Highly enriched uranium was in the bomb dropped on Hiroshima; that dropped on Nagasaki used ^{239}Pu .
- Enrichment plant** An installation for increasing the abundance of ^{235}U in uranium, through isotope separation processes such as gaseous diffusion, gas centrifuge, gas nozzle, chemical diffusion or laser excitation.

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| EURATOM | The European Atomic Energy Community, established in 1957 by the Treaty of Rome as the nuclear branch of the EC. |
| Facility attachment | The detailed plan for safeguarding a particular plant. It may include an estimate of annual routine inspection, define the material balance areas, and indicate the strategic points to which the IAEA's inspector may have access during routine inspections and at which safeguards instruments may be installed. |
| Fast breeder reactor (FBR) | A nuclear reactor that produces more fissile material than it consumes. It normally does this by converting a 'blanket' of fertile ^{238}U into fissile <i>plutonium</i> ; in the process it 'burns up' less of its plutonium fuel than the plutonium that it 'breeds' in the blanket. |
| Fissile material | Material composed of atoms which readily <i>fission</i> (such as ^{235}U and ^{239}Pu) when struck by a slow (thermal) or a fast neutron. |
| Footnote <i>a</i> projects | Projects approved by the Board for which no immediate funds are available. |
| Full-scope safeguards | Complete IAEA safeguards which apply to all peaceful nuclear activities (i.e., both materials and facilities) of a country. Safeguards may be either <i>de facto</i> or <i>de jure</i> full-scope safeguards: <i>de facto</i> safeguards cover all nuclear activities currently in operation in the non-NPT country, and <i>de jure</i> safeguards guarantee that future facilities, both those imported and those indigenously built, will also be safeguarded. See also <i>Safeguards agreement pursuant to the NPT</i> . |
| Gaseous diffusion | In the nuclear energy context this refers to a method of enriching uranium based on the fact that atoms or molecules of different mass (weight) will pass (diffuse) through a porous barrier or membrane at different rates. The method is thus used to separate ^{235}U from ^{238}U . As a rule gaseous diffusion plants are large and require much electricity. The nuclear weapon states used and still use such plants to produce weapon-grade ^{235}U as well as low-enriched uranium for <i>LWRs</i> . |
| G-77 | The 'Group of Seventy-Seven'—a term used to denote the developing countries acting as a bloc. The group originally consisted of 77 developing countries; it now contains many more. |
| Heavy water (deuterium oxide or D_2O) | Water composed of molecules of a heavy isotope of hydrogen (deuterium, which has two neutrons in its nucleus; 'ordinary' hydrogen has only one) and oxygen. |

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| Heavy water reactor (HWR) | A reactor that uses <i>heavy water</i> as a moderator. Other moderators are ordinary (light) water and graphite. The moderator slows down the neutrons emitted by ^{235}U , plutonium or by the nuclei of other fissioning atoms. This permits the fertile ^{238}U to 'capture' the neutrons and through subsequent decay be transformed into ^{239}Pu . Heavy water (and also graphite) is a more effective moderator than light water and makes it possible to produce a self-sustaining chain reaction with natural uranium; with light water as a moderator it is necessary to use enriched uranium to produce a chain reaction. See also <i>CANDU</i> . |
| IAEA | The International Atomic Energy Agency (headquarters in Vienna). Its Statute, which came into force in July 1957, endows the Agency with the twin purposes of promoting the peaceful uses of atomic energy and ensuring that nuclear activities with which the IAEA is associated are not used to further any military purpose. |
| Isotopes | Nuclides with the same atomic number but different mass numbers. For example, ^{235}U (atomic number 92, mass number 235) and ^{238}U (atomic number 92, mass number 238) are the principal isotopes occurring in natural uranium. |
| Light water reactor (LWR) | The most common type of power and research reactor, moderated and cooled by ordinary 'light' water. See also <i>heavy water reactor</i> . |
| London Suppliers' Guidelines | A set of guidelines (reproduced in appendix E) that most of the main suppliers of nuclear plants and materials agreed to in London in 1975–77. |
| Man-day | 'A day during which a single inspector has access to a facility at any time for a total of no more than eight hours' is the succinct definition given by the model NPT safeguards agreement (see appendix D). |
| Mt | 1 megaton (Mt) = 1 000 000 tonnes |
| MW(e) | Megawatt electric or one million (electric) watts. The unit used to indicate the electrical power that a power plant generates when it is operated at full capacity. |
| MW(th) | Megawatt thermal or one million (thermal) watts. The unit used to indicate the total power that a research reactor generates when it is operated at full power. |
| NPT | The Treaty on the Non-Proliferation of Nuclear Weapons or 'Non-Proliferation Treaty'. The NPT was the product of negotiations in the Eighteen-Nation Disarmament Committee (ENDC) in Geneva from 1965 to 1968 and especially of the US–Soviet agreement in 1967 on what it should contain. On 12 June 1968 the UN General Assembly commended the draft treaty that the ENDC had submitted to it and expressed the hope 'for the widest adherence to the Treaty'. The Treaty was opened for |

- signature on 1 July 1968 and came into force on 5 March 1970 when the necessary ratifications had been deposited with the three depositary governments (the USSR, the UK and the USA).
- OECD** The Organization for Economic Cooperation and Development. Its membership includes all countries in Western Europe and the USA, Canada, Japan, Australia and New Zealand, i.e., almost all the free-market industrialized countries. The OECD is the successor to the OEEC (the Organization for European Economic Cooperation) established after World War II to administer the Marshall Plan.
- Partial Test Ban Treaty (PTBT)** The Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water was concluded on 5 August 1963 between the USSR, the UK and the USA and was acceded to by many states, and has been in force since 10 October 1963.
- Plutonium (Pu)** An element which is artificially manufactured (it hardly exists in nature). Although there are other ways of manufacturing plutonium, almost all is produced in nuclear reactors. When the nucleus of an atom of ^{238}U captures an extra neutron (usually emitted by the fissioning of another nucleus in a nuclear chain reaction) it is eventually transformed into ^{239}Pu . ^{240}Pu is produced when ^{239}Pu captures a neutron instead of fissioning under the impact of the neutron. ^{239}Pu is the preferred isotope for making nuclear explosives or weapons; ^{240}Pu complicates the construction of an explosive because of its high rate of spontaneous fission. Generally speaking, the longer nuclear fuel is irradiated (i.e., the higher the 'burn-up') the more ^{240}Pu will be produced.
- Plutonium recycle** Use of *plutonium* as part of the fuel for a nuclear reactor. The plutonium may replace or partly replace ^{235}U and thus 'enrich' the fuel. The commercial alternative to recycling is to use the plutonium in a *fast breeder reactor* or to store it for later use.
- Reprocessing** Chemical treatment of spent fuels so as to separate the plutonium and remaining uranium from the unwanted waste products.
- Safeguards agreement pursuant to the NPT** A bilateral agreement between a state and the IAEA for the application of safeguards. Article III of the NPT gives the IAEA the task of applying safeguards on 'all source or special fissionable material in all peaceful nuclear activities within the territory of such State, under its jurisdiction, or carried out under its control anywhere'. Non-nuclear weapon states party to the NPT are to conclude safeguards agreements with the IAEA within 18 months of initiation of negotiations. Nuclear-weapon states party to the NPT are

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| | not obliged to apply IAEA safeguards to their peaceful nuclear activities, although some have voluntarily agreed to place part of their nuclear facilities under IAEA safeguards (the UK, the USA and France). |
| Safeguards implementation report (SIR) | An annual report by the Director General of the IAEA to the Board of Governors. It summarizes the performance of IAEA safeguards activities and includes: a safeguards statement concerning the IAEA's conclusions about the occurrence or non-occurrence of diversion or other violations of safeguards agreements in states in which IAEA safeguards were applied; an evaluation of safeguards effectiveness in terms of IAEA safeguards objectives; and an identification of implementation difficulties and a corresponding action plan to overcome the difficulties. |
| Spent fuel | Fuel removed from a reactor after use. It is usually removed when it contains too little fissile and fertile material and too high a proportion of fission by-products to sustain an economical operation of the reactor. |
| Thorium (Th) | A radioactive element with atomic number 90. Naturally occurring thorium consists only of the fertile isotope ^{232}Th which through transmutation becomes the fissionable ^{233}U which is of safeguards relevance. |
| Trigger List | A list of the materials (besides source and fissile material), plant components and equipment the export of which to a non-nuclear weapon state requires the application of safeguards on the plant in which it is used or on the material which its uses, processes, etc. This list is only relevant to exports to non-NPT non-nuclear weapon states since in these countries virtually all nuclear material is required to be safeguarded. The original Trigger List was agreed in 1974. It has since been expanded and forms part of the 1977 <i>London Suppliers' Guidelines</i> (see appendix E). |
| Ultracentrifuge | In the nuclear context, this means a rotating vessel used to enrich uranium. The heavier isotopes of UF_6 gas concentrate at the walls of the rotating centrifuge and are drawn off. |
| URENCO | The Uranium Enrichment Company, created in 1970 by the signing of the Treaty of Almelo by the FRG, the UK and the Netherlands. |