HISTORY OF THE INTERNATIONAL ATOMIC ENERGY AGENCY

The First Forty Years

by

David Fischer

A fortieth anniversary publication

The 'temporary' headquarters of the IAEA in the Grand Hotel, on the Ringstrasse in central Vienna. The Agency remained there for some twenty years, until 1979.

In 1979, the Austrian Government and the City of Vienna completed construction of the Vienna International Centre (VIC), next to the Donaupark, which became the permanent home of the IAEA and other UN organizations. Austria generously made the buildings and facilities at the VIC available at the 'peppercorn' rent of one Austrian Schilling a year.

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PREFACE

by the Director General of the IAEA

There is a rich literature about the United Nations which includes analyses of the Charter and different phases and aspects of the organization's work. There are also many personal recollections by individuals which add to the general store of knowledge on the UN. Less has been written about the specialized organizations in the UN family. Yet many innovations in international co-operation first emerged in such organizations and a close study of their statutes and records is often rewarding for the student of international affairs. However, official documents do not tell the whole story. Accounts by persons closely connected with such organizations help us to understand better how they function. Lawrence Scheinman's *The International Atomic Energy Agency and World Nuclear Order* has so far been the only systematic study of the IAEA. It was therefore felt that it would be a valuable and interesting contribution to the celebration of the fortieth anniversary of the Agency to publish a history of the organization as seen by someone who was "present at the creation" and has been involved in much of its life. Professor William Potter, the Director of the Center for Nonproliferation Studies at the Monterey Institute of International Studies, kindly agreed that the Institute would join the IAEA in sponsoring the project and sharing its cost.

The Institute commissioned Mr. David Fischer, who has been associated with the IAEA for more than forty years, to write the history of the Agency. David Fischer took part in the negotiation of the IAEA's Statute in 1954–1956 and served on the IAEA's Preparatory Commission. From 1957 until 1981 he was the Agency's Director and subsequently Assistant Director General for External Relations. In 1981 and 1982 he was Special Adviser to Director General Eklund and to myself. Since then he has served as a consultant to the IAEA on many occasions.

David Fischer was greatly helped by an Editorial Advisory Committee comprising Mr. Munir Ahmed Khan (formerly Chairman of the Pakistan Atomic Energy Commission and Chairman of the IAEA Board of Governors in 1986–1987), Professor Lawrence Scheinman (of the Monterey Institute of International Studies and formerly Deputy Director of the US Arms Control and Disarmament Agency) and Dr. Tadeusz Wojcik (Chairman of the Polish Nuclear Society and former chef de cabinet of the Director General of the IAEA). All three are closely related professionally, in different fields, to the

IAEA and served on the Advisory Committee in their personal capacities. Ambassador Roland Timerbaev, for a long time Resident Representative of the USSR to the IAEA, also read the draft manuscript of the History and provided many invaluable insights.

However, this book does not purport to express the views of the Advisory Committee or of the IAEA or its Member States. The responsibility for all statements is that of the author alone.

The philosopher George Santayana once wrote that “those who cannot remember the past are condemned to repeat it”. That risk is particularly high in an international organization with a rapid turnover of staff and of the representatives of the States that frame its policies. To understand the present character of the IAEA and its future potential, it is essential to know how and why the IAEA has become what it is today. The dry terms of the IAEA’s Statute and its records are not enough; the Agency has also been formed by experience, practice, style and tradition. It is hoped therefore that this book together with its companion piece — the reflections of persons who played a prominent part in the creation and development of the IAEA — will help to provide the needed historical perspective.

I would like to thank most warmly all those who have contributed the time and effort put into commemorating the Agency’s fortieth birthday. I would particularly like to thank Mr. Munir Khan, who first suggested the idea of the History and the collection of essays.

Hans Blix

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INTRODUCTION

The IAEA is unlike any other specialized organization of the United Nations family. Most of those agencies set out to achieve a broad economic or social aim: better health, better education, more and better food, economic progress and stability, preservation and enhancement of our natural and cultural heritage, safer travel and transport by sea or air.[1] The IAEA's fortunes are uniquely geared to those of a single, relatively new and controversial technology that can be used either as a weapon or as a practical and useful tool, that has almost infinite capacity to inflict harm but that also has an almost infinite potential to generate the energy on which the world will increasingly depend in the coming centuries to improve the conditions of life of its growing population. The IAEA was created in response to the deep fears and great expectations resulting from the discovery of nuclear energy, fears and expectations that have changed profoundly since 1945 and continue to fluctuate. As a result, what the IAEA is asked to do about nuclear energy, and indeed, what it can do and does, are much affected by the vicissitudes of national moods, international politics and technological change.

The IAEA's history illustrates these points. Its genesis was President Eisenhower's address to the General Assembly of the United Nations on 8 December 1953, though many of the ideas he presented had earlier roots. Diplomats and lawyers, advised by scientists, and drawing on the precedents set by other organizations, developed these ideas into a charter of an international agency, the IAEA Statute, which 81 nations unanimously approved in October 1956.

In the years following Eisenhower's speech and the approval of the IAEA's Statute the political and technical climate had changed so much that by 1958 it had become politically impracticable for the IAEA to begin work on some of the main tasks foreseen in its Statute. But in the aftermath of the 1962 Cuban missile crisis, the USA and the USSR began seeking common ground in nuclear arms control.[2] As more countries mastered nuclear technology, concern deepened that they would sooner or later acquire nuclear weapons, particularly since two additional nations had recently 'joined the club', France in 1960 and China in 1964. The safeguards prescribed in the IAEA's Statute, designed chiefly to cover individual nuclear plants or supplies of fuel, were clearly inadequate to deter proliferation. There was growing support for international, legally binding, commitments and comprehensive safeguards to stop the further spread of nuclear weapons and to work towards their eventual elimination. This found regional expression in 1967 in the Treaty for the Prohibition of Nuclear Weapons in Latin America (the Tlatelolco Treaty) and global expression, in 1968, in the approval of the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), a treaty that Ireland had been the first nation formally to propose some ten years earlier.[3]

The 1970s showed that the NPT would be accepted by almost all of the key industrial countries and by the vast majority of developing countries. At the same time the prospects for nuclear power improved dramatically. The technology had matured and was commercially available, and the oil crisis of 1973 enhanced the attraction of the nuclear energy option. The IAEA's functions became distinctly more important. But the pendulum was soon to swing back. The first surge of worldwide enthusiasm for nuclear power lasted barely two decades. By the early 1980s, the demand for new nuclear power plants had declined sharply in most Western countries, and it shrank nearly to zero in these countries after the 1986 Chernobyl accident.

Paradoxically, when all was well with nuclear energy, the governments of countries that had advanced nuclear industries tended to keep the IAEA at a distance; when matters went badly they were ready to agree to a more extensive role for the organization. This was true on the two occasions when it became clear that IAEA safeguards had been violated and also after the two major accidents that have taken place in nuclear power plants. In 1991, the discovery of Iraq's clandestine weapon programme sowed doubts about the adequacy of IAEA safeguards, but also led to steps to strengthen them, some of which were put to the test when the Democratic People's Republic of Korea (DPRK) became the second country that was discovered violating its NPT safeguards agreement. The Three Mile Island accident and especially the Chernobyl disaster persuaded governments to strengthen the IAEA's role in enhancing nuclear safety.

In the early 1990s, the end of the Cold War and the consequent improvement in international security virtually eliminated the danger of a global nuclear conflict. Broad adherence to regional treaties underscored the nuclear weapon free status of Latin America, Africa and South East Asia, as well as the South Pacific. The threat of proliferation in some successor States of the former Soviet Union was averted; in Iraq and the DPRK the threat was contained. In 1995, the NPT was made permanent and in 1996 the UN General Assembly approved and opened for signature a comprehensive test ban treaty. While military nuclear activities were beyond the IAEA's statutory scope, it was now accepted that the Agency might properly deal with some of the problems bequeathed by the nuclear arms race — verification of the peaceful use or storage of nuclear material from dismantled weapons and surplus military stocks of fissile material, determining the risks posed by the nuclear wastes of nuclear warships dumped in the Arctic, and verifying the safety of former nuclear test sites in Central Asia and the Pacific.

The world now has the best opportunity since 1945 not only of halting the spread of nuclear weapons, but also of drawing down and eventually eliminating nuclear arsenals. In other words, it now has the best prospects since the Second World War of realizing what were to become the two main aims of the NPT and of achieving the chief objectives implicit in Eisenhower's proposals.[4]

Approach and structure

The focus of this book is on the history of the IAEA as an organization. This is inevitably linked with the evolution of nuclear technology. Accordingly, the book sketches the fortunes of nuclear power since 1957, the main events that have affected confidence in nuclear safety and the evolution of nuclear arms control, insofar as this has affected IAEA safeguards.

The development of three of the Agency's main programmes, nuclear power, nuclear safety and safeguards, has been largely shaped by events beyond the IAEA's control, but their impact on the Agency has been determined, to a considerable degree, by the ways in which the Board of Governors and the Director General of the Agency have responded to them. Hence the effectiveness of the Board and the personality of the Director General have had a significant impact on the authority and effectiveness of the organization.[5]

Another major part of the IAEA's work has been to help transfer the practical applications of nuclear science to the developing world. In a relatively few cases this has involved nuclear power technology; far more commonly it has consisted of the transfer of the numerous and varied uses of radioisotopes and radiation — a broad stream of diverse and relatively small technical assistance projects, an activity seldom affected by turns in international politics, swings in national moods, a major nuclear accident or technological developments or fashions. The volume of such assistance has, however, been influenced by the flow of funds and the absorptive capacity of the receiving countries.

The book concludes with a brief discussion of some questions that the IAEA may have to answer before it turns fifty. The selection of these questions and the conclusions reached are the author's own.

A note of thanks

On a personal note the author would like to thank the many members of the IAEA Secretariat as well as the Editorial Advisory Committee who helped him to write this History. He is especially indebted to Paulo Barretto, Murdoch Baxter, Alfredo Cuaron, Pier Danesi, James Dargie, Michael Davies, Stein Deron, Alexandra Diesner-Küpfer, Steven Flitton, Nadine Flouret, Klaus Fröhlich, William C. Gerken, Ingrid Holzberger, Rich Hooper, John Hyland, Odette Jankowitsch, Gertrud Leitner, Gopinathan Nair, Gertrude Nemeth, Robert Parr, Bruno Pellaud, Dimitri Perricos, Jihui Qian, John Rames, Ghandikota V. Ramesh, Laura Rockwood, Ursula Schneider, Boris Semenov, Kelly Stephens and Claudio Todeschini. Special mention must be made of the invaluable detailed comments on the various drafts by Mohamed ElBaradei, Ray Kelleher, David Kyd, Muttusamy Sanmuganathan, John Tilemann and Maurizio Zifferero. Finally, thanks to Hans Blix himself, who took a personal interest in the undertaking, and to Bill Potter, Tariq Rauf and Chris Fitz of the Monterey Institute of International Studies who cast a benevolent eye on it from afar. The author is also greatly indebted to Paul Szasz, who reviewed the entire manuscript, to Allan Labowitz, who reviewed and edited most of it, to Myron Kratzer for his trenchant comments on IAEA safeguards and to Astrid Forland of the Bergen Center for the Study of the Sciences and Humanities for her knowledge of the early history of the IAEA. The errors and omissions are the author's own.

NOTES

[1] The safety functions of ICAO (the International Civil Aviation Organization) and IMO (the International Maritime Organization) are comparable to those of the IAEA but, unlike the latter, they are not confined to an activity based on a single form of energy.

[2] They first found such common ground in the Limited Test Ban Treaty of 1963.

[3] In a resolution submitted to the General Assembly on 17 October 1958.

[4] The diminishing threat of nuclear weapons since the dark days of the Cold War has been well summed up by the American author Richard Rhodes: "The world will not soon be free of nuclear weapons, because they serve so many purposes. But as instruments of destruction, they have long been obsolete." RHODES, R., *Dark Sun: The Making of the Hydrogen Bomb*, Simon and Schuster, New York (1995) 588.

[5] A more profound impact than that which is usually left by the chief administrative officer in a national ministry. This is equally true of other agencies of the United Nations and, in particular, the United Nations itself, where the personality of the Secretary General has played a crucial role in promoting the organization's successes and in causing its failures.

PART I

THE CREATION OF THE IAEA

Chapter 1

EISENHOWER PROPOSES A NEW AGENCY

On 8 December 1953, the President of the United States of America, Dwight D. Eisenhower, proposed at the General Assembly of the United Nations the creation of an organization to promote the peaceful use of nuclear energy and to seek to ensure that nuclear energy would not serve any military purpose.[1] Eisenhower's proposals led to the creation of the IAEA and helped to shape international co-operation in the civilian use of nuclear energy up to 1978, when a far reaching change in American nuclear law signalled the end of Eisenhower's programme of "Atoms for Peace".

Eisenhower began with a bleak warning. Hydrogen weapons were several hundred times more powerful than the bombs that had destroyed Hiroshima and Nagasaki "but the dread secret [of making the (atom) bomb] is not ours alone." The secret was shared by the United Kingdom, Canada and the Soviet Union and would eventually be shared by others. He tried to reassure the Soviet Union: "We hope that this coming [four power] conference may initiate a relationship with the Soviet Union which will eventually bring about a free intermingling of the peoples of the East and of the West..."[2] And he went on to declare that "the peaceful power of atomic energy is no dream of the future"; its benefits were already at hand.

The centrepiece of Eisenhower's proposal was the creation of an international atomic energy agency "to which the governments principally involved would make joint contributions" from their stockpiles of fissile material and natural uranium. The USA would seek more than the mere reduction or elimination of atomic materials for military purposes. "It is not enough to take this weapon out of the hands of the soldiers. It must be put into the hands of those who will know [...] how to adapt it to the arts of peace." The proposed agency would be responsible for the impounding, storage and protection of this bank of fissile and other materials. It would devise methods whereby nuclear materials "could be allocated to serve the peaceful purposes of mankind." Eisenhower made it clear that he wanted the new agency to avoid the fate of the ambitious Baruch Plan of 1946 that had foundered on the shoals of the Cold War. His proposal, he said, "had the great virtue that it can be undertaken without the irritations and mutual suspicions incident to any attempt to set up a completely acceptable system for worldwide inspection and control." Nonetheless his aim was nuclear disarmament, to banish the fear that "...the two atomic colossi... [would be] ...doomed malevolently to eye each other indefinitely across a trembling world..." He stressed that the nuclear disarmament his plan would bring about would be very gradual; in his bleaker moments he thought that the USA might have to retain its military might for forty years.[3]

Eisenhower's vision has been warmly praised and sharply criticized. The central element of his plan came to nothing — the concept that the IAEA would serve as a bank of nuclear materials drawing down US and Soviet stocks below the level where either could launch a knock-out blow against the other. For nearly forty years after its birth in 1957 the IAEA remained essentially irrelevant to the nuclear arms race. But the end of the Cold War has revived the idea of placing military stocks of fissile materials, including material from dismantled nuclear weapons, under the IAEA's surveillance, thus creating confidence that it will not revert to military use.[4]

Eisenhower gave a powerful impetus to the change that was beginning to take place in American and global nuclear policies; the change from a policy of secrecy and denial to one of openness — transparency — and to international co-operation in developing and applying nuclear technology for peaceful purposes, i.e. "Atoms for Peace".

It is precisely this concept that has attracted the most criticism. A well known British observer wrote in 1966 that "only a social psychologist could hope to explain why the possessors of the most terrible weapons in history should have sought to spread the necessary industry to produce them in the belief that this could make the world safer."[5] The late Gerard Smith wrote that Molotov's first reactions were similarly sceptical.[6] And opponents of nuclear power have been even more critical of the underlying rationale of "Atoms for Peace".

But the failure of previous attempts to prevent the spread of nuclear technology — indeed the history of science and of military invention — had already shown that, while the spread of the new nuclear technology might be slowed down, it could not be stopped. The issue was whether the USA should try to plug the now leaky dyke that had been built hastily by the US Congress in the McMahon Act of 1946, or whether it would take the lead in ensuring that the inevitable spread of nuclear technology would be subject to controls to ensure that it was used for peaceful purposes only, and as safely as possible. Apart from the USA, no other nation showed any interest in taking this lead, in fact for several years many nations in Europe and elsewhere resisted international controls and some were more interested in getting hold of the bomb than in preventing its dissemination.

In the long run, neither US attempts to preserve the nuclear monopoly, nor the controls that the supplying nations placed (much later) on their nuclear exports, would be decisive in determining whether nations used nuclear energy for military in addition to peaceful ends. The determining factor would be the security needs and perceptions of the growing number of nations that became technically equipped to make that choice. For most, the eventual choice was confirmed in the 1995 decision to extend indefinitely, in other words to make permanent, the Treaty on the Non-Proliferation of Nuclear Weapons (NPT).

A more practical charge can be laid against the idea that nuclear disarmament could be achieved by siphoning off stocks of fissile material. The concept was essentially a 'technical fix'. Until the USA and USSR had taken a conscious political decision to shrink their nuclear arsenals, no technical fix could compel them to do so. No inducement would persuade the Soviet Union to make a significant cut in its still scarce and precious stock of fissile material. This was soon demonstrated by the wildly asymmetrical commitments that the three nuclear weapon States made to place fissile material at the disposal of the IAEA. The USA pledged 5000 kg of contained uranium-235 and whatever amount would be needed to match the other States' contributions; the United Kingdom pledged 20 kg of uranium-235 and the USSR 50 kg.[7] Moreover, within a decade, scarcity of high enriched uranium would cease to be a major factor in constraining the nuclear arms race.

The world would have to wait until the end of the Cold War for the first decision to shrink nuclear arsenals. In the meantime the reverse was happening. Under Eisenhower's Presidency the US nuclear arsenal grew from 1200 warheads in 1952 to 18 700 in 1960; the Soviet arsenal grew from 50 to 1700. And in 1953–1954, Secretary of State John Foster Dulles enunciated the policy of "massive retaliation", in other words the USA would use its growing nuclear arsenal to counter any attack on its allies as well as the USA itself, even an attack by 'conventional' weapons.[8]

Eisenhower was also unduly optimistic about the imminent use of nuclear power and consequently about the civilian demand for fissile material. He maintained that: "The United States knows that peaceful power from atomic energy is no dream of the future. That capability, already proved, is here-now-today." In fact, the realization of "that capability" had to wait until the 1960s. Eisenhower was equally if not more sanguine about the prospects for other applications of nuclear technology. At the Centennial Commencement of Pennsylvania State University on 11 June 1955, he said: "Many engineers and scientists believe that radiation and radioactive isotopes may provide even greater peacetime benefits [than nuclear power]."[9]

But in another way Eisenhower's initiative led to one of his principal achievements.[10] In the early 1960s stopping the spread of nuclear weapons became a common cause of the USA and the USSR. The two leading powers forged bonds of mutual interest that remained undamaged by subsequent crises and that may have played a part in restoring relations between them as the Cold War neared its end. After 1963, US–Soviet co-operation succeeded in keeping the hostile rhetoric and sterile disputes of the Cold War out of the meeting rooms of the IAEA and enhanced the effectiveness of its Board of Governors and Secretariat.

NOTES

1 The text of Eisenhower's address is given in *Public Papers of the Presidents, Eisenhower* (1953) 813–822; and in *Atoms for Peace: An Analysis After Thirty Years* (PILAT, J.F., PENDLEY, R.E., EBINGER, C.K., Eds), Westview Press, Boulder, CO (1985) Appendix C, pp. 283–291.

2 The "coming conference" appears to be a reference to a forthcoming meeting between the USA, the United Kingdom, France and the USSR.

3 SOKOLSKI, H., "Eisenhower's original Atoms for Peace plan: The arms control connection", presented on 6 July 1983 at a seminar sponsored by the Woodrow Wilson Center's International Security Studies Program, Washington, DC, and published by the Center as Occasional Paper No. 52, p. 18.

4 The USA has begun to place some fissile material surplus to its military needs under IAEA supervision to verify that it does not revert to nuclear weapon use and Russia has agreed eventually to do the same.

5 BEATON, L., *Must the Bomb Spread?*, Penguin Books, Baltimore (1966) 88–89.

6 FISCHER, D.A.V., *Stopping the Spread of Nuclear Weapons*, Routledge, London and New York (1993) 41; and STOESSINGER, J.G., "Atoms for Peace: The International Atomic Energy Agency", *Organizing for Peace in the Nuclear Age,* Report of the Commission to Study the Organization of Peace, New York University Press, New York (1959) 120.

[7] The USA did not specify the level of enrichment of the uranium but it was assumed that most of it would be in low enriched form. However, in certain cases the USA was to supply high enriched uranium; for instance, the fuel it supplied to South Africa for the SAFARI materials testing reactor was 90% enriched. The Soviet Union supplied its clients with only low enriched uranium.

[8] HEWLETT, R.G., HOLL, J.M., *Atoms for Peace and War: 1953–1961, Eisenhower and the Atomic Energy Commission,* University of California Press, Berkeley, CA (1989) 272.

[9] EISENHOWER, D.D., *Public Papers of the Presidents*, 121, p. 594.

[10] SCHLESINGER, J.R., "Atoms for peace revisited", PILAT, J.F., et al., Eds, *Atoms for Peace: An Analysis After Thirty Years*, p. 7.

Chapter 2

1939–1953: THE DUAL CHALLENGE OF NUCLEAR ENERGY

The invention and use of the bomb

From the very beginning, the development of nuclear energy in all its facets has been truly international, emerging from widely scattered research laboratories, as the ideas and work of scientists in one country stimulated and fertilized the minds of their colleagues in others.

In the 1920s and 1930s the leading physicists and chemists of Europe and the USA were gradually unravelling the structure of the elements and the dynamics of their nuclei and of subatomic particles. On 6 January 1939, the German chemists Otto Hahn and Fritz Strassman reported in the journal *Naturwissenschaften* that they had bombarded and split the uranium atom into two or more lighter elements. They had discovered a new type of nuclear reaction — fission.[1] Their Austrian colleague, the physicist Lise Meitner, had noted that fission of the uranium nucleus would release energy — the energy that binds the nucleus together — potentially on a vast scale and she and her nephew, Otto Frisch, soon confirmed this experimentally.[2] A few weeks later the Hungarian physicist Leo Szilard, working in New York, showed that in the uranium fission process "about two" neutrons were emitted whenever a neutron released by this process collided with the nucleus of another uranium (uranium-235) atom. A self-sustaining fission reaction was possible.[3] In May 1939, Jean and Irène Joliot-Curie, the Austro-Hungarian scientist Hans Halban and the Polish scientist Leo Kowarski, refugees in France, repeated Szilard's experiment and took out patents for the production of nuclear energy as well as nuclear explosives.[4] Both the potential applications of nuclear energy, military and civilian, were beginning to unfold at the same time.

Colleagues who heard the news of the splitting of the uranium atom and the energy it released were quick to grasp its implications for peace — and especially for war if Nazi Germany were able to master these processes and deploy a nuclear weapon. Like many other Jewish scientists, Albert Einstein had emigrated to the USA to escape Hitler's clutches. On 2 August 1939, at the urging of Szilard and his fellow Hungarian Edward Teller, Einstein wrote to warn President Roosevelt that Germany was trying to produce enriched uranium, and urged him to make sure that the USA could arm itself with nuclear weapons before Nazi Germany did so.[5] Roosevelt took heed. He set in motion what eventually became the Manhattan Project,[6] the vast US undertaking that led to the making of the atomic bomb. British scientists, helped by refugees from Hitler, had been ahead of the USA on the path to the bomb in 1940 and 1941, and they made a decisive contribution to an enterprise that changed the world.

Another element, plutonium, was to prove as vastly powerful as enriched uranium when used as a nuclear explosive or a source of energy (in fact more powerful, weight for weight). Except as a man-made element, plutonium essentially does not exist on earth. In late 1940, Glenn Seaborg and his colleagues at the University of California produced a trace of one of its isotopic forms. Seaborg named the new element after the sun's outermost planet, Pluto, the ancient Greek God of the underworld, but also the Greek God of wealth.[7]

On 2 December 1942, two years after Glenn Seaborg's discovery, the Italian physicist Enrico Fermi achieved criticality in the world's first nuclear 'pile' or reactor which his team had built beneath the football stadium of the University of Chicago. Fermi was a refugee from the other European Fascist dictator, Mussolini. Fermi's success marked the first man-made self-sustaining fission reaction and the first artificial production of a significant amount of plutonium. After Fermi had finished his experiment his colleague, Arthur Compton, telephoned James Conant, the President of Harvard University: "Jim...the Italian navigator has just landed in the new world."[8] The first glimpse that the Old World saw of this new world was in August 1945 when the bombs fell on Hiroshima and Nagasaki.

On 3 July 1944, Niels Bohr sent a memorandum to the ailing President Roosevelt urging that the USA and the United Kingdom should take the USSR into their confidence about the progress they were making towards the manufacture of a nuclear weapon. The idea was rejected, particularly sharply by Winston Churchill, who recommended that steps be taken to ensure that Bohr passed no information on to Moscow.[9]

In June 1945, with Germany defeated, a group of prominent physicists from the Manhattan Project appealed in vain for an international demonstration of the power of the bomb before it was used as a weapon (against Japan) and pressed for an international agreement or agency to prevent its further use. The alternative would be "an unlimited armaments race". The group was chaired by James Franck, yet another refugee from Hitler, and it included Szilard and Seaborg.[10]

The United Nations Charter, signed in San Francisco on 26 June 1945, was the last great international treaty whose negotiators, except perhaps for a select few, were totally ignorant about the nuclear threat just below the horizon. Less than three weeks later, at Alamogordo, New Mexico, on 16 July 1945, Robert Oppenheimer and his team looked on in awe at the first man-made nuclear explosion. The news from Alamogordo reached US President Truman during the Potsdam summit meeting with Stalin and British Prime Minister Clement Attlee. Truman told Stalin that the USA now had a new weapon of unusual destructive force. Stalin appeared unimpressed. One report maintains that he made no comment, another that he said he was glad to hear the news and hoped the USA "would make good use of it against the Japanese." However, when he heard about the destruction of Hiroshima he is reported to have been greatly shaken, and on 20 August 1945 appointed Lavrenti Beria (chief of the NKVD — the Soviet secret police) to take charge of the Soviet bomb programme and spurred his own team of nuclear scientists to catch up with the USA at all costs.[11]

On 6 August 1945, six weeks after the Charter was signed, the world heard the news of the bombing of Hiroshima. In a violent flash 'Little Boy' released the equivalent of 10 000 tons (10 kilotons) of TNT and obliterated the city; 140 000 of its citizens died by year's end and 200 000 within five years. The bomb used high enriched uranium as its explosive charge and was of the gun-barrel or gun-assembly type. Its designers were so confident that it would work "first time" that it had not been tested before its use.[12]

Three days later a second bomb was dropped on Nagasaki; 70 000 of the inhabitants of what became known as the 'city of the dead' were killed in the blast or died before the year ended, and 70 000 more died in the next five years.[13] The bomb used plutonium as its charge, and its design was based on the device tested at Alamogordo.[14]

More than three months earlier, on 25 April 1945, Secretary of War Henry Stimson had briefed a still unwitting President Truman about the Manhattan Project. Stimson wrote that the control of the atomic bomb "will undoubtedly be a matter of the greatest difficulty and would involve such thoroughgoing rights of inspection and internal controls as we have never heretofore contemplated" and that "the question of sharing it with other nations...becomes a primary question of our foreign relations."[15]

On 12 September 1945, Stimson recommended to President Truman that the USA directly approach the USSR to conclude a covenant "to control and limit the use of the atomic bomb as an instrument of war and...to direct and encourage the development of atomic power for peaceful and humanitarian purposes..." US relations with the Soviet Union "may be perhaps irretrievably embittered by the way in which we approach the solution of the bomb with Russia. For if we fail to approach them now and merely continue to negotiate with them, having this weapon rather ostentatiously on our hip, their suspicions and their distrust of our purposes and motives will increase." Such an approach to the Soviets might be backed by the United Kingdom, but it should be "peculiarly the proposal of the United States. Action by any international group of nations...would not, in my opinion, be taken seriously by the Soviets." Unless such an approach was made there would "...in effect be a secret armament race of a rather desperate character."

Stimson's advice, repeated on the day he left office (21 September 1945), was not taken.[16] For the third time what might have been an opportunity to avoid a post-war nuclear arms race was missed. But one may question whether the inveterately suspicious Stalin would have grasped the hand that Bohr, Franck and Stimson wanted the USA to extend to him.

On 15 November 1945, President Truman and Prime Ministers Attlee of the United Kingdom and Mackenzie King of Canada, meeting in Washington, issued a "Three Nation Agreed Declaration on Atomic Energy" in which they said that they would be willing "to proceed with the exchange of fundamental scientific literature for peaceful ends with any nation that will fully reciprocate" but only when "it is possible to devise effective reciprocal and enforceable safeguards acceptable to all nations" against its use for destructive purposes.[17] They suggested that the new-born United Nations should promptly tackle the nuclear issue. Soon afterwards, on 27 December 1945, at a meeting in Moscow of the Council of Foreign Ministers, the USA and the United Kingdom proposed and the USSR agreed that a United Nations Atomic Energy Commission (UNAEC) should be created "to consider problems arising from the discovery of atomic energy and related matters."[18] The Soviets made it clear that the work of the UNAEC must be subject to the direction of the Security Council, with its veto rights, and the USA and the United Kingdom accepted this condition.[19]

The search for effective controls

In January 1946, by the first resolution of the first session of the General Assembly, the UNAEC was launched on its brief and barren career.[20] From 1945 until 1948, when the UNAEC concluded that its work had ceased to be meaningful,[21] the proclaimed aim of the USA and the USSR and their allies was not to prevent the spread of nuclear weapons but to do away with them altogether.

At the turn of the year Secretary of State James Byrnes had appointed a committee under the chairmanship of Dean Acheson and David Lilienthal to draw up proposals for the abolition of nuclear weapons and for controlling the peaceful uses of nuclear energy.[22] The report, published in March 1946,[23] examined virtually every problem that would arise in applying such control. One of its most radical conclusions — which was in conflict with what was later to be a fundamental premise of the NPT — was that "a system of inspection superimposed on *an otherwise uncontrolled exploitation of atomic energy by national governments* will not be an adequate safeguard" (emphasis in original). Hence an international authority should be created to own or "control and operate" all nuclear activities that lead to the production of fissile material, including all reactors except those that are "non-dangerous".[24] The authority would license and inspect all other nuclear activities and foster beneficial nuclear uses and research. When the authority was operating effectively the USA would stop making nuclear weapons, destroy those it had and give the authority full information about the production of nuclear energy.

On 13 June 1946, Bernard Baruch presented to the UNAEC the plan that bears his name.[25] It proposed the creation of an International Atomic Development Authority (IADA) that would be entrusted with "managerial control or ownership of all atomic energy activities potentially dangerous to world security." One of its first tasks would be "to obtain and maintain complete and accurate information on world sources of uranium and thorium and to bring them under its dominion."

Baruch made an important addition to the conclusions of Acheson and Lilienthal. He was particularly concerned about the problem of enforcing IADA's decisions, the problem of "penalization" as he put it, and he insisted that IADA should be able to impose sanctions or "condign punishments" and that its decisions should not be subject to the veto of any power.[26]

The Baruch Plan would thus have entailed a massive transfer of power to an international body, a transfer that Stalin and, indeed, the rulers of many other countries would never have accepted. The proposed elimination of the veto right was particularly objectionable. In Soviet eyes great power consensus — agreement between the "four policemen"[27] who were henceforth supposed to keep order in the world — was imperative. But in any case the Soviet Government was doing its utmost to get its own nuclear arsenal as quickly as possible.[28] A few days after the US bombing of Hiroshima and Nagasaki, Stalin formally decided to launch his own Manhattan Project. He had no intention of abandoning the field and allowing the USA to keep its weapons pending the effective operation of an agency that would be radically different in scope and authority from any international body yet dreamt of by the most visionary political thinkers and in which the West would probably have the leading role. On the US side there were also some, including Robert Oppenheimer, who were deeply distrustful of Baruch and his proposals, which they considered unrealistic.[29]

On 19 June 1946, Andrei Gromyko gave the Soviet reaction. Instead of the Baruch approach of 'control before disarmament' the Soviets proposed the reverse sequence — first the conclusion of an international convention, binding on all nations, that would outlaw the use and manufacture of nuclear weapons and require that all those in existence be destroyed within three months of the convention's entry into force. Only then should the UNAEC turn to the organization of controls to prevent the production of nuclear weapons.[30]

On 11 June 1947, the Soviet Union proposed a system of reporting and inspection of national nuclear programmes not unlike that accepted 20 years later in the NPT — with the important exception that the Soviet proposal would have applied to the nuclear activities of the USA and the USSR.[31] The USA and its allies found the proposed controls inadequate and rejected the proposal.

After 200 sessions and more than two years of sterile debate, UNAEC concluded its work at the end of 1949.

The alternative — preserve the US monopoly

Access to uranium would determine whether or not a nation could acquire nuclear weapons. Known uranium deposits were still few and limited, and the element was in extremely short supply. In October 1946, a US delegate at the UNAEC talks suggested to Secretary of State Byrnes that "the US and its allies form a group that will control atomic energy through the possession of such an overwhelming proportion of the raw materials that those nations left without the circle must pay the price of admission"[32] — i.e. they must renounce nuclear weapons. The group was formed — the Joint Development Agency comprising the USA, the United Kingdom and Canada — and it sought to corner the market by arranging to buy all the uranium that Belgium was producing in the Congo and all that South Africa and Australia would later produce, as well as US and Canadian production.[33] For several years the agency succeeded in buying almost all the uranium mined outside the Soviet Bloc, but in 1963 South Africa broke ranks and angered Washington by concluding a multi-year contract with France on the same conditions as its sales to the other two nuclear weapon States (i.e. without safeguards) for an amount of yellow cake equal to two thirds of France's annual production at that time and at a third of the price quoted by Canada during an earlier negotiation — aborted because Canada insisted on safeguards.[34]

At the end of July 1946, the US Congress adopted the McMahon Act (AEA/46) after six months of spirited debate. A version had already been approved in early June before Baruch presented his plan to the UNAEC. The Act was designed to maintain the US monopoly by stipulating, for instance, that until there were effective safeguards "there shall be no exchange of information with other nations with respect to the use of atomic energy for industrial [i.e. peaceful] purposes."[35] It has been pointed out that by this action, even while the UNAEC was debating the Baruch Plan, the US Congress was thus making "...virtually impossible any early surrender of atomic weapons to international control without further legislation."[36]

In 1945 only one country had the massive industrial infrastructure, the wealth, the material and the concentration of scientific expertise from Europe as well as the USA that would be needed to make nuclear weapons. North America was also beyond the reach of enemy bombers and safe from invasion. These unique advantages were bound to erode with time and other nations soon began to move into the nuclear era.

In September 1949, the Soviets carried out their first nuclear test.[37] The timing came as a shock to many US officials, including General Leslie R. Groves, the driving force behind the Manhattan Project. They had assumed that it would take as much as 20 years for the Soviets to become the world's second nuclear armed State.[38]

The United Kingdom became the third in October 1952.

Once the main scientific and technical breakthrough to a nuclear device had been made and had become public property, replicating such a device would be largely a matter of engineering. Hence, technical fixes to prevent proliferation would not work in the long term. Today, the technical ability to make a simple nuclear device is within the reach of 40 to 50 nations and the number of technically capable nations is bound to grow. The considerations that persuade most of these States to forego nuclear weapons are political, not technical; some of these States are, for instance, protected by alliances that extend nuclear umbrellas (though the need for these has diminished with the end of the Cold War) and for some of them it might be more dangerous to acquire than to renounce nuclear weapons.

The end of the US nuclear monopoly, the hardening deadlock at the UN[39] and the growing tensions of the Cold War gradually extinguished all hope of a world free of nuclear weapons — if not forever, then at least for the remainder of this century.[40] The sign that marks the entrance to Dante's *Inferno*, "lasciate ogni speranza, voi che entrate" seemed increasingly appropriate for an ingenious species of primate opening the gate to a nuclear arms race. Yet, Eisenhower was determined to offer a way out of this apparently hopeless situation.

In January 1953, Eisenhower had succeeded Truman and on 5 March 1953 Stalin died. By now the US monopoly in the civilian as well as the military use of nuclear technology was eroding and US corporations were beginning to fear the loss of markets to the British and the Canadians.[41] US policy makers and their allies had also concluded that it was idle to continue to talk about nuclear disarmament. They had come up against the wall of secrecy surrounding all Soviet military matters and, in particular, its nuclear activities (and had sought, though in the end unsuccessfully, to build an equally impenetrable wall of their own in the draconian McMahon Act of August 1946). It now seemed too late to verify with adequate assurance that neither the USA nor the Soviet Union had accumulated a secret stock of nuclear weapons or of fissile material. In short, it was clear that neither the visionary approach of the Acheson–Lilienthal plan nor the McMahon policy of denial was going to work. However, there were now new men at the helm in both nations, and Eisenhower wanted to find a way out of the nuclear deadlock. To the newly appointed Chairman of the US Atomic Energy Commission, Lewis Strauss, he said: "My chief concern...is to find some new approach to the disarming of atomic energy... The world simply must not go on living in the fear of the terrible consequences of nuclear war."[42]

In April 1952, Secretary of State Acheson had appointed a 'Panel of Consultants on Disarmament' under the chairmanship of Robert Oppenheimer to make recommendations about US nuclear policy; in particular, what the US Government should tell the country and the world at large about the incipient nuclear arms race and the dangers it would bring. The panel's recommendations became known as the 'Candor Report' or 'Operation Candor'. The report dwelt at length on the fear that the USSR might soon have enough nuclear weapons and bombers to destroy 100 key urban industrial targets — the US industrial base — and thus win World War III. These fears mounted after 12 August 1953 when the USSR detonated what the USA believed to be a hydrogen bomb.[43] All that the USA could do to fend off disaster would be to threaten retaliation.

The panel urged the President to take the American people fully into his confidence. He should disclose US fissile material production and assessments of Soviet strength so that neither side would misjudge the situation and be tempted to launch a preventive war. The two powers should agree to limit their arsenals and bomber fleets so that neither need "fear a sudden knockout blow from the other."[44] Eisenhower charged his chief speech writer, C.D. Jackson, to present the gist of the panel's report but Jackson's first drafts offered only a bleak picture of the Soviet nuclear threat and of atomic catastrophe. It seemed essential to hold out a more hopeful prospect.

It was not only growing fear of the Soviet nuclear arsenal and of nuclear war that changed US nuclear policy. Within the USA itself there was now a vigorous debate about the merits of private versus public ownership, of the need for freedom of research and communications between scientists, and also of 'small' versus 'big' government. The move towards privatization of the civilian uses of nuclear energy, eventually enshrined in the 1954 Atomic Energy Act, was gaining momentum.

It appears that in September 1953 Eisenhower came upon the idea that was to become the kernel of the 8 December speech, that of drawing the fissile materials of the nuclear weapon States into a common pool to be used by all nations for peaceful purposes.[45] As the 'pool' (or 'bank') idea evolved during the next weeks it was seen as a new and evolutionary approach to nuclear arms control, as a means of building East–West confidence, and as the road to an international agency that would promote the civilian applications of nuclear energy.

At the beginning of December 1953, Eisenhower met Churchill in Bermuda and showed him the draft of the speech, which Churchill warmly praised.[46] On 8 December Eisenhower presented the speech to the General Assembly, which greeted his ideas with applause. A year later, on 4 December 1954, it unanimously endorsed the creation of the new agency.[47]

NOTES

[1] RHODES, R., *The Making of the Atomic Bomb*, Simon and Schuster, New York (1986) 251–262; and HEWLETT, R.G., ANDERSON, O.E., *The New World: A History of the United States Atomic Energy Commission*, Vol. 1, Pennsylvania State University Press, University Park, PA (1962) 10.

[2] RHODES, R., *The Making of the Atomic Bomb*, pp. 262–264 and HEWLETT, R.G, ANDERSON, O.E., *The New World: A History of the United States Atomic Energy Commission*, p. 11.

[3] RHODES, R., *The Making of the Atomic Bomb*, p. 291.

[4] GOLDSCHMIDT, B., *Le Complexe Atomique*, Fayard, Paris (1980) 39.

[5] RHODES, R., *The Making of the Atomic Bomb*, pp. 303–314; ALLARDICE, C., TRAPNELL, E.R., *The Atomic Energy Commission*, Praeger, New York (1974) 3.

[6] Introducing a speech by Dr. Teller at a Navy League dinner on 25 April 1996 in Monterey, California, Dr. Paul M. Hoffman, President of the Monterey Peninsula Council, outlined the preliminary steps taken towards the Manhattan Project. First came an “Advisory Committee on Uranium”. Then President Roosevelt urged scientists to “accept the challenge as their duty to find a way to separate U-235 (fissionable uranium) from U-238 (normal — i.e. natural uranium).” On 6 December 1941 (the day before Pearl Harbour), the Office of Scientific Research and Development launched the Manhattan Project. On the British team’s composition (the team included brilliant French and Hungarian refugees, amongst others), see LAURENCE, W., *Men and Atoms,* Simon and Schuster, New York (1959) 59. Laurence, who was science editor of *The New York Times* in the late 1950s, insists that the British were “miles ahead” and that progress in the USA was painfully slow until M.L.E. Oliphant, arriving from the United Kingdom, told the US scientific community about the British programme and offered full British co-operation. (See also HEWLETT, R.G., ANDERSON, O.E., *The New World: A History of the United States Atomic Energy Commission*, pp. 19, 42–44, 50–52.)

[7] Hence, no doubt, Plutocrat!

[8] RHODES, R., *The Making of the Atomic Bomb*, p. 442.

[9] RHODES, R., *The Making of the Atomic Bomb*, p. 537.

[10] An extract from the ‘Franck Report’ is given in PORRO, J. (Ed.), *The Nuclear Age Reader*, Alfred A. Knopf, New York (1989) 11–13.

[11] RHODES, R., *Dark Sun: The Making of the Hydrogen Bomb*, Simon and Schuster, New York (1995) 176–178. Ambassador Roland Timerbaev, long time Resident Representative of the USSR to the IAEA, reports that there were many versions of Stalin’s reactions.

[12] In this design a subcritical mass is fired into another subcritical mass, e.g. a plug of high enriched uranium (HEU) is fired into a cylindrical channel or set of rings of HEU. In the collision, a critical mass is formed and an uncontrolled fission reaction begins. In a later design two or more subcritical masses were fired at each other, presumably to reduce the size of the warhead (RHODES, R., *The Making of the Atomic Bomb*, p. 702 and SPECTOR, L., *The Undeclared Bomb*, Ballinger, Cambridge, MA (1988) 453–454). The gun assembly design is no longer used by the nuclear weapon States, but South Africa used it for its six subsequently dismantled nuclear devices. The Nagasaki bomb was a sphere of plutonium with a small neutron source at its centre, surrounded by a tamper of uranium. The sphere was imploded into a much smaller supercritical mass by simultaneously detonating shaped charges ('lenses') of high explosive at numerous points of the periphery of the tamper (RHODES, R., *The Making of the Atomic Bomb*, pp. 575–576).

[13] The estimates of the dead of Hiroshima and Nagasaki are taken from RHODES, R., *The Making of the Atomic Bomb*, pp. 734 and 740–741. Rhodes writes that in both cities the death rate was about the same — 54%.

[14] In assessing these appalling statistics one must not forget that conventional weapons had already caused comparable holocausts: 83 000 men, women and children were burnt to death in Tokyo in a single night. Similar or even greater numbers had perished as a result of the bombing of Dresden.

[15] STIMSON, H.L., BUNDY, M., *On Active Service in Peace and War*, Harper and Brothers, New York (1947) 635.

[16] Ibid., pp. 643–645.

[17] BECHHOEFER, B.G., *Postwar Negotiations for Arms Control*, The Brookings Institution, Washington, DC (1961) 33.

[18] BECHHOEFER, B.G., *Postwar Negotiations for Arms Control*, p. 34.

[19] BECKMAN, R.L., *Nuclear Nonproliferation, Congress and the Control of Peaceful Nuclear Activities*, Westview Press, Boulder, CO (1985) 30. Ambassador Timerbaev affirms that the USA and the United Kingdom at that time accepted the Soviet Union's insistence that the work of the UNAEC be subject to the direction of the Security Council and the vetoes of its five permanent members.

[20] The resolution creating UNAEC invited it to present proposals:
(a) For extending between all nations the exchange of basic scientific information for peaceful ends;
(b) For the control of atomic energy to the extent necessary to ensure its use only for peaceful purposes;
(c) For the elimination from national armaments of atomic weapons and of all other major weapons adaptable to mass destruction;

(d) For effective safeguards by way of inspection and other means to protect complying States against the hazards of violations and evasions.

BECHHOEFER, B.G., *Postwar Negotiations for Arms Control,* p. 34.

21 BECHHOEFER, B.G., *ibid.,* p. 129.

22 Acheson was Assistant Secretary of State and later succeeded Byrnes as Secretary of State. Amongst Lilienthal's achievements was the launching of the Tennessee Valley Authority, the most ambitious and spectacular civil engineering project of Roosevelt's New Deal.

23 *The International Control of Atomic Energy*, Publication 2498, US Govt Printing Office, Washington, DC (16 March 1946). See also HEWLETT, R.G., ANDERSON, O.E., *The New World: A History of the United States Atomic Energy Commission*, pp. 538–554.

24 CONGRESS OF THE UNITED STATES, *Nuclear Proliferation Factbook,* Congressional Research Service, US Govt Printing Office, Washington, DC (1985) 21.

25 SIMPSON, J., HOWLETT, D., *The Baruch Plan*, PPNN Briefing Book, Volume II (*Treaties, Agreements and other Relevant Documents*, 2nd edn), The Mountbatten Centre for International Studies, Department of Politics, University of Southampton, Southampton (1993) N-1 to N-5.

26 BECHHOEFER, B.G., *Postwar Negotiations for Arms Control*, pp. 55–60.

27 The "four policemen" were the USA, the USSR, the United Kingdom and China. France later became the fifth. (BECHHOEFER, B.G., *Postwar Negotiations for Arms Control*, pp. 16–19.)

28 HOLLOWAY, D., *Stalin and the Bomb: The Soviet Union and Atomic Energy, 1939–56,* Yale University Press, New Haven, CT (1994) 129. This outstanding work contains much more than its title suggests and is, in fact, a history of the international and not only of the Russian development of nuclear weapons until after Stalin's death.

29 BECKMAN, R.L., *Nuclear Nonproliferation, Congress and the Control of Peaceful Nuclear Activities*, p. 30; and RHODES, R., "The day Jimmy Byrnes appointed Bernard Baruch was the day I gave up hope", *Dark Sun: The Making of the Hydrogen Bomb*, p. 240.

30 BECHHOEFER, B.G., *Postwar Negotiations for Arms Control,* pp. 44–45.

31 GOLDSCHMIDT, B., "A forerunner of the NPT? The Soviet proposals of 1947", *IAEA Bulletin* **28** 1 (1986) 58–64.

32 BECKMAN, R.L., *Nuclear Nonproliferation, Congress and the Control of Peaceful Nuclear Activities*, p. 34, quoting a memorandum to Byrnes from Fred Scarles, Jr., in US DEPARTMENT OF STATE, *Foreign Relations of the United States, 1946,* Vol. 1, US Govt Printing Office, Washington, DC (1972) 964, 966.

33 Sweden has large deposits of shale containing low grade uranium. In July 1945 the USA asked Sweden to ban all exports of its uranium. Sweden refused, but it is doubtful whether Sweden ever exported uranium (Bo Aler's article in *Personal Reflections*).

[34] GOLDSCHMIDT, B., *Le Complexe Atomique*, pp. 302–303.

[35] CONGRESS OF THE UNITED STATES, *The Atomic Energy Act of 1946*, Section 10(a)(1), Atomic Energy Legislation through 88th Congress, 2nd Session, Joint Committee on Atomic Energy, US Govt Printing Office, Washington, DC (1984) 226.

[36] BECKMAN, R.L., *Nuclear Nonproliferation, Congress and the Control of Peaceful Nuclear Activities*, p. 35.

[37] NOGEE, J.L., *Soviet Policy Towards the International Control of Atomic Energy*, University of Notre Dame Press, South Bend, IN (1961) 150.

[38] STIMSON, H.L., BUNDY, M., *On Active Service in Peace and War,* p. 643.

[39] In autumn 1951, the General Assembly abolished the UNAEC and established in its place the United Nations Disarmament Commission: BECHHOEFER, B.G., *Postwar Negotiations for Arms Control,* p. 136.

[40] GOLDSCHMIDT, B., *Le Complexe Atomique*, p. 94.

[41] By the end of 1952 there were already three declared nuclear weapon States and one or two others in the offing. The Soviet Union and the United Kingdom were starting work on their first nuclear power plants at Obninsk (5 MW(e)) and Calder Hall (50 MW(e)): *Nuclear Power Reactors in the World, April 1987 Edition,* Reference Data Series No. 2, IAEA, Vienna (1987), pp. 28 and 32. Canada was operating a large research reactor, while the Netherlands and Norway, neither of which had taken any part in the Manhattan Project, were jointly building a reactor and showing they could produce plutonium, the 'Jeep' reactor at Kjeller which came into operation in 1951. It used 7 tons of Norwegian heavy water as a moderator and coolant. (CONGRESS OF THE UNITED STATES, *Background Material for the Review of the International Atomic Policies and Programs of the United States*, Report to the Joint Committee on Atomic Energy, Vol. 3, US Govt Printing Office, Washington, DC (1960) 620.)

[42] BECKMAN, R.L., *Nuclear Nonproliferation, Congress and the Control of Peaceful Nuclear Activities,* p. 61, quoting STRAUSS, L.L., *Men and Decisions*, Doubleday, New York (1962) 336–337.

[43] The object tested is now known to have been a boosted fission device. The first true Soviet hydrogen bomb was tested only in November 1955 (HOLLOWAY, D., *The Soviet Union and the Arms Race*, Yale University Press, New Haven, CT (1983) 24).

[44] SOKOLSKI, H., "The arms control connection", *Atoms for Peace: An Analysis After Thirty Years* (PILAT, J.F., PENDLEY, R.E., EBINGER, C.K., Eds), Westview Press, Boulder, CO (1985) 40.

[45] BARLOW, A., *The History of the International Atomic Energy Agency* (unpublished thesis). The author of the book is an official in the Foreign and Commonwealth Office of the United Kingdom. Quoting EISENHOWER, D.D., *Mandate for Change, 1953–1963*, Heinemann, London (1963). See also SOKOLSKI, H., in PILAT, J.F., et al.

(Eds), *Atoms for Peace: An Analysis After Thirty Years,* p. 41, concerning the idea of an international pool of fissile material — the idea that was to become the kernel of the 8 December speech. BECKMAN, R.L., *Nuclear Nonproliferation, Congress and the Control of Peaceful Nuclear Activities,* p. 62, quotes Eisenhower's own words in *Mandate for Change*. The USA [and the USSR] should make "actual physical donations of isotopes [sic] from our then unequaled stockpile to a common fund for peaceful purposes."

46 BARLOW, A., *The History of the International Atomic Energy Agency*. The source he cites is DONOVAN, R.J., *Eisenhower: The Inside Story*, Harper, New York (1956) 185.

47 The full text of Eisenhower's speech is reproduced in PILAT, J.F., et al. (Eds), *Atoms for Peace: An Analysis After Thirty Years,* Annex C, pp. 283–291. A year later, on 4 December 1954, the General Assembly unanimously endorsed Eisenhower's proposal for the creation of the new agency. *First Annual Report of the Board of Governors to the General Conference Covering the Period from 23 October 1957 to 30 June 1958,* GC(II)/39, IAEA, Vienna (1958) 43.

Chapter 3

1954–1956: NEGOTIATION OF THE IAEA's STATUTE

The bilateral path

Even before Eisenhower launched "Atoms for Peace" the US Government had negotiated agreements for nuclear assistance or sales to the United Kingdom, Belgium and Canada. The agreement with the United Kingdom was a natural continuation of wartime co-operation,[1] while Belgium and Canada had played a critical role in supplying uranium for US nuclear weapons.

In 1954, the US Congress provided the legal basis for "Atoms for Peace" by enacting the Atomic Energy Act of 1954 (AEA/54) which drastically amended the McMahon Act. The USA, its hands now free, and the Soviet Union began to compete in offering nuclear research reactors to strengthen ties with friends and allies and to gain favour with the developing countries. In May 1955, the USA and Turkey concluded the first agreement for co-operation in the peaceful uses of atomic energy under AEA/54. By the end of 1959, the USA had concluded agreements with 42 countries.[2] Senator John Pastore, an eloquent proponent of nuclear energy, summed up the purpose of this competition: "If the Soviet Union should seize the initiative in bringing to those power-starved nations [of Asia] the great benefits of atomic energy we shall have lost the battle."[3] By 1968, the Soviet Union had narrowed the gap, having concluded nuclear co-operation agreements with 26 countries.[4]

Most of these agreements foresaw that responsibility for the safeguards to be applied by the USA under the bilateral agreement would eventually be turned over to the IAEA. The Soviet Union did not require either bilateral safeguards or safeguards under the new agency, but recipients of Soviet aid had to pledge to use it for peaceful purposes only and to return used fuel to the USSR.

Multilateral negotiations

The first Soviet reactions to Eisenhower's proposals were dismissive. On 19 March 1954, the US State Department handed Soviet Ambassador

Georgy Zaroubin an outline of the statute for the proposed agency based on President Eisenhower's proposal and during the following months five similar memoranda followed. They contained many of the features of the Statute approved two years later by 81 countries including the Soviet Union, but in 1954 the idea of an 'atoms for peace' agency was still unacceptable to the USSR.[5] Moscow had doubts about the wisdom of the underlying concept and insisted that priority be given to the Soviet Union's proposal for the total and immediate renunciation of nuclear weapons.[6] Gerard Smith, the leader of the US delegation that negotiated the SALT I Treaty, and a participant in many other disarmament negotiations, wrote that: "when Molotov protested to a dubious John Foster Dulles that the atoms for peace proposal would result in the spread worldwide of stockpiles of weapon grade material, I had to explain to Dulles that Molotov had been better informed technically than he. Subsequently, the Soviets asked how we proposed to stop this spread. The best we could reply was that 'ways could be found'."[7]

The USA kept the United Kingdom, France and Canada informed about its unpromising discussions with the Soviet representatives. On 1 May 1954, the USA told the USSR that it would go ahead with the creation of the agency whether or not the Soviet Union took part. In September the USA informed the UN General Assembly of its plans to create the agency and to call an international scientific conference on all peaceful aspects of atomic energy.[8] Since the Soviet Union's participation could not be counted on, the US concept of the agency was beginning to change. On 5 November 1954, Ambassador Henry Cabot Lodge informed the Assembly that in view of the Soviet rejection of the US proposal "...it might be preferable that the agency act as a clearing-house for requests rather than take custody of fissile material."[9] The concept of a 'clearing house' for nuclear transactions thus emerged as an alternative to that of an international pool or bank of nuclear material.

In December 1954, the United Kingdom presented the US State Department with the first text of a draft statute for the new agency. The USA soon responded with a revised draft of its own.[10] In early 1955, the USA, together with the United Kingdom, France, Canada, Australia, South Africa, Belgium and later Portugal, began negotiations in Washington on the basis of the US/UK draft. The last five members of the Eight-Nation Negotiating Group had been brought into the negotiations as producers of uranium; an indication of the political importance that the element still had in American eyes. The aim of the group was to reach agreement on the text of the statute, to go ahead and establish the agency and only then invite other States to join it.

The structure that the eight-nation group foresaw for the IAEA and several other provisions of the draft that emerged from its discussions were quite close to those of the final (1957) text of the IAEA's Statute. Unlike most intergovernmental bodies created after the war, the IAEA would operate in some respects like a trading organization, buying and reselling nuclear plant and fuel — in a way an international reincarnation of the US Atomic Energy Commission (USAEC). The IAEA's chief executive would be a 'General Manager' who would be responsible to a 16-nation board of directing States — a relatively small body by present international standards. The sole legal obligation that a State would assume by joining the IAEA would be to pay its assessed share of the cost of the IAEA's operations. Unless it received assistance from the IAEA, no Member State, nor any other nation, would be required to accept IAEA safeguards or safety standards,[11] nor to apply them to its exports and there would be no requirement to use the IAEA as a channel for nuclear supplies. In these respects the Statute is the same today, forty years later. But it was expected that the IAEA would flourish, that Member States would eagerly compete for a seat on its Board and would turn to the IAEA for the supply of scarce and precious uranium and for access to the latest products of nuclear technology. And "the functions of the Agency...[would] permit full assumption of responsibility [by the IAEA] for universal safeguards if and when the Great Powers agree."[12] The "Great Powers" (no longer the same as they were in 1955) are still a long way from such a consensus. Nonetheless, the Soviet Union's agreement in July 1955 to join the IAEA negotiations and the eventual agreement between the USA and the Soviet Union to create a new international agency in a vital and sensitive field would have been inconceivable during the last years of Stalin.[13] Together with progress in other negotiations, the agreement on the IAEA marked the first major thaw in the post-war relations between Moscow and Washington.

The agreement was particularly significant at a time when so many benefits were expected from the 'peaceful atom'. The prevailing euphoria was greatly boosted by the international conference on the peaceful uses of atomic energy that the USA had proposed in late 1954 and the General Assembly had agreed to hold. With worldwide encouragement, the United Nations now convened what became known as 'The First Geneva Conference' from 8 to 20 August 1955. It turned into the largest gathering of scientists and engineers the world had ever seen, with some 1500 delegates and more than 1000 scientific papers.[14] The Conference was indeed a landmark in the history of science, the first intergovernmental conference ever held to illuminate progress on a new technology.[15] It confirmed to the world that countless uses of nuclear energy, in particular the generation of electricity, were now feasible. In so doing it persuaded many nations to launch nuclear research and development programmes and sharpened their interest in the proposed IAEA.

The Conference also lifted the blanket of secrecy that had descended on nuclear research in the dark days of 1939, and did much to restore the international character of science. For the first time since the war Soviet scientists were able to attend a scientific meeting outside the USSR and meet their Western colleagues. In a heady atmosphere of competitive declassification (and, doubtless, to put pressure on the USA) France went so far as to publish the technology of reprocessing spent nuclear fuel to recover plutonium, until then a closely guarded secret. The only nuclear technology, other than the construction of the bomb itself, that remained under wraps was that of enriching uranium.

The prevailing optimism was typified by Admiral Lewis Strauss, the Chairman of the USAEC, who predicted that: "It is not too much to expect that our children will enjoy electrical energy too cheap to meter...will travel effortlessly over the seas and under them and through the air with a minimum of danger and at great speeds."[16] Others foresaw that nuclear energy would propel trains and cars and that nuclear desalting of the oceans would turn the deserts green. The President of the Conference, the eminent Indian physicist Homi Bhabha, predicted that "during the next two decades" scientists would have found a way of "liberating [thermonuclear] fusion energy in a controlled manner... When that happens the energy problems of the world will truly have been solved for ever..."[17] For Bhabha and his colleagues in the developing world, nuclear energy would provide a short cut to the prosperity that the industrialized countries were now beginning to enjoy. Churchill summed it up: atomic energy would be "a perennial fountain of world prosperity."[18] It is hardly surprising that the services of the IAEA were expected to be in great demand.

The USSR comes on board and the USA confronts the risks

A few weeks before the Geneva Conference, the Soviet Union had taken a step that was to transform the prospects for international nuclear co-operation and the nature and scope of the future IAEA. On 18 July 1955, it agreed to join the Statute negotiations in Washington and, as a token of its participation, to make available 50 kg of uranium-235 in low enriched form (i.e. below 20%

uranium-235) to the new agency and to join a study of the safeguards that the agency would need.[19] On 29 July 1955, the USA sent the Soviet Government the eight-nation draft of the statute and on 22 August circulated the draft to all the States that were then members of the United Nations or of any specialized agency.[20]

After the Geneva Conference experts from the USA, USSR, United Kingdom, France, Canada and Czechoslovakia met to consider the technical questions that would arise in drawing up a system of safeguards. This was the first serious discussion of nuclear controls since the early days of the UNAEC. Neither the USA nor the USSR was yet ready to put forward concrete proposals for the IAEA system, but the USSR was now prepared to commit itself to a strong system, at least in principle. Soviet support of rigorous safeguards was, however, much less evident 15 months later at the Conference on the Statute.[21]

It was in preparation for this meeting that the US negotiators and their scientific colleagues for the first time seriously confronted the dilemma of 'promotion versus control'.[22] The Suez crisis in October 1956 had spurred European effort to develop nuclear energy as an alternative to oil, thus bolstering, in Western eyes, the need for the "Atoms for Peace" policy. The policy was also serving the aim of strengthening economic and technical bonds between Europe and the USA. But the spread of nuclear technology "would increase the possibilities that the technology could be used for military purposes." As the third volume of the official history of the USAEC put it, "the problem was that international promotion and control of atomic energy were contradictory; the success of the one tended to hurt the cause of the other."[23] Moreover, there were grave doubts at that time whether it would be technically possible to develop effective safeguards; there was much discussion of 'tagging' or 'spiking' nuclear materials, for instance with gamma ray emitters that would make them easier to monitor, and astronomically high estimates were made of the number of inspectors that the IAEA would require to monitor a single nuclear plant.[24] And without effective safeguards it was doubtful whether the USA should join the IAEA or "...support the construction of any nuclear power plants abroad on a bilateral basis."[25]

John Hall, then Director of the USAEC Division of International Activities, put the question squarely: "In these circumstances, should the US withdraw from its announced intention of furthering atoms for peace throughout the world?" The answer he gave was "No".[26] Abandoning "Atoms for Peace" would not only involve a serious loss of face for President Eisenhower and the US Government, it would not avert the risk of proliferation, but, as the

USA saw it, merely leave the field open to other suppliers that were less concerned about the dangers of diversion. The problem was not how to abandon the policy but how to achieve its goals in a way "that minimized the proliferation of nuclear weapons throughout the world."[27]

Nuclear broker or clearing house versus nuclear 'pool' or 'bank'

The views of the USA about the fundamental role of the future agency depended to a great extent on whether or not the USSR would take part in the negotiations and contribute fissile material to the IAEA. If the USSR were to become an active member of the agency, then Eisenhower's concept of the IAEA serving as a pool or bank siphoning off nuclear materials from the stockpiles of the nuclear weapon States, and of thus slowly achieving nuclear disarmament, might become a reality. If, however, the USSR continued to remain aloof there would be no point in placing US and possibly some UK nuclear material under the physical control of the IAEA. This was clear from Ambassador Lodge's statement to the General Assembly referred to above.

Now that the USSR had agreed to join the negotiations and had pledged some fissile material, the USA swung back at least partly to the concept of the IAEA as a pool or bank and, as will be seen, the Statute reflects this concept, especially in Articles IX and XII.B. However, as we shall also see, the IAEA was not to become a pool or bank or, to any significant extent, a clearing house. In the late 1950s, one of the chief reasons was that many members of Congress preferred to supply direct to partners in bilateral agreements and thus bypass the IAEA and apply US safeguards to the transaction. Through such bilateral arrangements Congress could determine who would receive US nuclear material and make sure that it did not end up in hands that many members of Congress distrusted, such as those of the Soviet Union and its allies.

The Statute takes final shape

At the General Assembly in the autumn of 1955 it was agreed that the eight-nation group would be expanded to twelve (as the Soviet Union had proposed), that a revised version of the draft Statute would be circulated to all members of the UN and its specialized agencies and that a conference would be held at UN Headquarters in late 1956 to review and give final approval to the Statute.

On 27 February 1956, the USSR, Czechoslovakia, Brazil and India joined the Washington group — two 'Socialist' and two developing countries. For the first time developing countries could now exert some influence on the contents of the Statute. They sought to link the Agency more closely to the United Nations, to make the IAEA more like a UN specialized agency (symbolically, the 'General Manager' of the Agency became the 'Director General', a title customarily used in the specialized agencies) and India, with some support from the Soviet Union, sought to blunt the edge of safeguards.

The USA had reviewed its position on the IAEA and had concluded that since the Soviet Union was now participating, the question of the IAEA's custody of nuclear material would once again be a central issue. The other main issues that arose during the meetings of the twelve-nation group were the safeguards to be incorporated in the Statute[28] and the composition of the future Board of Governors.

During eight weeks — from 27 February until 18 April 1956 — the twelve-nation group elaborated the Statute in much the same form and content that it has today.[29] The group can therefore be regarded as the main collective architect of the IAEA, but in most cases it built upon the foundations laid by the eight-nation draft. It made no structural changes to that draft and maintained the IAEA's central function as a receiver, distributor, broker and safeguarder of nuclear materials.

In the following summary of the results of the twelve-nation group's work, the references given are to the articles of the Statute as they were numbered when the Statute was finally approved in October 1956 and as they are still numbered today.

The IAEA's objectives and functions

The twelve-nation group reaffirmed the dual aim of the IAEA set by the eight-nation group; the IAEA's purpose would be to promote the peaceful uses of nuclear energy and seek to ensure that it was not used "to further any military purpose" (Article II).

The IAEA's authorized functions were to be extremely broad. In summary the IAEA was empowered to:

— Take any action needed to promote research on, development of, and practical applications of nuclear energy for peaceful purposes (Article III.A.1);

— Provide materials, services, equipment and facilities for such research and development, and for practical applications of atomic energy "with due consideration for the needs of the under-developed areas of the world" (Article III.A.2);
— Foster the exchange of scientific and technical information (Article III.A.3);
— Establish and apply safeguards to ensure that any nuclear assistance or supplies with which the IAEA was associated should not be used to further any military purposes — and apply such safeguards, if so requested, to any bilateral or multilateral arrangement (Article III.A.5);
— Establish or adopt nuclear safety standards (Article III.A.6).

The Statute does not explicitly mention what was to become one of the main functions of the IAEA, namely the provision of 'technical assistance' (now 'technical co-operation'). However, the Statute underlined the special importance of helping the developing countries to make use of nuclear energy. This was implicit in Article II, which enjoined the IAEA to seek "to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world" and explicit in Article III.A.2, which requires the Agency to give "due consideration for the needs of the under-developed areas of the world." It was also explicit in the clause that the Conference on the Statute added to Article III on the proposal of Poland, which authorized the IAEA "to encourage the exchange and training of scientists and experts in the field of the peaceful uses of atomic energy" (Article III.A.4).[30] The first General Conference in 1957 called for priority to be given to the Agency's work of benefit to the developing countries and in 1959 the IAEA launched a fully fledged technical assistance programme under which it organized training courses and provided the services of experts and specialized equipment as well as fellowships. By the mid-1990s, the programme was valued at some $60 million a year.

Another significant clause required the IAEA to "conduct its activities in accordance with the purposes and principles of the United Nations to promote peace and international co-operation and in conformity with the policies of the United Nations furthering the establishment of safeguarded world-wide disarmament and...any international agreements entered into pursuant to such policies" (Article III.B.1).

Since it was foreseen that the IAEA's work would have a political as well as economic character, the twelve-nation group prescribed that the IAEA's main reporting link would be to the General Assembly of the United Nations rather than to the Economic and Social Council (ECOSOC) to which the United Nations specialized agencies report (Article III.B.4). Moreover, it was conceivable that the application of safeguards might raise issues of international security. Accordingly, on the proposal of the Soviet Union, the Statute also required the IAEA to submit reports to the Security Council if, in connection with the IAEA's work, "there should arise questions that are within the competence of the Security Council...as the organ bearing the main responsibility for the maintenance of international peace and security" (Article III.B.4). This provision would also enable the Soviet Union to exercise its veto in the Council if its interests so required (precisely what the Baruch plan had sought to avoid).

The relative powers of the General Conference, the Board of Governors and the Director General

The twelve-nation group also maintained the earlier draft's remarkable concentration of executive power in the Board of Governors rather than in the annual General Conference in which all Member States have the right to take part. The Board was to "have authority to carry out the functions of the Agency in accordance with this Statute" and subject to its responsibilities to the General Conference (Article VI). In practice this meant, inter alia, that the Board would exercise exclusive power in most safeguards matters: it would draw up and approve safeguards systems, appoint inspectors, approve safeguards agreements and, if doubts arose about the nuclear activities of a State in the context of IAEA safeguards, the Board would judge whether the State was complying with its safeguards obligations. If the Board found against the State it would report the non-compliance directly to the Security Council and the General Assembly (Article XII.C and, as noted, Article III.B.4).

The Board would also prepare the IAEA's programme and budget and submit the budget to the General Conference for approval; if the General Conference did not like the Board's proposals it could not change them, but could only return them with its recommendations to the Board, for eventual resubmission to the Conference (Articles V.E.5 and XIV.A).

In certain cases, however, the General Conference was to have the last word. Its concurrence would be needed for:

- — The approval of new Member States of the IAEA (Articles V.E.1 and IV);
- — The suspension of a Member that had persistently violated the Statute or any agreement made with that Member pursuant to the Statute (Articles V.E.2 and XIX);
- — The approval of reports required by the IAEA's relationship agreement with the United Nations (except reports on the violation of safeguards agreements which, as noted, were to go directly from the Board to the Security Council and General Assembly) (Articles V.E.6 and XII.C);
- — The approval of agreements between the IAEA and other organizations (Articles V.E.7 and XVI);
- — The approval of the appointment of the Director General (Article VII.A).

Even in these cases the General Conference could only act upon a recommendation by the Board. It could not alter a proposed agreement with another organization; as in the case of the budget it could only return the text of the draft agreement, together with its own recommendations to the Board, for resubmission to it. In practice the General Conference has never returned a proposed budget nor a proposed agreement to the Board and it does not formally approve the IAEA's annual reports to the United Nations.[31]

The authority of the Director General (the 'General Manager' in the eight-nation draft) was also to be circumscribed, at least on paper. He was to be the "chief administrative officer of the Agency", to be appointed by the Board with the approval of the General Conference (Article VII.A), and he was to "...perform his duties in accordance with regulations adopted by the Board" (Article VII.B).

In prescribing this unique division of power amongst the two Governing Bodies and the chief executive, the eight-nation and twelve-nation groups differentiated the IAEA from most of the specialized agencies of the United Nations.[32] In these organizations ultimate authority is usually vested in the periodical conference of all Member States. The chief executive officer submits the proposed budget direct to that conference (with the observations of the executive body) and the conference may make whatever changes it wishes.

When the Conference on the Statute reviewed the twelve-nation draft in October 1995, it left largely untouched the unprecedented concentration of power in the hands of the Board of Governors.

The composition of the Board of Governors

It seemed likely that the Board's decisions could vitally affect the expanding nuclear programmes of many Member States. Hence it became important for them to secure a permanent seat on the Board.

The eight-nation version of the Statute assigned 'quasi-permanent' seats (that is, permanent as long as they retained their leading status) to the five leading contributors of technical assistance and fissile materials. The eight chief producers and contributors of source materials (chiefly natural uranium) would have shared five seats.[33] Since some uranium production statistics were still secret and since some States had to be included to achieve an acceptable political balance it was necessary to name the eight States concerned. Six further members of the Board were to be elected by the General Conference.

In the twelve-nation group the Indian delegation came up with a complex but ingenious formula that has stood the test of time. In the form in which it was eventually approved the Indian formula divided the world into eight regions: North America, Latin America, Western Europe, Eastern Europe, Africa and the Middle East, South Asia, South East Asia and the Pacific, and the Far East.

Without naming the countries concerned, the Indian formula provided that the five Member States "most advanced in the technology of atomic energy including the production of source materials" would hold quasi-permanent seats on the Board. The five were understood to be the USA, USSR, France, the United Kingdom and Canada.[34] Similarly, quasi-permanent seats were to be held by the Member States considered to be the "most advanced in the technology of atomic energy including the production of source materials" but not located in the same areas as the top five. In 1956, five of the specified regions were not covered by the top five members: Latin America, Africa and the Middle East, South Asia, South East Asia and the Pacific, and the Far East.

It was understood that Brazil would hold the seat in Latin America, India in South Asia, South Africa in Africa and the Middle East, Japan in the Far East and Australia in South East Asia and the Pacific. The formula also assigned an alternating seat to the pair Belgium and Portugal and another to the pair Czechoslovakia and Poland (as producers of source material, i.e. natural uranium) and one other seat to a member to be selected by the Board as a supplier of technical assistance (it was tacitly understood that this seat would rotate amongst four Scandinavian countries — Denmark, Finland, Norway and Sweden).[35] The twelve-nation group thus sought to ensure that nine of its members would have quasi-permanent seats on the Board and three would serve every other year. One nation not participating in meetings of the group, Japan, would have a quasi-permanent seat[36] and one other, Poland, would have an alternating seat.[37]

A further ten members were to be elected for two-year terms by the General Conference "with due regard to equitable representation on the Board as a whole, of the members in the [eight] areas," one each from seven of the specified areas (North America being excluded since it was expected that the two members in this region, Canada and the USA, would be among the top five and hold designated seats). The remaining three elected members could come from any of the specified areas.[38]

Although the membership of the Board has since grown to 35 States, the top five have become the top ten and include China, and the Middle East has been joined with the South Asian region, the original Indian formula is still the organizing principle of the Board (Articles VI.A to VI.C of the Statute). Moreover, with one exception, all those States that in 1956 were assured permanent or, at least, continuous seats on the Board have retained them. The exception was South Africa, which lost its seat in 1977 and regained it in 1995.

Nuclear materials

Reflecting Eisenhower's idea that the principal aim of the IAEA would be to reduce the stockpiles of fissile materials in the hands of the nuclear weapon States, the Agency would have no right to refuse any such material made available to it. The IAEA would merely be empowered to specify the place and method of delivery of nuclear material "which it has requested a member to deliver from the amounts which that member has notified the Agency it is prepared to make available." The IAEA would also be required to accept responsibility for storing and protecting the materials in its possession and "as soon as practicable [to] establish or acquire the plant, equipment and facilities for the receipt, storage and issue of materials."[39]

On the other hand the Board would determine how much source material the IAEA would accept.[40]

'Agency projects'

It was foreseen that the normal arrangement by which the IAEA would provide or would arrange for a Member State to provide nuclear materials, equipment or services would be an 'Agency project' as defined in Article XI of the Statute. On the proposal of Brazil, the IAEA was authorized to help its members to secure finances "from outside sources" to carry out such projects. But the IAEA would not assume any financial responsibility for the project (Article XI.B).

Before approving an 'Agency project' the Board would examine the project's usefulness and feasibility, the adequacy of the resources available for its effective execution, the adequacy of health and safety standards and other relevant aspects including "the special needs of the under-developed areas of the world" (Article XI.E). A formal agreement would be concluded between the Agency (in effect, the Board) and the requesting State. This would specify the items to be transferred, the conditions for ensuring the safety of the shipment and the charges to be made. It would include undertakings by the State that the assistance provided would not be used in such a way as to further any military purpose and would specify the safeguards to be applied (Article XI.F).

In the years since 1957, the IAEA has approved many 'Agency projects', but few of them involved significant nuclear plants or quantities of nuclear materials. Consequently, contrary to the original expectations, these projects did not become the normal means of giving assistance to a developing country nor of triggering safeguards. In the 1960s, IAEA safeguards were usually brought into action by a request from the parties to a bilateral agreement, asking the Agency to apply the safeguards prescribed in that agreement.[41] From 1970 onwards the most common initiator of safeguards took the form of an agreement concluded between a non-nuclear-weapon State party to the NPT and the IAEA.

The most frequently used channel for providing the services of experts, training and equipment became the IAEA's technical assistance programme, later renamed the technical co-operation programme. The agreements under which such technical assistance was provided were soon deemed not to be 'Agency projects' within the statutory meaning of the term and thus not to require formal case-by-case evaluation and approval by the Board or the application of safeguards. The Secretariat also granted (and continues to grant) fellowships, arranges training courses and sends out scientific and technical experts from its staff without individual authorizations by the Board. In 1968, the Board also authorized the Director General to supply small quantities of nuclear materials for research purposes without explicit Board approval.[42]

As time passed 'Agency projects' were limited to formal — and increasingly infrequent — undertakings for the supply of a research reactor or reactor fuel, and in two cases, Mexico and Yugoslavia, for the supply of a power reactor and its fuel.[43] In both these cases the recipient government wished to distance itself on paper, for political reasons, from the actual supplier. In practice the research and power reactors and the reactor fuel went directly from the manufacturer or fabricator (nearly always a US company) and the IAEA's involvement was purely pro forma. As noted elsewhere, except in cases where, for political reasons, the purchasing nation wished to distance itself from the real supplier, importing countries generally found it simpler and no more expensive to enter into a commercial agreement with the manufacturer of the nuclear power plant.

Safeguards

The text of the draft Statute prepared by the eight-nation group had stipulated in Article II that the IAEA should ensure that the materials it supplied should be used only for peaceful purposes. The group drafted provisions, couched in general terms, for inspections and other verification measures.[44] When the twelve-nation group met, the USA put forward much more detailed proposals. The safeguards procedures it proposed were modelled on the safeguards prescribed in the numerous nuclear co-operation agreements that the USA was now concluding.[45] These safeguards were to become the substance of Article XII of the Statute as it was finally approved.

With US encouragement, similar inspection provisions were later included in the Treaty of Rome which established EURATOM, and in the 1957 Convention of the OECD under which the OECD's European Nuclear Energy Agency applied safeguards to its own joint enterprises.[46] As a result, the IAEA Statute, the Rome Treaty and the OECD systems use identical or very similar language to describe their safeguards, inspection rights and regimes. For instance, IAEA, EURATOM and OECD inspectors "...shall at all times have access to all places and data and to any person[s] who by reason of his [their] occupation deal[s] with materials, equipment, or facilities" subject to safeguards.[47]

On the basis of the US proposals the twelve-nation group decided that the IAEA would be authorized to:

— Examine and approve the design of nuclear plants (but solely in order to verify that they would not further any military purpose, would comply with safety standards and would permit the application of safeguards) (Article XII.A.1).
— Require the keeping of operating records (Article XII.A.3).[48]
— Call for and receive reports (Article XII.A.4).[49]
— Approve the means used for reprocessing spent fuel — but solely to ensure that reprocessing did not lend itself to diversion and complied with applicable safety standards — and require the deposit with the IAEA of "special fissionable material" (i.e. plutonium) surplus to that which the State concerned needed for reactors it was operating or constructing (Article XII.A.5).
— Send inspectors to the "recipient" State or States, designated by the IAEA in consultation with the State(s). As noted, the inspectors "shall have access at all times to all places and data and to any person" dealing with nuclear items required to be safeguarded. The inspectors' tasks would be to account for all nuclear material covered by the IAEA's agreement with the State, and verify compliance with the State's undertaking against "furtherance of any military purpose" and with any other conditions prescribed in the agreement with the State (Article XII.A 6).

The IAEA would also have authority to require the observance of nuclear safety measures (Article XII.A.2). Its inspectors were also to verify that in the IAEA's own operations it was complying with it own safeguards and safety measures (Article XII.B).

The inspectors would be required to report to the Director General any non-compliance (by a State) that their work might disclose. The Director General was required, in turn, to report the matter to the Board. If the Board confirmed that the State was not complying with its safeguards agreement it could call upon the State to comply forthwith. The Board would also be required to report the non-compliance to all Member States of the IAEA and to the Security Council and General Assembly of the United Nations. The IAEA would also have the right to impose specified sanctions (Article XII.C).

The Indian delegation soon made clear that it was firmly opposed to extensive safeguards. It sought to defer discussion of safeguards until the IAEA was in operation and was about to conclude agreements with individual governments, at which stage the matter should be treated on a case-by-case basis. India also opposed the application of safeguards to source material, in particular to natural uranium (which it planned to use in its CIRUS reactor).[50] India had some support from France, which likewise opposed safeguards on source materials. French lack of enthusiasm for safeguards reflected their resentment of US efforts during the late 1940s and 1950s to prevent France from getting the bomb.

The USSR also generally sought to limit the IAEA's responsibilities and the size of the IAEA's budget and to assert the rights of States over those of the IAEA.

The USA, supported by the majority of members of the group and, in particular, by the United Kingdom and Canada, successfully resisted most of the attempts to weaken IAEA safeguards, but India was able to introduce a phrase limiting the IAEA's safeguards rights and responsibilities solely to those "relevant to the project or arrangement".

Finances

The twelve-nation group agreed to divide the Agency's expenses into two categories:

— "Administrative expenses" to be met by assessed (i.e. compulsory) contributions by all members (Articles XIV.B.I and XIV.D). These expenses were to include the salaries of the Secretariat and the costs of meetings, preparing 'Agency projects', distributing scientific and technical information, and safeguards (less any amounts that might be recoverable under the agreement with the State concerned).

— 'Other expenses', i.e. the cost of materials, facilities, plant and equipment acquired by the IAEA or provided by it under agreements with Member States. The cost of items provided by the IAEA to Member States were to be covered by a scale of charges to be set by the Board (Articles XIV.B.2 and XIV.F). Any profits made by the IAEA as a result of its nuclear purchases and sales and any voluntary contributions it received were to be placed in a General Fund which the Board could use as it saw fit, subject to the approval of the General Conference (Article XIV.F).

As will be seen later, much of this complex machinery was never activated, but voluntary contributions to the General Fund became the main source of finance for the IAEA's technical assistance programme.

Relations with the United Nations

Reflecting their national interests, the West, the Soviet Union and the developing countries had widely different views on the desirable relationship between the United Nations and the IAEA. Generally, the West and especially the United Kingdom, USA, France, Belgium, Portugal and the 'Old Commonwealth' countries (Australia, South Africa, and to a lesser extent Canada) wanted as much autonomy as possible for the IAEA so as to insulate it from the political issues — the drive against the colonial powers and against the racist policies of South Africa — that then figured so prominently on the agenda of the General Assembly. This group also wished to prevent the developing countries from using their voting power in the General Conference to expand unduly the IAEA's technical aid. The Soviet Union would have preferred an agency directly responsible to the Security Council, thus enabling it to use its veto power if the West tried to use its predominance in the IAEA for anti-Soviet actions. The developing countries preferred an agency closely tied to the UN and responsible to the General Assembly. This was also the preference of senior UN officials including Secretary General Dag Hammarskjöld, who was thought to regard atomic energy, and even its peaceful use, as too important to be left to an autonomous body. In October 1955, Hammarskjöld established a special atomic energy subcommittee of the inter-agency Administrative Committee on Co-ordination to keep under review the future activities of the IAEA as well as those of several specialized agencies already interested in specific applications of nuclear science and nuclear energy.[51]

The compromise reflected in Article XVI of the Statute and subsequently in the relationship agreement between the IAEA and the UN was to require the IAEA to report annually to the General Assembly, to the Security Council whenever the IAEA activities involved questions of international peace and security (including infractions of safeguards agreements) and optionally to ECOSOC and other UN organs on matters within their competence. The Statute also requires the IAEA to consider any resolution addressed to it by any council of the UN and to report, if so requested, on the action that the IAEA or its members had taken "in accordance with this Statute as a result of such consideration."[52]

UNSCEAR

In 1954, seeking to deflect an Indian proposal calling for an immediate end to all nuclear explosions, the USA proposed and the General Assembly unanimously approved a resolution asking the United Nations to establish a committee to study the effects of radiation on human health.[53]

In March 1956, while the 12-nations were meeting in Washington, Secretary General Hammarskjöld took the step called for by the General Assembly resolution and set up the United Nations Scientific Committee on the Effects of Atomic Radiation, or UNSCEAR.[54] This would ensure that the United Nations — and not the IAEA — would play the role of watchdog in regard to an important matter of nuclear safety. The decision to create UNSCEAR was a reaction to fallout from military activities and thus, in the view of the West at the time, not a subject to be dealt with by the IAEA. But in time UNSCEAR was also to become the official international authority on the effects of radiation produced by peaceful as well as military activities and on the effects of natural as well as man-made radiation.

When most atmospheric testing ceased after 1963, natural and civilian emissions became the main and in time almost the sole sources of radiation affecting humans and their environment. And since the end of the Cold War, Western nations appear to have become less reluctant to see the IAEA involved in monitoring the effects of radiation arising from military activities, for instance at Semipalatinsk (now in Kazakstan), in the Kara Sea, from sunken submarines in the North Atlantic or from nuclear testing in the South Pacific (the Marshall Islands and Mururoa Atoll).

The Conference on the Statute

In April 1956, the USA circulated the revised version of the Statute on behalf of the twelve-nation group to all the States that at that time were members of the UN or any of its specialized agencies and invited them to send delegations to New York in September to finalize and approve the Statute.

The USA also circulated the draft rules of procedure of the conference agreed upon by the twelve-nation group. These were unsurprisingly weighted in favour of the twelve-nation draft; any amendment would require the approval of two thirds of the participating States[55] and the time allowed for proposing amendments was kept short.[56]

One question left open was the representation of China. The USSR, supported by Czechoslovakia and India, vigorously but unsuccessfully maintained that only the People's Republic of China had the right to represent the Chinese nation. This issue was to be a source of considerable friction in the IAEA's Governing Bodies for the next 15 years. The Soviet Union and its allies pressed their argument for the admission of the People's Republic and the ejection of the 'Republic of China' on every occasion when the question of Chinese credentials arose, in other words at every session of the General Conference and at every occasion when the Republic of China was elected to the Board. On every such occasion the USA was able to muster sufficient votes to block the Soviet proposal. This went on until 1971 when the Board, following the lead given by the UN General Assembly, accepted that only the People's Republic could legitimately represent that nation. But it was not until 1983 that China decided to join the IAEA.

On 20 September 1956, the Conference on the Statute opened at the United Nations Headquarters in New York. Eighty-two States took part. While the United Nations provided services and the venue, the Conference was an ad hoc meeting of the States concerned and not of the United Nations itself.

The Conference elected Ambassador J.C. Muniz of Brazil as its President. The 12 nations of the Washington Group generally rallied to the defence of their draft and warned against attempts to upset the 'delicate' balance that had been achieved in, for instance, the allocation of seats on the future Board of Governors and the division of power between the Board and the General Conference. While the Conference approved many clarifying amendments to the Statute, the final version of the Statute was essentially the same as the twelve-nation draft, with a slight shift in the balance of power towards the General Conference and a provision for a review of the Statute at the sixth General Conference in 1962 if a majority of the Member States so desired (in the event, they did not). The USSR made an unsuccessful attempt to require that the IAEA's budget be approved by at least three quarters instead of two thirds of the delegations attending the Board and the General Conference.[57]

Apart from the issue of Chinese representation, the only major disagreements related to the proposals in the twelve-nation draft for the IAEA's safeguards, which several developing countries likened to neo-colonialism. A special bone of contention was a clause in the draft Statute authorizing the IAEA to require the deposit with it of fissile material (i.e. plutonium) recovered as a result of reprocessing that exceeded the amount needed for reactors in operation or under construction in the country concerned. The Indian delegate (Homi Bhabha) argued that this would enable the IAEA Board of Governors ("23 gentlemen in Vienna") to dominate the States that received IAEA assistance. The French and Swiss delegations eventually devised an acceptable compromise.

India also opposed safeguards on natural uranium on the grounds that this would unfairly favour countries that had their own uranium reserves — and also opposed the principle implicit in the twelve-nation draft that safeguards should apply to succeeding generations of nuclear material, arguing that if a country like India turned to the IAEA for help in starting its nuclear programme this principle would ensure that it would never be free of safeguards.[58]

With one notable addition the safeguards provisions in the Statute remained very much as they had been drafted in Washington. The addition related to the Washington version of Article III.A.5. This authorized the IAEA to apply safeguards to its own projects and, "at the request of the parties, to any bilateral or multilateral arrangement." Thailand, obviously inspired by the USA, proposed adding the words: "or at the request of a State to any of that State's activities in the field of atomic energy." The more cynical delegations dismissed the proposal as naive — what government in its senses would inflict safeguards on itself? But the Conference accepted the proposal. One of the tasks of the Conference's co-ordinating committee was to ensure consistency between revised articles of the draft and the remainder of the Statute. In a late night session the committee decided not to bother about devising an additional clause in Article XIV ("Finance") that would provide a mechanism for recovering the cost of applying such implausible safeguards.

History was to prove the cynics wrong. The clause proposed by Thailand was to become a legal basis for the IAEA to apply safeguards in the non-nuclear-weapon States party to the NPT, in the five nuclear weapon States after they had offered to place at least some civilian nuclear activities under safeguards, in the parties to the Tlatelolco Treaty and to fissile material released from military stocks in nuclear weapon States.[59]

At the end of the Conference the USA announced that it was prepared to provide the IAEA with the equivalent of 5000 kg of contained uranium-235 and to match all contributions made by other countries before 1 July 1960.

The choice of the IAEA's headquarters

There were already four candidates for the permanent headquarters of the IAEA: Vienna, Geneva, Copenhagen and Rio de Janeiro. The Austrian Government had especially strong grounds for pressing its case. Choosing Vienna as the IAEA's seat would underline Austria's neutral status and mark its re-entry into the international community after the ignominious years of 'Anschluss' and after the end of the four-power occupation. Vienna, on the frontier between Western and Soviet spheres of influence, was acceptable to both Washington and Moscow. The fact that the IAEA was expected to handle and store large amounts of fissile material also pointed to a neutral site on the East/West frontier. The Austrian delegation carried the day. While the Conference formally left it to the Prepcom to make a final recommendation to the first meetings of the General Conference and Board of Governors, it prejudged the issue by adopting a resolution in favour of Vienna.[60]

Ratification of the Statute

On 23 October 1956, after a little more than five weeks, the Conference approved the complete text of the revised Statute. During the following three months, the 81 nations that had taken part in the Conference signed the Statute. The ratification process began as soon as the Conference had come to an end. The Statute entered into force nine months later on 29 July 1957, when 26 States (including those whose ratification was specifically required) had deposited their instruments of ratification.

The Suez crisis and its nuclear consequences

Soon after the conclusion of the Conference, and without warning, two major international crises erupted. On 29 October 1956, Israel, and subsequently the United Kingdom and France, invaded Egypt in an attempt (ending after a week in ignominious failure) to regain control of the Suez Canal. At the same time the Soviet Union intervened in Hungary to topple the Government of Imre Nagy and suppress the uprising of the Hungarian people. Neither event had a direct bearing on the negotiation of the IAEA's Statute. However, after France's withdrawal from Egypt, the French Prime Minister, Guy Mollet, who had hitherto firmly opposed a French nuclear weapon, decided to press ahead with the French nuclear weapon programme.[61] A French observer maintains that on the night of 5–6 November 1956 Mollet and the French Chief of the General Staff agreed that France must provide Israel with the means to acquire the bomb.[62] France's decision to provide Israel with the Dimona reactor and reprocessing technology dates from that time, and in this way the Suez debacle precipitated the emergence of two new nuclear weapon States.[63]

NOTES

[1] US officials had put a stop to this co-operation at least once during the war and it had been broken off after Roosevelt's death but was subsequently restored (GOLDSCHMIDT, B., *Les Rivalités Atomiques*, Fayard, Paris (1967) 70–84 and 124–125).

[2] CONGRESS OF THE UNITED STATES, *Background Material for the Review of the International Atomic Policies and Programs of the United States*, Report to the Joint Committee on Atomic Energy, Vol. 3, US Govt Printing Office, Washington, DC (1960) 897.

[3] BECKMANN, R.L., *Nuclear Non-Proliferation, Congress and the Control of Peaceful Nuclear Activities*, Westview Press, Boulder, CO (1985) 70, quoting the legislative history of AEA/54, p. 850.

[4] TIMERBAEV, R.M., *Peaceful Atom on the International Arena*, International Relations Publishers, Moscow (1969) 129 (in Russian).

[5] Stoessinger quotes another sceptical statement by Molotov: "The level of science and technique which has been reached at the present time makes it possible for the very application of atomic energy for peaceful purposes to be utilized for increasing the production of atomic weapons." STOESSINGER, J.G., "Atoms for Peace: The International Atomic Energy Agency", *Organizing for Peace in the Nuclear Age*, Report of the Commission to Study the Organization of Peace, New York University Press, New York (1959) 120.

[6] CONGRESS OF THE UNITED STATES, *Review of the International Atomic Policies and Programs of the United States*, pp. 723–725.

[7] SMITH, G., "Nuclear commerce and non-proliferation in the 1980s — Some thoughts", address to the US Atomic Industrial Forum, 29 April 1982. See also HEWLETT, R.G., HOLL, J.M., *Atoms for Peace and War: 1953–1961, Eisenhower and the Atomic Energy Commission*, University of California Press, Berkeley, CA (1989) 221–222; PILAT, J.R., PENDLEY, R.E., EBINGER, C.K. (Eds), *Atoms for Peace: An Analysis After Thirty Years*, Westview Press, Boulder, CO (1985) 29; and SZASZ, P.C., *The Law and Practices of the International Atomic Energy Agency*, Legal Series No. 7, IAEA, Vienna (1970) 24. Szasz quotes the Soviet Union's note to the USA dated 30 January 1954 charging that "...since even peaceful nuclear activities could lead to the production of materials usable for bombs, the proposed stimulation of such activities throughout the world could actually lead to an intensification of the arms race."

[8] CONGRESS OF THE UNITED STATES, *Review of the International Atomic Policies and Programs of the United States*, p. 726.

[9] CONGRESS OF THE UNITED STATES, ibid., p. 728.

[10] SZASZ, P.C., *The Law and Practices of the International Atomic Energy Agency*, p. 28.

[11] BECHHOEFER, B.G., STEIN, E., "Atoms for Peace, The New International Atomic Energy Agency", *Michigan Law Review* (April 1957) 761.

[12] BECHHOEFER, B.G., STEIN, E., ibid., p. 774.

[13] BECHHOEFER, B.G., "Negotiating the Statute of the International Atomic Energy Agency", *International Organization* (1959) 38.

[14] GOLDSCHMIDT, B., *Le Complexe Atomique*, Fayard, Paris (1980) 271.

[15] In fact, nuclear energy is the only technology whose progress has been marked by a series of intergovernmental conferences.

[16] US Atomic Energy Commission press release, remarks prepared for Founders' Day Dinner, National Association of Science Writers, 16 September 1954, p. 9, quoted in: HILGARTNER, S., BELL, R.C., O'CONNOR, R., *Nukespeak*, Penguin Books, New York (1982) 44. General David Sarnoff, head of the Radio Corporation of America, went even further, unwisely predicting that "it can be taken for granted that before 1980, ships, aircrafts, locomotives and even automobiles will be atomically fuelled" and "I do not hesitate to forecast that atomic batteries will be commonplace before 1980" (SCHLESINGER, J.R., "Atoms for Peace revisited", in PILAT, J.F., et al. (Eds), *Atoms for Peace: An Analysis After Thirty Years*, pp. 10–11).

[17] UNITED NATIONS, *Peaceful Uses of Atomic Energy* (Proc. Int. Conf. Geneva, 1955), Vol. 16, UN, New York (1956) 35. Today, 41 years later, scientists are still several years away from being able to "liberate fusion energy" in a usable manner, and at least several decades away from the generation of electricity at a competitive price by fusion energy.

[18] BECKMANN, R.L., *Nuclear Non-Proliferation, Congress and the Control of Peaceful Nuclear Activities*, p. 70.

[19] CONGRESS OF THE UNITED STATES, *Review of the International Atomic Policies and Programs of the United States*, pp. 729 and 844.

[20] This formula was commonly used by the USA to exclude the People's Republic of China and the German Democratic Republic.

[21] CONGRESS OF THE UNITED STATES, *Review of the International Atomic Policies and Programs of the United States*, pp. 844–845.

[22] HEWLETT, R.G., HOLL, J.M., *Atoms for Peace and War*, pp. 306–320.

[23] HEWLETT, R.G., HOLL, J.M., ibid, p. 307.

[24] 'Spiking' proved to be impracticable. A task force concluded that to monitor a moderate sized chemical plant [presumably a reprocessing plant] a full-time force of 40 inspectors would be needed. HEWLETT, R.G., HOLL, J.M., ibid., pp. 316–317.

[25] HEWLETT, R.G., HOLL, J.M., ibid, p. 315.

[26] HEWLETT, R.G., HOLL, J.M., ibid, p. 317.

[27] HEWLETT, R.G., HOLL, J.M., ibid, p. 318.

[28] CONGRESS OF THE UNITED STATES, *Review of the International Atomic Policies and Programs of the United States*, p. 731.

[29] Some of the outstanding personalities of the eight- and twelve-nation groups were Ambassador Gerry Wadsworth and Ronald Spiers of the US delegation (Spiers, subsequently US Ambassador in Egypt, did most of the drafting), Georgy Zaroubin, Soviet Ambassador in Washington, Homi Bhabha and Arthur Lall of the Indian delegation, Maurice Couve de Murville, later French Foreign Minister, and Bertrand Goldschmidt of France, 'Mike' Michaels of the United Kingdom, Bill Barton of Canada, Sir Percy Spender of Australia and Donald Sole of South Africa.

[30] BECHHOEFER, B.G., STEIN, E., "Atoms for Peace, The New International Atomic Energy Agency", p. 757.

[31] Article VI of the IAEA Statute requires the Board to make an annual report to the General Conference "concerning the affairs of the Agency and any projects approved by the Agency [i.e. by the Board]." This report is drafted by the Secretariat and normally submitted to the Board in June each year for its approval. In the early years this report was brought up to date after the autumn session of the General Conference and then submitted as the IAEA's Annual Report to the General Assembly, as required by Article III.B.4 of the Statute. A separate report was also prepared for ECOSOC. Since 1975, the annual report approved by the Board has become the sole official annual report of the IAEA and serves as the report to the General Conference and the General Assembly.

[32] Under Articles 57 and 63 of the United Nations Charter, the specialized agencies are intergovernmental organizations "having wide international responsibilities...in economic, social, cultural, educational, health and related fields" that are brought into relationship with the United Nations by agreements concluded with ECOSOC. They report on their activities annually to ECOSOC. The IAEA, however, was brought into relationship with the UN by means of an agreement approved by the General Assembly and its main links are with that body, to which it reports annually, and with the Security Council, to which it reports on issues within the Council's competence (essentially compliance or non-compliance with safeguards agreements). This reflects the fact that, unlike the specialized agencies, whose work is almost entirely in economic and social fields, the IAEA is required by its Statute to deal with issues of security. Until the late 1960s, when the IAEA's safeguards began to cover more nuclear plants and the entire nuclear fuel cycle of certain countries, there was little to differentiate the IAEA from a specialized agency of the United Nations. As the IAEA's safeguards operations expanded, and especially after the entry into force of the NPT, the IAEA's relations with the UN began to change. The First (Political) Committee of the General Assembly began to make a detailed examination of the IAEA's annual report. And in 1981 the IAEA made its first report to the Security Council.

[33] BECHHOEFER, B.G., STEIN, E., "Atoms for Peace, The New International Atomic Energy Agency", p. 754, footnote 35, and SZASZ, P.C., *The Law and Practices of the International Atomic Energy Agency*, pp. 139–140, para. 8.2.1.2.1.

[34] Japan and the Federal Republic of Germany were still far behind the United Kingdom, France and Canada in the use of nuclear energy. So was the People's Republic of China (which joined the IAEA only in 1984).

[35] SZASZ, P.C., *The Law and Practices of the International Atomic Energy Agency*, pp. 150–151, para. 8.2.2.3.1.

It is noteworthy that the uranium producing countries were able to ensure that 'the production of source material' rather than, for instance, the number of reactors in a particular State, would be explicitly mentioned as a factor to be taken into account in designating States for permanent seats on the Board, an aspect of relevance today to Australia, which has consistently been designated as the State most advanced in the technology of atomic energy including the production of source materials in the region of South East Asia and the Pacific. This is in spite of the fact that it has no nuclear power plants, only one nuclear research reactor and no other significant nuclear facilities but remains an important producer of uranium. In the relatively near future, Australia's right to the seat may nevertheless be challenged by Indonesia, which has three research reactors and is debating a programme for the construction of several large power reactors.

It is also noteworthy that the formula refers to States "advanced in the technology of atomic energy" rather than States advanced in the technology *of the peaceful uses* of atomic energy. In theory, at least, a State that had no civilian but did have a significant military nuclear programme could qualify for a permanent seat.

[36] Unless it were displaced by the People's Republic of China, but this was a distant prospect and was later solved by including both nations in the top category.

[37] SZASZ, P.C., *The Law and Practices of the International Atomic Energy Agency*, pp. 140–141, para. 8.2.1.2.1.

[38] SZASZ, PC.., ibid., p.151, para. 8.2.2.2.4.

[39] *IAEA Statute*, Articles IX.G, H and I.

[40] Ibid., Articles IX.A and B and BECHHOEFER, B.G., "Negotiating the Statute of the International Atomic Energy Agency", p. 51.

[41] The agreement might require that safeguards be applied to a particular plant or supply of fuel — or to all nuclear shipments between the two countries concerned. Or the recipient country might wish to maintain the fiction that the request for safeguards flowed from its own entirely voluntary and 'unilateral' decision. In practice it was a condition set by the supplying country.

[42] RAINER, R.H, SZASZ, P.C., *The Law and Practices of the International Atomic Energy Agency: 1970–1980, Supplement to the 1970 Edition of Legal Series No. 7*, Legal Series No. 7-S1, IAEA, Vienna (1973) 198.

[43] In a third case the IAEA supplied enriched uranium for 'booster rods' for a power reactor, the Kanupp reactor in Pakistan. The USA was the source of the enriched uranium (see INFCIRC/116 of 6 September 1968). A simultaneously concluded project agreement relating to this transaction had the effect of bringing the enriched uranium and the reactor under safeguards. The IAEA was not originally involved in the supply of the reactor itself or its initial natural uranium fuel, but some 15 months later Pakistan formally placed the reactor, its fuel and its heavy water under IAEA safeguards (see INFCIRC/135 of 13 November 1969).

[44] CONGRESS OF THE UNITED STATES, *Review of the International Atomic Policies and Programs of the United States*, p. 730.

[45] BECHHOEFER, B.G., STEIN, E., "Atoms for Peace", p. 764.

[46] Treaty Establishing the European Atomic Energy Community, Articles 77–81 and Convention on the Establishment of a Security Control in the Field of Nuclear Energy, Articles 3–5. MARKS, S.H. (Ed.), *Progress in Nuclear Energy*, Series X, Law and Administration, Pergamon Press, London (1959), 852–853 and 910**.** Also CONGRESS OF THE UNITED STATES, *Review of the International Atomic Policies and Programs of the United States*, p. 793. The "European Nuclear Energy Agency" of the Organization for European Economic Co-operation (OEEC) came into existence on

1 January 1958. The name of the OEEC was changed to 'Organisation for Economic Co-operation and Development' (OECD) and as the ENEA expanded to include, as noted above, Australia, New Zealand, Japan, the USA and Canada, it became the 'Nuclear Energy Agency' (NEA) of the OECD. Since the NEA's joint enterprise in Belgium (EUROCHEMIC) would automatically be under EURATOM safeguards, the two organizations concluded an agreement under which the NEA suspended the application of its safeguards on the plant in question.

47 *IAEA Statute,* Article XII.A.6 and Rome Treaty, Article 81. Similarly, both organizations have the right to call for the deposit with them of fissile material surplus to the immediate needs of the operator (*IAEA Statute,* Article XII.A.5, and Rome Treaty, Article 80).

48 For instance, in the case of a power reactor, the plant manager would keep records of the fuel loading and refuelling of the plant, its electrical output and changes in nuclear material and all untoward events at the plant. The manager would have to keep many of these records for safety purposes and for the economic operation of the plant.

49 These reports would cover all movements of and changes in nuclear material at the plant in question and any unusual event.

50 CONGRESS OF THE UNITED STATES, *Review of the International Atomic Policies and Programs of the United States*, p. 733.

51 Ibid., p. 763.

52 *IAEA Statute,* Articles III.B.4-5 and XVI.B.2. See also STOESSINGER, J.G., "The International Atomic Energy Agency: The first phase", *International Organization* **13** 3 (1959) 402.

53 HEWLETT, R.G., HOLL, J.M., *Atoms for Peace and War*, p. 303.

54 CONGRESS OF THE UNITED STATES, *Review of the International Atomic Policies and Programs of the United States*, p. 768.

55 Rule 24 of the Rules of Procedure of the Conference.

56 All proposals for amendment had to be submitted by the end of the eighth working day, i.e. by midnight on 2 October 1956.

57 Article XIV.H of the Statute provides that the decisions of the General Conference on *all financial matters* will require approval by two thirds of those present and voting. The same majority is required for the decisions of the Board on the Agency's budget.

58 BARLOW, A., *The History of the International Atomic Energy Agency* (unpublished thesis), citing GOLDSCHMIDT, B., "The origins of the IAEA", *IAEA Bulletin* **19** 4 (1977) 12–19.

59 It may be argued that the preceding clause ("to apply safeguards, at the request of the parties, to any bilateral or multilateral arrangement...") would give sufficient

authority for the IAEA to apply safeguards to non-nuclear-weapon States party to the NPT. But the clause was designed rather to apply safeguards to bilateral or multilateral supply agreements such as those between the USA and Japan or the USA and EURATOM. It would not provide authority for the IAEA to apply safeguards pursuant to the unilateral voluntary offers of the nuclear weapon States.

60 Much later, at a private luncheon in Vienna, Dr. Heinz Haymerle, then head of the political department in the Austrian Foreign Ministry, gave his reasons why Austria had been so intent on having the IAEA in Vienna. In 1937, he said, Austria had disappeared from the map and no one except Mexico (which refused to recognize the 'Anschluss') had noticed its disappearance. This time, by having an international organization in Vienna, the Austrian Government wanted to ensure that any repetition of its disappearance would be noticed!

61 GOLDSCHMIDT, B., "La France...abandonnée par l'Angleterre, freinée par l'O.T.A.N., contrecarrée par les Etats-Unis et menacée par l'Union sovietique...se retrouvait terriblement seule...[et] le gouvernement Mollet...son hostilité à l'armement atomique...se transforma du jour au lendemain en un intêret certain", *Les Rivalités Atomiques*, pp. 221–222.

62 Pierre Pean quotes Mollet as saying twice "Je leur dois la bombe" and the Chief of the General Staff, Ely, as agreeing "Il faut leur donner cette contrepartie pour assurer leur sécurite. C'est vital" (PEAN, P., *Les Deux Bombes*, Fayard, Paris (1982) 84). In an interview with the London *Sunday Times* on 12 October 1986, Francis Perrin, High Commissioner of the French Commissariat à l'Energie Atomique from 1951 to 1970, is quoted as saying "We wanted to help Israel... We knew the plutonium could be used for a bomb, but we considered also that it could be used for peaceful purposes." The *Sunday Times* report was summarized in *Nucleonics Week*, 16 October 1986.

63 For Guy Mollet's decision to go ahead with the French nuclear weapon programme see Goldschmidt, B., *Les Rivalités Atomiques*, pp. 215–222.

Le Monde writes that the Suez crisis not only accelerated the French programme, but that it also led to a secret agreement with Franz Josef Strauss of the Federal Republic of Germany and subsequently with Italy — for Germany and Italy as well as France to become nuclear weapon powers. Strauss was the second most important figure at that time in Chancellor Konrad Adenauer's cabinet and subsequently Premier of Bavaria and a vigorous opponent of the NPT. ("En Automne 1956, vers l'Europe nucléaire, échaudée par la crise de Suez, la France envisagea très sérieusement, il y a quarante ans, de se doter avec l'Allemagne et l'Italie d'une 'arme nouvelle' ", *Le Monde*, 27–28 October 1996.)

Chapter 4

1957 — THE PREPARATORY COMMISSION AND THE FIRST GENERAL CONFERENCE

An Annex to the Statute provided that a Preparatory Commission (Prepcom) would come into existence on the day the Statute was opened for signature and it laid down the Prepcom's composition and terms of reference. The Prepcom consisted of the representatives of 18 nations: the 12 nations that had met in the Washington group and 6 other States elected by the Statute Conference, a notable addition amongst the latter being Japan.[1] The Prepcom remained in existence until the convening of the first session of the IAEA's General Conference and the selection (by designation and election) of the first Board of Governors.[2] The Executive Director of the Prepcom was an exceptionally able and energetic Swiss diplomat, Paul Jolles, who later rose to one of the highest posts in his country's government.

The Prepcom's main tasks were to: [3]

— Prepare for the first session of the General Conference, propose its draft agenda and rules of procedure;
— Designate the non-elected members of the first Board (13 States at that time);[4]
— Recommend
  - the IAEA's 'Initial Programme' and budget (specifically for 1958) and the structure of its permanent establishment,
  - the location of the IAEA's permanent headquarters,
  - the draft of the agreement establishing the IAEA's legal relationship with its host government,
  - the financing of the IAEA.

— Negotiate a relationship agreement between the IAEA and the United Nations;
— Recommend the contents of the IAEA's relationship agreements with the specialized agencies of the United Nations and other international organizations that had programmes relating to nuclear energy.

The Prepcom's tasks were thus formidable, its staff worked until the small hours seven days a week. For many of its recommendations the staff could draw upon precedents set by the UN and its specialized agencies, such as the scale of contributions by Member States to be used to finance the IAEA's operations, the provisions of the Headquarters Agreement with the Government of Austria, the rules of procedure for the Board and General Conference, the IAEA's relationship with the UN and other international organizations, and its staff and financial regulations. For the Prepcom's most difficult task, drawing up the Initial Programme, what little guidance there was lay in the broadly worded authority given in the Statute itself.

Formally, the Initial Programme was limited to the first full year of the IAEA's work, i.e. 1958, but in practice it provided guidance for several years ahead.[5] The programme document opened with an eloquent and far-sighted introduction by Brian Urquhart, later to become one of the most influential and highly regarded officials of the United Nations.[6] In broad terms the Programme recommended that the IAEA should begin by helping its Member States to determine their needs for nuclear research and for using nuclear techniques and technologies.[7] It laid stress on the need to train personnel of the developing countries in the use of nuclear techniques.

More specifically, the IAEA should:

— (As noted) encourage a special programme of reactor construction to help Member States train staff, begin research and gain experience in reactor development.[8] However, the Initial Programme was fairly realistic about the prospects for nuclear power and assumed that the applications of nuclear science in agriculture, medicine, etc., would at first be the mainstay of the IAEA's technical work.[9]
— Establish internationally accepted standards of nuclear "health and safety", in particular for the safe transport of nuclear materials.[10]
— Promote the exchange of scientific and technical information by a series of scientific conferences, the publication of a bulletin and the creation of a technical library.[11]
— Arrange with Member States for the supply of nuclear materials and prepare for the receipt, storage and distribution of such materials and make similar preparations in regard to services, equipment and facilities made available to the Agency.[12]
— Advise Member States about their training programmes, survey available training facilities, determine the needs of developing countries for trained personnel and help them meet those needs (for instance by providing fellowships), consider taking part in the United Nations

Expanded Programme of Technical Assistance and study the need for regional centres and help to establish such centres.[13]
— Prepare to carry out its statutory responsibilities for nuclear safeguards, and acquire staff, including inspectors, for this purpose.[14]
— Set a 1958 target of $250 000 in voluntary contributions for launching a modest fellowship programme.[15]
— Set a "regular", i.e. assessed budget, of $3 465 000 for 1958.[16]
— Study the needs for a laboratory;[17] this was the only specific reference to the possibility of the IAEA acquiring physical assets.

The FAO and WHO had already established units dealing with the use of nuclear techniques in food and agriculture and medicine, WHO and ILO were concerned about nuclear safety and from 9 to 20 September 1957, just before the first General Conference of the IAEA, UNESCO held the first international conference on the use of radioisotopes.[18] Hence, the Initial Programme's stress on non-power applications of nuclear science and on various aspects of nuclear safety was bound to lead to disputes with some of the specialized agencies.

It had been the understanding of many delegations that the first Director General of the IAEA would be a scientist from a neutral country and the name of Harry Brynielsson, Managing Director of the Swedish Atomic Energy Company (Aktiebolaget Atomenergi), had been widely mentioned.[19] In August 1957, however, an article appeared in *The New York Times* announcing that the USA would propose the appointment of Sterling Cole, Republican Congressman from Painted Post, upper New York State, and influential Chairman of the Joint Committee on Atomic Energy of the US Congress (which had to approve US participation in the IAEA).[20]

In July and August 1957, the Prepcom's staff and national representatives moved to Vienna. The former were given temporary offices in the Musikakademie and worked to the sound of music as students and members of the orchestra practised their notes in adjoining rooms.

The first General Conference

The first session of the IAEA's General Conference took place in the halls of the Konzerthaus from 1 to 23 October 1957. The prevailing mood was a good deal more sombre than four years previously when Eisenhower had launched the idea of an agency. The Hungarian and Suez crises still cast their shadows. There was less assurance about the early use of nuclear energy.[21] US insistence on an American Director General presaged East/West strains and conflicts. Soon after the Conference opened, the Soviet delegate, Professor Vassily Emelyanov, startled the delegates and disconcerted NATO members by announcing the first flight in outer space around the earth — on 4 October 1957 — of a satellite, Sputnik-I or the 'travelling companion'. Sputnik-II followed a month later with a live dog, Laika, on board.[22]

As a gesture to the host country, the Conference invited Austrian President Adolf Schärf to address its opening session and former Austrian Foreign Minister Karl Gruber to preside over it.[23] After sorting out an unforeseen procedural problem,[24] the Conference proceeded to approve all the documents that had been prepared by the Prepcom and endorsed by the Board and to approve Finland's application for membership. The Conference recommended that the Board give priority to nuclear activities of benefit to the developing countries. The Conference also approved the selection of Vienna as the seat of the IAEA, the Agency's relationship agreement with the United Nations[25] and the appointment of Sterling Cole, the Soviets placing on record their preference for a neutral Director General but not insisting on a vote. It appears that in return for expected Soviet concurrence in Cole's appointment, Ambassador Pavel Winkler of Czechoslovakia had been elected as the first Chairman of the Board.

When the Conference opened the IAEA had 54 Member States, of which 52 sent delegations to Vienna. By the Conference's close membership had grown to 59.

The emergence of regional nuclear bodies in Western Europe

The European Atomic Energy Community (EURATOM)

While the IAEA Statute was gathering the ratifications needed to bring it into force, two new regional nuclear agencies, EURATOM and the European Nuclear Energy Agency (ENEA), were emerging in Western Europe. In some crucial respects they were likely to compete with the IAEA and with each other.

In July 1952, France, the Federal Republic of Germany, Italy and the three Benelux countries — often referred to as ‘the six’ — established the European Coal and Steel Community (ECSC). On 16 November 1956, at the height of the Suez crisis, the Foreign Ministers of ‘the six’ decided to appoint ‘three wise men’ under the chairmanship of Louis Armand (who was later to serve as first President of the EURATOM Commission) to set a target for the ECSC’s production of nuclear electricity. Their report, published in May 1957, recommended a target for ‘the six’ of 15 000 MW(e) of installed nuclear power by 1967.

On 25 March 1957, ‘the six‘ signed the ‘Rome treaties’ establishing EURATOM and the European Economic Community or ‘Common Market’. The treaties entered into force on 1 January 1958. In August 1958, the US Congress approved an ambitious US/EURATOM programme for building nuclear power plants in ‘the six’ under which the USA would supply enriched fuel, guarantee fuel fabrication and ‘fuel life’ and provide a market for plutonium.[26] During this period ‘the six ‘and EURATOM also negotiated an agreement for nuclear co-operation with the USA under which EURATOM would apply its safeguards to nuclear material and equipment supplied by the USA. Amongst its other consequences the US/EURATOM agreement would have the effect of severely limiting the potential scope of IAEA safeguards.[27]

The European Nuclear Energy Agency

The Organization for European Economic Co-operation (OEEC) was established on 16 April 1948. Its chief purpose was to channel US aid under the Marshall Plan to the 16 Western European nations that had indicated their willingness to take part in a programme of common action to bring about economic recovery.[28] The OEEC was a much looser and larger association of Western European nations than the Common Market, which it predated by some eight years.

In 1955, the OEEC agreed to establish a Commission for Energy and to explore the possibilities of co-operation in nuclear energy. On 18 July 1956, the Council of Ministers of the OEEC decided to set up a Steering Committee for Nuclear Energy to study the possibility of launching joint undertakings for the production and use of nuclear energy and to draw up an international security control (i.e. safeguards) system, chiefly to ensure that such joint undertakings “shall not further any military purpose”.[29]

On 20 December 1956, and on the recommendation of the Steering Committee, the Ministerial Council approved the creation of a:

— European Nuclear Energy Agency (ENEA),[30]
— Security control system,
— European reprocessing plant (EUROCHEMIC) as a joint undertaking.

The Council also approved preliminary ENEA activities in third party liability and, in particular, nuclear safety.

In June 1950, the USA and Canada had accepted an invitation "to associate themselves informally with the OEEC" and to attend its meetings.[31] In the years that followed, the USA gave its full support to the initiatives taken by the OEEC including those in the field of nuclear energy and subsequently the USA and Canada became full members of the organization. As its membership thus expanded to include non-European nations the OEEC changed its name to the Organisation for Economic Co-operation and Development (OECD).

Construction of EUROCHEMIC was completed (at Mol in Belgium) in 1960 and the EUROCHEMIC company operated until 1990.[32] The USA provided much help in the design and construction of the plant, including technical reports, long term secondment of US experts and visits of European scientists to US reprocessing plants.[33]

In 1958 and 1959, ENEA launched two further joint undertakings, a boiling heavy water research reactor at Halden in Norway (which reached criticality in June 1959) and the Dragon high temperature gas cooled reactor at Winfrith Heath in the United Kingdom.[34]

Despite considerable effort to reach agreement on projects to build a nuclear powered merchant ship and a high flux reactor, ENEA was unable to launch any further joint undertakings. It was more successful in preparing a 'Convention on Third Party Liability', on which it began work in 1958. Programmes of work were also begun on nuclear safety, radiation protection and the economic aspects of nuclear power. In 1960, it moved into a new field by establishing a study group on food irradiation. The question of the IAEA's relationship with the ENEA was raised in the Board almost immediately after the ENEA came legally into being on 1 January 1957, but the Board gave precedence to addressing relations with those specialized agencies that were already at work on the applications of nuclear energy that they considered to be within their terms of reference.

Soviet suspicion of EURATOM ensured that the relationship between the IAEA and EURATOM would for many years be cool and distant, and it remained so until after the entry into force of the NPT and the start of negotiations of a safeguards agreement between the two organizations and EURATOM's non-nuclear-weapon States. It was clear, on the other hand, that many of the programmes of the ENEA would overlap with those of the IAEA in Europe unless the two agencies could quickly agree on close co-operation and a sensible division of labour. The IAEA and ENEA soon developed good working relations, jointly sponsoring activities where their work overlapped. A formal agreement for mutual co-operation was negotiated and entered into force on 30 September 1960.[35]

The membership of the ENEA, like that of its parent the OEEC, eventually expanded to include nations outside Europe and similarly required it to drop 'European' from its name and become simply the 'Nuclear Energy Agency (NEA) of the OECD'.[36]

Agreements with other intergovernmental organizations

Optimism about the future of nuclear energy, the need to ensure nuclear safety as well as various political influences led to a proliferation of other regional nuclear energy bodies in the 1950s and 1960s. In Eastern Europe, the Council for Mutual Economic Assistance, better known in the West as COMECON, set up a nuclear unit chiefly in order to ensure uniformity in nuclear safety standards in its member countries.

The Organization of American States similarly established an Inter-American Nuclear Energy Commission (IANEC) with which the IAEA concluded a relationship agreement in 1960.[37] The two agencies occasionally held a joint scientific meeting but IANEC was perennially short of funds and the opportunities for co-operation were few and far between.

In 1964, at a conference in Tokyo, the Chairman of the Pakistan Atomic Energy Commission launched the idea of creating ASIATOM. The only concrete result at that time was that in 1964 the Director General of the IAEA appointed, on an experimental basis, a regional officer based at the headquarters of the UN Economic Commission for Asia and the Far East, in Bangkok.[38]

The IAEA also concluded co-operation agreements with the Organization for African Unity and the League of Arab States.[39]

NOTES

[1] The *IAEA Statute*, Annex I, para. A, names the 12 States (Australia, Belgium, Brazil, Canada, Czechoslovakia, France, India, Portugal, Union of South Africa, the USSR, the United Kingdom and the USA). The Prepcom came into existence on the day that the Statute was opened for signature, i.e. 26 October 1956, and remained in existence until 3 October 1957.

[2] *IAEA Statute*.

[3] *IAEA Statute*, Annex I, para. C.

[4] The Prepcom designated as members of the first Board the 'top five' (Canada, France, the USSR, the United Kingdom and the USA), five States from other regions leading in nuclear technology (Australia, Brazil, India, Japan and South Africa), two producers of uranium (Czechoslovakia and Portugal) and one purveyor of technical assistance (Sweden). (*First Annual Report of the Board of Governors to the General Conference Covering the Period from 23 October 1957 to 30 June 1958*, GC(II)/39, IAEA, Vienna (1958), p. 9, para. 38.)

[5] *Annual Report of the Board of Governors to the General Conference Covering the Period from 1 July 1958 to 30 June 1959*, GC(III)/73, IAEA, Vienna (1959), p. 1, para. 2.

[6] *Report of the Preparatory Commission of the International Atomic Energy Agency*, New York, 1957, document GC/1/1, pp. 3–6.

[7] Ibid., pp. 9–10, paras 26–30.

[8] Ibid., p. 14, para. 51.

[9] Ibid., pp. 11–12, paras 37–41.

[10] Ibid., pp. 22–25, paras 95–100.

[11] Ibid., pp. 18–19, paras 66–68.

[12] Ibid., p. 15, paras 55–56.

[13] Ibid., pp. 20–21, paras 75–79.

[14] Ibid., p. 22, paras 84–85.

[15] Ibid., p. 54.

[16] Ibid., p. 51, and CONGRESS OF THE UNITED STATES, *Background Material for the Review of the International Atomic Policies and Programs of the United States*, Report to the Joint Committee on Atomic Energy, Vol. 3, US Govt Printing Office, Washington, DC (1960) 739–740.

[17] *Report of the Preparatory Commission of the International Atomic Energy Agency*, p. 26, para. 104.

[18] CONGRESS OF THE UNITED STATES, *Review of the International Atomic Policies and Programs of the United States*, p. 776.

[19] ALLARDICE, C., TRAPNELL, E.R., *The Atomic Energy Commission*, Praeger, New York (1974) 204.

[20] The USA had formally raised the issue of Cole's appointment with Emelyanov in June 1957, but there had been some haggling with the USSR about the posts that it would get in the IAEA in return for agreeing to a US Director General (HEWLETT, R.G., HOLL, J.M., *Atoms for Peace and War: 1953–1961, Eisenhower and the Atomic Energy Commission*, University of California Press, Berkeley, CA (1989) 437).

[21] HEWLETT, R.G., HOLL, J.M., ibid., p. 435.

[22] HEWLETT, R.G., HOLL, J.M., ibid., p. 464.

[23] The delegations and the Secretariat were overwhelmed by the generous hospitality of the Austrian Government and the City of Vienna. This included a ball at the Schönbrunn Palace and a special performance of the 'Marriage of Figaro' at the Redoutensaal (with a cast that included Elizabeth Schwartzkopf and Lisa della Casa) offered by the Government and a ball at the Rathaus offered by the City of Vienna.

[24] In preparing for the Conference, the Secretariat had faced an unforeseen procedural problem. As noted, the Statute prescribes that the Board of Governors must draw up and submit the IAEA's budget to the General Conference for its approval and that similar procedures must be followed in regard to the relationship agreement with the United Nations, the appointment of the Director General and applications for membership. But according to the Statute there could be no Board of Governors until the General Conference, meeting in a regular annual session, had chosen the Board's elected members (under the Annex to the Statute the *designated* members of the first Board had been appointed by the Prepcom). The only procedure consistent with the Statute was, therefore, to hold a brief 'regular session' of the General Conference to elect the missing members of the Board, convene the Board itself to endorse the budget, approve the relationship agreement with the United Nations and other documents prepared by the Prepcom, recommend Finland for membership and then reconvene the General Conference in 'special session' to take action on the recommendations of the Board. The IAEA/United Nations relationship agreement entered into force on 17 November 1957.

[25] For these and other actions of the Conference, see *First Annual Report of the Board of Governors to the General Conference Covering the Period from 23 October 1957 to 30 June 1958*, pp. 2 and 43. On the initiative of the USA the second General Conference approved a resolution calling upon the IAEA to submit an annual report to ECOSOC as well as to the General Assembly (*Annual Report of the Board of Governors to the General Conference Covering the Period from 1 July 1958 to 30 June 1959*, p. 9, para. 41).

[26] CONGRESS OF THE UNITED STATES, *Review of the International Atomic Policies and Programs of the United States*, p. 809.

[27] As will be seen in Chapter 8, the safeguards of EURATOM embodied in the "Treaty Establishing the European Atomic Energy Community", Articles 77–81, closely resembled those in the IAEA Statute and in the OEEC Security Control Convention. This was chiefly for the simple reason that to obtain nuclear supplies from the USA, European safeguards had to be compatible with and closely resemble those that the USA was applying under its bilateral agreements for co-operation in the peaceful uses of atomic energy.

[28] CONGRESS OF THE UNITED STATES, *Review of the International Atomic Policies and Programs of the United States*, pp. 788–793.

[29] ENEA's safeguards are set forth in Articles 3–5 of the 'Convention on the Establishment of a Security Control in the Field of Nuclear Energy'. For the full text of the Convention, see MARKS, H.S. (Ed.), *Progress in Nuclear Energy*, Series X, Law and Administration, Pergamon Press, London (1959) 909–914. See also CONGRESS OF THE UNITED STATES, *Review of the International Atomic Policies and Programs of the United States*, p. 793.

[30] The "European Nuclear Energy Agency of the Organization for European Economic Cooperation" (OEEC) came into existence on 1 January 1958; CONGRESS OF THE UNITED STATES, *Review of the International Atomic Policies and Programs of the United States*, p. 788.

[31] Ibid., p. 788.

[32] NUCLEAR ENERGY AGENCY OF THE OECD, *History of the EUROCHEMIC Company 1956–1990,* OECD, Paris (1996), reviewed in *Enerpresse* No. 6729 (24 December 1996).

[33] CONGRESS OF THE UNITED STATES, *Review of the International Atomic Policies and Programs of the United States*, p. 794.

[34] Ibid., p. 795.

[35] *Agreements Registered with the International Atomic Energy Agency*, 11th edn, Legal Series No. 3, IAEA, Vienna (1994) 11.

[36] The USA and Canada became associate and subsequently full members of the ENEA. Japan, Australia, the Republic of Korea and Mexico eventually joined the NEA. In 1996, the first countries from the former Warsaw Pact, the Czech Republic and Hungary, were approved for membership. (See NEA Communiqués of 26 May 1994 and NEA/COM (96)12 of 27 June 1996.)

[37] *Agreements Registered with the International Atomic Energy Agency*, p. 12.

[38] *Annual Report of the Board of Governors to the General Conference 1 July 1963–30 June 1964,* GC(VIII)/270, IAEA, Vienna (1964), p. 34, para. 158. As Tadeusz Wojcik mentions in his essay in *Personal Reflections*, the experiment was not a success and the appointment was terminated in 1971. However, in 1996 the Philippines raised

the idea again at conferences in Tokyo and at the Third ASEAN Regional Forum in Jakarta (letter of 2 August 1996 from Ambassador Zaide of the Philippines in Vienna to Director General Hans Blix).

[39] The agreement with the League of Arab States came into force on 15 December 1971 (*Agreements Registered with the International Atomic Energy Agency*, p. 111).

PART II

1957–1997: THE IAEA IN OPERATION

Chapter 5

A CHANGING POLITICAL AND TECHNICAL ENVIRONMENT

1957–1961: A difficult start

After the first General Conference had closed its doors, the Agency began to tackle the task of establishing a new international organization in a city that still bore the scars of war and of its ten year occupation by the four Allied powers (France, the USSR, the United Kingdom and the USA). It was said that in 1945 Hitler had ordered a last stand in Vienna against the advancing Red Army. Many buildings along the Danube Canal, the last barrier before the heart of the city, were in ruins. Allied air raids had brought down the roofs of St. Stephan's Cathedral and of the Opera, but one of the first acts of the Austrian Government after the war was to restore both buildings to their pre-war splendour. Elsewhere, vacant lots showed where heavily damaged buildings had been demolished. Rubble still blocked parts of the city's main street (Kärntnerstrasse). Unlike New York and Geneva, untouched by the war, where all municipal facilities were fully functional, Vienna was just emerging from its tribulations. Except for its extensive but slow and noisy tram car network, communications were poor. Most buildings were badly heated and dimly lit. Many Viennese were still poor and shabby, motorcars were few and far between, electric goods and other 'luxuries' even scarcer. Austria, and particularly its eastern parts, had been isolated by war and occupation, few Viennese had travelled abroad for business or pleasure since 1939 and there was a sense of intellectual isolation. There was also some resentment against the new colony of rich foreigners, enjoying their duty-free commissary and extensive diplomatic privileges, relatively few of whom could speak German; a colony that was seen by some Viennese as a successor to the Allied occupation.

In 'The Third Man', Orson Welles had depicted the more seamy aspects of Vienna at the end of the 1940s. By the time the Prepcom arrived the black market of the early post-war years had largely disappeared — gone with the occupation — but Vienna remained a useful base for espionage for both NATO and the Warsaw Pact, and the IAEA Secretariat and delegations to the Agency were believed to harbour several secret service agents.

The IAEA's first tasks were to recruit qualified staff for the posts foreseen in the 1958 programme, and find a building to house the Secretariat and provide a meeting room for the Board of Governors. The Austrian Government offered several choices as temporary headquarters for the Secretariat until such time as the IAEA would build its permanent home. The temporary offers included a former hospital (Spital der Kaufmannschaft), a half-ruined castle (Schloss Kobenzl or Kobenzlhof) in the Vienna Woods above Grinzing, various government and private buildings,[1] and the empty Grand Hotel, a splendid example of 'Ring style' ('Gründer' style) late Victorian architecture which had been used by the Red Army until the end of the four power occupation in 1955. All except the Grand Hotel were too small or too remote from the centre of Vienna. On behalf of the IAEA, Paul Jolles chose the hotel, conveniently situated on the Ring and providing ample accommodation, including an area that could later be converted into the meeting room for the Board.[2]

United Nations rates of pay were very attractive and there was no difficulty in recruiting local staff. Dr. Karl Gruber, the President of the first session of the General Conference, was attached to the Director General's office with the task of helping the IAEA to fit into Austria, or, as the wits had it, helping Austria to fit into the IAEA.

Many Member States maintained continuity with the past by appointing as Governors on the Board or Resident Representatives the persons who had represented them at the Washington talks and the Statute Conference and on the Prepcom. Their familiarity with the evolution of the IAEA and the issues before it enabled them to play a leading role during the early years of the Agency and in some cases even for a decade or two later. By far the most influential, until he retired in the late 1970s, was the Governor from France, Bertrand Goldschmidt, Director of External Relations at the Commissariat à l'Energie Atomique. Goldschmidt had worked with the Curies before the war and with the British team in Canada on the fringes of the Manhattan Project, and on his return to France he helped to launch and direct the French nuclear energy programme. At the end of Sterling Cole's term, Goldschmidt worked hard to secure the appointment of Sigvard Eklund of Sweden as the second Director General, and during his 20 years in office Eklund frequently turned to Goldschmidt for advice. When Goldschmidt's retirement was in sight at the end of the 1970s the Board of Governors waived its informal rule that no representative of a nuclear weapon State could serve as its chairman and unanimously elected him to that post.[3]

Others who played a prominent role included Vassily Emelyanov of the USSR, who skilfully defended many difficult briefs, Pavel Winkler, Czechoslovak representative at the Washington talks, the Statute Conference and the Prepcom and the formidably skilful first Chairman of the Board, Michael Michaels of the United Kingdom, hard headed and caustic spokesman for the main Western policies, the forceful and gifted Homi Bhabha of India, Donald Sole of South Africa, whose good sense and intellectual acuity led to his election as third Chairman of the Board despite his nationality, Ismael Fahmy of the United Arab Republic — now Egypt — whose determination persuaded reluctant Western Governors to agree to establish the first IAEA sponsored regional centre in Cairo, and 'Biggy' Keenan, the Resident Representative of Israel who, though not a Governor, seemed to know better than anyone else what was going on in the IAEA and skilfully defended Israel's interests.

Nearly all the Governors had taken part in the Washington talks and the New York Conference on the Statute. The USA broke ranks by appointing as Governor Robert McKinney, a publisher from New Mexico who had had no prior association with the IAEA but who was known as a strong supporter of nuclear power and who had served as chairman of a Congressional panel on the impact of the peaceful uses of atomic energy.[4] McKinney's successor in 1959 was Paul F. Foster, former General Manager of the US Atomic Energy Commission (USAEC) and before that a distinguished Admiral, twice winner of the Congressional Medal of Honor, the highest American award for bravery, who seemed more accustomed, as Jolles once said, to giving commands than to negotiating compromises.

The news media usually ignored the existence of the IAEA. However, one appointment to the Agency caught their attention for a brief period, namely that of Vyacheslav Molotov as Soviet Ambassador and Resident Representative to the Agency. Molotov had been Stalin's Foreign Minister who subsequently appointed him Prime Minister of the Soviet Union.

Molotov arrived in Vienna in 1960 and returned to Moscow some 18 months later. He had served for three years as Ambassador to Outer Mongolia and had asked Khrushchev for a transfer to a European capital. Khrushchev, who did not want Molotov back in Moscow, readily agreed. The Soviet Foreign Ministry had informally proposed to the Netherlands that Molotov be appointed Ambassador in The Hague, but the Netherlands Government had refused to give their *agrément*; hence the posting to the IAEA, where no *agrément* had to be sought.[5]

The Board and the Director General at odds

From February 1955 until October 1957 there had been noteworthy co-operation between leading governments in creating the Agency and drawing up its Initial Programme — in the eight- and then in the twelve-nation negotiating group, in the Statute Conference and in the Prepcom. Wide differences of perception of the Agency's mandate now began to emerge, and they were exacerbated by renewed and growing East/West tensions. It was soon obvious that the path of the Board would not be smooth. Ralph Bunche, the well known and highly regarded Under Secretary General of the United Nations, who represented the UN at the IAEA on a number of occasions, remarked that the Cold War raged more violently in the IAEA Board than in the UN itself.

One reason was the US decision to impose an American Director General on the IAEA despite Soviet objections, and Soviet concern that the IAEA would be run as an instrument of US policy. Cole's own idiosyncrasies did not make his task any easier. Given the authority he had possessed as Chairman of the Joint Committee of the US Congress on Atomic Energy, it was perhaps natural that he should regard himself as a leader rather than a servant of the IAEA's Member States. He had little direct experience in administration or diplomacy, he was impatient of protocol and diplomatic conventions, a trait that did not always endear him to the ambassadors with whom he had to deal, and he sometimes had difficulty in selecting the right issues on which to make a stand. He was not popular with economy minded Western European delegations, who were annoyed by US insistence that he should receive a salary and perquisites second only to those of the Secretary General of the United Nations and were alarmed by his penchant for launching, or trying to launch, what they regarded as costly projects that had little to do with the mandate of the IAEA.[6] The heads or representatives of European nuclear energy agencies also held against him his ignorance of nuclear science.

Nonetheless, Cole's many years in Congress as Chairman of the powerful Joint Committee had given him considerable insight into the international politics of nuclear energy. Moreover, no other appointment "could provide so much assurance of Congressional support during the first critical years of the agency."[7] And he was not in the least a tool of Washington. For instance, he was highly critical of the numerous agreements that the USA concluded in the late 1950s for providing bilateral nuclear aid to friendly countries and thereby undercutting what was supposed to be one of the IAEA's chief functions, and he demanded a change in US policy.[8] His nickname, 'Stub' (believed to stand for stubborn), suggested a determined and aggressive character and he showed his indifference to the policies of his own Republican Administration by inviting Robert Oppenheimer to visit the IAEA, despite the fact that the USAEC, influenced by Senator McCarthy and the prevailing virulent anti-communism, had suspended Oppenheimer's security clearance. To Cole's credit he also succeeded in building up the IAEA's establishment, surmounting resistance by Western and Eastern European members of the Board. He tried hard to bring IAEA safeguards into operation and he fought with the US Administration (and lost) on the issue of IAEA versus EURATOM safeguards described in Chapter 8.[9]

Cole was unlucky in his timing. The unanimous agreement on the IAEA's Statute on 23 October 1956 was one of the many products of the relative international calm that had followed the death of Stalin and the armistice in Korea. A few days later, the invasions of Suez and Hungary shattered this calm. In late 1957, the launching of Sputnik led many in the USA to fear that the Soviet Union was winning the battle of advanced technology (in fact the USSR remained essentially defenceless against a US air attack until the end of the 1950s[10]). In 1958–1959, the Berlin crisis erupted and in May 1960 the Soviet Union shot down the U-2 'spy plane'. In April 1961, the USA suffered a humiliating fiasco at the Bay of Pigs in Cuba, and in August 1961 another crisis erupted when East Germany began building the Berlin Wall. These events reflected deteriorating East/West relations and cast their shadow on the proceedings of the IAEA's Governing Bodies.

It was also becoming abundantly clear that the idea of the IAEA serving as a nuclear material 'bank' or 'pool' for the supply of such materials would not work.[11] Under Articles IX.C and F of the Statute, each Member State was to notify the IAEA in a timely manner of the nuclear materials it was prepared to make available. At the request of the IAEA the State would, without delay, deliver specified material to another member or to the IAEA. As soon as it could do so the Secretariat diligently asked all Member States known to be producers of fissile or source material about the amount and composition of the materials they would put at the IAEA's disposal. As noted above, the USA had already declared that it would make available 5000 kg of contained uranium-235 and would match the amounts that other States made available before 1 July 1960, the USSR had pledged up to 50 kg and the United Kingdom 20 kg. Some other States (Canada, India, Portugal, South Africa and Sri Lanka) responded with offers of source material.[12] But with some minute exceptions none of this material was physically transferred to Vienna, the IAEA never felt the need to acquire facilities for storing nuclear material, and no guards were recruited.[13]

When, from time to time, a Member State would ask the IAEA to arrange for the supply of a research reactor and its fuel, or several years later, when, as we have noted, Mexico and Yugoslavia asked the IAEA for the same service in procuring power reactors, the IAEA played the role of broker between governments rather than that of the primary supplier foreseen in the Statute. But even the IAEA's brokering role came to little. In part, this was because nuclear power took off much more slowly than expected,[14] but also because it was simpler, quicker and no more costly for the importer to deal directly with the supplier. In the Mexican and Yugoslav cases the States preferred, probably for political reasons, not to buy direct from a superpower, but rather to resort to the legal fiction of obtaining US made plants from the IAEA.

Under Article XIV.F, any profits ("excess of revenues") the IAEA made from its role of nuclear supplier or broker and any voluntary contributions it received were to be placed in a "General Fund". This was to be used as the Board and General Conference decided (Articles XIV.E and F). There was, however, no occasion for the IAEA to levy charges for nuclear services, and the IAEA failed to earn any excess revenues from this source. Hence the IAEA made no attempt to prepare the scale of charges that it was enjoined to draw up. But the General Fund was established and voluntary contributions were sought, firstly to meet the cost of the fellowships that the Prepcom had included in the 1958 budget. Such voluntary contributions were to become the main continuing source of cash for the IAEA's technical assistance programme.

However, in the late 1950s and early 1960s it was not the failure of the IAEA's functions as a 'pool' or 'bank' or supplier of nuclear material that inflicted the most serious blow on the organization, on its safeguards operation and eventually on Cole himself. For a variety of reasons, the Agency's chief patron, the USA, chose to arrange nuclear supplies bilaterally rather than through the IAEA. One reason was that the IAEA had been unable to develop an effective safeguards system. Another was that in a bilateral arrangement it was the US Administration, under the watchful eyes of Congress, that chose the bilateral partner rather than leaving the choice to an international organization that would have to respond to the needs of any Member State whatever its political system, persuasion or alliance. But the most serious setback came in 1958 when, for overriding political reasons, the

USA chose the bilateral route in accepting the safeguards of EURATOM as equivalent to — in other words as an acceptable substitute for — those of the IAEA. The far-reaching implications of this decision will be explored later.

When Cole arrived in Vienna on 4 December 1956 to take up his four year appointment, Paul Jolles still controlled virtually all the Secretariat. He continued to be in charge of all non-technical operations until his departure in 1961[15] and he also kept his hand firmly on the most rapidly growing programme of the Agency, namely, technical assistance.[16] It was probably inevitable that relations between the former master of the IAEA, still on the bridge, and the new captain would not be easy, but the strain in their relations was sharpened by differences in temperament. Jolles was a cool-headed, experienced and polyglot diplomat, enjoying the respect and confidence of his colleagues, while Cole was a blunt, no-nonsense, monolingual politician. Sensing the strain, Brian Urquhart, who had been Jolles' second in command in the Prepcom secretariat, decided to return to New York.

It was also soon obvious that certain members of the Board of Governors and, indeed, the Chairman himself wanted to keep the American Director General on a very short leash and to remind him that he was "under the authority of and subject to the control of the Board of Governors" (Article VII.B of the IAEA Statute). For instance, in June 1958 the Board decided that the Director General should submit a written report every two months "on all major developments in the Agency's work" (in effect, in the Secretariat's work), an uncongenial task since there was still very little to report.[17] The delegations of Czechoslovakia, India, Egypt and some other members of the Board, referring to another phrase in Article VII.B of the Statute requiring the Director General to "perform his duties in accordance with regulations adopted by the Board," proposed that the Board should set about drafting a compendium of such regulations. After prolonged discussions the majority of Governors concluded that what the Statute had in mind were the staff regulations, financial and other standing regulations of the Agency and not a set of rules uniquely designed to govern the conduct of Mr. Cole!

During the first few years hardly any matter could be discussed without provoking lengthy, ideologically tinged, arguments. On the proposal of several Western delegations, but against the spirited opposition of India and the Soviet Union and its allies, it was decided that the Board should normally meet in private and that its records should be classified. The minority argued that this lack of what would now be called transparency, was undemocratic and contrary to the practice of the United Nations and most of its agencies.

On the second point they were certainly correct. On the other hand, meeting behind closed doors eventually helped the Board to shorten its sessions and to develop into an effective executive body in which decisions were taken reasonably promptly without too many 'grandstanding' statements designed to win public support rather than to contribute to a serious debate.

Another apparently innocuous issue was the granting of 'consultative status' to non-governmental organizations (NGOs). Such status would give these organizations the right to be represented at certain meetings of the Agency and bring their views to the IAEA's attention. The United Nations Economic and Social Council had drawn up complex rules to govern the grant of such status to NGOs interested in its work. In response to a US proposal at the first General Conference, the Secretariat drew up a simpler scheme to enable it to tap the expertise of bodies such as the International Commission on Radiological Protection, the first body to set internationally accepted limits to radiation exposure, while keeping out organizations with only a politically partisan axe to grind. The Board approved the rules and granted consultative status to 19 organizations, including the International Confederation of Free Trade Unions and the International Federation of Christian Trade Unions, both of which proclaimed an interest in protecting workers against radiation exposure.

Trouble began in early 1959 when the Board received an application by another international labour organization, the World Federation of Scientific Workers (WFSW), a body that the USA and some other Western countries regarded as a mouthpiece of the extreme Left. It was said that the WFSW had accused the USA of dropping poisoned flies on North Korea during the Korean War (a charge first levelled by Yakov Malik, Soviet delegate at the United Nations Disarmament Commission in March 1952).[18] After the majority of Governors had rejected the application by the WFSW, the Soviet Union and other Warsaw Pact countries successfully blocked all further grants of consultative status. After nearly two years of argument the impasse was eventually solved by a tacit agreement to abandon the entire procedure for granting such status.[19]

A heated discussion also flared up on the issue of whether to invite EURATOM to send an observer to the second General Conference, the Soviet Union contending that " ...no argument could cancel the military character of EURATOM..." By a vote of 15 to 3 the Board decided to issue the invitation.[20] And although the creation of the Division of Safeguards had been approved by the General Conference when it adopted the Agency's 'Initial Programme', the Board held no less than 25 meetings on the issue of whether to recruit the first staff for the Division. When one reads the records of the first Board, Cole's impatience with the way in which it sought to micromanage the IAEA becomes more understandable. The continuing and often barren polemics in the Board caused it to hold 84 meetings between October 1957 and the end of June 1958 and 72 during the next 12 months.[21]

Nonetheless, a good deal was achieved. By early summer 1958, the IAEA had appointed all its key staff. To help the Agency get down to work the USA offered the services of 20–30 consultants, $125 000 towards a fellowship fund, a radioisotope laboratory as well as two mobile laboratories and a small reactor (the latter offer was not taken up).[22] In 1958, 13 Member States offered a total of 140 subsidized or fully paid fellowships.[23] By September 1958, when the second session of the General Conference opened, almost all technical programmes were at least nominally under way and co-operation agreements were in force or awaiting formal approval with the FAO, WHO, UNESCO, WMO and ILO and the UN Expanded Programme of Technical Assistance (EPTA).[24]

From 1 to 13 September 1958 the United Nations convened a second and much larger 'Geneva Conference'. As noted in Chapter 6, Sigvard Eklund, the future Director General of the IAEA, served as its Secretary General. The IAEA's contribution was very modest: two technical papers and some scientific staff.[25] The ice had been broken in 1955 and by the time of the second Geneva Conference there was less to disclose and not much left to declassify; the USA and the United Kingdom published for the first time all the results of their research on thermonuclear fusion, a field that had first been brought to the public's attention by the eminent Soviet physicist Igor Kurchatov in a lecture at Harwell two years earlier. In general, the Conference showed that the optimism of the early 1950s about the prospects for cheap nuclear power was beginning to flag.

At the end of 1958, the IAEA established a standing Scientific Advisory Committee (SAC) identical in composition with that appointed by Dag Hammarskjöld to oversee the scientific organization of the 1955 and 1958 Geneva Conferences. SAC was destined to play a large role in running the IAEA's technical programmes until 1988, when it made way for more focused guidance on specific programmes by small specialist advisory groups. Amongst the leading scientists who were members of SAC and thus exercised a powerful influence on the IAEA's earlier programmes were its long-time chairman, W.B. Lewis of Canada, well known for his part in developing the

CANDU reactor, Sir John Cockcroft of the United Kingdom, Isidor Rabi of the USA (Nobel Prize winner in physics and one of the architects of the Manhattan Project), as well as three Governors whose names have already been mentioned — Homi Bhabha of India, Bertrand Goldschmidt of France and Vassily Emelyanov of the Soviet Union, and the energetic and creative Secretary, Henry Seligman (the IAEA's Deputy Director General for Research and Isotopes).

In September 1958, the General Conference decided, despite the hesitations of some Western Europeans and the strong opposition of the USSR, that the IAEA should construct a 'functional' laboratory in Austria. The Board approved the plans for the laboratory in April 1959. It was to be located at Seibersdorf, 33 km southeast of Vienna, and adjacent to the Austrian national nuclear research centre operated by the Studiengesellschaft für Atomenergie which put the laboratory site at the IAEA's disposal for a nominal fee. The USA donated $600 000, thus matching the amounts set aside in the IAEA's 1959 and 1960 budgets to build and equip the laboratory.[26] The headquarters laboratory and its successor at Seibersdorf also received numerous gifts of equipment from other Member States.

The tasks that the laboratory undertook in its early years included:

— Analyses of samples contaminated by radioactive fallout from the testing of nuclear weapons,
— Preparation of international radioactive standards,
— Calibration of equipment for measuring radioactivity,
— Quality control of special materials used in nuclear technology,
— Measurements and analyses in support of the IAEA's health and safety and safeguards work,
— Services to Member States using the facilities installed to carry out the foregoing tasks.[27]

The Seibersdorf laboratory came into operation in 1961 and in January 1962 it distributed its first set of radioactive samples to other laboratories and to hospitals and clinics in Member States to enable them to calibrate their radiation measuring instruments.[28]

The IAEA and the banning of nuclear tests

During the late 1950s there was mounting pressure by the general public and by many scientists for a total stop to nuclear testing. Concern focused especially on the bone seeking radioisotope strontium-90, which nuclear tests injected into the atmosphere and which eventually found its way into the food chain. Since strontium-90 partially replaces calcium in milk, it was seen as a potential cause of childhood cancers.[29] The tragic fate of the crew of the Japanese fishing boat *Lucky Dragon*, victims of fallout from the 'Bravo' test of a hydrogen bomb on 1 March 1954 on Bikini Atoll, was perceived as a dramatic demonstration of the dangers of continued testing.[30] Later that year, at the tenth session of the United Nations General Assembly, India called for an immediate suspension of all nuclear tests.[31] Throughout the mid-1950s, testing remained a subject of sharp international debate and a political issue in the USA itself which, after much internal discussion, declared an unlimited moratorium on nuclear tests on 31 October 1958 (the Soviet Union had already announced a moratorium more than half a year earlier, in March 1958).

In July 1958, in one of the most important developments in post-war arms control, the Soviet Union and the West undertook the task of drawing up a treaty banning all tests. From 1 July 1958 to 21 August 1958, a conference of experts from eight nations met in Geneva to discuss the feasibility of detecting underground tests.[32] In a precursor of discussions that were to take place nearly forty years later they proposed an extensive land and ship based monitoring system and the use of weather reconnaissance aircraft to sample the air for radioactivity. They also proposed the creation of an 'international control organ' as one of the steps needed to launch and support the system.

It appeared that the IAEA was the logical organization to verify a commitment to stop testing — "to assume the inspection function. It was the only global atomic authority in existence." Its Statute endorsed the principle of international inspection. It had safeguards personnel ready to go into action. The developing countries would "welcome an opportunity to subject the nuclear powers to a form of reciprocal control" and "the cost of setting up an entirely new organ would involve a great deal of wasteful duplication."

However, it was not to be. In the 1960s, the Western nations and particularly the USA were insistent that the IAEA should concern itself only with peaceful nuclear activities and verification of a ban on testing was not, in their view, a peaceful activity.[33]

For reasons that have not been very well articulated but are obviously not the same as those put forward by the West in 1958, the negotiators of the Comprehensive Test Ban Treaty (CTBT) approved by the United Nations General Assembly in 1996 decided not to entrust the IAEA with the task of verifying the Treaty.[34] However, the Treaty does enjoin close co-operation between the organization to be set up to oversee the execution of the Treaty (the CTBTO) and thus holds out the possibility of a close IAEA/CTBTO working relationship.[35]

The first safeguards

Despite the resistance of the Soviet Union and several developing countries, led by India, the Western members of the Board were able in 1959 to get the IAEA's safeguards operation under way on a small and hesitant scale — the application of safeguards to the three tons of natural uranium that Canada had supplied to Japan. In 1961, after much debate, the Board approved the first rudimentary safeguards system for research reactors, i.e. reactors not larger than 100 MW(th). The evolution of the system is discussed in greater detail in Chapter 8.

Policy formation

We have seen that under the IAEA's Statute, most major political and administrative decisions are to be taken by the Board or jointly by the Board and the General Conference. In 1959, the Board established standing committees on the budget and programme and on technical assistance, and short lived ad hoc committees on subjects such as nuclear supplies, negotiations with the specialized agencies, permanent headquarters and non-governmental organizations. Since 1959, the Board has not established any new standing committees to provide it with expert advice.[36]

Member States, especially the major powers, exert a decisive influence over the IAEA's policies and actions, especially where politics are concerned. They do this collectively at the meetings of the Board and the General Conference and their committees and even more effectively in daily individual contacts with the Director General and his staff. Ironically, there is no area in which this was done more persistently than in the one that the Statute explicitly stipulates as the exclusive preserve of the Director General, namely the appointment of staff. Almost from his first day in office Cole was put under pressure by Member States to appoint their own citizens and by developing Member States to increase the proportion of staff, especially senior staff, from their own group of countries. For all senior appointments (Deputy and Assistant Directors General and Directors of Divisions) the Board required the Director General to consult it before making a formal appointment.

As the Statute requires, the Board submits the IAEA's budget and annual report to the General Conference, but in practice it does so on the basis of drafts prepared by the Secretariat, normally in informal consultations with the members of the Board, who indicate what scope of activities and expenditures the Board will accept (almost invariably less than those originally proposed by the Secretariat).

The 'Initial Report' of the Prepcom formed the basis of the IAEA's first technical programmes, but a pattern soon emerged for their further development. The Secretariat would prepare proposals for a particular technical activity or project, such as a set of international safety codes. The Director General, on the advice of the technical Department or Division concerned, would appoint a group of experts, usually after consulting the Member States from which the experts were to be drawn, to study and discuss the Secretariat's proposals. The results of this process would be incorporated in the programme and budget that the Director General would submit to the Board. SAC would also review annually the scientific programme of each Department and, in particular, proposals for scientific meetings and for the support of research. In due course the Director General appointed standing technical committees to monitor particular aspects of the programme (e.g. safety standards, guides and manuals, nuclear waste management, safeguards and technical co-operation). Eventually, as we have noted, these specialist groups and ad hoc meetings of senior experts replaced SAC itself when the appointments of its members expired in September 1988.

In this way the Secretariat came to take the initiative for most of the IAEA's technical work. But Member States frequently came forward with their own proposals, during the meetings of the Board or the General Conference, in technical committees or in discussions with the Secretariat. Although most committees are nominally *advisory* to the Director General, the reality is that they were chosen by him with the object of securing recommendations that were likely to influence the views of governments rather than his own views. The Board also established special committees of representatives of Member States to draw up major policy documents such as the safeguards systems of the 1960s and of 1970–1971 (for the NPT).

While, according to the Statute, the Director General is "under the authority of and subject to the control of the Board" he has become not only the IAEA's "chief administrative officer" as the Statute puts it, but in effect the IAEA's chief executive.

An able Director General has great power to influence the course steered by an international body like the IAEA. His ability to guide policy decisions usually increases with length of service; delegates come and go, he usually stays. The Director General can be most effective when determining the organization's response to an emergency and least influential where a group of leading countries decides on a hard and inflexible line, for instance when the leading donor countries collectively decide that there will be no growth in the organization's budget.

The election of a new Director General

By the time Cole's term of office neared its end the IAEA was helping several developing countries to use isotope and radiation techniques and was doing useful work on nuclear safety and in promoting the exchange of nuclear information. But, partly because of the USA's own actions, none of the three main functions (nuclear supplier, guardian of the peaceful use of nuclear energy, nuclear power promoter) that Eisenhower had foreseen for the IAEA had borne fruit. By vigorously promoting numerous bilateral co-operation agreements, the USA had bypassed the organization that it had done so much to create, and by accepting EURATOM safeguards it had excluded the IAEA from the region of the world where, other than in the USA itself, nuclear power seemed most likely to flourish. Even the IAEA's role as the international clearing house for nuclear information was partly pre-empted by the United Nations when, on the proposal of the USA, it convened the first and second Geneva Conferences.

To some observers the IAEA seemed to have become little more than a means of meeting certain rather low priority needs of the more technically sophisticated developing countries, and even here it faced competition from established United Nations agencies. It was asked whether it had really been sensible to set up an elaborate new international body chiefly to provide services that existing agencies were capable of offering and, in some cases, had already begun to provide. The only faint sign that better days might be in store was that the IAEA now had a rudimentary safeguards and inspection system, that one State, Japan, had brought IAEA safeguards into operation, and that one or two others might soon follow suit.

In June 1961, the main item on the Board's agenda was the appointment of the Director General. As an American, Cole could hardly expect Soviet support, as a former Republican congressman he could not expect political support from the Kennedy Administration, nor was he popular with the Western Europeans. Jolles, highly regarded by all political groups, might have been a non-contentious choice as Cole's successor, but he had accepted a senior position in the Swiss Government.

The USA decided that this time it would be best to follow the plan that had been informally agreed and then abandoned in 1957 and select a neutral scientist as Director General. With strong support from the West the USA pressed for the appointment of Sigvard Eklund, who was highly regarded by the European nuclear establishment and who had served with distinction as Secretary General of the Second Geneva Conference.

But having acquiesced to an American in 1957, the Soviet Union considered that it was now time for a Socialist Director General. At first, it pressed the idea of a 'Troika' (under a Bulgarian Director General), much like the troika it was proposing to the United Nations in the search for a successor to Dag Hammarskjöld. When that failed the Soviet Union joined a group of African and Asian States in support of the candidacy of the Indonesian Ambassador (Indonesia, under Sukarno, having close ties with Socialist governments). The matter eventually came to a vote in the General Conference, which confirmed the Board's choice of Eklund by a vote of 46 to 16 with 5 abstentions. Emelyanov then walked out of the conference hall, announced that the Soviet Union would have no contact with Eklund, and that he personally would neither speak to him nor answer his letters.

What was the key to this behaviour? By now the Soviets were describing safeguards, the IAEA programme of prime importance to the West, as a spider's web designed by the capitalists to throttle the nuclear progress of the developing countries. It seemed as though the Soviet Union had concluded that the IAEA was of little use to it, except as a political stage on which it could side with the more radical developing countries. Soviet relations with the USA were also reaching their nadir, the worst storm of the Cold War was brewing in the Caribbean, and in this charged atmosphere there was no incentive for the Soviets to support a candidate who enjoyed the favour of the USA.

Whatever the reason for Emelyanov's attack on Eklund, Soviet hostility quickly vanished and in due course the Soviet Union came to value Eklund highly. He had full Soviet support when he was reappointed in 1965 and again in 1969, 1973 and 1977, and the Soviet Union might have backed him for a further term if he had made his services available in 1981 when he retired to become Director General Emeritus of the IAEA.

1961–1981: The IAEA comes of age

During the years 1961 to 1981, all the main programmes of the IAEA reached maturity. At the same time orders for nuclear power plants rose rapidly and then, in the West, began to level off; the nuclear non-proliferation regime was firmly established and began to play an important role in international politics and the flow of assistance to enable developing countries to use nuclear techniques grew from $2 286 000 in 1961 to $24 449 000 in 1981.[37] The same period saw a substantial growth in the IAEA's work relating to nuclear safety.

The appointment of Eklund marked the beginning of a climate change in the affairs and fortunes of the IAEA, but the definitive alteration of course had to wait until 1963, when the Soviet Union spectacularly revised its attitude to IAEA safeguards, a development examined in greater detail in Chapter 8. From the start, safeguards had been one of the main, if not the principal, tasks of the IAEA in the eyes of the USA and of some other Western States. The signal in 1963 that the other superpower, the Soviet Union, had now come to share this perception foreshadowed a major realignment in the policies of the industrialized world as a whole and in the way in which the affairs of the IAEA would be conducted. This led to changes in the pattern of co-operation in other activities of the Agency and helped it to evolve into one of the most effective international organizations. Moreover, for most of the next two decades the lead would be given by Washington and Moscow acting in concert.

In the 1960s, concern grew that nuclear weapons would spread around the world. There were several grounds for apprehension: the Cuban missile crisis; the addition in 1960 and 1964 of two States to the nuclear weapon club; the proposals in NATO for a multilateral nuclear armed force; the half-secret discussions between French, German and Italian politicians suggesting that Germany and Italy might also acquire the bomb,[38] and rumours that Israel was about to do so. President Kennedy spoke of the possibility of 15–25 nuclear weapon States by the mid-1970s, and think-tanks and serious authors, concerned about the fate of mankind, painted similar or even darker pictures. The reaction was a growing determination to halt the spread of nuclear weapons and some confidence that it could be done. It became clear that IAEA safeguards could be a significant part of this effort.

The 1970s also saw a sudden upturn in the prospects for nuclear power characterized by a stream of orders for nuclear power plants, first in North

America, then in Europe and then, more tentatively, in the developing world. In 1964, construction of the first nuclear power reactors in a developing country began at Tarapur and in Rajasthan in India. The improvement in the prospects for nuclear power also brought new opportunities and more work for those units in the IAEA dealing with the major uses of nuclear energy and safety, but it also deepened concern in certain countries about the likelihood of nuclear proliferation.

The 1970s confirmed the role of the IAEA as the chief international instrument for verifying non-proliferation. But several issues had first to be resolved. Would the USA and the USSR and other members of the Eighteen-Nation Disarmament Committee (ENDC) be able to bridge their differences on the need for and the content of a non-proliferation treaty? If so, would the treaty gain enough international support to bring it into force? Would the IAEA be able to agree on a standard safeguards agreement and could it do so in time to enable the parties to comply with the strict timetable set by the treaty? And if so, would the leading industrial non-nuclear-weapon States ratify the treaty and accept these safeguards? Eventually, the answer to all these questions was 'yes'.[39] But in the meantime there had been some severe shocks to the non-proliferation regime.

Eklund changes the IAEA's course

In May 1996, Sigvard Eklund was the keynote speaker at a symposium celebrating the fiftieth anniversary of the Oak Ridge National Laboratory.[40] Alvin Weinberg, for many years the Director of the Laboratory, summed up Eklund's contribution to the IAEA: He was the man who took over the Agency when it was still an experiment of uncertain outcome and turned it into a major force for international security.

Eklund began his long stewardship by changing the Agency's course. Reflecting his personal and professional inclinations, he sought to stress the scientific and technical character of the IAEA's work. He was soon helped in this by U Thant, the new United Nations Secretary General, who did not share his predecessor's interest in nuclear energy and who agreed that the IAEA should have responsibility for the scientific aspects of the 1964 (third) Geneva Conference. In 1964, the Board of Governors also accepted Eklund's proposal to establish a centre for theoretical physics in Trieste[41] and to set up a joint Division with the FAO to promote the use of nuclear techniques in food and agriculture. Other scientific landmarks of Eklund's early years at the IAEA were an agreement with Monaco to extend the duration and scope of the IAEA's laboratory in the Principality, which was studying the effects of radioactivity on life in the sea,[42] and the expansion of the IAEA's laboratory at Seibersdorf. Several able IAEA scientists helped to persuade a hesitant Board to approve these novel international projects, but their success owed much to Eklund's reputation as a prudent and effective manager.[43]

When the occasional political storm blew up or when wide differences emerged about the IAEA's policies and practices, Eklund was often content, at least at first, to leave the issue to be settled by the USA and the USSR, and the political structure of the IAEA in the later 1960s was likened to a superpower condominium. With time and increasing political experience, Eklund's understanding of international politics deepened, his sense of confidence and his command of the IAEA became stronger and the leading members of the Board increasingly sought his advice or mediation.

Eklund also put an end to some wasteful practices that had crept into the IAEA's working habits. He eliminated unnecessary paper, cut down staff travel and attendance at conferences outside Vienna and persuaded the Board to dispense with three of the four annual reports that the Secretariat had been required to prepare and the Board to approve, including the burdensome bimonthly report to the Board and the special annual reports to ECOSOC and the General Assembly.

By 1962–1963 the atmosphere in the Board of Governors had begun to improve. Debates became markedly less confrontational and within a few years the heads of national nuclear energy commissions, instead of diplomats accredited to the Austrian Government, formed the majority of Governors. The annual number of the Board's meetings shrank to two, of two or three days each, and half-day sessions before and after the General Conference. The Board had become a reasonably effective executive body, wasting little time on speeches. Eklund deliberately sought to avoid controversy and established the tradition of extensive consultations with missions before each Board meeting so as to secure compromises that would avoid the need for votes and tiresome explanations of votes.

In 1974, the General Conference accepted the Secretariat's proposal that it should abolish one of its two main committees and fit all its work into one week, usually from Monday to Friday, instead of the best part of two weeks. This was an almost unprecedented self-denying ordinance in the UN family.[44]

The spirit of Vienna

In the mid-1960s, it became customary to refer to a 'spirit of Vienna' — a benevolent genie that presided invisibly over the Board, the delegations to the IAEA and the Secretariat.

There is little doubt that the atmosphere in the IAEA was unique, at least in those years. Personal relations between delegations and the Secretariat were as a rule very warm and informal. Russians and Americans, Arabs and Israelis, Indians and South Africans built up friendships the likes of which were hard to find in New York, Geneva or other cities that were home to UN agencies. One of the reasons was that many of those involved had known each other for many years, in some cases since the Washington negotiations, and had come to have confidence in and to respect one another. The heads of national nuclear authorities understood each other well as fellow scientists grappling with similar problems. They met regularly but informally in groups like the European Nuclear Society. The IAEA was also the only intergovernmental organization in the city and was still quite small. The Austrian Government, the Austrian Ministry of Foreign Affairs and Vienna itself, emerging from its post-war shadows, contributed their share of goodwill and 'Gemütlichkeit'. The spirit of Vienna began to fade a little after the 1976 General Conference in Brazil, which tended to deepen the dividing line between the G-77 and the industrialized countries, and it faded a little more after the IAEA ceased to be 'the only show in town' and then moved out of the old city and into the modern and more impersonal surroundings of the Vienna International Centre (VIC) — a move that was vainly resisted by some senior members of the Secretariat. But the spirit of Vienna lingered on into the 1980s, as Ambassadors Keblúšek and Kirk point out in their essays in the companion book to this history, *Personal Reflections*, and at least some traces of it were left in the early 1990s.

In 1965, the General Conference was held abroad for the first time — in Tokyo. Japan had once again become a major international power and had done the IAEA an invaluable service by setting in motion the IAEA's safeguards. Japan's invitation to the IAEA also marked, more grimly, the twentieth anniversary of the bomb on Hiroshima.

By the end of the 1970s, the Austrian Government and the City of Vienna had completed the construction of the VIC, which they had offered as the permanent home for the IAEA and other United Nations agencies in Vienna. In 1979, the IAEA moved out of the 'temporary' headquarters in the

Grand Hotel where it had been housed for some twenty years. Austria generously made the buildings and facilities at the VIC available at the 'peppercorn' rent of one Austrian Schilling a year.

A changing Board of Governors

By 1960 the number and proportion of African and Middle Eastern members of the IAEA had grown considerably but the 1957 Statute allotted Africa and the Middle East only one elective seat on the Board. To show solidarity with other Africans and to preserve its designation on the Board as the African member "most advanced in the technology of atomic energy including the production of source materials," South Africa proposed increasing by two the number of seats assigned to the region. In 1961, the Board and the General Conference approved an amendment to the Statute adding two more elective seats to the region and also confirming an informal understanding that Latin America would have three elective seats.[45]

By the late 1960s, the proportion of developing Member States in the total membership had much increased and the Conference of Non-Nuclear-Weapon States held in Geneva in 1968 was highly critical of the 'unrepresentative composition' of the Board. In 1968, the General Conference asked the Board to review the relevant article of the Statute (Article VI) and early in 1969 the Board set up a committee to do so.

Since it was also clear that the NPT would soon come into force, the Federal Republic of Germany and Italy foresaw that they might soon be pressed to place their entire nuclear industries under IAEA safeguards. They would thus become two of the four States that would bear the brunt of NPT inspection, the others being Japan and Canada. The Federal Republic of Germany and Italy each contended that this should justify their having a permanent seat on the Board instead of serving only intermittently as in the past (Japan and Canada had enjoyed what were, in effect, permanent seats since the days of the Prepcom).

Ambassador Roberto Ducci of Italy spearheaded the campaign, proposing a Statute amendment under which the seats allotted to the States "most advanced [in the world] in the technology of atomic energy including the production of source materials" (the criterion for designation) would be increased from five to nine so as to make room for two more 'permanent' Western Europeans.[46] The amendment eventually approved accepted Italy's proposal to increase the top category from five to nine, reduced the regional leaders from five to three and increased the elective seats from 12 to 22 — a total of 34. The areas covered by two of the eight regions — into which the world was divided for the purpose of constituting the Board — would be changed: the Middle East would be detached from Africa and attached to South Asia ('Africa and the Middle East' would become 'Africa', and 'South Asia' would become 'the Middle East and South Asia').

The Committee, the Board and subsequently the General Conference considered several other proposals but could not reach a consensus. Finally, in 1970 after much hard discussion, the General Conference approved by a majority vote the gist of the Italian proposal.[47]

The only significant opposition to the Italian proposal came from the Soviet Union and its allies and from South Africa. The Soviet Union was not yet ready to accept the Federal Republic of Germany as a permanent member of the Board, at least not until the Federal Republic had ratified the NPT and accepted IAEA safeguards. Ambassador Georgy Arkadiev, who had now become the Resident Representative of the Soviet Union to the IAEA and whose jovial sense of humour endeared him even to his ideological adversaries, argued stoutly but in vain against the Italian proposal. For its part, South Africa saw the Italian proposal as the writing on the wall for its permanent seat. As long as the Middle East and Africa formed a single region, the only credible alternative to designating South Africa as the regional Member State "most advanced in the technology of atomic energy..." was to designate Israel. This would be unacceptable to the Arab members of the IAEA and to their supporters. However, once the Middle East was detached from the African region, the way would be open to designate another African as an alternative to South Africa, which is what happened in 1977 when the Board designated Egypt to the African seat.

Italy's success was relatively short lived. The amendment to the Statute entered into force in 1973. In the early 1980s, the Western Europeans that were not in the top category reached a gentleman's agreement that the designated seat 'permanently' occupied by Italy would henceforth rotate amongst Belgium, Italy, Spain, Sweden and Switzerland. In 1983, Italy was replaced by Belgium as a designated member of the Board.

Deciding which State was the most advanced nuclear nation in a particular region was not always an easy matter. When, for the third time, Argentina challenged the designation of Brazil as the most advanced Member State in Latin America in 1962, the Board set up a panel of three experts to weigh the evidence and the committee called on both governments to substantiate their claims with factual information. The committee came to the Solomonic conclusion that there was "not sufficient basis for stating that either Argentina or Brazil is the country 'most advanced'..." In the meantime the two nations had agreed to take turns on the Latin American designated seat on the understanding that when either of the two was not occupying the designated seat, it would hold one of the elective seats assigned to the region. This compromise would commit other Latin Americans to carry out the elective part of the bargain and apparently most of them had concurred in it.[48] Despite some objections from Mexico this arrangement has been maintained ever since.

When Egypt challenged the designation of South Africa in 1977 the Board indulged in no such quasi-judicial procedures to determine which of the two nations was "the most advanced in the technology of atomic energy" but took a patently political decision in favour of Egypt — and continued to do so each year until the apartheid government disappeared.

After Chernobyl, Italy abandoned nuclear power and decommissioned its nuclear power plants. The Western Europeans that were most vigorous in contesting the Italian seat in the early 1980s have since either stopped work on the nuclear plants that they were constructing (Spain), or have a de facto or de jure moratorium on any further construction (Belgium, Switzerland) or have decided to phase out those plants they now operate (Sweden). It might be thought that, having turned against nuclear power, the nations concerned would find it embarrassing to be designated to a seat on the IAEA's Board of Governors as a leading nuclear State. They show few signs of embarrassment. But it may be argued that the moratoria and the Swedish 'phasing out' reflect the political conclusions of the moment rather than final decisions to abandon nuclear power — in reality, they are decisions to 'wait and see'.

China

As already noted, the issue of the representation of China had arisen at every session of the IAEA's General Conference; the Soviet Union and its allies as well as many non-aligned countries pressing vigorously for the rejection of the credentials of 'Nationalist' China and admission of the People's Republic. This issue was becoming increasingly divisive as a growing number of Western countries as well as all Socialist countries recognized the People's Republic as the legitimate government of China.

The USSR also consistently pressed for admission to the IAEA of the German Democratic Republic, the People's Republic of Viet Nam, the

Democratic People's Republic of Korea (DPRK, North Korea) and Mongolia, but for several reasons the issue of representation of these countries was less divisive than that of China.

On 25 October 1971, the United Nations General Assembly decided that the Government of the People's Republic was the only authority entitled to represent China at the United Nations and expelled " ...the representatives of Chiang Kai-shek from the place they unlawfully occupy in the United Nations and in all the organizations related to it." The Assembly had the legal right to expel the unwanted representatives only from the United Nations itself and not from other United Nations agencies, but the Assembly's decision was considered to be a recommendation to those agencies.[49]

On 9 December 1971, the Board of Governors took the recommended action in regard to the representation of China at the IAEA. The People's Republic itself did not formally react to the Board's decision until 1983, when it applied and was promptly approved for membership of the IAEA.[50] In 1972, the IAEA discontinued all technical co-operation projects and support of research in Taiwan, but with the tacit assent of Beijing continued to apply safeguards to all nuclear material and plant on the island.[51]

The Group of 77 flexes its muscles

On 1 June 1973, the second amendment of the IAEA's Statute came into force. The Board membership rose from 25 to 34, developing Member States now having a slim majority.

In September 1976, the General Conference met in Rio de Janeiro for its third session away from IAEA Headquarters.[52] For the first time the Group of 77 (G-77) made its weight felt in the IAEA, asking the Board of Governors to review its customary designation of South Africa as the member of the Board from Africa and, despite strenuous US opposition, deciding to grant observer status to the Palestine Liberation Organization. In June 1977, the Board decided by a vote of 19 to 13, with one abstention, to uphold the Chairman's nomination of Egypt as the Member State in Africa "most advanced in nuclear technology including the production of source materials."[53] Egypt's nuclear programme was very modest and it produced no source materials (i.e. uranium) but worldwide revulsion against apartheid made it politically inevitable that the South African Government would sooner or later lose its seat on the Board. This revulsion also led to the rejection of the credentials of the South African delegation when the General Conference met in New Delhi in September 1979. After a democratic government had taken power in Pretoria, South Africa, with Egypt's concurrence, regained its seat on the Board in 1995.

The NPT

After Kennedy became President in 1961, the US Government set up an advisory committee under the chairmanship of Henry D. Smyth to recommend ways of strengthening the IAEA and the policies the USA should follow towards it.[54] The main conclusion was that the USA should play a more active and positive role in the IAEA and should persuade States receiving US nuclear assistance to accept IAEA instead of US safeguards. The new policy was underlined by the appointment of Smyth as US Governor.[55]

By 1963 the international environment had improved. After narrowly avoiding nuclear war over Cuba in October (or so it seemed at the time) the USA and the USSR drew back into détente. An early product of their less hostile relationship was agreement to connect a 'hot line' between Moscow and Washington. More important by far was the conclusion in 1963 of the Limited Test Ban Treaty, co-sponsored by the USA, the USSR and the United Kingdom.

Since October 1958, Ireland had been eloquently recommending to the United Nations General Assembly the early conclusion of a treaty to prevent the "wider dissemination of nuclear weapons". In January 1964, the USA and the USSR each proposed an agenda for the ENDC in Geneva. Their proposals had four subjects in common, one of them being a nuclear non-proliferation treaty. By 1965, the USA and the USSR agreed that attention in Geneva should first be focused on this issue and both presented widely different drafts of such a treaty. The US draft included a reference to "International Atomic Energy Agency or equivalent international safeguards." By "equivalent international safeguards" the USA clearly meant the safeguards of EURATOM. This was unacceptable to the Soviet Union, which maintained that EURATOM safeguards amounted to self-inspection by a small group of NATO powers. Eventually, and after many consultations between the USA and the EURATOM nations, the USA and the Soviet Union agreed that the treaty should place an obligation on all non-nuclear-weapon States to accept the safeguards of the IAEA, but that the EURATOM non-nuclear-weapon States should have the right jointly to conclude the relevant agreement with the IAEA.[56]

In the ENDC itself the non-nuclear-weapon States also insisted that the treaty should impose obligations on the nuclear weapon States to end the nuclear arms race and to reduce, and eventually eliminate, their nuclear arsenals and should explicitly recall the commitment of the nuclear weapon States to seek to ban all nuclear tests.[57]

The leading industrial non-nuclear-weapon States, in particular the Federal Republic of Germany, Japan and Italy, pressed for formal undertakings that the treaty would not impede economic development, international nuclear co-operation or nuclear trade, nor block their access to advanced nuclear technologies such as enrichment and reprocessing. The developing countries sought assurances that their needs for nuclear technology would be addressed and that they would be able to enjoy whatever benefits might be derived from the peaceful uses of nuclear explosions.[58]

There were clear indications, as the treaty began to take shape, that the IAEA would at last begin to play a role in strengthening international security. In September 1967, the President of the 11th General Conference and head of the Czechoslovak nuclear energy authority, Dr. Jan Neumann, formally affirmed, on behalf of the members of the IAEA, the Agency's readiness to accept the safeguards responsibilities that the NPT assigned to it — responsibility for verifying that non-nuclear-weapon States party to the treaty were complying with their undertakings not to divert nuclear material to nuclear weapons.[59]

By mid-1968, the demands of the non-nuclear-weapon States had been largely accepted by modifications to and expansion of the draft proposed by the USSR and the USA. After approval by the ENDC and commendation by the General Assembly, the treaty was opened for signature on 1 July of that year.

On 5 March 1970, the requisite number of nations had ratified the treaty and it entered into force. In the words of a keen and sympathetic observer of the IAEA, Professor Lawrence Scheinman, Deputy Director of the US Arms Control and Disarmament Agency in the mid-1990s, this event "gave the IAEA a tremendous boost, making it the keystone of the non-proliferation regime, and catapulting it from the periphery to the centre of the international political system..."[60]

The IAEA's subsequent success in drawing up a radically new safeguards system and model agreement by consensus and in a remarkably short time (April 1970 to March 1971) ensured that the Agency would promptly be able to conclude the agreement with each non-nuclear-weapon State required by the treaty.

To soften the discriminatory aspect of a treaty that imposed very different obligations on the nuclear and on the non-nuclear-weapon States, and to encourage widespread adherence, the USA and the United Kingdom offered to place all their civilian nuclear plants under safeguards when such safeguards were put into effect in the non-nuclear-weapon States.[61] Since there was no prospect that the IAEA would have the staff or money needed to safeguard the entire large and still growing civilian fuel cycle of the USA or the substantial fuel cycle of the United Kingdom, it was necessary to devise some criteria by which the IAEA would select particular plants in each country from the long list of those that would become 'eligible' for safeguards. This was done on the margins of the meetings of the safeguards committee. The rules for selection were proposed by the Australian Governor, Maurice Timbs. The Federal Republic of Germany and the other leading industrialized non-nuclear-weapon States let it be known that they endorsed the Timbs criteria under which the IAEA would choose those US and British plants that embodied the most advanced technology or were particularly important for international nuclear trade. The selection should change from time to time so as not to discriminate between competing plants. It was expected that a significant proportion of the plants offered would be selected for full safeguards. In practice the IAEA's resources never permitted it to select more than a few plants in each nuclear weapon State.

On 14 February 1967, even before the conclusion of the NPT, the Latin American nations opened for signature the Treaty of Tlatelolco designed to create a nuclear weapon free zone in that region.[62]

As the decade drew to a close an unusual event — the 1968 Conference of Non-Nuclear-Weapon States — showed the growing interest amongst the developing nations in the imminent entry into force of the NPT and their understandable wish to have credible assurances about their immunity from nuclear threat if they were to forego the right to possess nuclear weapons. The chief sponsors of the conference were Pakistan and Yugoslavia and their decision to hold it in Geneva reflected their wish to keep a distance from the IAEA, which was thought to be too much influenced by the two superpowers.

The first shock to the newly created 'nuclear non-proliferation regime' came on 18 May 1974, when India carried out an underground nuclear explosion at Pokharan in Rajasthan. India declared that the aim of the explosion was "with a view to the possible uses of nuclear explosives in mining and earth moving operations."[63] A large research reactor supplied by Canada (known as the CIRUS reactor) had been the source of plutonium for the explosion. This was the first (and so far the only) nuclear test that had used fissile material produced by a reactor designed and supplied for use only in 'peaceful' research. The Canadians were not mollified by the Indian explanation that the plutonium had been used for a "peaceful nuclear explosion."[64]

Pakistan raised the matter at the Board's meetings in June 1974, suggesting that the explosion might have an impact on the IAEA's technical assistance programme.[65] All the Governors who spoke, with the exception of the Governor from India, expressed concern about the explosion, but there was no suggestion that the Board should condemn it. The Governor from India emphasized that his country had not violated any treaty or agreement, but Canada demurred; in its view the test was a breach of the agreement under which Ottawa had supplied the reactor. The Governor from India also maintained that the explosion was an integral part of the Indian Government's policy of applying nuclear energy for peaceful purposes. India, he said, was opposed to nuclear weapons and nuclear proliferation and the Indian Government had categorically declared that it did not intend to manufacture nuclear weapons.

At first other reactions abroad were restrained, except in Canada, but eventually the explosion had widespread repercussions. Although India was not a party to the NPT and the CIRUS reactor was not operating under IAEA safeguards, the explosion was seen by some as a challenge to the Treaty and a demonstration that IAEA safeguards were ineffective. It also cast doubt, especially in the USA, on the efficacy of the export controls required by Article III.2 of the NPT, and it was an important factor in the US decision largely to abandon Eisenhower's "Atoms for Peace" policy and replace it with the 1978 Nuclear Non-Proliferation Act and to launch the exercise known as the 'International Nuclear Fuel Cycle Evaluation'. The Pokharan explosion also strengthened the growing opposition to nuclear power in several Western countries, where anti-nuclear circles argued that it had shown that the military and civilian uses of nuclear energy were inseparable. These developments eventually affected the work of the IAEA, leading some industrialized nations such as the USA and a few Western Europeans to place greater emphasis on safeguards and less on the promotion of nuclear power.

Two other events sharpened doubts, especially in the USA, about the efficacy of the regime and especially about existing nuclear export controls. After the Yom Kippur war, the Arab oil boycott and the steep increase in the price of oil persuaded influential American policy makers that nuclear power, now seen by many developing nations as a reliable and cheaper substitute for oil, would spread rapidly around the world. This, it was thought, would inevitably lead to a proliferation of reprocessing and enrichment plants and a worldwide plutonium economy. Reports that France and the Federal Republic of Germany were about to sell reprocessing and enrichment technology to non-nuclear-weapon States not party to the NPT seemed to confirm these fears.

In consequence, the USA and the Soviet Union agreed in Moscow in late 1974 to establish a Nuclear Suppliers' Group (NSG) of governments that were, or were expected to become, exporters of nuclear materials or equipment. Some fifteen governments first met in London in 1975 and soon became known as 'the London Club'.[66] The NSG published its first set of recommendations for more stringent export controls on 21 September 1977 (INFCIRC/254). France, though not a party to the NPT, had agreed to take part in its meetings, provided that they were held behind closed doors, a procedure that deepened the suspicions of several importing countries about the work of the group.

Two of the main NSG Guidelines of 1977 were that exporters should require the application of IAEA safeguards to plants built in non-nuclear-weapon States on the basis of transferred technology, and that exporters should exercise restraint in transferring reprocessing and enrichment technology and sensitive materials. In practice, at least until recently, the latter Guideline has resulted in a complete halt to the authorized export of these technologies (but it did not prevent smuggling abroad of enrichment plant components, as the disclosures about the Iraqi nuclear programme in 1991 and earlier reports on the Pakistani programme were to show). The Guidelines also enjoined exporters to insist on adequate measures for the physical protection of nuclear materials in the importing country and to require that re-exports be made only with the consent of the original exporter.

The NSG Guidelines did not differentiate between non-nuclear-weapon States party to the NPT and non-parties. Some of the former held that the Guidelines were incompatible with "the right [of all parties] to participate in the fullest possible exchange of equipment, materials, and scientific and technological information for the peaceful uses of nuclear energy" embodied in Article IV.2 of the NPT. This led to many complaints at the second NPT Review Conference in 1980.

In 1991 it became clear that Iraq's clandestine nuclear weapon programme had relied heavily on imports of components for enrichment plants and of equipment that could be used to make such components. It was also clear that most of these imports came from members of the NSG. The NSG agreed that the Guidelines should be made much more watertight. In particular, they agreed that nuclear exports should be made only to non-nuclear-weapon States that had accepted comprehensive safeguards and that export controls should also be imposed on items of equipment that could have nuclear as well as non-nuclear uses — the so-called 'dual-use' items.

But this was much later. In 1977, Jimmy Carter took office as President of the USA. Although he had once served as an engineer in a US nuclear submarine, he had not become enamoured of nuclear power and once referred to it as the energy source of the last resort. He was particularly opposed to the use of plutonium for civilian purposes which, he feared, would lead to a worldwide plutonium economy and rampant proliferation of nuclear weapons. The majority in the US Congress shared the President's concerns, and Congress enacted the Non-Proliferation Act of 1978 (P.L. 242) that reflected those concerns and went even further along the path of denial, as its critics called it. In effect, the law sought to use the influence of the USA, as the world's major supplier of nuclear plant and enriched fuel, to limit and eventually put an end to the separation of plutonium and production of high enriched uranium (HEU) for civilian purposes. The policy could hardly avoid being discriminatory since the nuclear weapon States would still need and separate plutonium for their warheads and HEU for their submarines.

Nearly all US nuclear co-operation agreements then in force included a clause requiring the recipient to obtain the prior consent of Washington before reprocessing any spent fuel of US origin or enriching uranium (above a certain level of enrichment), or re-exporting any nuclear item that the USA had supplied. The 1978 Act added new export conditions; for instance:

— As a general rule, there would be no US nuclear exports to a non-nuclear-weapon State unless it accepted IAEA safeguards on all its nuclear material — as non-nuclear-weapon States party to the Treaty were already required to do;[67]
— In the case of new US supplies, IAEA safeguards must be permanent;
— No nuclear material, equipment or sensitive nuclear technology could be exported to any non-nuclear-weapon State that had terminated IAEA safeguards.

Prior consent of the USA must also be sought before the reprocessing, enrichment or re-export of any nuclear material produced by the use of US equipment.

In effect, the Act called for the renegotiation of almost all existing US nuclear co-operation agreements.

The Act was taken to mean that applications for prior US consent to reprocessing would be examined on a stringent case-by-case basis and that the USA would no longer give any other country a general or automatic authorization to reprocess fuel of US origin.[68]

On 19 October 1977, President Carter convened an international conference in Washington to launch the 'International Nuclear Fuel Cycle Evaluation' (INFCE). The heads of national nuclear energy agencies and other senior officials from some forty nations took part. The President hoped to temper the strong opposition that the new US policy had aroused in other countries that had advanced nuclear power programmes; INFCE would demonstrate, he hoped, that the 'once-through' fuel cycle (in which spent fuel is not reprocessed to extract the uranium remaining in the fuel and the plutonium that has been produced in it, but is disposed of as nuclear waste) was the cycle less likely to lead to proliferation, and they would therefore be persuaded to accept the US approach and follow similar policies. The US case was somewhat weakened by the revelation that a Pakistani scientist working in a Dutch firm subcontracted to the gas centrifuge enrichment plant at Almelo had returned to his country with the plans of the plant and a list of possible suppliers of crucial components. The implication, confirmed later in Iraq and by the disclosure of the South African programme, was that enrichment rather than reprocessing might be the preferred path to nuclear weapons.

INFCE took place in Vienna from November 1978 and ended in a final plenary meeting on 25–27 February 1980. It was a massive operation. Sixty-six countries took part in at least some of INFCE's 133 meetings and the Agency provided a great deal of administrative and technical support, but INFCE was a US and not an IAEA operation. It was chaired by Professor Abe Chayes of Harvard University who, despite his strong support for the policy of the Carter Administration, was impeccably impartial and also a very able chairman. INFCE produced a vast amount of documentation but many of its conclusions or assumptions were soon overtaken by events. For instance, INFCE's expectations of a rapid expansion of nuclear power, a shortage of uranium and a rise in its price, and the likely early use of the breeder reactor all turned out to be false.

Despite President Carter's expectations (and, one may add, despite the obvious fact that reprocessing of spent nuclear fuel can directly lead to the acquisition of weapon usable material, while the 'once-through' fuel cycle cannot), INFCE conspicuously refrained from identifying any particular fuel cycle as being more 'proliferation-prone' than another. INFCE's fundamental and sensible conclusion was that a national decision to acquire nuclear weapons is essentially political and not dependent on the choice of a particular fuel cycle. But to a considerable extent the US Congress, in the 1978 Non-Proliferation Act, had pre-empted the conclusions of INFCE.

INFCE also recommended international co-operation in the storage of plutonium to ensure against its misuse, similar co-operation for the long term storage of spent fuel, and long term assurances of nuclear supply linked, however, with effective safeguards against proliferation. INFCE thus led directly to an IAEA study of international plutonium storage, another of long term international spent fuel storage and to the creation of the IAEA Board of Governors' Committee on Assurances of Supply.

Regrettably, the net result of these efforts was very modest. It proved impossible to set up an international plutonium storage system,[69] no nation showed an interest in providing storage for other nations' spent fuel[70] and the Board's Committee on Assurances of Supply has little to show for its pains. In fact, by 1995 some of the problems it set out to solve had changed or disappeared. Nuclear energy had become a buyers' market, for most countries there was no problem in getting supplies of nuclear fuel or nuclear power plants — on condition, however, that if the importer were in a non-nuclear-weapon State, its government must accept comprehensive IAEA safeguards. All but three importers (India, Israel and Pakistan) and all but one major exporter (China) had accepted that condition.

The results of the March 1987 'United Nations Conference for the Promotion of International Co-operation in the Peaceful Uses of Nuclear Energy', which traced its origins to INFCE, were similarly meagre.[71]

On 28 March 1979, the first serious accident at a nuclear power plant — Three Mile Island in Pennsylvania — made headlines throughout the world. The accident and its consequences are discussed in Chapter 8.

In 1980, the parties to the NPT met in Geneva for the second NPT Review Conference. Two issues dominated the meeting: nuclear supplies and the conclusion of a treaty banning all nuclear tests. The NSG Guidelines and the US Non-Proliferation Act of 1978 attracted sharp criticism from many developing countries and from at least one industrialized country, Switzerland, which was having difficulty in getting US consent to the reprocessing of US-origin spent fuel. Nonetheless, delegates in the committee dealing with the civilian use of nuclear energy were able to cobble together the draft of a consensus report. But no consensus could be reached in the committee dealing with nuclear arms control and disarmament. The non-nuclear-weapon States pressed for the prompt negotiation of a comprehensive test ban treaty; the USA and the United Kingdom resisted, and the opposition of two out of the three nuclear weapon States then party to the NPT amounted, in effect, to a veto. The conference ended without a final declaration and amid forebodings about the future of the NPT.

In June 1980, the IAEA's Committee on Assurances of Supply began discussing how nuclear supplies and services could "be assured on a more predictable and long term basis in accordance with mutually acceptable considerations of non-proliferation" and what the IAEA's role should be in this context. The main suppliers sought relatively strict export controls; at a minimum, customer nations should be required to accept IAEA safeguards on all their nuclear *imports* from those suppliers and on the nuclear material produced as a result of such imports. The USA, Canada, Australia and the Scandinavian countries went further, requiring comprehensive safeguards as a condition of supply to non-nuclear-weapon States, in other words, safeguards on all nuclear activities in the importing country, whether or not the activities were import dependent. The importing nations not party to the NPT sought the minimum of restrictions on exports, and some would have been happy to dispense entirely with IAEA safeguards. Even amongst NPT parties there was lingering resentment against the 1978 Non-Proliferation Act, which several saw as an arbitrary demand by the USA for changes in agreed supply contracts and a threat to rupture those agreements if the US conditions were not met.

In September 1979 there was also much concern about what appeared to be a signal indicating a nuclear explosion high over the South Atlantic near South Africa. A panel set up by President Carter to evaluate the incident concluded that the signal was probably not caused by a nuclear explosion, but some US and British writers still think otherwise.[72]

1961–1981: A summing up

The scope and range of many of the IAEA's programmes were clearly defined by the end of 1981 and would not undergo any radical changes during the next 15 years. There would be an almost fourfold increase in the funds available for nuclear assistance (from $16 475 000 to $60 300 000), but the technical range of projects in that programme, and the countries in which it operated, would remain much the same.

Severe shocks were in store, however, for the safeguards and nuclear safety programmes. While the NPT had transformed the role the IAEA would play on the international stage, the safeguards system was still focusing almost exclusively on meticulous accounting for nuclear material in plants that non-nuclear-weapon States party to comprehensive safeguards agreements had declared to the IAEA, and that was therefore under safeguards. As noted, this focus led inevitably to the most intense inspection of those countries where most of the nuclear material was located — the Federal Republic of Germany and other European Union States, Japan and Canada. The disclosure in the early 1990s that Iraq had long been operating undeclared nuclear plants showed that there were serious defects in the system.

The industrialized countries, especially those that had large nuclear programmes, still tended to see the IAEA's work on nuclear safety as principally of benefit to developing countries. It would take the worst accident in the history of nuclear technology to change their minds and to accept that nuclear safety was a vital international as well as a national responsibility and to use the IAEA as an instrument for enhancing nuclear safety in the industrialized as well as in the developing world.

1981–1997: Years of challenge and achievement

The most recent period in the Agency's history saw the end of euphoria about the prospects for nuclear power — euphoria on which the worst accident at a nuclear power plant seemed to set a tombstone — the first violations of IAEA safeguards and the IAEA's reactions to those challenges, and, most fundamentally, a sea change in the international political environment in which the Agency operates, and, partly as a consequence, confirmation that the NPT and comprehensive IAEA safeguards will remain permanent features of that environment and play a significant role in underpinning international security.

Israel bombs the Tamuz reactor

The year 1981 began well. On 26 February, Egypt, a signatory of the NPT since 1 July 1968, ratified the Treaty. It has been speculated that Egypt withheld its ratification for so many years because of numerous indications that Israel was building up a nuclear arsenal and that it ratified the NPT in the expectation that, under US pressure, Israel would do likewise and dismantle its nuclear weapons. But this is surmise and implies a degree of naiveté in Cairo that is hard to credit. In any event, the fact that the leading country in the Arab world — and in a region of great political tension — had become an NPT party was good news for the Treaty's supporters.

But the good news did not last. On Sunday 7 June 1981, Israeli aircraft attacked and destroyed Tamuz 1, the 40 MW(th) materials testing reactor that France had built for Iraq at the Tuwaitha research centre south of Baghdad. Israel had apparently long suspected that the Iraqi Government planned to use the reactor to produce material for nuclear weapons, and had made several attempts to dissuade France from supplying it. It was widely believed that Israeli agents were responsible for blowing up the core of the reactor while it was still in Toulon, awaiting shipment to Iraq, and might have been responsible for the death in Paris of one of the engineers in charge of the project.[73]

The international reaction to the bombing raid was harshly critical of Israel. It was the first armed attack on a civilian nuclear plant (under IAEA safeguards) and was seen as a breach of a long standing taboo and as an ominous precedent. The Director General and the Board of Governors also interpreted the attack as an assault on IAEA safeguards. On 8 June 1981, the United Nations Security Council strongly condemned the attack and called upon Israel to pay compensation to Iraq for the damage inflicted and to urgently place all its nuclear activities under IAEA safeguards. The Board, meeting from 9 to 12 June,[74] likewise strongly condemned the Israeli action and asked the General Conference to consider suspending Israel from the exercise of its rights and privileges of membership in the IAEA.[75]

In September 1981, the IAEA General Conference voted to suspend all technical assistance to Israel and decided that at its next session, i.e. in September 1982, if Israel had not yet complied with the Security Council's resolution, the General Conference would consider suspending Israel's rights and privileges of membership. In practice, this would amount to the exclusion of Israel from the Agency.

The appointment of a new Director General, Dr. Hans Blix

Much of the Board's time in 1981 was spent, however, debating a completely different subject; the choice of a new Director General to succeed

Sigvard Eklund, who was coming to the end of his fifth term or 20 years in that post.[76] Eklund had not made himself available for a sixth term; had he done so there is little doubt that he would have had the support of the USSR and many other Member States.

Half a dozen names were put forward as candidates,[77] but, after numerous ballots, the choice became a duel between State Secretary Hans Haunschild, permanent head of the Federal Ministry for Research and Technology of the Federal Republic of Germany, who soon had the support of Western delegations, and Domingo Siazon, Ambassador of the Philippines in Austria and Governor and Resident Representative to the IAEA, who had the support of most developing countries. But the USSR did not want either. When the issue came to a vote, as it did frequently in the absence of a consensus, the USSR and its allies were able to prevent either candidate from getting the two thirds majority required for appointment. Eventually, as the General Conference came near, the USA sounded the Swedish Government and the latter put forward the name of State Secretary Hans Blix, who was well known and highly regarded in international circles, not only as an eminent international lawyer but also as a skilled and experienced diplomat.[78] Blix had also served as Foreign Minister of Sweden under a previous government and as a defender of nuclear power in a Swedish referendum in 1980. Haunschild now withdrew, but Siazon remained in the ring for another few rounds of voting. Finally, on the evening of Saturday 26 September, the closing day of the 1981 session of the General Conference and the last day on which the Conference could take up the matter, Blix obtained the two-thirds majority required. At about eight o'clock on that evening, and on the proposal of Siazon, the Board appointed Blix by acclamation.[79] In the early hours of Sunday morning the General Conference approved the Board's decision, also by acclamation.[80]

The appointment of citizens of the industrialized countries as the first three Directors General of the IAEA did not escape some sharp criticism by the developing countries. Various undertakings were given to increase the proportion of their citizens in the senior ranks of the IAEA Secretariat and to give favourable consideration to their candidates when Blix completed his first term of service as Director General.[81]

On the proposal of the delegate of India, Homi Sethna, the General Conference conferred on Eklund, by acclamation, the title of Director General Emeritus of the International Atomic Energy Agency.[82]

The aftermath of the Israeli attack

Within a year the tension caused by the Israeli attack on the Iraqi reactor was to put the diplomatic skill of Hans Blix to a severe test. Compliance with the Security Council's resolution would have required Israel promptly to dismantle the nuclear arsenal that it was widely assumed to possess. By September 1982, when the General Conference met for its regular annual session, it was clear that Israel had no intention of doing so. In the meantime, the 1982 Israeli occupation of southern Lebanon had further sharpened anti-Israeli sentiment in the Arab States. On the other hand, both Houses of the US Congress had adopted a resolution calling for a boycott of any UN body that suspended Israel or rejected its credentials and requiring that the regular contribution of the USA to that body be withheld until it reversed its action. The stage was set for a confrontation.

As the General Conference opened, the Arab States began canvassing a draft resolution condemning the attack and calling upon the Conference to suspend Israel's rights and privileges of membership. It soon became clear, however, that such a resolution would not get the two thirds majority that the Statute required for such a decision.[83] At the last moment, the Arab delegations changed their tactics and began instead to press for the rejection of Israel's credentials, a decision that required only a simple majority. The Arab proposal took the form of an Iraqi amendment to the draft resolution on credentials recommended by the Conference's General Committee approving the credentials of all delegations, including those of the delegation of Israel.[84]

In a roll call vote, the votes on the Iraqi amendment were evenly divided. The President (Ambassador Siazon of the Philippines) accordingly announced that the amendment had not been carried. At the request of the delegate of Iraq and on the instructions of the President, the Secretary of the Conference read out the list of countries that had taken part in the vote and the votes that they had cast. At that point the delegate of Madagascar, whose country's name was not on the list read out, declared that he had been present at the time of the vote and wished to have his vote in favour of the Iraqi amendment recorded.[85] After a statement by the IAEA's chief legal officer to the effect that Madagascar had the right to have its position taken into account, the President ruled that the vote of the delegation of Madagascar was valid. The US delegate immediately appealed against the President's ruling and asked for a roll call vote on his appeal. The appeal was rejected by a majority of three votes. The Iraqi proposal was then adopted by a majority of one. In a further roll call vote the amended resolution, now rejecting the Israeli credentials, was adopted by a majority of two. Thereupon the delegations of the United Kingdom and the USA walked out of the conference hall, followed closely by most other Western delegations. Before withdrawing from the General Conference, the US delegate announced that his Government "would reassess its policy regarding United States support for and participation in the IAEA and its activities."[86]

The USA was (and still is) by far the main supporter of most of the IAEA's programmes as well as the largest contributor to its regular budget and technical assistance programme. Its withdrawal from the IAEA would have been the most severe blow that any Member State could inflict on the organization.

The legal advice that had been given to the President of the Conference was certainly questionable, and the substance and timing of the President's decision and its consequences, in Washington's view, could hardly have been worse. For instance, the rejection of Israel's credentials could have served as a precedent for similar action at the UN General Assembly which was about to open.

Nonetheless, in 1981 Iraq was a party to the NPT in good standing, the reactor was under IAEA safeguards and the Israeli attack was the first military strike ever made against a nuclear plant. It had been launched at a time when, in practice if not in law, Israel and Iraq were at peace with each other. The attack had been condemned by the USA as well as by almost all of the other members of the United Nations. The USA had done more than any other nation to create and sustain the IAEA and it attached great importance to IAEA safeguards. Its willingness to withdraw from the Agency was a measure of the influence of Israel on US foreign policy.[87]

The US withdrawal may well have been intended as a warning to the Arab States not to try to reject the credentials of Israel's delegations in the UN and elsewhere.[88] Paradoxically, however, the Israeli credentials, now rejected, had been issued only for the 1982 General Conference. Once the Conference was over, an hour or less after the USA and other Western delegations had walked out, Israel could operate as usual in the IAEA. The USA, by contrast, withdrew from *all* participation. Since this was in October, the immediate practical effect was much less than it would have been early in the year. But it was, nevertheless, urgent to get the USA back into the Agency.

With the help of the Chairman of the Board (Ambassador Emil Keblúšek of Czechoslovakia) and the US, Soviet and many other delegations, the

Director General made strenuous and eventually successful efforts to persuade the US Government to review its decision. The negotiations focused on a statement that Blix would read at the February 1983 meetings of the Board.[89] On 14 October 1982, Blix sent a letter to all Governors concerning "the factual and legal situation" in which he affirmed that Israel remained a fully participating member of the IAEA. This apparently succeeded in reassuring Washington and, at the February 1983 session of the Board, after referring to his letter of 14 October, Blix was able to express gratification that the USA had decided to resume its participation in the Agency's activities.[90]

Chernobyl

In the early hours of 26 April 1986, Unit 4 of the four power reactors at Chernobyl in Ukraine blew up. The explosion hurled a plume of highly radioactive steam, smoke and dust high into the atmosphere. The pressure tubes of the reactor had ruptured under intense heat and pressure, the graphite moderator in the plant had burst into flames, and hydrogen released by the water–graphite reaction may have caused a second explosion. With the utmost heroism local firemen attempted to extinguish the flames. The radioactive cloud spread first over northern and central Europe, then over western and southern Europe and Turkey, and gradually over all the northern hemisphere, its radioactivity diffusing and decaying as it moved.

In August 1986, the IAEA and the Soviet Union convened an international post-accident review meeting and in September the Director General's International Nuclear Safety Advisory Group (INSAG) analysed its proceedings and results. The meeting had been a breakthrough for *glasnost*, noteworthy for some of the frank and comprehensive reports given by the Soviet participants and for the free and open discussions that had followed. A good deal more information about the accident emerged in the next few years and INSAG reviewed its findings in 1992.

The cause and consequences of the accident and the actions that the IAEA took in response to it are examined in greater detail in Chapter 7, which deals with the IAEA's work on nuclear safety, and later in this chapter there is a brief reference to the conference, 'One Decade after Chernobyl', which the IAEA, the European Union and WHO convened in 1996 to review the accident. It will suffice to note here that Chernobyl had a profound political and economic effect, helped to discredit the Soviet system, and had a disastrous impact on the local environment and on the mental health of much of the population living in nearby regions of Belarus, Ukraine and European Russia. It was by far the worst blow ever inflicted on nuclear power; it put an end to nuclear power programmes in several countries and left a deep sense of unease amongst the population, even in many of those countries that continued to build new nuclear power plants. It also led to an immediate surge of support for a major extension of the IAEA's work relating to nuclear safety, including the prompt negotiation and conclusion of conventions on early notification of a nuclear accident and assistance in the event of such an accident.

The Convention on Nuclear Safety

Since the late 1960s, the IAEA Secretariat had from time to time sought — in vain — to persuade the nuclear industry of the utility of an international convention on the safety of nuclear power as a means of establishing uniform global standards, allaying public mistrust and promoting nuclear commerce. As we have seen, Chernobyl led to a more receptive attitude towards proposals for expanding the IAEA's role in nuclear safety.

In 1992, largely as a result of an initiative taken by Klaus Töpfer, the German Minister for the Environment, and the support of Director General Blix, the Secretariat began work on an international convention on nuclear safety and by 1995 the convention was opened for signature. The evolution and main features of the convention are examined in Chapter 7.

South Africa

In December 1982, the United Nations General Assembly called upon South Africa to stop developing its ability to make nuclear weapons and to place all its nuclear activities under IAEA safeguards. It also requested the IAEA to refrain from helping South Africa's nuclear activities and to exclude South Africa from all IAEA technical working groups. This was to become an annual exhortation by the General Assembly to the Agency and to the nations that were thought to be helping South Africa's nuclear programmes.[91]

From 1987 until 1990, the Board of Governors and the General Conference debated whether to suspend South Africa from exercising its privileges and rights of membership in the Agency — a decision that would in practice have put an end to South African participation in the IAEA.[92] Understandably, the pressure for suspension came chiefly from other African States. It was resisted by many Western governments, some of which were pressing Pretoria to join the NPT, and they argued that suspension of South Africa would undermine their efforts. There were also numerous meetings between representatives of South Africa and of the three NPT depositary governments at which South Africa was urged to accede to the NPT without further delay.

In June 1987, the Board, overriding Western objections, decided first that the suspension of South Africa's rights and privileges could be decided by the votes of a simple majority of the members of the Board, and then, by a vote of 22 to 12, with 1 abstention, recommended that the General Conference should proceed with such a suspension.[93] However, in September 1987, when the time came for the General Conference to take action, there were hints that South Africa might be changing its policies and might now accede to the NPT. Accordingly, the General Conference decided to defer its decision for a year. After further indications that South Africa was considering adherence to the NPT, the Conference again deferred a decision in 1989 and 1990.[94]

After South Africa had acceded to the NPT on 10 July 1991 and concluded its NPT safeguards agreement with the Agency on 16 September 1991, the General Conference asked the Director General to verify the completeness of the 'Initial Report' that South Africa had submitted to the IAEA in accordance with its safeguards agreement, and in which it was required to list all its nuclear plants and nuclear material. The Secretariat was thus faced with the considerable task of verifying, with as much precision as possible, how much enriched uranium South Africa had produced during the previous 16 years, i.e. since the mid-1970s. The task was made easier by the co-operation of the South African nuclear authorities, who provided the IAEA with access and data beyond those required by its NPT safeguards agreement, including all the operating records of South Africa's previously unsafeguarded enrichment plant, and permitted the IAEA inspectors "to go any place, any time". In 1992, the Director General reported that the IAEA had found no evidence that the Initial Report submitted by South Africa was incomplete.[95]

In 1993, the President of South Africa, F.W. de Klerk, disclosed that, since 1979, South Africa had constructed six nuclear warheads and that it had dismantled all six in 1989. The disclosure confirmed the earlier suspicions of other African countries — which many Western countries had tended to question — that South Africa had been secretly making nuclear weapons. But South Africa had also become the first, and was so far the only, nuclear weapon State to scrap its nuclear arsenal. After de Klerk's statement, the

South African Government invited the IAEA to verify that it had indeed terminated the weapon programme and had dismantled the six nuclear warheads and placed their fissile material — HEU — under IAEA safeguards. The South African authorities arranged access to all the facilities that had been used in the nuclear weapon programme, including unused test sites and the plant in which the warheads had been assembled. The IAEA team found "substantial evidence of the destruction of non-nuclear material components used in nuclear weapons and...no indication to suggest" that substantial amounts of depleted or natural uranium used in the programme were missing.[96] At the NPT Review and Extension Conference in 1995, a reformed South Africa played a crucial part in securing the decision of the conference to extend the NPT indefinitely.

China

On 5 September 1983, almost 12 years after the expulsion from the IAEA of the representatives of the Taiwanese authorities, the People's Republic of China applied for membership in the IAEA. On 11 October 1983, the General Conference unanimously approved the application. China became a member on 1 January 1984, when it deposited its instrument of ratification of the IAEA's Statute. All States that had significant nuclear activities were now members of the Agency.[97]

In order to provide a seat for China on the Board of Governors without displacing any other Member State, the Board and the General Conference, in June and September 1984, unanimously approved an amendment to the IAEA Statute. The amendment raised from nine to ten the number of seats on the Board that are assigned to the Member States "...most advanced in the technology of atomic energy..."[98] Without waiting for the amendment to the Statute to enter into force (which it did on 28 December 1989), the Board, in June 1984, designated China as a member in the "most advanced" category.

In 1989, China concluded an agreement permitting the IAEA to apply safeguards to nuclear material in any Chinese plants on a list that it would submit to the Agency.[99] All five acknowledged nuclear weapon States had thus offered to accept IAEA safeguards on all their civilian nuclear plants, in the case of the USA and the United Kingdom, or on specified plants, in the case of France, the USSR and China.[100] However, the IAEA's limited funds permitted it to apply safeguards in only a handful of the offered plants.

The preamble to China's 1989 agreement with the IAEA referred to China's intention to require safeguards on all its nuclear exports.[101] China's nuclear export policy now resembled that followed by several Western and Eastern European countries before 1990. China had pledged to require safeguards on any nuclear equipment or material that it exported, but it would not make export to non-nuclear-weapon States conditional upon the application of safeguards on *all* nuclear activities in the importing State. In other words, it would not insist on the comprehensive safeguards required, since the late 1970s, by the USA, Australia and Canada and some other 'Northern' countries as a condition of nuclear supply, and which were now required by all other major nuclear exporters.

In 1992, China acceded to the NPT.

Germany

On 3 October 1990, Germany was formally reunified. The next day, Bonn informed the IAEA that, following the accession of the German Democratic Republic to the Federal Republic of Germany, the rights and obligations arising from all agreements to which the Federal Republic of Germany was party and that were relevant to the IAEA would also relate to the territory of the former German Democratic Republic.[102] The chief nuclear agreement in this category was that between the IAEA, EURATOM and its non-nuclear-weapon States, which would henceforth supplant the safeguards agreement between the IAEA and the former German Democratic Republic.

In the same year —1990 — at the fourth NPT review conference, Hans Dietrich Genscher, Vice Chancellor and Foreign Minister of the Federal Republic of Germany, took many of his Western European colleagues by surprise by announcing that the Federal Republic would make comprehensive safeguards a condition of new nuclear supplies to any non-nuclear-weapon State. Within the next two or three years all members of the European Union and Switzerland agreed to follow the same policy. The NSG adopted it as a rule governing future nuclear exports, and it was endorsed by the NPT Review and Extension Conference in 1995.[103]

In the early 1990s, Germany also contributed significantly to the general tightening of national nuclear export controls. To some extent, this was a reaction to disclosures about the active role that certain German engineers and companies had played in helping Iraq's clandestine nuclear programme and in other questionable nuclear exports, but Germany was by no means alone in this regard. Germany was also active in the early 1990s in proposing measures to strengthen IAEA safeguards, such as the universal reporting system.

Nuclear weapon free zones

In the 1980s, three of the leading countries in Latin America — Argentina, Brazil and Chile — radically changed their policies concerning non-proliferation and IAEA safeguards. One of the factors that may have helped to cause the change was the advent of democracy and civilian governments in Buenos Aires, Brazilia and Santiago, but the change had already begun under the former military rulers. Whatever its cause, the change transformed the prospects for fully implementing the Tlatelolco Treaty and thus making Latin America and the Caribbean countries and their surrounding seas forever free of nuclear weapons and nuclear explosives of any kind.[104]

On 28 November 1990, at Foz do Iguaçú in Brazil, the Presidents of Argentina and Brazil signed a 'Declaration on Common Nuclear Policy' in which they agreed jointly to apply comprehensive bilateral safeguards that would also be subject to international verification. They underlined the symbolic importance of their action by inviting the Director General of the IAEA to the ceremony attending the signing of the Declaration. In July 1991, the two Presidents signed an agreement[105] establishing a common system and a joint agency for the accounting for and control of nuclear materials — the Brazilian–Argentine Agency for Accounting and Control of Nuclear Materials, or ABACC. The two nations and ABACC then negotiated a safeguards agreement with the IAEA similar in many respects to that between the IAEA and EURATOM and its non-nuclear-weapon States. The agreement provided for the application of IAEA as well as bilateral safeguards on all nuclear material in all Argentine and Brazilian nuclear activities and on all relevant nuclear exports. The Presidents of Argentina and Brazil came to the IAEA in December 1991 to sign the agreement and subsequently addressed the Board on its significance.[106] The agreement entered into force in March 1994.[107]

The evolution of the ABACC agreement and the subsequent safeguards agreement with the IAEA suggests that, where two nations have long distrusted one another's nuclear activities, there must first be a thaw in their political relations before any progress can be made with safeguards of any kind. It may then be necessary for them to reach agreement on intrusive 'adversarial' mutual inspections before they are ready to accept international safeguards. This may apply to South Asia and the Middle East as well as to Argentina and Brazil.[108]

On 18 January 1994, Chile became party to the Treaty of Tlatelolco; its comprehensive safeguards agreement with the IAEA required by that Treaty came into force in April 1995.[109] Chile subsequently acceded to the NPT on 25 May 1995.[110]

Cuba also made known its intention of joining the Treaty and signed it in 1995.[111] When Cuba ratifies the Treaty and concludes a comprehensive safeguards agreement with the IAEA, the Treaty will come into force for the entire region of Latin America and the Caribbean, including its adjacent oceans, so that it will extend to the eastern and northern borders of the zones covered by the Rarotonga and Antarctic Treaties.

After South Africa had joined the NPT and dismantled its nuclear arsenal the door was opened to a nuclear weapon free zone in Africa. In 1995, as noted later, the African nations, meeting in South Africa, reached agreement on the text of the Pelindaba Treaty, as it was called, and in April 1996 this treaty was opened for signature in Cairo.

In 1995, France completed a series of nuclear tests that had aroused sharp criticism amongst the nations of the Pacific and in some parts of Western Europe. France then announced that it would carry out no more tests and that it would dismantle its testing facilities on Mururoa Atoll in the South Pacific. France, the United Kingdom and the USA then signed the Protocol to the Rarotonga Treaty in which they undertook to respect the nuclear weapon free status of the region. The Rarotonga Treaty had been designed as much, if not more, to put an end to nuclear testing in the region as it was to keep nuclear weapons out of the hands of the South Pacific nations, none of which has shown any inclination in recent years to acquire them.[112] With the entry into force of the Protocols to the Treaty it became an effective instrument for achieving both aims.

In December 1995, the ten nations of South East Asia reached agreement on and opened for signature the Bangkok Treaty establishing a nuclear weapon free zone in that region.

In 1985, only a single regional treaty banning all nuclear weapons and all nuclear testing was effectively in force: the Antarctic Treaty of 1959. By the end of 1996, five regional treaties were in force or in the process of ratification (the Antarctic, Tlatelolco, Rarotonga, Pelindaba and Bangkok Treaties). The Southern Hemisphere and the lower latitudes of the Northern Hemisphere were on the way to becoming a vast nuclear weapon free zone. A promising approach was in hand for the step-by-step elimination of nuclear weapons. This may have encouraged initiatives to establish similar zones in Central Asia, North East Asia and Eastern Europe. But proposals to establish such zones had made little progress in the Middle East and South Asia — the regions that, since the end of the Cold War, had become those in most urgent need of the elimination of the nuclear threat.

Iraq's clandestine nuclear weapon programme

In 1991, after the end of the Gulf War, the Security Council requested the IAEA to verify the elimination of Iraq's ability to acquire nuclear weapons. IAEA inspectors gradually unveiled the full extent of Iraq's large clandestine nuclear weapon programme and its repeated violations of the comprehensive safeguards agreement that, as a party to the NPT, it had concluded with the IAEA. The fact that Iraq's nuclear weapon programme had been under way for several years, perhaps a decade, without being detected by the IAEA, led to sharp criticism of the Agency and posed the most serious threat to the credibility of its safeguards since they had first been applied some 30 years earlier. Critics compared the IAEA's safeguards unfavourably with what they claimed to be the much bolder and more aggressive operations of the special United Nations commission, UNSCOM, that the Security Council created to monitor the elimination of Iraq's potential for waging chemical and biological warfare and of its arsenal of longer range missiles. There were proposals in one or two academic journals in the USA to take some or all of the safeguards operation out of the hands of the Agency and transfer it to another international authority such as the Security Council.

The IAEA's safeguards had been able effectively to monitor all the *declared* programmes of the many States that had accepted them. The IAEA reacted vigorously to the challenge posed by Iraq by instituting reforms that made it far better equipped to detect any *clandestine* nuclear activities that might exist in States having comprehensive safeguards agreements. The IAEA's determined and decisive performance in the case of the DPRK put a damper on the criticism of the Agency and, together with the passage of time, seems to have put an end to most proposals for transferring its safeguards responsibilities elsewhere. This question is also discussed in Chapter 12.

Since 1994, the IAEA has kept its inspectors continuously in Iraq[113] and it has completed arrangements for the ongoing monitoring of Iraq's compliance with the relevant Security Council resolutions.

Chapter 8 contains a detailed examination of the Iraqi programme and the steps the IAEA has taken to meet future challenges to it safeguards operations.

The violations by the DPRK of its safeguards agreement

In 1992, after lengthy negotiations and under growing international pressure, the DPRK brought into force its NPT safeguards agreement with the IAEA. However, the IAEA was unable to verify that the Initial Report submitted by the DPRK covered — as it was required to do — all nuclear material in that country. In February 1993, the IAEA requested a special inspection of two locations that appeared to be nuclear waste stores and that the DPRK had not listed in its Initial Report. After the DPRK had rejected the request, the Board concluded that the DPRK had violated its safeguards agreement and reported the violation to the Security Council, whereupon the DPRK gave notice of its withdrawal from the NPT. The USA interceded, and the DPRK suspended its notice of withdrawal but continued to hamper the application of safeguards. In 1994, a major international crisis seemed imminent. Former US President Carter stepped in and secured the outline of a possible settlement. After President Kim Il Sung's death, the USA and the DPRK reached agreement on a scheme that would freeze and eventually dismantle the DPRK's nuclear programme in return (chiefly) for the supply of two large power reactors of US design.

The DPRK's dispute with the IAEA, which became a challenge to its membership as a whole and to the Security Council, and the steps taken to defuse the ensuing crisis, are examined in detail in Chapter 8.

Other developments affecting IAEA safeguards

Two other developments of particular importance to IAEA safeguards should also be mentioned. In 1992, China and France acceded to the NPT. All five nations recognized as nuclear weapon States under the NPT had thus become party to the Treaty. In the same year, the IAEA and EURATOM agreed to a 'partnership approach' in an effort to eliminate unnecessary duplication in the application of safeguards under the 1977 agreement (INFCIRC/193). It was expected that the new approach would eventually reduce by as much as two thirds the routine inspections that the IAEA carries out in the 13 non-nuclear-weapon States of the European Union.

'Sustainable development' and climate change

During the 1980s, concern continued to deepen about mankind's ability to sustain economic development without further injury to the planet's natural environment and depletion of its finite natural resources. An international mark of this concern was the decision to hold the United Nations Conference on Environment and Development in Rio de Janeiro in June 1992.

In 1988, in preparation for the Rio Conference, the General Conference asked the Director General to prepare a report for the Board for submission to the United Nations General Assembly on the Agency's contribution to "environmentally sound and sustainable development."[114]

During the Rio Conference two treaties were opened for signature, one of direct interest to the IAEA being a 'United Nations Framework Convention on Climate Change'. The Conference also adopted 'Agenda 21' — a document described as "a global consensus on environment and development issues [of the 21st century] and a political commitment at the highest level to international co-operation."[115] In 1993, the General Assembly established a 53-nation Commission on Sustainable Development and the United Nations Secretary General set up a parallel interagency committee to co-ordinate the approach of the various organizations in the United Nations system. This interagency committee appointed the IAEA as 'task manager' on radioactive wastes, one of the 40 chapters covered by Agenda 21.

In September 1995, the Secretariat provided the Board with a detailed survey of the IAEA's work contributing to sustainable development.[116] Most of this work is described in Chapters 7, 9 and 10 of this book. The IAEA programmes that have made the largest direct contribution are those dealing with the management of nuclear waste and with nuclear safety and radiation protection. Many of the FAO/IAEA activities in, for instance, conservation and the use of plant and animal genetic resources (helping to maintain biodiversity) and more effective conservation and use of water have clearly been relevant. So too has been the IAEA's work in human health, in monitoring pollutants, in controlling insect pests and, in particular, the work of the IAEA's Marine Environment Laboratory in Monaco on radioactive and non-radioactive pollution[117] of the oceans and the Caspian Sea.

It is now a truism that the burning of fossil fuels is a major potential threat to the environment. The industrialized countries have hardly made any progress in reducing the emission of greenhouse gases, in particular carbon dioxide, the leading cause of global warming. Moreover, there are rapidly rising emissions in the developing countries for whom fossil fuels are the most readily available energy source.

In October 1995, the IAEA jointly with the European Union, the World Bank, the World Meteorological Organization and five other international and regional agencies held a conference in Vienna entitled 'Electricity, Health and the Environment' as a follow-up to a similar 1991 IAEA symposium in Helsinki. The 1995 conference noted that much more information and better computer tools had become available since the Helsinki meeting, that nuclear power already played an important role in reducing carbon dioxide and other pollutants emitted in the generation of electricity, and that there was still significant uncertainty about the risks caused by the emission of carbon dioxide and its effect on average global temperatures. However, if greenhouse effects were included in an overall assessment of the environmental impact of electricity generation, then hydro-power and nuclear power were the only available large scale energy sources that had relatively low 'external' costs (i.e. indirect costs besides capital, operating and maintenance costs). The conference also noted that positive messages were not getting through to decision makers and the public or leading to more support for nuclear power.[118]

'Zero [real] growth' and financial crises

In 1984, the main contributors to the IAEA's regular budget decided that they would not accept real growth in that budget. Since then the amount available to the Agency for its programmes other than technical co-operation has, with one or two exceptions, remained the same in real terms. The exceptions were a moderate increase (after Chernobyl) in the funds available for the nuclear safety programme and various 'tied' grants that Member States have made to programmes of particular interest to them, especially safeguards.

The 'zero-growth' strait-jacket eventually caused the IAEA, and particularly its expanding safeguards operation, a good deal of financial strain. The amount of nuclear material that had to be safeguarded increased constantly as new plants came into operation, as the amount of spent fuel built up and as the entire nuclear programmes of South Africa, Argentina, Brazil, Ukraine and other republics of the Commonwealth of Independent States and the Baltic States came under safeguards. The number of plants using particularly sensitive material (e.g. reactors using mixed oxides of plutonium and uranium

— MOX — fuel) and hence requiring more frequent inspection, also continued to grow.

This growing demand was partly but by no means fully offset by the agreement between the IAEA and EURATOM on a partnership approach to their safeguards operations or by cancellations of previous orders for nuclear plants, particularly in Germany, where the construction of a large reprocessing plant at Wackersdorf had been abandoned and where the Siemens company decided not to start up the MOX fuel fabrication plant it had built at Hanau.

In 1991, when Russia was unable to pay its assessed contribution, the amount available for regular budget programmes fell by about 4%. The IAEA had to defer the purchase of equipment for safeguards and data processing systems, and the conclusion of several research contracts.[119] In 1992, an even deeper cut of 13% had to be made in the budgets of all IAEA Departments.[120]

In 1993, Russia was able to resume payment of its assessed share of the budget but the requirement for 'zero growth' remained in place.[121] Despite this constraint, the IAEA has been able to expand many of its core programmes; chiefly because of the special 'extrabudgetary' contributions that governments made to activities of particular interest to them. While these contributions were welcomed by the Agency, they tended to take the direction of the IAEA's work partly out of the hands of its Governing Bodies and its Secretariat and into those of the donor countries.

Did zero growth and the financial tribulations of 1991 and 1992 eliminate all waste — 'press all the water' — out of the IAEA's budget? They may have eliminated some projects of marginal interest and induced greater efficiency, but they also forced the IAEA to curtail certain important activities. For instance, as an independent, authoritative and hard-headed source, the US General Accounting Office, put it in 1993: "...the Department [of Safeguards] had to defer or cancel inspections, equipment purchases, and other activities. Because of its financial difficulties, IAEA has been unable to maintain its equipment inventory or fully meet certain inspection goals."[122] The situation probably became more critical after the General Accounting Office came to those conclusions in 1993.

In the case of nuclear safety the same report drew attention to the fact that "in the absence of adequate budgets the IAEA had come to rely on cost-free experts, for instance to staff operational safety review missions, and there was concern that these sources were uncertain and may not always be available for future activities."[123]

Nuclear trafficking

The dissolution of the USSR left Russia and most other successor States with inadequate legal and technical systems for preventing the theft of nuclear material and the smuggling of such material out of the country. From 1992 onwards the IAEA carried out special programmes to help the successor States of the Soviet Union to apply effective preventive measures. It also encouraged them to ratify and apply the 1987 Convention on the Physical Protection of Nuclear Material as well as the IAEA's guidelines on physical protection.[124]

Since many Russian nuclear scientists had lost their former comparatively privileged positions and had seen their salaries reduced to a pittance it was also feared that at least some of them might be tempted to sell on the black market whatever fissile material they could lay their hands on or sell their services to terrorists or dubious governments. Although this particular fear has so far proved to be largely unfounded, the number of smuggling incidents rose rapidly from 1991 to 1994.

In that year there were the first detected attempts at smuggling weapon usable material (plutonium and HEU) — three in Germany and one in the Czech Republic. In all cases the amounts of material involved were at least an order of magnitude smaller than the 'significant quantity' that the IAEA has estimated a beginner country would need for its first atom bomb.[125] The largest amount of fissile material intercepted was 2.73 kg of HEU (87.7% enriched) that the Czech police seized in Prague on 14 December 1994. In the German cases the largest amount of fissile material intercepted was approximately 363 g of plutonium intercepted at Munich airport on 10 August 1994.[126]

According to information available to the IAEA, national and international police authorities had been unable (at least by the end of 1996) to discover any organized gang or 'mafia' behind these operations or any plausible customers for the smuggled material. Nonetheless, the matter was disturbing and in many countries public opinion became increasingly alarmed. In September 1994, the General Conference called upon Member States to make every effort to prevent trafficking in nuclear materials.[127] The Conference recognized that States themselves had the main responsibility for preventing trafficking — crime must be addressed at its source — but stressed that close co-operation between States was also essential and the IAEA should support its Member States in their efforts by:

— Helping them to prevent trafficking (for instance, helping them to draft laws and regulations, helping them to apply effective measures of physical protection and of the accounting and control of nuclear material, and effective export and import controls);
— Helping them to respond quickly and effectively to any incident that occurs, for instance, by rapid and accurate analysis of confiscated materials;
— Providing training in prevention and response;
— Promoting the exchange of information.

In 1992, the IAEA had begun the systematic collection of reports in the media on incidents of trafficking in radioactive materials so as to ensure that the organization itself was fully aware of such incidents.[128] In December 1994, the Board approved a number of proposals to enhance the services the IAEA could offer in helping Member States to improve the protection of nuclear material and to detect and suppress trafficking. In 1995, the functions of the 1992 database were expanded so as to enable the IAEA to provide its Member States and the public with authoritative information about reported smuggling attempts. The database became fully operational in respect of media reports in August 1995, and in late 1995 the IAEA began seeking information directly from the authorities of the States concerned.[129] Governments agreed to provide information on the date and place of any incident and a brief description of the material involved, and they may volunteer confidential information about the composition and origin of the material, its packaging and the persons involved. If the IAEA did not hear from the government about an incident mentioned in the media and media reports persisted, the IAEA would take the matter up with the government concerned.

In 1995, the IAEA also held a number of meetings with Member States, the UN, EURATOM and international police organizations such as INTERPOL to assess the extent of the trafficking problem and to recommend further action, for instance systematic sharing of information, improved detection of smuggled material at frontier crossings, fuller use of the database and prompt notification of incidents. By the end of 1995, 25 nations had informed the IAEA that they were prepared to take part in the sharing of information, and it was expected that the number would rapidly increase.[130] The main difficulty in some cases was internal: deciding which national authority should be the point of contact with the IAEA.

According to the IAEA's database the number of confirmed — and intercepted — attempts to smuggle in nuclear material went up from 43 in 1993 to 44 in 1994 and down to 27 in 1995 and 17 in 1996. The cause of the decline between 1994 and 1996 was not clear, nor was there any indication whether it was temporary or that the existence of a market for such material might be questionable — in other words, that nuclear smuggling is a dangerous and unremunerative exercise.[131]

A cursory analysis of the IAEA database shows that in the four years 1993–1996, 132 incidents were confirmed: 54 in Germany, 22 in the Baltic States and 10 in Poland. The remainder were scattered as far afield as India, Ecuador and Kazakstan, but most were in Eastern Europe and the Balkans. What was perhaps more to the point were the quantities and nature of the materials: 82 of the cases involved natural, depleted or low enriched uranium, mostly in gram quantities, but in three cases in amounts of several kilograms. The largest amount was 149.8 kg of 3.3% enriched uranium — typical low enriched reactor fuel — in Kazakstan. Six of the cases involved gram or milligram quantities of plutonium.[132]

In short, during these four years no confirmed case involved an amount or type of nuclear material that could be considered significant from the point of view of diversion or explosive use.[133] In fact, the only persons put at risk by this trafficking were the traffickers themselves who, in a few cases, exposed their persons to highly radioactive substances such as cobalt-60 and strontium-90. Of course, this does not mean that all cases of trafficking were detected, nor that this relatively innocuous pattern will continue, nor that controls and monitoring of contraband material can be relaxed. On the contrary, the fact that the spotlight has been turned on this criminally dangerous trade and that the national and international organizations concerned are increasingly alert to it may help to account for the decline in the number of confirmed incidents.

The IAEA's membership and finances at the end of 1996

By the middle of 1997, the IAEA's membership had risen from the 54 that had joined it when the first General Conference opened in October 1957 to a total of 124. For more than one quarter of its history the IAEA had been operating under zero growth in its regular budget. Under the 1996 regular budget the resources available to it amounted to $249 million (down from $251 million in 1995), plus $63.3 million (compared with $63.5 million in 1995) for technical co-operation activities. The apparent increase in the regular budget, shown in Table I in Annex 3, was due entirely to changes in the rate of exchange and inflation; there was no increase in real terms.

1981–1997: Summing up

It is now a truism that the 17 years from 1981 to 1997 and especially those around the turn of the decade brought about the most far-reaching changes in the world's political scene since 1945: the end of the Cold War and of the fear of a nuclear Armageddon, the beginning of major nuclear disarmament in Russia and the USA, widespread disenchantment with Marxist and statist economics and conversion to market philosophies, the dissolution of the Soviet Union and the Warsaw Pact and the end of Communist party rule in Eastern Europe, Russia and other successor States of the USSR, a widespread movement towards democracy in Latin America, the end of white rule and apartheid in southern Africa, rapid economic progress in China and in the 'tigers' of North East and South East Asia, and progress towards a European Union. Some issues did not change; for instance, political mistrust persisted between the leading nations in South Asia (but there had been no war between them for more than 20 years). Despite the Oslo accords the Middle East remained volatile, though perhaps less so than in the previous two decades.

Many of these changes had an impact on the IAEA's programmes, particularly those relating to safeguards, which will be examined in Chapter 8. The period also saw the worst nuclear accident and the gravest set-back to nuclear power since it first came into use in the 1950s, a challenge to the credibility of the non-proliferation regime in Iraq and the DPRK, and the IAEA's responses to these challenges, and for the IAEA as a whole, a financial crisis, mitigated to some extent by special contributions by several Member States.

As the period drew near to a close there were several other crucial developments. In April 1996, the Agency, the European Commission and WHO convened a major conference to sum up the consequences of the Chernobyl accident, as they could now be perceived ten years after it had happened. All the interested UN and regional agencies worked together to ensure that the findings of the Conference were of the highest scientific order and authority and that they would be as widely disseminated as possible.[134] The Conference attracted more than 800 experts from some 70 countries. It findings are examined in more detail in Chapter 7.[135]

Another important development affecting nuclear safety was the entry into force on 24 October 1996 of the 'Convention on Nuclear Safety' (also examined in more detail in Chapter 7). By 30 June 1997, 37 countries had become party to the Convention and they included most nations operating nuclear power reactors (though not yet the USA). By that date, the drafting of a joint convention on the management of spent fuel and radioactive waste had been completed.[136]

The crucial event affecting IAEA safeguards was the decision of the parties to the NPT to extend the treaty indefinitely and thereby also to extend indefinitely the duration of safeguards agreements concluded in accordance with the Treaty between the IAEA and non-nuclear-weapon States. The parties took this decision (without a formal vote) at the Review and Extension Conference held at UN Headquarters in New York in May 1995. At the same time, the parties approved a document setting out the principles and objectives in the light of which the implementation of the Treaty will be assessed, and also approved arrangements for strengthening the review process itself. The decisions of the parties implied "a renewed and collective commitment... to the exclusively peaceful use of nuclear energy," and a commitment by the weapon States to nuclear disarmament.[137] The Agency's role as the central point for nuclear co-operation was confirmed, and "the Agency was expressly recognized as the competent authority responsible for verifying compliance with safeguards agreements."[138] The Conference also "urged support for Agency efforts to strengthen safeguards and to develop its capability to detect possible undeclared nuclear activities."[139] It also recommended that "nuclear material released from military use be placed under Agency safeguards as soon as practicable"[140] and called for the early conclusion of a cut-off convention and for the creation of additional nuclear weapon free zones. The Conference stressed the importance of concluding a comprehensive nuclear test ban treaty not later than the end of 1996.

Progress has been made in achieving a number of these aims. In 1995, the Board of Governors had authorized the Secretariat to put into effect those elements of the 'Programme 93 + 2' that did not require additional legal authority. In May 1997, the Board approved a protocol to existing comprehensive safeguards agreements that will provide the legal authority for several safeguards measures that go beyond the existing system, for instance, access by the IAEA to more information about a State's nuclear activities, more intensive inspections, including access beyond previously agreed 'strategic points' in a safeguarded plant, access to any installation within the perimeter of a nuclear site, and access to plants engaged in nuclear related activities such as those manufacturing components of enrichment plants. The changes foreseen in the protocol are also designed to make safeguards under comprehensive agreements more cost efficient.

As already noted, in April 1996 the States concerned signed and opened for signature in Cairo the Pelindaba Treaty establishing a nuclear weapon free zone in Africa,[141] and in December 1995 a treaty creating such a zone in South East Asia was signed in Bangkok. When these treaties enter into force and when the remaining steps are taken to bring the Tlatelolco Treaty fully into effect, the following regions of the world will be free of nuclear weapons under international law: Antarctica; Latin America and the Caribbean; the South Pacific; Africa; South East Asia.

By the end of 1996, the IAEA was already verifying that certain nuclear material (HEU and plutonium) declared by the USA to be surplus to its military needs remains removed from the military programme. In September 1996, the Russian Minister for Atomic Energy, Viktor Mikhailov, the US Secretary of Energy, Hazel O'Leary, and Director General Hans Blix agreed to explore the technical, legal and financial issues relating to the verification of nuclear material withdrawn from military use.[142]

Also in September 1996, the UN General Assembly approved and opened for signature a Comprehensive Test Ban Treaty.[143]

In short, since 1990 there has been a consolidation and extension of the NPT regime to a point where universality is closer than appeared possible even a few years ago. Some 45 States acceded to the NPT between 1990 and 1996, including the last two nuclear weapon States, China and France, as well as Argentina and South Africa. Five nuclear weapon free zones each requiring IAEA verification are in force or in gestation. IAEA safeguards or verification have been extended, for the first time, to cover former nuclear weapon material in the USA and South Africa. Finally, much strengthened IAEA safeguards have been approved by the Board of Governors.

At the end of 1996, Hans Blix informed the Board that he would not seek to extend his appointment beyond the current term. His 16 years of service as Director General of the IAEA would thus come to an end in December 1997.

During those 16 years Blix had guided the IAEA through several crises and under his direction the Agency has accomplished much to enhance its authority and role in international affairs. The crises included the temporary withdrawal of the USA from the IAEA at the end of 1982, the Chernobyl disaster, and violations of their safeguards agreements by Iraq and the DPRK.

The IAEA's accomplishments, under Blix's direction, included prompt and effective reaction to Chernobyl, its authoritative analyses of the causes and effects of that accident, the two conventions on early notification and mutual emergency assistance negotiated (exceptionally swiftly) in 1986, the entry into force of the Nuclear Safety Convention in 1996 and the completion of work on the draft of a convention on the management of nuclear waste. Blix had responded with similar effectiveness to the revelation of Iraq's clandestine nuclear weapon programme and the DPRK's breach of its safeguards agreement. His analysis of the lessons of Iraq provided the framework for 'Programme 93 + 2' approved by the Board in May 1997 — the most important development in international nuclear safeguards since the establishment of the NPT safeguards system in 1971. The growing efficacy and impartial application of IAEA safeguards were undoubtedly factors in the 1995 decision of the parties to make the Treaty permanent.

In June 1997, by a unanimous decision, the Board appointed Dr. Mohamed ElBaradei as successor to Dr. Blix. Dr. ElBaradei is a distinguished international lawyer and diplomat and author of numerous publications on the United Nations, the IAEA and international law. He has served the IAEA since 1984 in several senior capacities, most recently (since 1993) as Assistant Director General for External Relations. He carries the rank of Ambassador in the Egyptian Foreign Service. It is expected that at its autumn session the General Conference will approve Dr. ElBaradei's appointment.

NOTES

[1] Also the Musikakademie itself, where the IAEA was temporarily housed, the Venediger Au near the Prater, the 'Gutman' building on Schwarzenbergplatz near the Konzerthaus, the Biberstein building and the Gartenbaugrund, the Coburg Palace and the Stadtschulrat in the First District (i.e. the inner city). A partial listing is given in document GOV/68 of 18 December 1957. Later there was some discussion of a castle at Laxenburg (now housing the International Institute for Applied Systems Analysis) as a possible permanent headquarters for the Agency.

[2] Until new meeting rooms were built, the Board met in a suitably refurbished chamber in the Hofburg palace. For reasons that remain obscure, the IAEA's Director of Finance occupied the honeymoon suite in the Grand Hotel and sat below a suitably unclad mural of Venus.

After the IAEA moved to its newly built headquarters in the Donaupark, the Grand Hotel was first refitted as a bank and since then has reverted partly to its original role of a luxury hotel and has also been transformed into an upmarket shopping centre. Until the 1980s, when the Austrian Government built a new conference centre at the Donaupark, the General Conference held its annual session in the halls of the Hofburg Palace.

3 The Board elected Goldschmidt as its chairman on 11 December 1979 (document GOV/OR.541 of April 1980). Goldschmidt was the author of several illuminating books about the wartime and post-war development of nuclear energy and about nuclear relations between the Allied governments. The best known is *Le Complexe Atomique* (Fayard, Paris (1980)), subsequently translated into English by the American Nuclear Society.

4 The panel had concluded that nuclear power could well be the key to the economic future of the USA and had recommended the expeditious development of nuclear power including, if necessary, the "construction of one 'demonstration' plant of each major reactor size and type with public funds." HEWLETT, R.G., HOLL, J.M., *Atoms for Peace and War: 1953–1961, Eisenhower and the Atomic Energy Commission*, University of California Press, Berkeley, CA (1990) pp. 205 and 327–328.

5 Personal communication from Ambassador Roland Timerbaev, for many years Soviet and later Russian Resident Representative to the IAEA. Molotov's appointment filled the air with rumours. It was reported — correctly — that Stalin had kept Molotov's wife, Paulina Semenovna Zhemchuzhina, in prison in the late 1940s. She was Jewish and was suspected by Stalin and Beria of supporting the Zionist cause. It was also said that Molotov's staff, who obviously disliked him, fed him incorrect information so as to make him look foolish when he spoke in the Board or General Conference. What was undeniable was that he was deliberately humiliated by being listed as the fourth ranking member of the Soviet delegation at the General Conference.

6 See HEWLETT, R.G., HOLL, J.M., *Atoms for Peace and War*, p. 437, on Cole's salary. Cole also unnecessarily exposed himself to some ridicule by producing his own bizarre design for a special flag for the IAEA — in place of the UN flag — and trying to persuade a hilarious Board to approve it. A somewhat harebrained proposal by a senior IAEA scientist, unwisely endorsed by Cole, was that the IAEA should buy tens of thousands of cattle, pigs and other mammals, possibly transport them to a Mediterranean island and irradiate them over a period of 15–20 years to study the genetic and somatic effects of a diet containing strontium-90. Inevitably, the proposal became known in the Secretariat as the "cow project"; it was unanimously rejected by the Board. (See STOESSINGER, J.G.,

"Atoms for Peace: The International Atomic Energy Agency", *Organizing for Peace in the Nuclear Age*, Report of a Commission to Study the Organization of Peace, New York University Press, New York (1959) 168.) But Cole was kind and loyal to those whom he liked and he made many friends.

[7] Lewis Strauss to John Foster Dulles (HEWLETT, R.G., HOLL, J.M., *Atoms for Peace and War*, p. 437). See also STOESSINGER, J.G., "The International Atomic Energy Agency: The first phase", *International Organization* **13** 3 (1959) 404.

[8] STOESSINGER, J.G., "The International Atomic Energy Agency: The first phase", p. 404. By the end of 1958, 68 bilateral agreements for nuclear assistance had been concluded, 45 by the USA, 12 by the United Kingdom, 9 by the Soviet Union and 2 by Canada, ibid., p. 405.

[9] Very briefly, the issue was whether the USA would accept EURATOM safeguards as a substitute for those of the IAEA as the pro-Western European diplomats at the State Department and the Secretary of State, John Foster Dulles, urged. Despite the opposition of Cole and Lewis Strauss, the Chairman of the USAEC, Eisenhower accepted the State Department's recommendation.

[10] "However formidable on the ground, from the air the Soviets were naked unto their enemies." Until 1960 the Soviet Union was "defenceless against [US] strategic bombing." RHODES, R., *Dark Sun: The Making of the Hydrogen Bomb*, Simon and Schuster, New York (1995) pp. 349 and 348.

[11] As a consequence, several articles of the IAEA's Statute were doomed to be dead letters. In particular, Articles IX, X and XIII dealing with the supply to the IAEA of nuclear hardware and services and payment for such supplies; Article XIV.E enjoining the IAEA to draw up a scale of charges for hardware and services it supplied; and Article VII.G implicitly providing for the recruitment of guards. Under Article IX.A, the materials were to be stored by the member or "in the Agency's depots". Under Article IX.H, the IAEA was to be responsible for storing and protecting materials in its possession (for instance, against forcible seizure) and for ensuring their "geographical distribution of these materials in such a way"...as to avoid concentrating them in any one country or region. Under Article IX.I, the IAEA was to acquire all the facilities needed for "for the receipt, storage and issue" and "control laboratories for the analysis and...verification of [nuclear] materials received" as well as "housing and administrative facilities for any staff required..." The Agency had no occasion to take action under any of these provisions.

[12] *First Annual Report of the Board of Governors to the General Conference Covering the Period from 23 October 1957 to 30 June 1958*, GC(II)/39, IAEA, Vienna (1958), p. 39, para. 177.

[13] The exceptions were gram quantities of fissile material that the USA provided (much later) to the IAEA's laboratory. Member States also submitted requests for small amounts of nuclear and other radioactive material for use in their laboratories. After a request had been approved by the Board, the USA or one or two other suppliers sent the material direct to Member States. In due course the Board delegated to the Director General the authority to approve such transfers.

[14] As the 1958–1959 Annual Report of the Board put it: "the cost of nuclear power production...has not yet been reduced sufficiently to make it economically attractive" except in special circumstances. (*Annual Report of the Board of Governors to the General Conference Covering the Period from 1 July 1958 to 30 June 1959*, GC(III)/73, IAEA, Vienna (1959), p. 3, para. 8.)

[15] Document GOV/OR/254, para. 75.

[16] The administration of fellowships had been assigned to one Department in the Secretariat. The administration of other types of technical assistance (for which funds became available in 1959), namely the services of experts and the scientific equipment, was somewhat illogically assigned to another Department. So Jolles appointed, in his own extensive 'Department of Administration, Liaison and Secretariat', a 'co-ordinator' for technical assistance. By this appointment three Departments in the Secretariat became responsible for administering technical assistance.

[17] "Duties of the Director General", Rule 8 (a), *Board of Governors, Provisional Rules of Procedure,* GOV/INF/5, IAEA, Vienna (1958) 5.

[18] BECHHOEFER, B.G., *Postwar Negotiations for Arms Control*, The Brookings Institution, Washington DC (1961) 11.

[19] SZASZ, P.C., *The Law and Practices of the International Atomic Energy Agency*, Legal Series No. 7, IAEA, Vienna (1970) 313–314. There has been no grant of consultative status since then, but by the 1970s the issue had ceased to be divisive. In 1975, the General Conference asked the Board to invite every year appropriate NGOs to attend its future regular sessions, that is NGOs concerned with developing the peaceful uses of nuclear energy or research in the nuclear sciences.

[20] Document GOV/OR.74, para. 45.

[21] *First Annual Report of the Board of Governors to the General Conference Covering the Period from 23 October 1957 to 30 June 1958*, p. 9, para. 40; and *Annual Report of the Board of Governors to the General Conference Covering the Period from 1 July 1958 to 30 June 1959*, Annex I.C, p. 56.

[22] CONGRESS OF THE UNITED STATES, *Background Material for the Review of the International Atomic Policies and Programs of the United States*, Report to the Joint Committee on Atomic Energy, Vol. 3, US Govt. Printing Office, Washington, DC (1960) 740–741.

[23] *First Annual Report of the Board of Governors to the General Conference Covering the Period from 23 October 1957 to 30 June 1958*, p. 30, para. 131.

[24] EPTA was one of the two precursors of the present United Nations Development Programme — the other precursor, then still in gestation, was the United Nations Special Fund, which was designed to focus on larger projects.

[25] Document GOV/OR.98, paras 12–18 (Sterling Cole's report to the Board on the conference) and CONGRESS OF THE UNITED STATES, *Review of the International Atomic Policies and Programmes of the United States*, p. 773. Before the conference, Cole tried but failed to persuade the Austrian Foreign Ministry that it should use its influence with the UN to have the venue of the conference transferred to Vienna.

[26] *Annual Report of the Board of Governors to the General Conference Covering the Period from 1 July 1958 to 30 June 1959*, pp. 48–49, paras 227–228.

[27] Ibid, p. 49, para. 229, and material provided by the Director of the laboratory.

[28] *Annual Report of the Board of Governors to the General Conference 1 July 1961 to 30 June 1962*, GC(VI)/195, IAEA, Vienna (1962), p. 1, para. 2 and p. 11, para. 70.

[29] HEWLETT, R.G., HOLL, J.M., *Atoms for Peace and War*, pp. 265 and 473.

[30] HEWLETT, R.G., HOLL, J.M., ibid., pp. 175–178.

[31] HEWLETT, R.G., HOLL, J.M., ibid., p. 303.

[32] BECHHOEFER, B.G., *Postwar Negotiations for Arms Control*, pp. 490–491.

[33] STOESSINGER, J.G., "The International Atomic Energy Agency: The first phase", p. 409.

[34] The Conference on Disarmament (CD), which meets in Geneva, negotiated the draft of a comprehensive Nuclear Test Ban Treaty in the course of 1994–1996. India found the draft unacceptable. Hence the CD, which takes decisions by consensus on issues of substance, was unable to approve the draft text, whereupon Australia took the initiative and submitted the draft text to the UN General Assembly together with a resolution approving it. Numerous delegations co-sponsored the Australian resolution, which was adopted on 19 September 1996 by a large majority of members of the United Nations (158 voted in favour of the resolution, three against and five abstained).

If and when the CTBT enters into force the parties will establish an agency in Vienna which will operate its own monitoring system. In the meantime the prospective parties have agreed to establish a Preparatory Commission in Vienna.

[35] Article II.A.8 of the CTBT.

[36] From 1957 to 1959, the Board also established temporary committees on subjects such as the negotiation of agreements between the IAEA and the specialized

agencies, the selection of the IAEA's permanent headquarters and the rules to govern the IAEA's acceptance of contributions and gifts. Since then the Board has set up ad hoc committees to advise it on numerous topics. They include the Board's own size and composition, the financing of technical co-operation and of safeguards, the contents of safeguards systems, assurances of nuclear supplies, the texts of various conventions and, most recently, means of making safeguards more effective and efficient.

[37] The IAEA's own funds plus EPTA/Special Fund (later UNDP), plus the estimated value of contributions in kind. A good deal of this growth was offset by inflation, but even so it was very substantial.

[38] VERNET, D., "Vers l'Europe nucléaire, échaudée par la crise de Suez, la France envisagea très sérieusement, il y a quarante ans, de se doter avec l'Allemagne et l'Italie d'une 'arme nouvelle' ", *Le Monde*, 27 October 1996.

[39] Some States had difficulty in complying with the timetable. A State that was party to the NPT when the Treaty entered into force was required to begin the negotiation of its safeguards agreement with the IAEA within 180 days of the date of the NPT's entry into force, and to bring the safeguards agreement into force within 18 months after the negotiation began. A State that acceded later was required to begin safeguards negotiations on or before its date of accession and (likewise) to bring the safeguards agreement into force within 18 months after the negotiation began. The five non-nuclear-weapon States of EURATOM began their negotiation of the safeguards agreement in 1971 and signed it in 1973, but only brought it into force on 21 February 1977, five years after negotiations began. Even under the more generous interpretation that the States concerned could not be bound by the Treaty's timetable before they had acceded to the Treaty (which they did on 2 May 1975) they were still more than three months late in bringing the safeguards agreement into force! But this sin of omission pales before the delays that attended the entry into force of numerous other agreements — see Chapter 8.

[40] The Oak Ridge Laboratory was actually built in 1943 and the calutrons in its Y-12 plant produced the HEU for the Hiroshima bomb. One of the main purposes of the symposium was to 'consecrate', in a non-religious sense, a large Japanese bronze bell, with scenes of Japan and Tennessee on its panels, designed to keep alive the memory of the bombing of Hiroshima and Nagasaki and to help ensure that nuclear weapons were never used again.

[41] *Annual Report of the Board of Governors to the General Conference 1 July 1963 to 30 June 1964*, GC(VIII)/270, IAEA, Vienna (1964); p. 12, para. 69; and *Annual Report of the Board of Governors to the General Conference 1 July 1964 to 30 June 1965*, GC(IX)/299, p. 35, para. 150. As early as 1960, Abdus Salam, the eminent Pakistani physicist, had

made the case to the IAEA's General Conference for the creation of a theoretical physics centre. He argued that the IAEA was looking for useful things to do, but did not have much money, and that all you needed for work in theoretical physics was a pencil and paper — unlike the large and costly machines essential for work in experimental physics. Salam mobilized support from a number of leading physicists including Richard Feynman, Paul Dirac, Robert Oppenheimer, Henry Smyth and physicists in the USSR.

42 As a follow-up of the research agreement concluded by Sterling Cole on 10 March 1961.

43 The outstanding figures were Henry Seligman, the Head of the Department of Radioisotopes and Radiation, and Carlo Salvetti, Head of the Division of Research and Laboratories. Seligman had been Director of the Isotope Division at Harwell in the UK, and Salvetti had been Director of the Nuclear Research Centre at Ispra in Italy. Both were dissatisfied with the direction their establishments were taking and sought scientific refuge in the IAEA. There were many other pioneers: Mac Fried, the first director of the Joint FAO/IAEA Division; Brian Payne, who launched the IAEA's — and the world's — first international nuclear hydrology programme; Hugh Belcher, who helped build up the IAEA's work in nuclear medicine; Jacques Servant, who launched the IAEA's nuclear safety work; Dragan Popovic and Allan McKnight, who helped establish the IAEA's role in safeguards; and Munir Kahn and Bob Skjöldebrand, who were the driving force of the IAEA's programme in nuclear power. Upendra Goswami, the first Director and later Head of the Department of Technical Assistance, was largely responsible for what was then the most important of the IAEA's programmes and remains so in the eyes of many of the IAEA's Member States. On the non-technical side credit must be given to John Hall, who succeeded Jolles as the Head of Administration; Algie Wells, who replaced Hall in this post for several years; Carol Kraczkiewicz, the first Director of Personnel; and Paddy Bolton, for many years Secretary of the Board and the General Conference.

44 RAINER, R.H., SZASZ, P.C., *The Law and Practices of the International Atomic Energy Agency: 1970–1980*, *Supplement 1 to the 1970 Edition of Legal Series No. 7*, Legal Series No. 7-S1, IAEA, Vienna (1993) 28–29.

45 SZASZ, P.C., *The Law and Practices of the International Atomic Energy Agency*, p. 141. The amendment came into force on 23 January 1963.

46 This would have the result of reducing the number of regional nuclear leaders by two as they (India and Japan) graduated into the top nine. In other words, the number of States to be designated as leading nuclear States within regions *not* represented by the 'nine world leaders' would be reduced from five to three, namely, the States most

advanced in the technology of atomic energy, including the production of source materials, in Africa, Latin America and South East Asia and the Pacific. Two States previously in this category, India and Japan, would move up into the top nine.

47 SZASZ, P.C., *The Law and Practices of the International Atomic Energy Agency*, pp. 142–143; and RAINER, R.H., SZASZ, P.C., *The Law and Practices of the International Atomic Energy Agency: 1970–1980*, pp. 52–53.

48 SZASZ, P.C., *The Law and Practices of the International Atomic Energy Agency*, p. 147.

49 RAINER, R.H., SZASZ, P.C., *The Law and Practices of the International Atomic Energy Agency: 1970–1980*, pp. 14–15.

50 Director General Blix and a senior Japanese member of the IAEA's staff as well as the Government of Pakistan did much, in informal contacts with senior Chinese officials in Beijing and Vienna, to persuade the Government of the People's Republic that China should join the IAEA.

As a result of the Board's decision China could have taken its seat in the Agency at any time it found convenient and did not need to submit a formal application for membership. If Beijing had taken this course, however, it would have recognized implicitly the legality of the action taken by the authorities in Taiwan when they signed and ratified the Statute of the IAEA in 1957. This would have been contrary to the policy of the People's Republic, which apparently was not to recognize the legality of any action taken by Taiwan after 1949 when the Taiwanese authorities fled from the mainland.

51 Taiwan had ratified the NPT on 27 January 1970 and its ratification had been recognized by the USA until it broke off diplomatic relations with the 'Republic of China'. When the Board took its decision, the Secretariat had perforce to break off the negotiation of an NPT safeguards agreement, but it was by no means in the interest of the IAEA, or of the People's Republic or of the other parties to the NPT to withdraw the IAEA's inspectors. Accordingly, the IAEA continued to apply safeguards on the basis of an informal understanding that a previous agreement between the USA, the 'Republic of China' and the IAEA would in practice remain in force and that all nuclear plant and material in Taiwan would brought under that agreement. (See also RAINER, R.H., SZASZ, P.C., *The Law and Practices of the International Atomic Energy Agency: 1970–1980*, pp. 16–17.)

52 The second was in Mexico City in 1972. The opening was the scene of a bizarre diplomatic encounter. Mexico did not recognize the Government of General Franco and the Spanish Republic still maintained diplomatic representation in Mexico City, and, in accordance with the custom of the General Conference, had to be invited, together with all other diplomatic missions, to the opening of the

Conference. The official Spanish delegation was very unhappy and there were fears of a public protest, but the opening passed off without any visible incident.

53 Document GOV/OR.501, para. 93.

54 Author of the 'Smyth Report' on the Manhattan Project, which was written in 1946 to account to Congress for the vast sums spent on the Project. According to Bertrand Goldschmidt (*Le Complexe Atomique*, p. 80), the Smyth Report helped France, and probably the USSR, to avoid blind alleys on the path to their first nuclear weapons. Smyth was a distinguished scientist and a man of great personal charm and integrity. When charges were made that Robert Oppenheimer was a security risk Smyth was the only member of the panel set up to pass judgement on Oppenheimer who opposed the suspension of Oppenheimer's security clearance.

55 BARLOW, A., *The History of the International Atomic Energy Agency* (unpublished thesis), quoting ALLARDICE, C., TRAPNELL, E.R., *The Atomic Energy Commission*, Praeger, New York (1974) 205–208.

56 The Soviet/US and US/EURATOM compromises on IAEA safeguards are reflected in Article III of the NPT.

57 "...to pursue negotiations in good faith for the cessation of the nuclear arms race at an early date" and "on a treaty on general and complete disarmament under strict and effective international controls" in the language of Article VI of the NPT. The commitment to a comprehensive test ban treaty is contained in the eleventh preambular paragraph of the NPT.

58 Articles IV and V of the NPT.

59 *Annual Report of the Board of Governors to the General Conference 1 July 1967 to 30 June 1968,* GC(XII)/380, IAEA, Vienna (1968), p. 1, para. 2.

60 SCHEINMAN, L., *The International Atomic Energy Agency and World Nuclear Order*, Resources for the Future, Washington, DC (1988) 37–38.

61 The US offer related to all nuclear activities, except those having security significance. The formula of the United Kingdom was different but meant much the same.

62 The IAEA's NPT safeguards system and the Treaty of Tlatelolco are examined more fully in Chapter 8.

63 It is estimated that the explosion, which took place 100 metres underground, had a yield of the order of 10–15 kilotons; in other words, it was in the same range as the bombs dropped on Hiroshima and Nagasaki. GOLDBLAT, J., "The Indian nuclear test and the NPT", *NPT: Paradoxes and Problems* (MARKS, A.W. (Ed.)), Arms Control Association, Washington, DC (1975) 31.

64 The CIRUS reactor, as it is called, uses natural uranium as its fuel and heavy water as its coolant and moderator and is an excellent machine for producing weapon grade plutonium (after the Suez crisis of 1956 France supplied a similar reactor to

Israel). The original model was built in Canada after the war, and Canada later supplied a similar machine to Taiwan. The relevant agreement between Canada and India specified that as long as the reactor used Canadian fuel, Canadian safeguards would apply. When India was able to substitute its own natural uranium for the Canadian fuel, the residual Indian commitment was to use the reactor and its products for peaceful purposes only; hence the Indian statement that the Pokharan test was a "peaceful nuclear explosion".

[65] Document GOV/OR.469.

[66] Communication from Ambassador Roland Timerbaev, who took part in the Moscow consultations and was present when the agreement on the NSG's Guidelines was reached.

[67] In the case of existing agreements, the importing non-nuclear-weapon State had a two-year grace period to come into compliance with the Act. New agreements and renegotiated agreements would only be concluded with non-nuclear-weapon States that already placed all nuclear material under safeguards. The Act also required physical protection of nuclear items supplied by the USA, US consent on re-exports, and several other conditions of supply.

[68] In view of the President's and Congress's antipathy to reprocessing, the customers of the USA concluded that only in exceptional cases would the USA give its prior consent. The US/EURATOM Agreement of 1958 did not require prior US consent for the reprocessing or enrichment of nuclear material of US origin. EURATOM refused to renegotiate, and to avoid an interruption of current and future US supplies the President had to resort to a clause empowering him to waive the renegotiation requirement if he deemed that it was in the US national interest to do so. Until 1995, when the US/EURATOM agreement expired, successive US Presidents annually waived the renegotiation requirement. Thus, in practice, EURATOM and Japan were given 'programmatic' consent for reprocessing — in other words long term advance consent to reprocessing. The USA and EURATOM have since negotiated a new agreement that has resolved this problem.

[69] The main plutonium producing and using countries have, however, met in recent years and agreed to publish reports on the amount of plutonium they hold in storage and on their production and use of plutonium. The European Union also laid down strict rules to govern the export of plutonium so as to ensure that it remains under IAEA safeguards, and to guard against the stockpiling of civilian plutonium, an aim implicit in Article XII.A.5 of the IAEA's Statute.

[70] In the 1980s, there were reports that China had offered to accept and store nuclear waste from the Federal Republic of Germany and Brazil, but at a high price. Apparently no agreement was reached.

[71] *Annual Report for 1987*, GC (XXXII)/835, IAEA, Vienna (1988), p. 14, para. 32. The Conference was held at the Palais des Nations (the United Nations centre) in Geneva.

[72] For example, HERSH, S.M., *The Samson Option*, Random House, New York (1991) 271–283; MOORE, J.D.L., *South Africa and Nuclear Proliferation*, Macmillan Press, London (1987) 116.

[73] According to a possibly apocryphal tale by Goldschmidt, the Iraqi authorities at first asked for a replica of the 480 MW(e) Vandellós I reactor that the French Commissariat à l'Energie Atomique had built in Spain. This gas cooled graphite moderated reactor was of the type that had been used to produce substantial quantities of weapon grade plutonium in the United Kingdom, France and elsewhere. When President Valéry Giscard d'Estaing heard about the Iraqi request, his reaction was that they should be told that France did not make that type of reactor any longer, but that they should be offered the most expensive French research reactor, thereby recouping some of the money that France was spending on Iraqi oil. Accordingly, the French provided what was, in effect, a copy of the OSIRIS reactor, a 70 MW(th) materials testing plant that uses HEU as its fuel and is named after the ancient Egyptian god personifying the power of good and sunlight, and re-christened it 'OSIRAQ'.

[74] Documents GOV.OR.564–567.

[75] See the essay by Ambassador Roger Kirk in *Personal Reflections*. Ambassador Kirk was the Resident Representative of the USA to the IAEA from 1978 until 1983.

[76] Part or all of 14 meetings of the Board were spent on this subject (GOV/OR.568–570 and GOV/OR.572–579 and 583–585).

[77] Eibenschutz, Mexico; Haunschild, Germany; Imai, Japan; Korhonen, Finland; Siazon, Philippines; Wilson, Australia; Zangger, Switzerland.

[78] Blix had been legal adviser in the Foreign Ministry from 1963 to 1976 and Under Secretary of State in charge of international development co-operation from 1976 to 1978. He was appointed Minister of Foreign Affairs in 1978. He had served in New York and Geneva on the Swedish delegations to the General Assembly and to the Conference on Disarmament. In the 1980 referendum on nuclear power he had headed the Liberal Party Campaign Committee in favour of retaining the Swedish nuclear energy programme.

[79] Document GOV/OR.585.

[80] GC(XXV)/OR.237, para. 127. The General Conference would normally have finished its session on the previous Friday, but its agenda in 1981 was unusually heavy. Besides the appointment of a new Director General it had to: address the Israeli attack on the Tamuz reactor; demand that technical co-operation be

financed in a more certain and predictable manner; pressure for the expansion of the Board; and deal with demands that more persons from the developing countries be appointed to senior positions in the IAEA.

81 A resolution proposed by the Board and adopted by the General Conference recommended that the Board "give particular consideration to candidates from developing areas who meet the requirements for that high office in appointing the Director General after the expiration of the above mentioned term of Mr. Blix." The term referred to in the resolution was from 1 December 1981 to 30 November 1985. In fact, Dr. Blix's tenure was renewed for three further terms until 30 November 1997. (GC(XXV)/658.)

82 Document GC(XXV)/OR.237, paras 40–41.

83 *IAEA Statute*, Article XIX.B.

84 The Iraqi amendment would simply have added to the draft resolution the words "with the exception of the credentials of the delegation of Israel", GC(XXVI)/OR.246, p. 5, para. 19.

85 Some delegates maintained that the Madagascar delegate was not present when the vote was taken.

86 Document GC(XXVI)/OR.246, paras 19–62.

87 A senior member of the US mission to the IAEA, about to return to the USA, subsequently told the author that the original instructions to the US delegation did *not* call for US withdrawal if Israel's credentials were successfully challenged. When the members of the Israeli delegation learnt this — on the last morning of the conference — they expressed strong dissatisfaction and said they would contact the Israeli Embassy in Washington. Within a few hours the instructions to the US delegation were changed. See also KIRK, R., in *Personal Reflections*.

88 In most UN forums, as in the IAEA General Conference, only a simple majority of votes would be needed to secure the rejection of any delegation's credentials.

89 The Austrian Government provided facilities for the negotiations at a well known Alpine resort, but the parties had little time for skiing!

90 Document GOV/OR.600.

91 *Annual Report for 1982*, GC(XXVII)/684, IAEA, Vienna (1983), p. 16, para. 63. This theme was also taken up by the NPT review conferences, which called upon South Africa to renounce nuclear weapons and to accede to the Treaty.

92 *Annual Report for 1987*, p. 15, para. 41.

93 Documents GOV/OR.677 and GOV/2311. The Statute (Article XIX.B.) prescribes that the suspension by the General Conference of the rights and privileges of a Member State requires the votes of a two thirds majority of the members present and voting. The only matter which requires the approval of two thirds of the

members of the Board is the amount of the Agency's budget (Article VI.E), but the Board may by a simple majority decide that decisions on other questions or categories of questions shall require the votes of a two thirds majority of its members.

94 *Annual Report for 1987*, p. 15, para. 41; *Annual Report for 1988*, GC(XXXIII)/873, IAEA, Vienna (1989), p. 10, para. 39; and *Annual Report for 1989*, GC(XXXIV)/915, IAEA, Vienna (1990), p. 7.

95 *Annual Report for 1992*, GC(XXXVII)/1060, IAEA, Vienna (1993), pp. 4–5.

96 *Annual Report for 1993*, GC(XXXVIII)/2, IAEA, Vienna (1994), p. 157.

97 *Annual Report for 1983*, GC(XXVIII)/713, IAEA, Vienna (1984), p. 7, para. 2.

98 See Article VI.A of the *IAEA Statute* and the *Annual Report for 1984*, p. 7, paras 1–2.

99 Document INFCIRC/369.

100 *Annual Report for 1989*, p. 103.

101 The second paragraph of the preamble to the 1989 safeguards agreement (INFCIRC/369) reads as follows:
"Whereas China has declared that in its exports of nuclear material and equipment, it will require the recipient countries to accept safeguards by the International Atomic Energy Agency...and that nuclear material and equipment imported to China will only be used for peaceful purposes."

102 *Annual Report for 1990*, GC(XXXV)/953, IAEA, Vienna (1991) 140.

103 By the end of 1995, the NSG included all nuclear exporters amongst the industrial States and Argentina, South Africa and the Republic of Korea. But China was not a member.

104 With one significant exception, however. The Tlatelolco Treaty, like other regional treaties creating nuclear weapon free zones, does not derogate from the right of innocent passage of naval vessels carrying nuclear warheads.

105 Agreement on the "Exclusively Peaceful Utilization of Nuclear Energy".

106 Document GOV/OR.772.

107 *Annual Report for 1994*, GC(39)/3, IAEA, Vienna (1995), p. 3.

108 FISCHER, D., *The Regional Track for the Last Three NPT Holdouts — Israel, India and Pakistan*, Programme for Promoting Nuclear Non-Proliferation, Issue Review No. 5, Mountbatten Centre for International Studies, Department of Politics, University of Southampton, Southampton (May 1995).

109 *Annual Report for 1995*, GC(40)/8, IAEA, Vienna (1996) 70.

110 Ibid., p. 64.

111 *Annual Report for 1995*, p. 71, footnote a.

112 Professor Baxter, the first head of the Australian Atomic Energy Commission, was known to be a proponent of a nuclear Australia, and at least one of his colleagues

shared his views. Since the 1960s, Australia has become one of the strongest proponents of non-proliferation, strict safeguards and nuclear export controls.

113 *Annual Report for 1995*, p. 45.

114 The General Conference's request was made in its resolution GC(XXXII)RES/494, see *Annual Report for 1988*, p. 9, para. 37.

115 Document GOV/INF/773, p. 1, para. 2.

116 Document GOV/INF/773.

117 In studying non-radioactive pollution, the Marine Environment Laboratory makes use of the techniques developed by nuclear science.

118 *Annual Report for 1995*, pp. 4–5 and Box 3.

119 *Annual Report for 1991*, GC(XXXVI)/1004, IAEA, Vienna (1992) 1.

120 *Annual Report for 1992*, p. 1.

121 Zero growth continued to be enjoined in 1996.

122 UNITED STATES GENERAL ACCOUNTING OFFICE, *Nuclear Nonproliferation and Safety, Challenges Facing the International Atomic Energy Agency*, Report to the Chairman, Committee on Governmental Affairs, US Senate, GAO/NSIAD/RCED-93-284 (September 1993) 6.

123 Ibid., pp. 65–66.

124 The guidelines are set out in document INFCIRC/225/Rev. 3.

125 As noted elsewhere, this is 8 kg of plutonium, or 25 kg of HEU, or its equivalent. It is well known that countries that have long standing nuclear weapon programmes use only a half or less than half of these quantities for their nuclear weapons and that a country advanced in the use of nuclear energy would need much less, but these are not likely to be the target customers of nuclear smugglers!

126 *Summary Listing of Incidents Involving Illicit Trafficking in Nuclear Materials and Other Radioactive Sources — 4th Quarter 1996*, attached to the IAEA's letter of 29 January 1997, Reference N4.11.42.

127 The following material is based chiefly on "Combating illicit trafficking of nuclear material and other radioactive sources", *IAEA Yearbook 1996*, IAEA, Vienna (1996) E17–E27 and on "Security of material", *Annual Report for 1995*, p. 49.

128 Document GOV/2773 of 24 November 1994, Attachment, para. 1.7. In this document the Director General gave a report to the Board on what the IAEA had done and could do to help governments prevent or take action in response to trafficking and sought the Board's approval of additional IAEA activities.

129 In October 1996, the IAEA distributed its first periodic authoritative listing of incidents involving trafficking — in other words, incidents verified and confirmed by the State concerned.

130 *Annual Report for 1995*, p. 49. By the end of 1996, the number of participating countries had risen to 47 and it included almost all nations with a programme in nuclear energy or producing nuclear materials.

131 This is, of course, a controversial question. In the author's view the more sensationalist media tend to exaggerate the gravity of these incidents and the danger that a group of terrorists would be technically able to make a nuclear weapon. The reports that the governments of so-called 'rogue' States are anxious to obtain smuggled material are unsubstantiated and not very convincing. For any government the political consequences of being caught dealing in a nuclear black market would be very grave. Moreover, until now all States that have launched nuclear weapon programmes have been interested in acquiring the ability to make nuclear warheads in series, rather than the material needed for one or two bombs.

132 The same pattern continued on a reduced scale in 1996.

133 For a more extensive discussion of the incidents that have been reported, see HIBBS, M., "No plutonium smuggling cases confirmed by IAEA since Munich", *Nucleonics Week* (6 March 1997).

134 The conference was jointly sponsored by the European Commission, the IAEA and WHO and was held in co-operation with the UN, UNESCO, UNEP, UNSCEAR, FAO and OECD/NEA. The President of the conference was Angela Merkel, German Minister for the Environment.

135 Amongst the findings of the Conference were the following:

— 237 persons were admitted to hospital and in 134 cases acute radiation syndrome was diagnosed. Within three months 30 members of the plant's staff and the firemen had died, 28 persons died of acute radiation injuries and two more from injuries unrelated to radiation. *(One Decade After Chernobyl, Summing up the Consequences of the Accident, Summary of the Conference Results*, IAEA, Vienna (1996), p. 6, para. 12.).

— The "only clear evidence to date of a public health impact of radiation exposure", was "a highly significant increase in the incidence of thyroid cancer" amongst persons who were still children in 1986. By April 1996, three had died (*One Decade After Chernobyl*, pp. 7 and 8, paras 15 and 21; and the *Annual Report for 1996*, GC(41)/8, IAEA, Vienna (1997), p. 3, Box 3).

— Amongst the longer term health effects, "leukaemia, a rare disease, is a major concern after radiation exposure" and among "the 7.1 million residents of the 'contaminated' territories and 'strict control zone', the number of fatal cancers is calculated...to be of the order of 6600 over the next 85 years against a spontaneous number of 870 000 deaths due to cancer." (*One Decade After Chernobyl*,

p. 9, paras 25–26). There had been no increase in the incidence of other cancers or hereditary effects that could be attributed to the accident.

— There were numerous psychological disorders amongst the affected population, but it was difficult to distinguish such disorders from the effects of economic and social hardship in the region; no sustained severe impact on ecosystems had so far been observed, though continuing attention must be given to the 'sarcophagus' around the destroyed reactor.

136 *Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management*", IAEA document GOV/2916.

137 *Annual Report for 1995*, p. 2.

138 Ibid.

139 Ibid.

140 Ibid.

141 In recognition of the assistance provided by the IAEA in drafting the Treaty, Blix and the IAEA's Assistant Director General for External Relations, Mohamed ElBaradei, were invited to attend the signing ceremony.

142 *Annual Report for 1996*, p. 5.

143 In 1997, the Preparatory Commission of the CTBT Organization, which will verify compliance with the Treaty, set up office at the Vienna International Centre.

Chapter 6

THE IAEA AND NUCLEAR POWER

The first steps

At the beginning of 1944, one year after the world's first reactor went critical, Enrico Fermi and his colleagues began to work on a small test facility to demonstrate the validity of the breeding principle. On 20 December 1951, nuclear heat was transformed into electrical energy for the first time in a small (1.1 MW(th)) experimental breeder reactor, EBR-1, in Idaho in the USA. But the development of nuclear power began in earnest only after the world's first nuclear power plant was brought into commercial operation in Obninsk in the USSR in 1954 (powered by a light water cooled, graphite moderated 5 MW(e) reactor), when the first British gas cooled, graphite moderated power reactor at Calder Hall (50 MW(e)) went critical in May 1956 and the first US pressurized water cooled and moderated power reactor at Shippingport (90 MW(e)) went critical in December 1957.

Launching of the Agency's programme

As noted in Chapter 4, the Preparatory Commission (Prepcom) of the Agency, which functioned from November 1956 until October 1957, had made a considerably more sober judgement of the prospects for nuclear power than the optimistic assessment of Eisenhower when he launched the concept of an international atomic energy agency in December 1953 and the even more euphoric forecasts of the first Geneva Conference in summer 1955.

In fact the Prepcom was at somewhat of a loss as to know what it should recommend on this subject in the IAEA's Initial Programme. Obviously the IAEA would not command the investment capital needed to promote the use of nuclear power in the industrialized nations by building demonstration power reactors as some national nuclear energy authorities were doing. In the end the Prepcom recommended that the Agency encourage the exchange of scientific and technical information on reactor technology, provide advice, promote training, evaluate reactor projects and carry out feasibility studies. It might also launch a special programme for the construction of a limited number of reactors at locations to be decided by the Board of Governors for purposes of training, research, materials testing and the production of electricity. The IAEA could not itself finance such a programme but would need to look to outside sources.[1] Nothing came of this proposal.

From 1958 onwards, one of the main aims of the IAEA's nuclear power programme was to encourage the development of smaller nuclear power reactors suitable for use in developing countries. At that time 'small' reactors were taken to mean those generating up to 50 MW(e) (the industrialized countries were beginning to build reactors two or three times that size). The search for the elusive 'small' or 'medium sized' power reactor was to continue up to the present time,[2] but the reactors called 'small' and 'medium' were to keep on growing in size.

In September 1958, the second session of the IAEA General Conference specifically asked the Secretariat to study the power requirements of the developing countries and the technology and costs of smaller reactors and help train developing country personnel in the use of nuclear power.[3] By the end of 1959, 20 Member States, many of them 'developing', had asked the IAEA to advise them on the possible use of nuclear power.

In 1958, the IAEA embarked in a modest way on its statutory role of broker for the supply of nuclear reactor fuel. On 23 September of that year Japan requested the IAEA to provide three tons of natural uranium in metallic form for the Japanese 10 MW(th) research reactor, JRR-3. The Board invited those States that had offered nuclear materials to submit tenders for the fuel. Canada offered, in effect, to donate the fuel to the IAEA; the offer was accepted and the Board approved the first supply and project agreements between the IAEA and a Member State.[4] This transaction set a pattern for the future — the IAEA was the nominal supplier but the uranium was sent directly from Canada to Japan. As noted in Chapter 8, this transaction also triggered the first application of IAEA safeguards. The fact that natural uranium was readily available on the open market and the amount requested was only half the fuel that the reactor required, and the various statements by Japanese spokesmen all made it clear that the purpose of the request was to set in motion the IAEA procedures for approving Agency projects, for exercising its supply function and for applying safeguards.[5]

Subsequently, Finland requested the IAEA to help it acquire a small research reactor (a TRIGA Mark II) and to arrange for supplies of enriched fuel for the reactor and for a critical assembly. Austria made a similar request for fuel for 'ASTRA', its 10 MW(th) research reactor.[6]

In 1961–1963, the IAEA Secretariat made its first studies of national nuclear power projects in the Philippines (for which a feasibility study was subsequently approved by the United Nations Special Fund),[7] in Yugoslavia for a 'demonstration' power reactor, and in Pakistan, the Republic of Korea and Thailand for nuclear power plants. Of these States, the Republic of Korea, Pakistan and the former Yugoslavia have since built and operated power reactors.[8]

The Geneva Conferences

As we have noted, the United Nations convened a ground breaking international conference in Geneva in 1955 on the peaceful uses of atomic energy. That conference heard the Soviet Union's report on operating experience with the first prototype nuclear reactor (the Obninsk reactor referred to previously) as well as reports on various prototype power reactors under construction in several industrialized countries. In September 1958, Dag Hammarskjöld convened a second and much larger 'Geneva Conference'. Sigvard Eklund, the future Director General of the IAEA, served as its Secretary General. About 5000 delegates took part and over 2150 papers were submitted. The Conference confirmed that the optimism of the early 1950s about the prospects for cheap nuclear power was beginning to flag. In reporting on the results of the Conference to the Board, Sterling Cole said that no "exceptionally novel communications" were submitted. Bertrand Goldschmidt commented on the "excessive increase" in the number of participants and recommended that the agenda of any future large conference be limited to the "problems of atomic energy" and that the IAEA should begin convening smaller conferences on specialized nuclear topics.[9] Both recommendations became IAEA policy and from the 1958 Conference the Agency learned a good deal about how to run a scientific meeting.

The timing of the 1958 Conference was unfortunate from the point of view of the IAEA. It did not yet have "a Secretariat capable of plausibly asserting, against the strong opposition of the Secretary General, its ability to assist the conference significantly."[10] In other words, the Conference showed that the IAEA did not yet have a commanding position in nuclear energy matters within the UN system and that a major project could be carried out without its help.[11]

U Thant, the Burmese diplomat who succeeded Hammarskjöld as Secretary General after the latter's death in an air crash (in what was then

Northern Rhodesia) was less interested than his predecessor in maintaining the role of the United Nations in the development of the civilian uses of nuclear energy. In August–September 1964, U Thant convened the third Conference in this series, appointed the Soviet representative on the IAEA's Board of Governors, Vassily Emelyanov, as President of the Conference and entrusted responsibility for the scientific aspects of the meeting to Eklund, who had now been Director General of the IAEA since 1961. In all, 3600 members of delegations and observers took part in the meeting, substantially fewer than in 1958.[12] Unlike the first two Geneva Conferences, the third focused on a single topic, nuclear power, and it signalled the start of a new international race towards nuclear power.

The Conference also marked the acceptance by the United Nations of the IAEA's primary role amongst UN agencies in the civilian use of nuclear energy; as we have seen, this was a role that Hammarskjöld had been reluctant to concede when Sterling Cole headed the Agency. The meeting demonstrated that the IAEA had also been accepted by governments and industry as the leading international body for promoting nuclear energy and nuclear safety, and it thus gave a new thrust to the IAEA's work in these fields.

From 6 to 16 September 1971, the fourth and last Geneva Conference focused on the commercialization of nuclear power and the practical problems of integrating nuclear power into national economies but also, significantly, on the impact of nuclear power on the environment.[13] Participants from developing countries "confirmed considerable interest in small and medium sized reactors that would best fit into their electrical grids."[14] The Conference was jointly sponsored by the United Nations and the IAEA, with the latter publishing its proceedings. Dr. Glenn Seaborg, the US scientist who was the first person to produce and identify plutonium and who gave it its name, served as President of the Conference, which attracted over 4000 participants.

1960 to the early 1970s: The boom in nuclear power

By the early 1960s, demonstration power reactors were in operation in all the leading industrial countries, although the economic competitiveness of nuclear energy was still in question.[15] But in December 1963, the General Electric Company of the USA put in a bid for the construction of a nuclear power plant at Oyster Creek, New Jersey, at a price that would clearly make it competitive with any coal or oil fired plant.[16]

This striking offer came as a surprise to the electrical and nuclear industries, launched a wave of optimism about the future of nuclear power and set the tone for the third Geneva Conference in 1964. On the basis of reports given to the Conference it was foreseen that by the turn of the century "more than half the electric power requirements of some large industrial countries will be met by nuclear electricity."[17] It was also expected that by 1980, 167 000 MW(e) of nuclear generating capacity would be installed (within a year this estimate had risen to 200 000 MW(e)).[18] By 1967, US utilities alone had ordered more than 50 power reactors, with an aggregate capacity larger than that of all orders in the USA for coal and oil fired plants.[19]

Although estimates of the amount of nuclear power that would be installed by 1980 continued to rise,[20] in many ways the 1964 Geneva Conference marked the high tide of optimism about the future use of major nuclear technologies, not only for generating electricity but also for seawater desalination and for propelling merchant ships. There were more modest expectations about the share of total installed nuclear capacity that would fall to nations 'outside the main industrial countries': it would be less than 5% by 1980 according to the IAEA's *Annual Report* for 1968–1969.[21]

At first, the 1970s witnessed a steady rise in orders for nuclear power plants. The Arab–Israeli war of 1973 led to an oil boycott by the Arab States and this, in turn, caused a fourfold increase in the price of oil and provoked a record spate of orders.[22] However, by 1975 the curve of orders had already passed its peak. From 1974 to 1975 the volume of orders dropped abruptly from 75 000 MW(e) to 28 000 MW(e).[23] The IAEA's *Annual Report for 1975* called the decline temporary, attributing it to economic recession, rising capital and fuel costs and environmental concerns.[24] Nonetheless, in 1975 the IAEA was still forecasting that the world's installed nuclear capacity would reach 1.0–1.3 million MW(e) by 1990 and 3.6–5.3 million MW(e) by 2000.[25] In fact, by the end of 1995, the world's total capacity stood at only 344 422 MW(e),[26] or less than one tenth of the 1974–1975 lower estimate for the year 2000. It was also clear that the growth in capacity between 1995 and 2000 would be modest.

It should be pointed out that the IAEA was not alone in overstating the prospects for nuclear power growth. The independent forecasts of other international bodies such as the International Institute for Applied Systems Analysis and the OECD's (E)NEA were equally wide of the mark.

Uranium and thorium reserves and consumption

In 1965, the IAEA joined the ENEA in compiling periodic surveys of the known reserves of uranium and estimated current and future consumption. The surveys did not cover Eastern Europe, the USSR or China, for which no public statistics of reserves or consumption were available. The two agencies published their first joint report in December 1967.[27]

Concern that the world might run short of uranium also stimulated some interest in the other naturally occurring element that could provide a source of nuclear power, namely thorium.[28] This is ten times more common in the earth's crust than uranium and there are particularly large thorium deposits in India and Brazil. By 1965, three thorium based reactors were in operation in the USA and in June that year an IAEA panel reviewed the use of thorium as a reactor fuel.[29] But despite the expectations of the 1960s and thorium's relative abundance and its attractive technical and economic features, it failed to emerge as a significant nuclear fuel and is still not used today in any nuclear power reactor in operation or under construction. One obvious reason is that with the continuing surplus of uranium and sharp fall in its price the incentive to develop a new nuclear fuel and fuel cycle remained very low during the 1980s and early 1990s. Already by 1981 it was clear that the market for uranium was beginning to go into glut. Its price had dropped from about $40/lb U_3O_8 at the beginning of 1980 to $23.5–$25.0/lb in 1981 and many uranium workings had been cut back or stopped.[30] This trend continued throughout the rest of the period covered by this history.

The primacy of the light water reactor

The 1970s also witnessed the growing preference in many countries for the light water nuclear power reactor, using low enriched uranium as its fuel and ordinary water as its coolant and moderator. The light water reactor was built originally to a US design in Western countries (in the USA as part of a propulsion unit for nuclear warships) and to a similar Soviet design in the USSR and Eastern European countries.

Almost from the start of their nuclear power programmes, the light water reactor was the preferred choice of the Federal Republic of Germany, Spain, Sweden and subsequently Japan. France and the United Kingdom, however, originally chose a different concept, the gas graphite reactor using natural (unenriched) uranium as its fuel, moderated by graphite and cooled by carbon dioxide. The reasons for the French and British choices were threefold. It was not clear at first that the light water reactor would be the cheapest nuclear source of electricity. Indeed, when the United Kingdom commissioned the Calder Hall plant, the British nuclear authorities believed they had stolen a march on their US colleagues and potential competitors. Secondly, in the late 1950s and early 1960s, neither France nor the United Kingdom had its own enrichment plant and choosing the light water reactor would have made them dependent on the USA for fuel. Thirdly, the earlier gas graphite reactors were also good sources of weapon grade plutonium and both countries used it for this purpose. In the case of the United Kingdom, some early reactors of this type were dual purpose, producing both electricity and military plutonium. (A French gas graphite research reactor also became the source of unsafeguarded plutonium at Dimona in Israel.)

In the late 1960s, at the urging of France's State owned generating corporation, Electricité de France, the French authorities abandoned the gas graphite cycle and turned to light water power reactors, building them at first under licence from Westinghouse. In the late 1980s, the United Kingdom followed suit with its first order for a light water reactor. In the meantime the United Kingdom (alone) had built a number of 'advanced gas cooled reactors' and had experimented with other designs.

The Soviet Union built two types of power reactor, light water reactors in the WWER series of Soviet design, but similar in basic concept to the US Westinghouse reactor, and the RBMK, the type made conspicuous by Chernobyl. The Soviet Union exported only the WWER light water power reactors and then only to its allies in the Warsaw Pact and to Finland and Cuba. The construction of the Cuban reactor was eventually suspended, but may now be renewed.

One country, Canada, successfully marketed a quite different nuclear power reactor, the CANDU (Canada deuterium–uranium), using natural uranium (as a rule) as its fuel and heavy water as its coolant and moderator. The CANDU reactor had its origin in research reactors built in 1944 and 1945, when Canada was a partner with the USA and the United Kingdom in the development of nuclear weapons.[31] The CANDUs owed much of their success to W.B. Lewis, the British born Vice-President for Research and Development of Atomic Energy of Canada Limited in the 1960s,[32] long time chairman of the IAEA's Scientific Advisory Committee and indefatigable proponent of the heavy water reactor. Canada built some 20 CANDUs to generate much of its own electricity and sold CANDUs to India, Pakistan, Argentina, Romania, China and the Republic of Korea, as well as NRX type research reactors (a prototype of the CANDU) to India and Taiwan, the former being the source of the plutonium for the Indian nuclear explosion of 1974. The fuel of light water reactors is changed at intervals of up to 15 months or more, while the CANDUs (and gas graphite and RBMK) reactors are continuously fuelled ('on-load' or 'on-line' fuelling).

The IAEA does not influence the choice that countries make between reactors of various designs, but the decisions sometimes had implications for the IAEA's safety programme. For instance, the Soviet Union's acceptance of the RBMK design, and its failure — despite the warning given by the Three Mile Island accident — to correct certain identified design defects, was one of the main causes of Chernobyl and led to a major setback for nuclear power. The choice of reactor also has implications for IAEA safeguards. An on-line refuelled safeguarded reactor requires more intensive inspection than does a reactor in which the fuel is changed at intervals of a year or more. Large 'research' or dual purpose or 'dedicated' reactors fuelled with natural uranium and moderated by graphite or heavy water have been the source of most of the plutonium used in nuclear test explosions and warheads. The acquisition of a research reactor of this type may thus be the precursor of a military programme, as it was in Israel and may have been in India.

It was thus also significant that the Democratic People's Republic of Korea (DPRK) chose the natural uranium gas graphite design for its main research reactor and its prototype power reactors, and that one of the chief objects of the "Agreed Framework" accepted by the DPRK in 1994 (see Chapter 8) was to put an end to the operation of the existing reactor and to stop further construction by the DPRK of gas graphite reactors, replacing them, in effect, by two large light water power reactors.

The peaceful uses of nuclear explosions: A discredited technology?

In the 1960s and early 1970s, the USA and the Soviet Union constantly extolled the benefits to be derived from the peaceful uses of nuclear explosions, the so-called 'PNEs'.[33] It has been suggested that, at least in the case of the USA, and perhaps in the case of the Soviet Union and the United

Kingdom, exaggerating the potential value of PNEs was a stratagem used by the weapon laboratories to defend the need for nuclear testing, which Kennedy, Khrushchev and Macmillan wanted to discontinue. Similar suspicions arose in 1995–1996 about attempts to preserve the right to carry out PNEs under a comprehensive test ban treaty, but the enthusiasm of the 1960s for this technology may equally have had its roots in the nuclear euphoria of the time.[34]

Whether or not ulterior motives played a part, the US and Soviet boosting of PNEs made them a major issue at the 1968 Conference of Non-Nuclear-Weapon States and in the drafting of the Tlatelolco and Non-Proliferation Treaties. The NPT devotes one of its longest and most detailed articles (Article V) to the peaceful uses of nuclear explosions. Argentina's and Brazil's proclaimed right under the Tlatelolco Treaty to carry out PNEs became a major impediment to the conclusion of the comprehensive safeguards agreements with the IAEA that are called for by that Treaty.[35] In the 1970s, India and South Africa used the supposed benefits to be derived from PNEs as a justification for developing nuclear explosive technology, which is basically the same whether the explosive is used in a weapon or to dig a canal.

The IAEA's work on PNEs began in 1968 when the General Conference called for a report on the Agency's responsibilities to provide services in connection with nuclear explosions for peaceful purposes.[36] Under the NPT only the five recognized nuclear weapon States have the right to carry out a PNE. The IAEA and the United Nations General Assembly agreed that the IAEA was the "appropriate international body" referred to but not named in Article V of the NPT through which the supposed benefits would be obtained. It was also agreed that the IAEA was the organization — again not named in Article V — that should ensure that PNEs were "appropriately" observed. It turned out that the chief purpose of such observation was to ensure that there was no transfer of nuclear explosive technology from the nuclear weapon State carrying out the explosion.[37] In late 1970, the Board of Governors convened a working group which prepared a set of guidelines for such observation, which the Board subsequently approved.[38]

The chief reason for not naming the IAEA in Article V of the NPT when the Treaty was being drafted in 1965–1968 was that the developing countries on the ENDC[39] suspected that the Agency was unduly compliant with the wishes of the superpowers and they wanted to keep the door open for the creation of a new organization more responsive to the needs of developing countries. In retrospect, it is remarkable that serious consideration should have been given to creating another agency for the purpose of promoting what turned out to be a failed technology. Perhaps one reason was that the two superpowers themselves had done so much to boost this idea.

Throughout the 1970s, many nations maintained a lively interest in the civilian uses of nuclear explosions and they eventually accepted that the IAEA should play a leading role in the international application of the technology. In December 1972, the United Nations General Assembly commended the IAEA for its work on this subject and asked it to set up a service to arrange for such explosions under international control.[40] In 1975, Director General Eklund established a unit in the Secretariat (consisting, however, of a single official) to deal with requests for PNE services such as information, and feasibility, safety and economic studies. In June 1975, the Board set up an advisory group, open to all Member States, to recommend procedures for dealing with Member State requests, to propose the structure and content of the agreements to be concluded with States supplying and receiving such services and to address any other question within the IAEA's competence such as safety, the economics of PNEs and comparisons between PNEs and conventional alternatives.[41]

Although a few States sought information or advice from the Secretariat about the possibility of using PNEs,[42] no formal request for a PNE was confirmed and no need ever arose for either "appropriate international observation" or for a PNE service. In due course the PNE unit in the IAEA was quietly disbanded.

In the end, only the USA and the USSR, and conceivably India, carried out any PNEs.[43] The 1963 Limited Test Ban Treaty had already marked the end of any explosions that would disperse substantial fallout (as would building a canal or harbour). The USA abandoned its programme in the late 1970s and the Soviet Union carried out its last PNE in the late 1980s.

The campaign against reprocessing

In May 1977, the IAEA celebrated its twentieth birthday by holding a conference in Salzburg on nuclear power and its fuel cycle, about which there was still much optimism. In a sense this meeting, in which more than 2000 persons took part, was a successor, in fact the only successor, to the four Geneva Conferences. There was a consensus at Salzburg that more uranium resource efficient reactors — in other words fast breeder reactors — would eventually be needed and with them more reprocessing plants.

This view was not shared by the science and technology spokesman for US President Carter in Salzburg, Joseph Nye.[44] One of the highlights of the conference was a luncheon talk in which Professor Nye informed a somewhat shaken audience of heads of national nuclear energy commissions about the new nuclear power policy of the Carter Administration. As noted, this was to abandon the fast breeder reactor as the goal of nuclear (fission) power programmes, and to put a stop to reprocessing and the separation of plutonium. Instead, the USA would favour the 'once-through' fuel cycle: spent nuclear fuel would be stored and eventually permanently disposed of in unreprocessed form. Nye's luncheon talk foreshadowed the end of the Clinch River fast breeder reactor and the Barnwell reprocessing plant, both then under construction in the USA.

The new policy was fated to bring the USA into protracted disagreement with its allies in Western Europe and with Japan. Like Director General Eklund himself, most heads of national nuclear energy authorities still saw reprocessing and breeder reactors as the only way of making full use of the energy content of natural uranium and of ensuring an almost inexhaustible source of energy for electricity production.[45] They also argued that as the radioactivity of spent fuel stores declined, such stores would become 'plutonium mines': in other words, relatively accessible sources of plutonium for nuclear weapons, becoming steadily more accessible as time passed.

Small and medium sized power reactors

We have noted the encouragement that the first General Conference in 1957 gave to the development of small and medium sized power reactors. In the late 1960s, it was becoming clear that for reasons of economy the trend was towards ever larger nuclear power plants. If developing countries were to make full use of nuclear power, it would be necessary to persuade manufacturers to offer plants in the range of 100–500 MW(e) and preferably closer to 100 MW(e).[46]

To encourage manufacturers to do so, the IAEA carried out a survey in 1968–1969 of what the potential market in the developing countries would be by 1975–1980 for smaller plants in the 100–500 MW(e) range and of the capital investment that the developing countries would need to build these plants.[47] The survey concluded that the developing countries expected to install 20 000 to 25 000 MW(e) of nuclear plants between 1970 and 1980 and a further 25 000 to 35 000 MW(e) between 1980 and 1985.[48] Despite the fact that the definition of 'smaller' had grown fourfold or more since the pursuit of these elusive reactors began in 1958, these projections proved to be badly wrong. Depending on the definition of 'developing country', the total combined nuclear capacity of Latin American, South and East Asian and African developing countries was less than 10 000 MW(e) by 1985 — including the Republic of Korea (2720 MW(e)) South Africa (1840 MW(e)) and Taiwan (4918 MW(e)). If the Republic of Korea and Taiwan are left out, the total in 1985 amounted to less than 5000 MW(e).[49]

It was also clear that there were wide variations between the estimates of the capital cost of a nuclear plant in the country of manufacture and a similar plant in an importing country. Moreover, the noticeable trend towards higher capital and lower fuel costs for both conventional and nuclear plants worked in favour of fossil fuel. This made it more difficult to offset the significantly higher capital cost of a nuclear power plant by its lower fuel cost.[50]

In 1972, the IAEA launched another attempt to help developing countries assess the potential of nuclear power, once again in the form of a survey of the developing country market for smaller plants. (The survey made use for the first time of a computer package — the 'WASP' package referred to later.)[51] The Secretariat presented the results of the survey to the General Conference in September 1973; it concluded that in the 14 countries surveyed, there could be a market for about 100 nuclear power plants in the size of 600 MW(e) or larger.[52] A 1974 article in the *IAEA Bulletin* went much further; it maintained that if the price of oil remained at $6–7 per barrel or higher, nuclear plants of 100 MW(e) would become economically competitive and the potential number of plant orders would be over 205 in 44 developing countries, including three plants in Uganda and two in Liberia.[53]

However, nuclear manufacturers, flooded with orders for larger plants, showed little enthusiasm for smaller ones. Those developing countries that were in the market for nuclear power — Argentina, Brazil, Mexico, South Africa, Iran, the Philippines, the Republic of Korea and Taiwan — had sufficiently large grids or electrical networks to accommodate nuclear plants of standard sizes — about 500–1000 MW(e). There was one notable exception — India — which, in line with its policy of self-sufficiency, went on building replicas of the two relatively small (220 MW(e)) natural uranium heavy water reactors it had bought from Canada in the 1960s.[54]

In 1984, the Secretariat launched a new survey to determine the availability of and market for smaller plants. Sixteen manufacturers provided data on 24 designs that could be offered commercially at that time or within the next ten years and 15 developing countries provided information about their requirements.[55] In June 1985, Director General Hans Blix informed the Board of Governors that the first phase of the survey had been completed; the finding was that while in the past practically no smaller reactors had been commercially available, 26 designs of plants smaller than 600 MW(e) were now on offer, several technically mature and proven. In fact, a number of power reactors in this range had been in successful operation in the Soviet Union.[56] But "buyer countries in the developing world were hesitating because they required clear evidence that these reactors would be economical in their individual circumstances."[57]

In 1987, an updated report of the project concluded that further progress in introducing smaller power reactors could only come as a result of country specific studies involving potential customers, suppliers and the IAEA, but no country had shown any interest in such studies and the IAEA had not been able to obtain reliable data on the cost of such plants from potential suppliers.[58]

Since then the only new smaller reactor design that developing countries have ordered or are themselves building is the Chinese pressurized light water reactor rated at 300 MW(e), one built at Qinshan in China and one under construction at Chashma in Pakistan (it is understood that the Chinese reactor is a prototype of a 600 MW(e) design).

Developing countries continue to be interested in the use of smaller units but, according to the IAEA's *Annual Report for 1995*, interest is turning to uses other than electricity production, such as the use of very small reactors for desalting sea water (see below) and district heating. Some industrialized countries have considered the construction of small reactors as prototypes for the more effective recovery of oil, for gasifying coal and producing methanol.[59] China is reported to be building 200 MW(th) nuclear units for district heating. However, it may take much time and work to overcome public resistance and to show whether nuclear energy can be used more cheaply and effectively than other technologies for such purposes. Strong public resistance compelled the Russian nuclear authorities to stop or suspend the construction of reactors for district heating in Gorki and Novovoronezh.

Today, more than forty years after the IAEA began seeking it, the small nuclear power plant has still not materialized — except in the form of the 200–220 MW(e) reactors that India, and India alone, has built since the late 1960s, a few other reactors that survive from the 1960s and a variety of smaller Soviet reactors including those of the WWER-440 MW(e) type.[60] However, the latter were not widely known and appreciated outside the Soviet Union and a few other, chiefly Eastern European, countries. The Soviet Union was not active or successful in putting these achievements to commercial use in more countries.

The 'small or medium sized' plant had grown from less than 50 MW(e) in the late 1950s to as high as 600 MW(e) in 1984–1985. The top of that range is not much smaller than the lower range of the nuclear power plants under construction today, namely, 700–1500 MW(e).[61] The regions of the world where nuclear power is slowly expanding, Eastern and South East Asia and, to some extent, Central Europe, are not likely to need small plants.[62]

Nuclear desalting and the 'agro-industrial complex'

During the 1960s and early 1970s, there was a strong surge of interest in the use of nuclear power for desalting sea water, using the fresh water to grow irrigated crops and simultaneously using the reactor's heat to generate electricity (in a so-called 'agro-industrial complex'). The prospect of turning the deserts green has universal appeal and the potential use of nuclear energy for this purpose fired the public's imagination. Both Presidents Kennedy and Johnson were personally interested in nuclear desalting technology and in 1964 President Johnson highlighted the technology in a so-called 'Water for Peace' programme. In March 1963, a group of consultants mapped out for the Agency a programme of work on nuclear desalting[63] and Chile, Greece, Mexico, Peru, Taiwan, Tunisia and Turkey subsequently turned to the IAEA for advice on this subject.[64]

In 1964, at the third Geneva Conference, the USA announced that it had started an "aggressive and imaginative programme to advance progress in large scale desalting of sea water." The USSR and USA concluded an agreement in November 1964 for co-operation in nuclear desalting and undertook to keep the IAEA fully briefed on the progress they made.

Experts from the IAEA staff took part in US consultations with the United Arab Republic (Egypt), Israel and Tunisia about the construction of dual purpose generating/desalting plants. US technologists and diplomats put forward the idea of a 'Middle East Nuclear Desalination' (MEND) plant that would supply Egypt and Israel with plentiful fresh water and provide a framework for peaceful co-operation between two hostile countries. The USA and Mexico planned to build a large dual purpose plant near the head of the

Gulf of California to provide 190 000 cubic metres of fresh water a day and generate 1600 MW(e). The Soviets actually built a smaller dual purpose plant incorporating a fast breeder reactor on the Caspian Sea at Shevchenko, (now Aktau, Kazakstan — see also the section of this chapter dealing with breeder reactors).[65]

In October 1965, the IAEA convened the first international symposium on nuclear desalting. US experts now injected a note of realism into the discussions. They reported that the study of the plant that the USA and Mexico had planned to build had shown that, even on favourable assumptions, the cost of desalting would work out at about six US cents per cubic metre of fresh water. For large scale agricultural use the cost of water should be of the order of one to two cents. The US experts concluded that nuclear desalting could become economically attractive "...only if the nuclear fuel cycle costs and the capital cost of reactors [as well as other associated costs] are substantially lowered."[66]

Faced with discouraging economics, interest in nuclear desalting began to flag and large projects for the use of the technology were quietly shelved. Except for the Soviet/Kazak plant, none left the drawing board. As the cost of nuclear power went up in the 1980s and the real cost of oil and natural gas went down, the prospects for large scale nuclear desalting seemed to recede still further.

However, in recent years interest in this use of nuclear energy has revived, but more realistically, as a possible means of producing potable (drinkable) water, and not the large quantities of very cheap water that would be needed for farming or industry. In 1988, on the initiative of a number of North African and other Arab countries, the General Conference again took up this question in the form of a resolution entitled 'Plan for the Production of Low Cost Potable Water'.[67] In 1992, the Secretariat produced a report that concluded that the best option was "large nuclear plants integrated into the [national electric] grid and supplying electricity to separately located desalination plants using reverse osmosis [as the technology for producing drinkable water]."[68] The General Conference discussed the matter again in 1993 and 1994 and called for further studies and more donations of funds by interested governments.[69]

An IAEA regional study of the feasibility of nuclear desalting in North Africa, completed in 1995, concluded that the use of nuclear energy for the production of potable water "is technically feasible and the costs are competitive with those of fossil fuelled plants in the region."[70] The renewed interest in nuclear desalting shown by the countries of North Africa, the Maghreb and the Middle East is understandable in view of their acute need for more fresh water for growing urban populations.

Shrinking nuclear programmes in the West

One of the reasons why the IAEA's projections of future nuclear power growth were so wide of the mark was that they consisted largely of aggregations of the over-optimistic forecasts by national authorities. With time, the IAEA's projections became more realistic. Today both the IAEA and national authorities follow the more cautious practice of giving not only widely differing upper and lower figures for a date some 20 years ahead, but also of stressing that the figures do not purport to be predictive and of describing the major causes of uncertainty.[71]

Towards the end of the 1970s the shrinking flow of nuclear power orders in the USA dried up completely, and it has not revived. The most obvious cause was the Three Mile Island accident in March 1979 — despite the fact that the accident caused no loss of life or injury to human health.[72] During that year, 1979, earlier orders for 14 power reactors were cancelled and, in the following years, US utilities continued to cancel orders they had already placed. By 1980, the IAEA's *Annual Report* noted that "if present trends are not reversed, a general slow-down in nuclear power programmes must be expected after 1990."[73] The *Annual Report for 1983* was even more pessimistic, warning of the possibility of "severe difficulties for the nuclear industry in the second half of this decade."[74]

Nonetheless, until the Chernobyl accident in 1986, politicians in the West and elsewhere continued to affirm their confidence in nuclear power. At the July 1981 summit in Ottawa the leaders of the G-7 nations — the world's seven leading industrial nations — proclaimed that "...we intend in each of our countries to encourage greater acceptance of nuclear energy..." In the same year the Prime Minister of India informed the United Nations Conference on New and Renewable Sources of Energy in Nairobi that "nuclear energy is the only power source able to meet India's demands and, unless we have something positive to take its place, we cannot talk of replacing it."[75]

Several milestones of a sort were passed during the 1980s. As noted below, the first commercial sized fast breeder reactor went on line in 1980; the second, with more than double the power of the first, went on line in 1986.

But several other fast breeder reactor projects were cancelled. In 1989, Germany stopped the construction of its first large reprocessing plant at Wackersdorf in Bavaria. It was to have been the third major plant in Western Europe for reprocessing spent fuel from light water reactors, the other two being at La Hague in France and Sellafield in the United Kingdom. In the same year the USSR suspended the construction of a large reprocessing plant in Siberia.[76] The number of new power reactor construction starts in the world declined from 18 in 1985 to four in 1986 — the year of Chernobyl — and hovered between six and one until 1995 when no 'construction starts' were recorded. In 1996, work began on building two plants in China and one in Japan.[77]

East Asia: A somewhat different picture

East and South East Asia offered a contrast to Western Europe and North America. At the end of 1985, 33 nuclear power plants with a total capacity of 23 665 MW(e) were in operation in Japan. Ten years later, the figures had risen to 51 plants totalling 39 893 MW(e) in operation and a further three under construction. During these ten years, 1985–1995, opposition to nuclear power did increase in Japan and it was becoming difficult to persuade local authorities to approve new sites for nuclear plants, but the majority of the members of the Diet and the central Government remained firmly and sometimes outspokenly in favour of more nuclear power, partly because they saw no alternative except growing dependence on imported oil. Japan also still seemed firmly committed to building a large reprocessing plant and a large fast breeder reactor. In December 1995, the leak of two to three tonnes of sodium at the Monju 280 MW(e) fast breeder reactor (which has put the reactor out of operation since that date) and a number of other incidents, in which the authorities deliberately suppressed or distorted information, has cast a pallor over the further spread of nuclear energy, and, in particular, over the prospects for the reprocessing/fast breeder reactor fuel cycle in Japan.[78] Some of these incidents resulted in the exposure of workers to low doses of radiation, but no resulting health effects have been reported. In 1997, it was still too early to assess the long term effects of these events on Japanese nuclear policies, but there is little doubt that at least for the present they have come under a cloud.

The growth of nuclear power was even more striking in the Republic of Korea than in Japan, from three power reactors with a total capacity of

2720 MW(e) in operation at the end of 1985 to 11 with a total capacity of 9120 MW(e) in operation at the end of 1995 and a further five under construction. In 1994, China brought its first three nuclear power plants into commercial operation and it was planning several more, Indonesia was planning to build as many as eight nuclear power plants and Thailand and Viet Nam were showing interest in nuclear power.

Except for OSART[79] missions to Japan in 1988 and 1995 (and, of course, the extensive application of safeguards), the IAEA's involvement in the Japanese nuclear power programme was minimal. However, from 1985 to 1995 the IAEA organized numerous training courses, seminars and workshops in China, Indonesia, the Republic of Korea and Thailand, advised Indonesia on the planning of its nuclear programme and sent several safety and siting missions to the countries in the region.[80]

Fusion

Nuclear fusion is the energy source of the sun and all other stars. The scientific and technological challenge of nuclear fusion research is to create controlled miniature suns on earth (in other words, fusion power plants) to produce heat and electricity. To achieve a fusion reaction it is necessary to confine a high density plasma consisting of the nuclei of two isotopes of hydrogen (deuterium (D)) and (tritium (T)) at a temperature comparable to that of the interior of the sun and other stars, and the confinement must eventually be continuous in order to sustain the reaction. The plasma is held in place — and away from the walls of the reactor — by extremely powerful magnetic fields, hence the term 'magnetic confinement.'[81]

Deuterium is relatively easily extracted from sea water, and tritium can be bred from lithium, which is so abundant in the earth's crust that fusion can be regarded as an inexhaustible source of energy.[82] The primary fuels and the end product of fusion (the inert gas helium) are neither toxic nor radioactive, nor do they contribute to the greenhouse effect. Criticality accidents are impossible. However, deuterium–tritium fusion reactors contain some radioactive substances in the form of tritium, or radioactive materials produced by the irradiation of parts of the reactor structure.

Fusion research was declassified at the 1958 United Nations Conference on the Peaceful Uses of Atomic Energy (see Chapter 5) and this opened the way to the regular exchange of information amongst fusion researchers.[83] In

October 1960, the IAEA published the first issue of the quarterly journal *Nuclear Fusion*[84] and in January 1978, the journal became a monthly publication.[85] The first international conference on 'Plasma Physics and Controlled Nuclear Fusion Research' was convened by the IAEA at Salzburg in September 1961,[86] the second at Culham (in the United Kingdom) in September 1965, the third at Novosibirsk in 1968 and the fourth in Madison, Wisconsin, in 1971. The fifth conference was held in Tokyo in 1974 and from that time on conferences were held at two-yearly intervals.[87] The 16th conference, in which some 600 researchers took part, was held in Montreal in October 1996 and the next is scheduled for 1998 in Yokohama.

In the late 1960s, interest grew in magnetic confinement, especially in the configuration known as the 'tokamak' (from its acronym in Russian) and many tokamak machines were built. The results of the research carried out using these machines were both complementary and directly comparable, and led to formal agreements for international co-operation.

In 1970, the IAEA created an advisory body, the International Fusion Research Council (IFRC), which has since met annually, and in 1978 launched a series of workshops to assess the design of a large, 'next generation' tokamak, the INTOR (International Tokamak Reactor).[88] The workshop then began assessing the data needed for a tokamak fusion reactor and in 1981 developed a conceptual design of an INTOR. The design was updated in 1983 and 1985.[89] The last projects of the workshop, from 1985 to 1987, included a definition of the database for fusion, a study on possible innovations for a tokamak reactor and a comparison of various national concepts for a next generation tokamak.[90]

On the basis of discussions at the summit between Presidents Reagan and Gorbachev in November 1985, it was recommended that international co-operation in fusion research be expanded.[91] In April 1988, this political mark of encouragement helped to lead to the initiative of the four leaders in fusion (the European Union — which was still known as the European Community at that time — Japan, the USSR and the USA) to launch the ITER (International Thermonuclear Experimental Reactor) project, in other words to draw up the conceptual design of a thermonuclear reactor, the natural successor of the INTOR concept.[92] The aim of ITER is to confirm the scientific feasibility and address the technical feasibility of fusion as a potentially safe and environmentally acceptable and practically inexhaustible source of energy. ITER was to be carried out as a collaboration of the four fusion leaders (the European Community included in its contribution Switzerland and Canada) under the auspices of the IAEA. The ITER conceptual design was successfully completed in December 1990,[93] and in July 1992 the ITER parties proceeded to the engineering design of the projected reactor, again under the auspices of the IAEA. This phase is expected to last for six years.

Other confinement systems that show potential advantages over the tokamak are being investigated, thus ensuring sufficient breadth to the international effort to develop the full potential of fusion. Besides supporting this effort by publishing the *Nuclear Fusion* journal and sponsoring biennial fusion energy conferences, the IAEA has convened many specialist meetings, organized Co-ordinated Research Programmes, and assisted the work on fusion in developing countries.[94]

It is obvious that scientists and engineers will still have to surmount major technical hurdles before being able to demonstrate that a controlled nuclear fusion reactor is technically feasible, and that the commercial use of that technology lies in an even farther future, namely around the middle of the 21st century.[95] Up to now there is no formal commitment by the parties of the ITER project to build the machine and there is some doubt about the continuation of adequate financial support. Nonetheless, if the technical and economic barriers can be overcome, fusion technology holds out the prospect of generating electricity with a much smaller emission of radiation to the environment than the small quantity released by existing fission power plants during normal operation, on the basis of a virtually unlimited supply of feedstock — namely water.

Information on nuclear power

Since it began work in 1958, the IAEA has published data on civilian nuclear reactors in Member States. The publications started with a ten volume *Directory of Nuclear Reactors*, the first of which was published in 1959 and the last in 1976. In 1971, the IAEA also began to issue an annual report on operating experience with nuclear reactors. In 1980, the earlier data were computerized and the IAEA launched the 'Power Reactor Information System' (PRIS), which has provided design and general information on all civilian power reactors in operation, under construction or shut down, throughout the world, as well as power reactor operating experience and historic data on shutdown reactors. Since 1980, PRIS has been updated several times and it has become the world's most authoritative databank on nuclear power reactors.

Since 1981, the PRIS database has been used to compile the IAEA's annual publication *Nuclear Power Reactors in the World*, frequently referred to in this book. In 1989, PRIS was made available on-line to Member States and in 1995 it was also made available through the Internet. By 1997, 76 users in 33 Member States had on-line access to PRIS. Since 1991, the IAEA has also offered PRIS data on diskette in a form that standard personal computers can use — the 'MicroPRIS'. By 1997, it was being used by more than 200 organizations in more than 50 Member States and 9 international organizations.

Beginning in 1992, the IAEA also created a database containing country profiles of the economic, energy and electricity characteristics and of the industrial structure and organizational framework for nuclear power in various Member States; so far 30 of the 32 States having or building nuclear power plants have contributed information for these profiles.

Helping Member States to plan their energy systems

Since the early 1970s, the IAEA has devised ways of helping Member States to use computer technology in planning their energy and electricity systems. The computer tools that the IAEA has devised take account of all potential sources of energy and give due consideration to the possible role of nuclear power.

As concern about the environment became a major factor, the IAEA, in co-operation with eight other international organizations, developed a methodology, software and databases to enable Member States to make comparative assessments of various means of generating electricity and to draw up their plans for the generation of electricity in a manner consistent with the objectives of 'sustainable development'. These assessments were designed to take account of all relevant factors (technical, economic, environmental and human health) of the various steps in the energy chain of each option for generating electricity — for instance from mining or other forms of resource extraction to the disposal of waste and the decommissioning of the plant. The computer tools that the IAEA developed with the help of some Member States, in particular the USA, are the following.

The Tennessee Valley Authority and the Oak Ridge National Laboratory in the USA developed the 'Wien Automatic System Planning' (WASP) package in 1972 to enable the IAEA to assess the economic competitiveness and the potential role of nuclear power in electricity supply systems. In 1972–1973, the IAEA used WASP to carry out a market survey of the prospects for nuclear power in developing countries and used it subsequently for planning studies of electricity systems in individual countries. In the light of the experience gained, the IAEA produced improved versions of the program in 1979, 1994 and 1996, and it has become one of the most widely used tools in the planning of the growing electricity systems of many Member States.

The IAEA developed the 'Model for Analysis of Energy Demand' (MAED) package in 1981 to help determine the demand for energy and electricity in various countries, and thus provide better forecasts to be used in WASP studies. Both MAED and WASP have been used to carry out many projects under the IAEA's technical co-operation programme.

Argonne National Laboratory developed the 'Energy and Power Evaluation Program' (ENPEP) package in 1985 and transferred it to the IAEA for use by Member States in energy, electricity and nuclear power planning studies. ENPEP is a set of personal computer based tools and includes personal computer versions of WASP and MAED as well as seven other systems. It has been used in several studies as a comprehensive framework for analysis and decision making, taking into account energy, economic and environmental factors.

The 'VALORAGUA' model was developed for planning Portugal's power generating system. In 1992, the IAEA and Electricidade de Portugal developed a personal computer version of VALORAGUA. This model enables WASP studies to take full account of the contribution of hydro generated electricity and the combined application of VALORAGUA and WASP enables the energy planner to determine the optimal expansion of electricity supply systems using both thermal (conventional and nuclear) power and hydro power.

In 1985, the IAEA developed the 'BIDEVAL' computer program to help Member States evaluate bids for nuclear power plants. The IAEA has organized regional and national training courses to train experts from developing countries in the use of this tool.

'DECADES' is short for an interagency program of 'Databases and Methodologies for Comparative Assessment of Different Energy Sources for Electricity Generation'. This is a tool introduced in 1993 and used to evaluate the trade-offs between technological, economic and environmental aspects of various systems for generating electric power. It consists of databases and analytical software. The two types of databases are:

— A 'Reference Technology Database' covering about 300 typical facilities associated with the full energy chains of electricity generating plants using fossil fuels, nuclear power and renewable energy; and
— A country specific database covering about 25 countries and including site specific data on more than 2500 facilities that form the full energy chains of different electricity generating plants.

The analytical software used by DECADES provides access to information in the technology databases and permits the analysis and comparison of costs and environmental impacts of power plants and their full energy chains as well as entire energy systems.

Standing international working groups

Almost since it began work the IAEA has made use of standing international (expert) working groups (IWGs). In recent years they have played an increasingly important role, especially in efforts to improve the safety and reliability and reduce the costs of nuclear power. The working groups typically consist of about 25 leading nuclear specialists from those Member States that have a direct interest in the subject with which the IWG deals. The IWGs meet at intervals of one to two years to review the present status of their subjects by exchanging information and by studying reports on the progress made in national programmes. They discuss the operating experience that has been gained with the facilities or equipment concerned with their technology (for example, instrumentation and control, or design and development of advanced reactors), identify promising areas for international co-operation and advise the IAEA on its nuclear power and related programmes.

As a rule, the IWG is the sole worldwide forum for discussing and disseminating specialized information on national programmes dealing with a particular type of reactor or a particular technology related to nuclear reactors (for instance, the impact of age on reactors of various types and on their components). The main tangible products of the working groups are the publications resulting from their Co-ordinated Research Programmes, their technical meetings and other publications such as status reports on various national programmes for the development of reactors.

All IWGs devote attention both to the performance of existing power reactors and to improvements in nuclear reactor technology, but four are concerned with questions relating to all or most types of power reactors and four are specifically concerned with particular types of reactors.

IWGs dealing with general issues

The names of the working groups identify the topics with which they deal. The IWG on 'Life Management of Nuclear Power Plants' is a successor to an IWG on the 'Reliability of Reactor Pressure Vessel Components' set up in 1975, which in turn had its origins in an IWG on 'Engineering Aspects of Irradiation Embrittlement of Reactor Pressure Vessel Steels' established in 1969. It is particularly concerned with the impact of ageing on nuclear power plants and their components and on those factors that limit the lifetime of plants, and with technical means of extending plant lifetime. One of the most useful products of this IWG and its predecessors has been a 25 year long study dealing with the behaviour of reactor materials under neutron irradiation. This has provided much better understanding of and comprehensive information about the radiation induced changes that take place in such materials during reactor operation.

The IWG dealing with power plant instrumentation and control was established in 1970. The group focuses on the use of computers and other information technologies, the engineering aspects of the interface between operators and machines (the 'human–machine interface') and on simulators for training purposes as well as on the development of instruments and controls.

The IWG dealing with the training and qualification of nuclear power plant personnel was established recently (1994) in recognition of the fact that the safety and reliability of nuclear power plants depend as much (if not more) on the competence of plant personnel as on the quality of equipment and instruments. Besides advising the IAEA on its own programmes, the IWG aims to identify areas where the IAEA can help Member States to increase their ability to train personnel for the safe, reliable and economic operation of nuclear power plants. The IWG also helps to ensure that IAEA standards are implemented and serves as a source of advice for the IAEA's technical co-operation programmes.

The IWG on 'Water Reactor Fuel Performance and Technology' was set up in 1976 and focuses on the design and performance of nuclear fuel, fuel assemblies and components such as control rods and on the processes and phenomena that occur in water reactors.

Advanced reactors

Nuclear power was first developed chiefly by national nuclear energy establishments working more or less independently of each other. An early exception was the high temperature gas cooled reactor (HTGCR). In the 1950s, certain member countries of the OECD's ENEA pooled their resources in the 20 MW(th) Dragon project in the United Kingdom, which went critical in 1964.[96] However, for the development of fast breeder reactors the nations concerned initially chose the national path. In the 1950s and 1960s, France, the Federal Republic of Germany, Japan, the USSR, the United Kingdom and the USA each began to build prototype fast breeder reactors of roughly similar size and having many features in common. Subsequently, as national financing of advanced reactor programmes began to shrink, international co-operation through the IAEA and other organizations became increasingly important, providing a forum in which nuclear establishments could exchange information and seek means of co-ordinating their work to help meet the high costs of development, and to focus on key issues that hindered such development.

Over time the IAEA has established four IWGs to co-ordinate its activities relating to advanced reactor technologies, namely those on light water cooled, gas cooled, heavy water cooled and liquid metal cooled (i.e. fast breeder) reactors. Smaller specialist meetings were convened in selected areas of technology as well as larger, more broadly based technical committees, workshops and symposia. Advanced reactor designs include, as a rule, concepts that will enhance their safety such as features that give operators longer grace periods (for instance, more time to respond to a signal), and that protect more effectively against the release of radioactivity to the environment. Advanced designs may incorporate built-in 'passive' safety features that depend on natural forces such as gravity and convection to ensure the flow of coolant in an emergency and make safety functions less dependent on pumps and other active systems and components that would have to be started up at short notice.

From 1987 until 1996, the IAEA's work on both light and heavy water reactors was carried out chiefly by an IWG on 'Advanced Technologies for

Water Cooled Reactors'. In 1997, the operation was, in effect, divided between two IWGs, dealing respectively with light and heavy water reactors.

Water cooled reactors have long since become the world's predominant nuclear power reactor: 396 of the 437 power reactors in operation at the beginning of 1996 were water cooled and their leading place in installed nuclear capacity was even more obvious; it was rated at 330 100 MW(e) out of a world total of 344 400 MW(e), representing about 96% of the world's total. Amongst them, the *light* water cooled reactors generated 297 100 MW(e), or 78% of the total amount of electricity produced by nuclear power.

By the mid-1990s, very large water cooled reactors of advanced design with outputs well above 1000 MW(e) were coming into operation in the Far East, Europe and North America. In 1996, for instance, a 1130 MW(e) pressurized water power reactor and two 1315 MW(e) advanced boiling water reactors were started up in Japan, the first 1445 MW(e) pressurized water reactor in France and a 1165 MW(e) pressurized water reactor in the USA. A large 650 MW(e) heavy water reactor came into operation in Romania. While changes to a proven design are kept as small as possible, there is nonetheless a wide range of design improvements to increase reliability, make designs more user friendly, improve economics and enhance safety.

The IAEA's IWG on 'Gas Cooled Reactors' was established in 1978 and currently includes 12 Member States, the European Union and the OECD/NEA.[97]

The fast breeder reactor

The fast breeder reactor represents an advanced technology that merits special attention not only because it offers a potentially almost unlimited source of electric power and heat, but also because of all advanced nuclear reactor types (except those that are essentially improvements in the design of the existing generation of light water reactors) it has so far received the most technical support and attention.

As the prospects for nuclear power improved in the 1970s there was mounting concern whether known uranium reserves would be able to meet the growing demand for nuclear fuel. As noted at the beginning of this chapter, the first electricity generated by nuclear energy had its origin in an experimental breeder reactor. This, in the long run, spurred interest in the development of commercial breeder reactors. In principle, use of the breeder would make it possible to extract sixty times more energy from a given amount of uranium than could the current generation of reactors. This would thus make it economic to exploit lower grades of uranium ore, perhaps even the very small concentration of uranium in sea water. Accordingly, the breeder would, it was argued, present humanity with an almost inexhaustible source of electric and thermal energy. In the early days of the IAEA there seemed to be a race between the proponents of breeder reactors and the fusion enthusiasts; who would be the first to achieve a commercially viable machine?

At the third Geneva Conference it was predicted that "full-sized fast breeder power stations will probably be commissioned in the early 1970s."[98] The Conference also noted that "virtually all countries with major nuclear power programmes now devote considerable efforts to developing fast reactor systems, the economic breeder reactor being the ultimate goal."

The IAEA soon began to take an active interest in the development of breeder reactor technology. A meeting of experts in December 1964 helped it to prepare a programme for monitoring progress in the development of the technology[99]; in 1967 the Agency established an IWG on fast reactors and in 1970 an IAEA symposium in Monaco reviewed the evolution of fast breeder systems.[100]

As far back as 1963 the USA had completed the Fermi fast breeder reactor, producing 61 MW(e) of electricity.[101] Ten years later, in 1973, the USSR brought into operation the first medium sized prototype fast breeder reactor, the BN-350, at Shevchenko (now Aktau in Kazakstan). This reactor, with an equivalent capacity of 350 MW(e), is still producing both electricity and desalted water for Aktau city and neighbouring industries. In the 1980s, two more fast breeder reactors were commissioned, a prototype medium sized reactor, the Phénix (250 MW(e)), in France and the commercial sized BN-600 (600 MW(e)) in the USSR. In 1994, Japan commissioned the 280 MW(e) Monju fast breeder reactor (which, as noted, following a sodium leak, has been out of action since December 1995), and Russia plans to resume building two 800 MW(e) fast breeder reactors in the South Urals.[102] In 1986, the first fast breeder reactor of a fully commercial size, the Superphénix at Creys-Malville, rated at 1242 MW(e), was connected to the French grid.[103]

The USA has long since brought its fast breeder reactor programme to a halt and, despite the initiatives taken in the 1980s, Western Europe appears to be following suit. In 1991, Germany stopped construction of a 327 MW(e) prototype fast breeder reactor at Kalkar[104] and in 1994 the United Kingdom closed down its 250 MW(e) prototype fast breeder reactor at Dounreay.[105]

Superphénix itself has had several operating problems and was shut down for some two years in the early 1990s.[106] Chiefly because of the large capital cost incurred in building Superphénix,[107] Electricité de France appears to have abandoned plans to build a series of fast breeder reactors. Superphénix is being converted into a plutonium burner and will be used for research instead of breeding plutonium. The expectations that lasted until the early 1980s (and in some quarters the fears) of a worldwide boom in breeder reactors have faded, at least for the next decade or two.[108]

It should be stressed that though the fast breeder reactor is still far from being economically competitive, its technology is proven. Twenty fast breeder reactors have been built and operated, five of which were prototypes or of commercial size. Fast breeder reactors have accumulated 280 reactor-years of experience, more than 85 of which resulted from the operation of the five larger reactors mentioned earlier. Fast breeder reactors continue to offer an indefinitely sustainable source of energy as well as the technical means of reducing the space and storage time needed for high level waste (the fast breeder reactor can be used to transmute long lived actinides[109]). They also offer the means of reducing the stocks of plutonium resulting from the dismantling of nuclear weapons and recovered from the spent fuel of present thermal reactors — in other words, the plutonium separated in civilian reprocessing plants like La Hague in France and Sellafield in the United Kingdom. If other sources of energy become scarce and expensive, the fast breeder reactor, despite recent setbacks, offers a technically tested alternative. In the meantime, it seems sound policy to maintain and improve fast breeder reactor technology, enhance its safety and reduce its costs — objectives to which the IAEA has been seeking to contribute.

The prospects for nuclear power in the early 1990s

In 1988, the world's installed nuclear power capacity passed 300 000 MW(e). As noted, at the end of 1996 it stood at 350 964 MW(e) (in 442 plants), and 35 plants totalling a further 26 728 MW(e) were under construction.

In September 1994, the IAEA held an international conference entitled 'The Nuclear Power Option'. The consensus of the conference was that nuclear power will continue to provide about the same proportion of world electricity as it does at present (about 17%) and that a mix of energy sources helps to assure a stable supply and price.[110] But it is clear that the future of nuclear power and of the IAEA's programmes dealing with it will depend largely on five factors:

- — The future demand for electricity (especially in Asia, where growth in demand seems likely to be strongest, and where the prospects for nuclear power are better than in other regions).
- — The relative cost of generating electricity by burning fossil and nuclear fuels. (Recent trends in most countries of North America and Western Europe have not been favourable to nuclear energy, coal or oil. In most of these countries the only rapidly expanding source of energy for electricity generation is natural gas.)[111]
- — Maintaining a superior safety record for nuclear energy to offset the lingering memories of Chernobyl. (As Director General Blix put it in 1991: "The future of nuclear power depends essentially on two factors: how well and how safely it actually performs and how well and how safely it is perceived to perform." Blix included under 'safety' the safe disposal of nuclear waste.)
- — Persuading the public that nuclear waste can be disposed of without endangering the health of future generations (the technology is available, public confidence is lacking).
- — In the longer run, how seriously the world takes the threat of global warming, which stems largely from the 'greenhouse gases' emitted by fossil fuels. (This applies particularly to North America and Western Europe where, except in France, nuclear energy programmes do not seem likely to flourish unless drastic steps are taken to curb the use of fossil fuel for electricity generation. It also applies to the two countries in Asia where energy consumption and the burning of coal seem bound to grow massively in the next century, namely China and India.) [112]

The Intergovernmental Panel on Climate Change (IPCC) is the main international body assessing the impact of greenhouse gases on the world's climate. The IAEA provided a considerable amount of material to the Panel, but in 1994 the IAEA went on record as stating that the draft assessments the Panel made in that year did not "adequately reflect the potential contribution that nuclear energy could make to meeting energy demands while reducing carbon dioxide emissions."[113] Subsequently, the head of the OECD's International Energy Agency noted in a statement to a UN meeting that "nuclear energy accounted for the greater part of the lowering of carbon density of the energy economies of the OECD countries over the last 25 years."[114] Nonetheless, the past years have shown how difficult a task it will be to persuade energy authorities and governments, in the countries concerned and particularly in developing countries like India and China, to pay the cost of reducing carbon dioxide emissions and to persuade the public that nuclear energy is one of the viable solutions to the problem of global warming. The reluctance of the IPCC to recognize the potentially benign role of nuclear energy was another pointer in this direction.

This chapter has charted the varying prospects for nuclear power from the euphoria of 1955 to the mild disappointments of the late 1950s and early 1960s to the boom of the 1970s and to the slump in much of the West and in several developing countries in the 1980s and early 1990s. It is difficult for later generations to capture the sense of achievement that marked the operation of the first reactors and the construction and startup of the first nuclear power plants. Here, at last, the ingenuity of mankind — in the work of brilliant scientists — had unlocked a potentially inexhaustible source of energy that did not depend on the muscles of tamed animals or the vagaries of wind and weather or the burning of coal or oil that had been laid down 60 million years ago, but which, instead, released the binding energy of the atom itself. In the 1980s and early 1990s, many of a younger generation seemed, rather, to triumph when a nuclear power plant was shut down or a windmill was put up or a gas burning power plant was opened. We cannot know what the future holds, but it is certain that we have not seen the end of the story. Perhaps another generation will see in nuclear power not only a source of abundant energy but also the main hope for avoiding the problems that will follow if the temperature of our atmosphere is allowed to go on rising.

NOTES

1 *Report of the Preparatory Commission of the International Atomic Energy Agency*, document GC.1/1, GOV/1, pp. 13–14, paras 48–51.

2 See, for instance, the *Annual Report for 1995*, GC(40)/8, IAEA, Vienna (1996) 10.

3 *Annual Report of the Board of Governors to the General Conference Covering the Period from 1 July 1958 to 30 June 1959*, GC(III)/73, IAEA, Vienna (1959), p. 4, para. 10; and IAEA General Conference Resolution GC(II)/RES/27.

4 *Annual Report of the Board of Governors to the General Conference Covering the Period from 1 July 1958 to 30 June 1959*, pp. 45–46. paras 215–216. In his essay in *Personal Reflections*, Ambassador Bill Barton writes that Canada offered to sell the fuel for $1.00!

5 SZASZ, P.C., *The Law and Practices of the International Atomic Energy Agency*, Legal Series No. 7, IAEA, Vienna (1970) 420–421. The Board subsequently cancelled the application of safeguards and safety measures that had been applied under this project since the quantity of uranium was below the exemption limit established by the first safeguards system and did not represent substantial assistance to the operation of the JRR-3 reactor.

6 *Annual Report of the Board of Governors to the General Conference 1 July 1959–30 June 1960*, GC(IV)/114, IAEA, Vienna (1960), p. 37, paras 224–226.

7 The United Nations 'Special Fund' and its 'Expanded Programme for Technical Assistance' were the precursors of the present United Nations Development Programme.

8 *Annual Report of the Board of Governors to the General Conference 1 July 1961–30 June 1962*, GC(VI)/195, IAEA, Vienna (1962), p. 7, para. 45; *Annual Report of the Board of Governors to the General Conference 1 July 1962–30 June 1963*, GC(VII)/228, IAEA, Vienna (1963), p. 7, paras 41 and 43; *Annual Report of the Board of Governors to the General Conference 1 July 1963–30 June 1964*, GC(VIII)/270, IAEA, Vienna (1964), p. 20, para. 77. The plant that Yugoslavia eventually built at Krško, now in Slovenia, is not the demonstration reactor studied in the early 1960s. The Philippines completed the construction of a nuclear power plant, but when Corazon Aquino succeeded President Marcos it was decided not to start up the reactor, chiefly because the plant was believed to be in an earthquake zone.

9 Document GOV/OR.98.

10 SZASZ, P.C., *The Law and Practices of the International Atomic Energy Agency*, pp. 281–282.

11 Indeed, as noted in Chapter 5, the IAEA's contribution was very modest: two technical papers and a few members of the Conference's scientific staff.

12 *Annual Report of the Board of Governors to the General Conference 1 July 1964–30 June 1965*, GC(IX)/299, IAEA, Vienna (1965), p. 4, paras 10–17. The Conference took place from 31 August to 9 September 1964.

13 *Annual Report 1 July 1971–30 June 1972*, GC(XVI)/480, IAEA, Vienna (1972), p. 37, para. 114.

14 Ibid., p. 37, para 116.

15 In Belgium, Canada, France, Germany, Italy, Japan, the USSR, Sweden, the United Kingdom and the USA. All, with the exception of the Obninsk reactor in Russia, have since been closed down.

[16] *Annual Report of the Board of Governors to the General Conference 1 July 1963–30 June 1964*, p. 19, para. 74.

[17] This has proved to be correct of only one large industrial country, France, and of Sweden, Belgium and Lithuania, and almost true of Bulgaria. In Belgium and Sweden, more than half the electricity produced is now generated by nuclear power, but in Belgium there is now a de facto moratorium on new orders for nuclear power plants and Sweden still remains committed, at least on paper, to phase out nuclear power by the year 2010.

[18] *Annual Report of the Board of Governors to the General Conference 1 July 1964–30 June 1965*, p. 5, para. 20; and *Annual Report of the Board of Governors to the General Conference 1 July 1965–30 June 1966*, GC(X)/330, IAEA, Vienna (1966), p. 15.

[19] The following orders were placed worldwide for new power reactors:

Year	Total capacity (MW(e))
1966	23 000
1967	30 000
1968	34 000
1969	19 000
1970	25 000

[20] It rose in 1968 to 300 000 MW(e), in 1969 to 300 000–350 000 MW(e) and in 1971 to 340 000 MW(e).

In the same year (1971), the estimate for 1985 was 710 000 MW(e) with a 30% margin of error (*Annual Report 1 July 1970–30 June 1971*, GC(XV)/455, IAEA, Vienna (1971), p. 30, para. 73). In 1995, the global installed nuclear capacity amounted to 344 422 MW(e). (*Nuclear Power Reactors in the World, April 1966 Edition,* Reference Data Series No. 2, IAEA, Vienna (1996) 11.)

[21] *Annual Report of the Board of Governors to the General Conference 1 July 1968–30 June 1969*, GC(XIII)/404, IAEA, Vienna (1969), p. 20, para. 64.

[22] Since the mid-1970s, the real price of oil has fallen steeply and today it is no higher in real terms than it was before the 1973 Arab–Israeli war.

[23] *Annual Report for 1975*, GC(XX)/565, IAEA, Vienna (1976), p. 30, para. 89.

[24] *Ibid.*, p. 30, paras 89–90.

[25] *Annual Report 1 July 1974–30 June 1975,* GC(XIX)/544, IAEA, Vienna (1975), p. 32, para. 100.

[26] *Nuclear Power Reactors in the World*, *April 1996 Edition*, p. 11.

[27] *Annual Report of the Board of Governors to the General Conference 1 July 1967–30 June 1968*, GC(XII)/380, IAEA, Vienna (19), p. 11, para 34.

[28] Thorium cannot be directly used as a source of heat to produce steam for a turbogenerator. However, when bombarded with neutrons, thorium is transmuted into uranium-233, a fissile isotope of uranium.

[29] *Annual Report of the Board of Governors to the General Conference 1 July 1964–30 June 1965*, p. 11, para. 31.

[30] *Annual Report for 1980*, GC(XXV)/642, IAEA, Vienna (1981), p. 23, para 73; and *Annual Report for 1981*, GC(XXVI)/664, IAEA, Vienna (1982), p. 36, para. 101.

[31] CONGRESS OF THE UNITED STATES, *Background Material for the Review of the International Atomic Policies and Programs of the United States*, Report to the Joint Committee on Atomic Energy, Vol. 3, US Govt Printing Office, Washington, DC (1960) 507.

[32] Ibid., p. 502.

[33] The term PNE is a misnomer, since there is no such thing as an intrinsically 'peaceful' nuclear explosive or explosion. The NPT itself is careful to refer to the "potential benefits of any peaceful applications of nuclear explosions."

[34] See DOKOS, T.P., *Negotiations for a CTBT 1958–1994*, University Press of America, Lanham, MD (1995) 20.

[35] In 1979–1980, Argentina discussed with the IAEA Secretariat the contents of an agreement that would place all nuclear material in that country under safeguards and thereby enable Argentina to comply with the Tlatelolco Treaty which, according to Admiral Costa Madera, the Argentine Governor, his Government planned to ratify. The author, who led the IAEA team, explained that the IAEA Board would not approve a safeguards agreement under which nuclear material could be withdrawn from safeguards to be used in a PNE. The Admiral insisted that this was Argentina's right under the Tlatelolco Treaty. Despite strenuous efforts to find a compromise, no agreement could be reached and the discussions petered out.

[36] See Resolution GC(XII)/RES/245, *Annual Report of the Board of Governors to the General Conference 1 July 1968–30 June 1969*, p. 24, para. 81. The report on PNEs was issued as document GC(XII)/410. See also *Annual Report of the Board of Governors to the General Conference 1 July 1969–30 June 1970*, GC(XIV)/430, IAEA, Vienna (1970), pp. 27–28, para. 69.

[37] *Annual Report 1 July 1971–30 June 1972*, p. 30., para. 89.

[38] Document INFCIRC/169.

[39] The Eighteen-Nation Disarmament Committee which drafted the NPT. In practice, only 17 nations took part in the ENDC's work; the French chair remained empty.

[40] United Nations General Assembly Resolution 2829 (XXVI).

[41] *Annual Report 1 July 1974–30 June 1975*, p. 9, paras 24–25.

[42] For instance, to excavate a harbour in Western Australia, to build a canal through the Krai Peninsula in Thailand, to remove a sand bank blocking a harbour in Madagascar, to link the Qattara Depression in Egypt with the Mediterranean, and to build a sea level canal across the Isthmus of Panama. The Malagasy enquiry was formal but, after a change of government, it was not pressed.

[43] As noted, India maintained that the test it carried out at Pokharan in 1974 was a peaceful nuclear explosion.

[44] Professor Nye was then Deputy Undersecretary of State for Security Assistance in the Carter Administration.

[45] In principle, the closed fuel cycle involving the reprocessing of spent fuel and the use of the recovered plutonium in a breeder reactor can produce 60 times more energy from a given amount of uranium than the once-through cycle.

[46] The engineer's rule of thumb is that no single plant should produce more than about one fifth of the total output of the grid or network; otherwise there is a danger of a system blackout if the oversized plant falls out. Hence the smaller the network, the smaller should be the largest plant in that network. As networks grow it becomes possible to accommodate larger plants.

[47] *Annual Report of the Board of Governors to the General Conference 1 July 1968–30 June 1969*, p. 23, para. 76.

[48] *Annual Report of the Board of Governors to the General Conference 1 July 1969–30 June 1970*, p. 27, para. 66.

[49] Ten years later, in 1995, the total installed nuclear capacity of the developing countries (including China and South Africa, but excluding Taiwan and the Republic of Korea) amounted to only about 8500 MW(e). The figures given in this section are based on *Nuclear Power Reactors in the World, April 1986 and April 1996 Editions.*

[50] *Annual Report of the Board of Governors to the General Conference 1 July 1969–30 June 1970*, p. 27, para. 64.

[51] *Annual Report 1 July 1971– 30 June 1972*, p. 27, para. 78.

[52] In fact, only 4 of the 14 countries covered by the survey have built nuclear power plants — Argentina, the Republic of Korea, Mexico and Pakistan.

[53] LANE, J., "The impact of oil price increases on the market for nuclear power in developing countries", *IAEA Bulletin* No. 1/2 (1974) 66. Of the 44 countries listed in the article, three have built or are building nuclear power plants — Pakistan, Iran and Cuba.

[54] Unlike those two plants the new reactors were not placed under IAEA safeguards, but India was not under any legal obligation to do so.

[55] *Annual Report for 1984*, GC(XXIX)/748, IAEA, Vienna (1985), p. 29, para. 91.

56 They included four power reactors of 12.5 MW(e) in Bilibino producing both electricity and district heat, a number of reactors in nuclear icebreakers, and district heating reactors of 500 MW(th) under construction in Gorki and Novovoronezh (construction of which has, however, been stopped or suspended). A fast breeder reactor at Shevchenko (now Aktau in Kazakstan) was producing electricity and desalted water for an isolated industrial region. In fact, more that a dozen of the now 'famous' WWER-440 reactors were built in the USSR and a number of former Socialist countries and are still in commercial operation.

57 Document GOV/OR.635, para. 11.

58 *Annual Report for 1987*, GC(XXXII)/835, IAEA, Vienna (1988), p. 26, para. 72.

59 *Annual Report for 1995*, p. 10. There is also some interest in Japan in using reactors of advanced design — high temperature reactors — as a source of industrial heat for gasifying coal, producing methanol and for the more effective recovery of oil.

60 Apart from the Indian heavy water reactors, the smallest nuclear power plants that are now under construction are Chinese 325 MW(e) plants (in China and Pakistan and, possibly, in Iran) and some older 430 MW(e) Soviet WWER plants in Slovakia. It is reported that the next Chinese built plants will be of the order of 600 MW(e), the few plants in prospect in the former Soviet Union in the WWER series will be of the order of 1000 MW(e).

61 Of the 37 nuclear power reactors listed in *Nuclear Power Reactors in the World, April 1996 Edition*, as under construction at the end of 1995, more than a third (13) were under 700 MW(e), including plants in Argentina, India, the Republic of Korea, Pakistan, Romania and Slovakia.

62 However, the concept is still alive. Some very large reactors — with a capacity of some 1500 MW(e) — are now being commissioned. Each represents a very large capital investment and if for any reason the plant has to be taken out of operation the consequence is a major loss of electric power. A utility has more flexibility of operation if it has a park of smaller plants. Studies are being made of the possibility of upgrading submarine reactors to approximately 300 MW(e), while manufacturers in the USA and Canada are looking at plants of 600 MW(e). In the USA, the Nuclear Regulatory Commission has cleared the design of compact Westinghouse plants of 300 and 600 MW(e). (Information provided by Dr. Munir Khan.)

63 *Annual Report of the Board of Governors to the General Conference 1 July 1963–30 June 1964*, p. 22, paras 95–96.

64 *Annual Report of the Board of Governors to the General Conference 1 July 1966–30 June 1967*, GC(XI)/355, IAEA, Vienna (1967), p. 15, para. 36.

65 See the following: *Annual Report of the Board of Governors to the General Conference 1 July 1964–30 June 1965*, p. 13, para. 46, p. 14, para. 49, p. 15, para. 51; *1 July 1965–30*

June 1966, p. 21, para. 69; *1 July 1966–30 June 1967*, p. 15, paras 35–37; *1 July 1967–30 June 1968*, pp. 12–13, paras 39–40; *1 July 1968–30 June 1969*, pp. 23–24, paras 78–80; *1 July 1969–30 June 1970*, p. 27, para. 68; *1 July 1970–30 June 1971*, p. 31, paras 80–81.

66 *Annual Report of the Board of Governors to the General Conference 1 July 1965–30 June 1966*, p. 23, paras 79 and 80.

67 *Annual Report for 1989*, GC(XXXIV)/915, IAEA, Vienna (1990) 7.

68 *Annual Report for 1992*, GC(XXXVII)/1060, IAEA, Vienna (1993) 19.

69 *Annual Report for 1993*, GC(XXXVIII)/2, IAEA, Vienna (1994) 19; *Annual Report for 1994*, GC(39)/3, IAEA, Vienna (1995) 30.

70 *Annual Report for 1995*, p. 5.

71 The latest figures (March 1996) give a range of between 375 000 MW(e) and 535 000 MW(e) for the year 2015. The latter is about one tenth of the 1975 upper projection for the year 2000!

72 The Presidential Commission set up to review the causes and results of the accident concluded that the radiation exposure which it caused would "lead to no additional cancer deaths or, if there were any, they would be so few that they could not be detected" amongst the more than two million people living within a 50 mile radius of the plant. In the same population, about 325 000 cancer deaths must be expected from other causes. (*Annual Report for 1980*, p. 3, para. 4.) New nuclear power plant orders had begun to decline in the USA some years before the accident, but Three Mile Island was the coup de grâce.

In fact, during 1995 no country anywhere began the construction of a new nuclear power plant (*Nuclear Power Reactors in the World, April 1996 Edition*, p. 13). No new orders were placed in the USA during 1996 and most observers foresaw an indefinite halt to any new US orders.

73 *Annual Report for 1980*, GC(XXV)/642, IAEA, Vienna (1980), p. 22, para. 67.

74 *Annual Report for 1983*, GC(XXVIII)/713, IAEA, Vienna (1984), p. 25, para. 70.

75 *Annual Report for 1981*, p. 8, para. 10.

76 *Annual Report for 1989*, p. 6.

77 *Nuclear Power Reactors in the World, April 1996 Edition*, pp. 13 and 50; and *IAEA Press Release*, PR/97/6 (24 April 1997).

78 YOSHIKAWA, M., "Japan: Review shows Japan nuclear agenda on the ropes", *Reuters News Service*, 7 May 1997.

79 Operational Safety Review Team — see Chapter 7.

80 For instance, the IAEA held five workshops in Thailand in 1993, chiefly for persons who would be deciding whether or not the country should proceed with a nuclear power programme and to provide for the training of nuclear power plant operators

(*Annual Report for 1993*, p. 13). The IAEA held six training courses in Indonesia in 1994 (*Annual Report for 1994*, p. 18). It helped China to assess the economics of nuclear power in 1993 and 1994 and held an ASSET (Assessment of Safety Significant Events Team) training seminar in China in 1992, sent an OSART mission to assess the safety of China's first nuclear power plant at Guangdong and an expert mission on the management of nuclear accidents to China in 1993 (*Annual Report for 1993*, pp. 125 and 128). OSARTs visited the Republic of Korea in 1986 and 1989 and there was an ASSET mission in 1991.

81 Fusion is the opposite of the nuclear fission process that takes place in today's nuclear power plants. In fission, the nuclei of heavy elements, such as uranium, split apart forming lighter elements. In fusion, the nuclei of light elements, such as hydrogen, combine to form heavier elements. In both cases, the reactions release a large quantity of energy.

82 *Status Report on Controlled Thermonuclear Fusion, Executive Summary and General Overview*, International Fusion Research Council, IAEA, Vienna (1990) 3.

83 Ibid., p. 26.

84 *Annual Report of the Board of Governors to the General Conference 1 July 1960 to 30 June 1961*, GC(V)/154, IAEA, Vienna (1961), p. 33, para. 205; *Nuclear Fusion* **1** 1 (1960).

85 *Nuclear Fusion* **18** 1 (1978).

86 *Annual Report of the Board of Governors to the General Conference 1 July 1961 to 30 June 1962*, p. 8, para. 52.

87 Subsequent conferences were held in Berchtesgaden, Innsbruck, Brussels, Baltimore, London, Kyoto, Nice, Washington, Würzburg and Seville. See "Foreword", *Plasma Physics and Controlled Nuclear Fusion Research* (Proc. 6th Int. Conf. Berchtesgaden, 1976), Vol. 1, IAEA, Vienna (1977).

88 *Status Report on Controlled Thermonuclear Fusion, Executive Summary and General Overview*, p. 27.

89 STACEY, W.M., "INTOR Workshop: Design, concept, critical issues, innovations, database assessment, summary", *Plasma Physics and Controlled Nuclear Fusion Research 1988* (Proc. 12th Int. Conf. Nice, 1988), Vol. 3, IAEA, Vienna (1989) 199.

90 *International Tokamak Reactor: Phase Two A, Part III* (Report Workshop Vienna, 1985–1987), Vols 1 and 2, IAEA, Vienna (1988).

91 CLARKE, J.F., in *Plasma Physics and Controlled Nuclear Fusion Research 1986* (Proc. 11th Int. Conf. Kyoto, 1986), Vol. 1, IAEA, Vienna (1987) 5.

92 MAISONNIER, C., in *Plasma Physics and Controlled Nuclear Fusion Research* 1988 (Proc. 12th Int. Conf. Nice, 1989), Vol. 1, IAEA, Vienna (1989) 3.

93 Foreword, *ITER Interim Design Report Package and Relevant Documents*, IAEA, Vienna (1996).

[94] *Status Report on Controlled Thermonuclear Fusion, Executive Summary and General Overview*, p. 9.

[95] FLAKUS, F.N., CLEVELAND, C.C., DOLAN, T.J., "Nuclear fusion: Targeting safety and environmental goals", *IAEA Bulletin* **4** (1995) 24. The authors suggest that ITER "could begin significant DT operation (fusion of deuterium and tritium) around 2005–2010...A demonstration fusion power plant could then begin operation about two decades later."

[96] INTERNATIONAL ATOMIC ENERGY AGENCY, *Directory of Nuclear Reactors*, Vol. 5, IAEA, Vienna (1964) 277–282. The Dragon was fuelled with high (93%) enriched uranium and thorium, graphite moderated and helium cooled.

[97] Three other Member States not members of the IWG take part in the gas cooled reactor programme.

[98] *Annual Report of the Board of Governors to the General Conference 1 July 1964–30 June 1965*, p. 5, para. 19.

[99] *Annual Report of the Board of Governors to the General Conference 1 July 1963–30 June 1964*, p. 22, para. 94.

[100] *Annual Report of the Board of Governors to the General Conference 1 July 1967–30 June 1968*, p. 10, para. 33; and *Annual Report of the Board of Governors to the General Conference 1 July 1969–30 June 1970*, p. 25, para. 58.

[101] The Fermi was shut down in 1972 (*Nuclear Power Reactors in the World, April 1996 Edition*, p. 49).

[102] Following an accidental discharge of between 700 and 3000 kg of its sodium coolant, the Monju was taken out of operation for extensive repairs at the beginning of 1996. ("Phoenix in der Asche", *Der Spiegel* 6 (1977) 166.)

[103] The data given in this and the next paragraph are chiefly drawn from *Nuclear Power Reactors in the World, April 1996 Edition*.

[104] After spending some $6 billion on it according to a German magazine (notably critical of nuclear power). ("Phoenix in der Asche", *Der Spiegel*, p. 167.)

[105] *Nuclear Power Reactors in the World, April 1996 Edition*, p. 48.

[106] Superphénix was restarted in 1996 and was operating at full power towards the end of the year.

[107] Estimated by the same German magazine at $5–6 billion and eventually twice that sum ("Phoenix in der Asche", *Der Spiegel*, p. 168).

[108] Most of the technical and economic problems that the fast breeder reactor has run into have derived from the reactor's use of liquid metal as a coolant. The small size of the fast reactor core results in high specific heat. The coolants used by thermal (current generation) reactors — namely water or a gas such as carbon dioxide — could not carry away this heat rapidly enough to the fast breeder reactor's heat

exchanger. Moreover, the use of water as a coolant would slow down (moderate) the fast neutrons that are crucial to the functioning of a fast breeder reactor. Hence the use of a liquid metal, usually sodium, for this purpose. Sodium, however, is not only highly corrosive, but also bursts into an intensely hot fire if it comes into contact with air or water. Severe physical damage can thus be caused by a sodium leak, necessitating measures to prevent or protect against such leaks, several of which have occurred in the past. These measures helped to push up the capital cost of the fast breeder reactor. However, while sodium leaks can lead to a fierce fire, they have not resulted in any loss of life or severe injury to plant operators.

[109] Defined as heavy radioactive metallic elements.

[110] *Annual Report for 1994*, pp. 4–5.

[111] A generating plant using natural gas costs as little as one fifth as a nuclear power plant of the same size, and it can be quickly added to the grid in the form of a relatively small unit. It thus allows a utility to respond flexibly to fluctuations in demand. On the other hand, operating costs per unit of electricity produced in a gas fired power station are higher than in a modern nuclear plant, and natural gas is a wasting asset. ("...at current levels of use exploitable oil and gas will run out within fifty years", BLIX, H., "The global need for nuclear power", keynote address to the Second Philippine Nuclear Congress, Manila, 10 December 1996.) Burning natural gas also produces greenhouse gases — less carbon dioxide than coal or oil but much more (in the form of leaked methane) than a coal or oil fired plant.

[112] The enthusiasm of the 1970s for unconventional and renewable sources of energy, chiefly wind power and solar energy, has generally given way to a more realistic appreciation of their potential. Their contribution will expand, but except for the use of solar energy as a source of heat for domestic water supply, and wind, solar and geothermal in special situations — e.g. certain windy coasts, remote locations, presence of geothermal sources — their overall impact is likely to remain marginal to total demand. Solar, wind, and biomass now jointly provide 0.1% of the total commercial energy the world uses (see BLIX, H., "The global need for nuclear power").

[113] *Annual Report for 1994*, p. 5.

[114] BLIX, H., "The global need for nuclear power", quoting from a speech given by the Executive Director of the OECD International Energy Agency (IEA) to the Second Session of the UN Framework Convention on Climate Change. (The IEA — not to be confused with the IAEA or the NEA! — was established by the OECD after the oil crisis of 1974 with a view to helping the OECD States deal with any repetition of that crisis.)

Chapter 7

NUCLEAR SAFETY AND THE MANAGEMENT OF NUCLEAR WASTE

In a narrow sense nuclear safety means dealing effectively with the risks associated with the nuclear fuel cycle, and radiation safety means dealing with risks arising from the uses of ionizing radiation, including the use of radioisotopes and radiation in medicine, industry and various branches of research. Waste management similarly relates to risks arising from radioactive waste and includes the disposal of such wastes. In this chapter the term 'nuclear safety' is used, when convenient, as an umbrella to cover all such activities.

From the start, the IAEA's work relating to nuclear and radiation safety and the management of nuclear and other radioactive wastes has, in accordance with its Statute, fallen into the following broad categories:

— Supporting research (for instance, on radiation effects and on the behaviour of radionuclides in the environment);

— Promoting the exchange of information, for instance, by scientific meetings, and by specialized publications;

— Establishing a comprehensive range of standards, regulations, codes of practice, guides, etc., dealing with most aspects of the civilian nuclear fuel cycle and with radioactive waste;[1]

— Helping Member States, especially developing countries, to strengthen the national infrastructure for dealing with nuclear safety, radiation safety and radioactive waste management and providing advice on specific questions or problems;[2]

— Promoting binding international conventions on nuclear safety, early notification of a nuclear accident, mutual assistance in case of radiological emergencies, management of radioactive waste, liability in the case of accidents, liability of operation of nuclear ships, and physical protection of nuclear material against criminal acts.

Nuclear safety

The approach

The Statute foresaw that in any project or other arrangement to which the IAEA was requested to apply safeguards it should have the right "to require the observance of any health and safety measures prescribed by the Agency" and that the IAEA's inspectors would have the responsibility of determining whether "there is compliance with" those health and safety measures.[3] The requirement to observe the IAEA's health and safety standards was to apply, in the first place, to the IAEA's own operations which, it was assumed, would involve the transport and storage of large amounts of nuclear material. It was also tacitly assumed that the conclusion of Agency project agreements, which would require the project to be subject to safeguards — including those relating to nuclear safety — would lead to the widespread application of mandatory IAEA safety standards.

The Prepcom accordingly foresaw the recruitment of safety inspectors. The first 'health and safety measures', including 'safety standards' approved by the Board on 31 March 1960, authorized the Agency to carry out not more than two safety inspections a year of an assisted operation.[4]

In practice, the cases where the IAEA has required a State to apply IAEA safety measures have been limited to 'Agency projects' and to technical co-operation projects (even though the latter do not normally provide for the application of safeguards).

As noted in Chapter 8, the Board of Governors in 1959 and 1960 took decisions that ensured that the function of safeguards inspection should henceforth be kept separate from the application of safety measures. No safety inspectors were ever formally appointed. A few safety inspections carried out by the IAEA in the early 1960s were apparently undertaken by ad hoc inspectors from the then existing Division of Health, Safety and Waste Management.[5]

In February 1976, the Board approved a revision of the 1960 *The Agency's Health and Safety Measures*. The revised document replaced the concept of carrying out routine inspections to verify compliance with the Agency's health and safety measures by that of advisory safety missions to be carried out with the agreement of the State. In effect, the IAEA "waived its statutory right of carrying out routine verification of Agency assisted operations through health and safety inspections..." and replaced it with a voluntary system.[6]

We shall revert to this matter at the end of this chapter.

In 1958, the IAEA began collecting information about the nuclear safety and waste management practices and regulations of Member States and on the work of other international bodies in these fields. This provided the Agency with background information it would need to draw up its own international recommendations. The Agency also began work on a manual of safe practices for isotope users.[7]

For most of the early 1960s, the IAEA's work on nuclear safety, radiation protection and nuclear waste management consisted of drawing up international recommendations, guides and standards. In other words the IAEA was beginning to lay the basis for national regulations and legislation in countries that had not yet introduced their own nuclear safety standards. This work was carried out chiefly at IAEA Headquarters rather than in the field. In the latter part of the decade the emphasis was increasingly placed on helping developing countries to apply its recommendations.

In 1960, the Board approved *The Agency's Health and Safety Measures* referred to above, to be applied when the Agency carried out projects in its Member States.[8]

By the end of 1961, the IAEA had issued eight sets of recommendations on nuclear safety covering a wide range of topics, including safe operation of research reactors, safe use of radioisotopes and radioactive waste disposal in the sea. Another important early safety standard dealt with the safe transport of nuclear materials. The Board approved these transport regulations in September 1960 (they were published in 1961) and recommended them to Member States and other international bodies concerned with various modes of carriage.[9] During the first half of the 1960s, the Agency helped them to incorporate the IAEA's recommendations into their own regulations.[10]

In June 1962, the Board approved the IAEA's *Basic Safety Standards for Radiation Protection*.[11] These were derived essentially from the recommendations of the International Commission on Radiological Protection (ICRP), which is generally regarded as the impartial and authoritative international body in this field. The basic standards were revised in 1967 and again in the early 1980s[12] to take into account the increasingly rigorous recommendations of the ICRP. The standards were to be revised again ten years later.[13]

The IAEA's direct involvement in reactor safety began with an analysis of a fatal accident at the Vinča reactor in Yugoslavia in October 1958 and with a safety analysis of the Japanese JRR-3 project.[14] The Vinča analysis led to an IAEA publication containing studies of all unclassified reactor accidents.[15] In

1960, the IAEA arranged for an international evaluation of the safety of the DIORIT research reactor in Switzerland. This was the first of many such evaluations that the Agency was to arrange in the years ahead.[16]

On 10 March 1961, the IAEA signed an agreement with the Principality of Monaco and the Oceanographic Institute in Monaco (whose Director was Jacques Cousteau) for co-operation in research on the effects of radiation in the sea.[17] Subsequently, the parties extended the agreement until 1974 and, in the process, the project was transformed into the International Laboratory of Marine Radioactivity (ILMR) and again later into the IAEA Marine Environment Laboratory, or IAEA-MEL (see Chapter 10).

In June 1963, the Board approved the first international agreement for the provision of assistance in the event of a nuclear accident. The agreement (between the IAEA, Denmark, Finland, Norway and Sweden) was signed in October 1963.[18]

In the early days of the IAEA, the nuclear safety staff would extol the safety and environmental advantages of nuclear power. It entailed no risk of disastrous dam breaks like the one at Malpasset in the south of France in 1950 which caused 412 deaths,[19] no major mining accidents, no smelly chimneys belching smoke and soot. Moreover, until the Three Mile Island accident the industry had an excellent safety record. In fact, there were no serious *radiation induced* casualties at any civilian nuclear power plant until the Chernobyl disaster. Despite nuclear energy's horrific entry onto the world stage in 1945, there was certainly no animus against the civilian use of nuclear power in the 1950s and early 1960s.

Towards the end of the 1960s, growing public concern about nuclear safety and the prospect of the 1972 Stockholm Conference on the Human Environment began to affect the IAEA's programme. In the IAEA's 1970–1971 *Annual Report,* there is the first mention in a formal IAEA document of the "continuing public debate about the impact of nuclear energy on the environment" and on the role of the IAEA in the Stockholm Conference.[20] The Agency also began to direct more attention to problems of nuclear waste management.

In August 1970, the IAEA and the US Atomic Energy Commission held a large symposium in New York on the environmental aspects of nuclear power stations. The conference concluded that "nuclear power stations contribute far less to environmental pollution than other forms of thermal power" not only because they do not discharge smoke, soot or particles but also "because of the care that the nuclear industry has taken in designing its installations to contain radioactivity safely, as a result of which the radioactive 'dose' released to the public is trivial in comparison with natural radioactivity."[21] This conclusion may have been factually correct at the time but it reflected a complacency that was to be severely jolted nine years later by Three Mile Island and shattered in due course by Chernobyl.[22]

An interesting aspect of the environmental debate, which was to grow louder and louder during the next two decades, was that until quite recently it focused almost exclusively on civilian nuclear power and largely ignored the fact that the number of nuclear reactors in naval vessels was comparable to the total number of civilian power reactors. It is true that submarine reactors are much smaller than today's nuclear power plants but, as has become obvious since the end of the Cold War, submarines are by no means exempt from accident or mismanagement and the ultimate disposal of naval reactors, including those that have already sunk or been scuttled, is now seen as a major and very difficult environmental problem.

If one needed an example of selective concern one could choose the citizens of Copenhagen, who have firmly rejected nuclear power, have made numerous complaints about the Barsebäck reactor 20 kilometres away in Sweden,[23] but do not seem to have been perturbed by the repeated passage of nuclear submarines within a couple of kilometres of Copenhagen's doorstep.

Ironically, at the same time that the Soviet navy was quietly dumping high level nuclear waste in the form of used naval reactors and their spent fuel off the coast of Novaya Zemlya, the delegation of the Soviet Union frequently and forcefully insisted in the IAEA Board of Governors that there should be a complete prohibition of the Western European practice of dumping low level nuclear wastes at sea.

Even before the Three Mile Island accident and the Chernobyl disaster, public attitudes towards nuclear power began to change, especially in the USA, but also in much of Western Europe. This is not the place to examine the causes of the change; one may merely note that it soon became a historical fact, and that it had a marked effect on the emphasis, balance and scope of the IAEA's work.

Following the June 1972 United Nations environment conference in Stockholm, the members of the UN agreed in 1973 to establish an agency in Nairobi to tackle international environmental problems, the United Nations Environment Programme (UNEP). The IAEA also obtained special funding to expand its safety work in 1973, and sought UNEP help in carrying out several recommendations of the Stockholm Conference.[24]

The Nuclear Safety Standards programme

In 1974, the IAEA launched the major new Nuclear Safety Standards (NUSS) programme. This was a comprehensive series of Codes and Safety Guides intended to ensure the safe design, siting and operation of the current generation of nuclear power reactors and enhance their reliability. Some safety experts from Western Europe initially resisted the Secretariat's proposal to create the NUSS series; there were even some unfounded suspicions that NUSS was a disguised attempt to constrain the burgeoning nuclear industry of France and Germany by imposing US standards.

The IAEA planned eventually to extend NUSS to fast breeder reactors and other plants in the nuclear fuel cycle. By the time of the Three Mile Island accident the IAEA had published five Codes and ten Safety Guides in the NUSS series and a further 39 had been or were being prepared.[25]

As Tadeusz Wojcik points out in his essay in *Personal Reflections*, NUSS was launched at a time when nuclear power was booming, orders for new plants were coming in at the rate of 25–35 a year, many of the orders were for the first nuclear power plant in the country concerned and the IAEA was being called upon to assess the safety of projects at different levels of completion. The choice before the IAEA was to form a standing team of experts, backed up by an advisory committee, to examine each of the projects submitted to it, or alternatively to reach international agreement on the technical principles on which to base safety and reliability criteria for designing, constructing and operating nuclear power plants. Subsequently, the IAEA would draw up guides and manuals prescribing how to meet the established safety and reliability criteria. The IAEA decided on the second solution and agreed that a series of five NUSS Codes and 47 Safety Guides should be prepared between 1975 and 1980.

In 1974, the Board discussed whether the forthcoming NUSS documents should have the status of recommendations or should be legally binding, and decided on the former — NUSS documents would be recommendations. The debate was reopened in the 1980s, after the NUSS series had been completed, but, once more, any mandatory prescriptions were rejected. However, in 1987, replies to an IAEA questionnaire from 47 Member States showed that the basic concepts, purposes and functions of their nuclear regulatory bodies generally conformed to the relevant NUSS recommendations.

The issue arose again in 1992 when the IAEA began work on a nuclear safety convention. The group drafting the convention decided not to incorporate any reference to the NUSS codes because of concern about setting in stone, in other words ‘petrification’, of standards that were likely to be subject to many changes over time.[26]

Three Mile Island

On 28 March 1979, the core of one of the two nuclear reactors at the Three Mile Island nuclear power station in Pennsylvania overheated and partially melted down. There was no significant release of radiation beyond the containment structure of the plant and no one was physically injured. But this was the first major accident at a civilian nuclear power station and the psychological effect on the population in the neighbourhood, and eventually throughout the Western world, was immense. So was the damage to the plant itself and to the reputation of the nuclear power industry. In 1979, the total capacity of nuclear power plants on order worldwide actually decreased by about 8000 MW(e); eight new plants were ordered but 14 previous orders were cancelled.[27]

It is of some interest that both the Three Mile Island accident and the far more disastrous accident at Chernobyl took place in the two nuclear weapon States that had done more than any other nation to promote the civilian as well as military use of nuclear energy, but States that had also taken dangerous short cuts in the early days of the nuclear arms race. These short cuts had no direct relevance to the Three Mile Island accident, but they seem to have contributed to the poor nuclear safety culture in the Soviet Union, a deficiency that played a significant role in the Chernobyl accident.

After Three Mile Island, Director General Eklund convened a group of leading nuclear safety experts to consider what actions the IAEA and its Member States should take. They recommended that the IAEA should hold specialized meetings on the lessons of the accident, expand safety research and the exchange of information, arrange emergency assistance and provide technical assistance on nuclear safety. States should publish the results of their nuclear safety research more quickly and freely, require an adequate emergency plan before licensing the sale or purchase of a nuclear power plant, negotiate bilateral, multilateral and regional agreements for mutual assistance in the case of an accident, periodically test their plans for dealing with emergencies and ask the IAEA routinely to check the safety work of Member States.[28]

Brazil, the Federal Republic of Germany and Sweden wrote to Eklund proposing that the IAEA's nuclear safety programme be promptly reviewed and new initiatives undertaken.[29] The Federal Republic of Germany proposed that international co-operation should focus on evaluating safety concepts, exchanging views on the future of such concepts and comparing basic safety requirements, and that States should intensify nuclear safety research and engineering. Sweden stressed the importance of harmonizing national nuclear safety rules and offered to host an international meeting on nuclear safety.

At the first meeting of the Board after the Three Mile Island accident, Governors were unanimous in welcoming the three-nation proposals as well as those of the Director General for expanding the IAEA's programme — provided that, in 1979, the expansion was financed by additional voluntary contributions (which was what Eklund had recommended). The Board was more guarded about Eklund's recommendation that a number of posts should be added to the Professional staff of the Division of Nuclear Safety and that the regular budget should be increased to finance an expanded safety programme in 1980. France, the Federal Republic of Germany, Canada and the United Kingdom stressed, as they had often done in the past, that national authorities bear ultimate responsibility in matters of nuclear safety.

The accident showed that a State lacking the nuclear experience and resources of the USA would have grave difficulty in coping with an accident on the scale of Three Mile Island and would urgently need international assistance. With the help of leading national experts, the IAEA Secretariat prepared recommendations for prompt notification of a nuclear accident and for mutual assistance in the case of an accident.[30] Eklund's recommendations that both matters should be the subject of international conventions were turned down; in the view of the Board clear guidelines would suffice.[31] As Tadeusz Wojcik notes in *Personal Reflections,* the fact that it took two days before the world knew about Chernobyl showed that 'clear guidelines' did not suffice to avoid a reprehensible delay before the public was told about a major accident, and that a binding convention was indeed needed.[32]

The Board did agree on the importance of sharing internationally the lessons learnt from Three Mile Island. In fact, it was clear that the views of governments were beginning to be more broad-minded about the IAEA's role in nuclear safety. But the rate of change was slow. It would take another far more serious accident to bring about a drastic revision of national attitudes towards the IAEA's proper responsibilities in nuclear safety.

An immediate consequence of the Three Mile Island accident was the expansion of the NUSS programme that the group of experts and Eklund had recommended. The IAEA also accepted the Swedish offer to serve as host for a nuclear safety meeting and decided to hold a conference in Stockholm in October 1980 focusing on "current nuclear power plant safety issues." The Stockholm conference attracted wide interest, bringing together about 700 nuclear specialists and energy policy makers. It came to the reassuring conclusion that there were "no factors related to *safety* that limit the use and development of nuclear power" (emphasis in the original),[33] but identified the "machine–man interaction" — i.e. the way in which the operators interact with and control their plants — as an area of weakness and recommended better training of the operators of nuclear power plants and better and more user friendly control instruments. Chernobyl was at first also blamed chiefly on those in control of the plant, but later analyses laid more blame on defects in the design of the Chernobyl type (RBMK) reactor.

In November 1979, the Director General reported to the Board that all Member States had been informed of the Agency's willingness to help them incorporate its Codes and Safety Guides into their domestic legislation. He also reported that the Secretariat was making a study of what a government would need in the way of experts, equipment and services to deal with a nuclear emergency and that it was compiling a roster of national experts who would be available to help out in the event of another serious nuclear accident.[34]

Three Mile Island served notice on the nuclear authorities in many countries that a major nuclear accident at a large nuclear power plant was not simply a remote contingency suitable for theoretical studies but a real possibility that nuclear authorities must do everything in their power to avoid, and for which preparations had to be made in case a serious accident nonetheless took place. It certainly gave much impetus to the IAEA's work relating to nuclear emergencies.

The nuclear establishments of North America, Western, Central and Northern Europe, as well as those of Japan, the Republic of Korea and the developing countries, generally took the lessons of the accident to heart in the knowledge that an accident of similar magnitude on their territories would inflict a massive and possibly lethal blow to their nuclear industries. In the USA, the nuclear industry set up a national organization (INPO, the Institute of Nuclear Power Operations) to improve operating safety, for instance by collecting, evaluating and exchanging reports on all nuclear 'incidents' at their plants so as to prevent a repetition of Three Mile Island.[35] The accident also hastened the transfer of responsibility for nuclear safety, in certain countries, from the national nuclear energy agency to an independent regulatory authority. It is notable that in the 18 years that have passed since Three Mile Island, the OECD and developing countries that have nuclear power plants have been free of any serious nuclear accident. There have been a number of leaks of reactor coolants which have attracted extensive attention in the media, but no human life has been threatened and no grave damage has been done to any nuclear plant outside the former Soviet Union.

The Soviet Union's nuclear industry seemed to learn little from Three Mile Island. There appears to have been no attempt to apply its lessons. Part of the explanation is perhaps that the Soviet Union was still a closed society operating a command economy in which the experience of other countries could only be internalized and translated into practical action if it had been understood and acted upon by those who gave the commands.

Incident Reporting System

The IAEA had long been trying to set up a global system of reporting on all nuclear accidents and incidents at nuclear power plants (with analyses of cause and recommendations about means of reducing the chances of future accidents), but had run into resistance, apparently on the grounds that the information in question was confidential or proprietary. If the system showed that a particular design of plant or a particular nuclear power station was accident-prone, it could reflect badly on the manufacturer or operator.

In 1978, the OECD's Nuclear Energy Agency (NEA) went ahead and took the first steps to set up its own Incident Reporting System (IRS). In March 1979, the Three Mile Island accident gave additional impetus to the efforts of both agencies and in January 1980 the IRS began operating on a two year trial. At the end of 1981, the NEA member countries formally approved the operation of the system and in 1983 the IAEA extended the IRS to all its interested Member States.[36] The aim of the system is to bring 'safety significant' incidents to the attention of operators, regulators, constructors and designers of nuclear power plants to enable them to analyse the causes of the incidents and make improvements to avoid the recurrence of a similar incident.

In 1986, the United Kingdom, Canada and Yugoslavia joined the IRS and today virtually all States operating nuclear power plants are in the system.[37] Since 1982, the total number of reports that the IRS has received each year has ranged from 231 in 1985 to 87 in 1984 — on average between

150 and 160 a year. Since 1996, the NEA and IAEA have jointly operated the IRS. By 1997, 31 States were selecting events to be reported to the IRS. In April 1997, the computerized database established by the IRS (the Advanced Incident Reporting System, or AIRS) contained 2522 reports.[38]

The annual nuclear safety review

In 1982, after review by the Board, the IAEA published its first annual nuclear safety review covering 1980–1981 and outlining worldwide trends in nuclear safety and related IAEA work.[39] The review summarized the conclusions that could be drawn from Three Mile Island. One was that the safety systems of a nuclear power plant (at least of the type in operation at Three Mile Island) could operate correctly even in extreme accident conditions. The review also listed design improvements that the accident had shown to be desirable. It highlighted the need to make reactors more user friendly through better instrumentation in the control room as well as the need for better training of operators and the need to pay more attention to emergency planning.

The first and second safety reviews also featured the new dose limitation system recommended by the ICRP — essentially there should be no increase in radiation exposures unless in practice they produced a positive net benefit outweighing possible negative effects, doses should be kept 'as low as reasonably achievable' and there should be absolute dose limits above which no one should be exposed.

The ICRP recommendations were incorporated into the revised *Basic Safety Standards for Radiation Protection* issued by the IAEA in 1982 on behalf of the ILO, NEA and WHO, as well as the Agency.

The reviews published in 1983, 1984 and 1985 focused on natural sources of radiation, the creation of the International Nuclear Safety Advisory Group (INSAG), the launching of OSARTs (discussed later), technical safety issues and safety analyses of specific nuclear plants under construction such as Sizewell B in the United Kingdom, the Superphénix fast breeder reactor in France, the fast breeder reactor at Kalkar in Germany, as well as an advanced pressurized water reactor in Japan and a high temperature gas cooled reactor in Germany.

From 1986 to 1988, the contents of the annual reviews were naturally dominated by Chernobyl. From 1989 onwards the review was incorporated into the *IAEA Yearbook*.

Chernobyl

If the Pokharan nuclear test was the major nuclear event of the 1970s, the Chernobyl accident on 26 April 1986 had similarly far-reaching repercussions for nuclear energy and the IAEA. We shall look at three aspects of the accident: its causes, its national and international consequences and its impact on the IAEA.

First, the causes. The Governments of Russia, Ukraine and Belarus, and the IAEA, jointly with other international organizations and with a great deal of help from other nations, have carried out several thorough and detailed analyses of what went wrong on 25 and 26 April 1986 and why. As noted in Chapter 5 and below, the IAEA and the Soviet Union convened a crucial international post-accident meeting in August 1986. The proceedings and results of that meeting were analysed by INSAG in September of that year and revised by INSAG in 1992. The two other major projects arranged by the IAEA and other international bodies concerned were the 'International Chernobyl Project' (1990–1991) and an international conference, 'One Decade After Chernobyl', in 1996.[40] The sequence of events described below is based on, and the passages quoted are taken from, the revised INSAG report of 1992.

At first there was a tendency to put most blame on the operators for carrying out a dangerous experiment and for reckless disregard of safety requirements.[41] More recent analyses tend to attribute the disaster also to fundamental defects in the design of the plant. But at a deeper level the Soviet system itself must also be held responsible. The lack of elementary concern about nuclear safety has become clear in numerous operations and incidents, e.g. the Kyshtym accident in the 1950s as a result of which a large region around a reprocessing plant and several rivers were heavily contaminated, or the reckless disposal of nuclear waste and obsolete naval reactors and occasionally their spent fuel in the Kara and Barents Seas, as well as in leaky or overfilled storage facilities on the Kola Peninsula and around Nachodka in the Russian Far East. The lack of a 'safety culture' was also obvious from the fact that the Soviet nuclear authorities were aware of the design defects of the RBMK reactor and did little or nothing to rectify them despite the fact that two earlier accidents (Leningrad Unit 1 in 1975 and Chernobyl Unit 1 in 1982) "had already indicated major weaknesses in the characteristics and operation of RBMK units,"[42] and the lack of a clear cut and responsive national chain of command and delineation of responsibilities for nuclear safety. This state of affairs may partly be attributed to the nuclear arms race itself and the corners that were cut in the middle and late 1940s and the 1950s, when the Soviet Union was striving desperately to catch up with the USA and get one jump ahead in the design and production of nuclear warheads and their means of delivery. There seems little doubt that the USA also cut corners; and partly as a consequence it now faces an astronomical cleanup bill.

The following paragraphs contain a simplified outline of what happened on 25 and 26 April 1986.

Nuclear power reactors need a stand-by source of electric power to keep instruments, controls and pumps functioning if, in an emergency, the reactor has to be shut down or shuts itself down and if the electricity supply from the national or regional grid is lost. The aim of the test at Unit 4 that led to the accident was to assess the ability of one of the turbogenerators to provide enough power for an adequate length of time while the reactor, and consequently the turbogenerator, were being run down and the stand-by diesel generators had not yet sprung into operation. For this purpose it was planned firstly to bring down the power of the reactor from its rated output of 1000 MW(e) to 700 MW(th) (about 210 MW(e)) and to start the test by switching off steam from one of the turbogenerators. (The safe course would have been to bring the output of the reactor down to zero, but this would have ruled out the possibility of a second test —which the operators wanted to retain in case the first test was not successful.) The test began just after one o'clock in the morning (01:06) on 25 April and the explosion occurred at 01:24 on the morning of 26 April — slightly more than 24 hours later.[43]

During the test the operators — trying to maintain the decreasing power level and keep alive the possibility of a second test — deliberately and in violation of their operating rules withdrew most of the control and safety rods from the reactor core and switched off some important safety systems that were making it difficult to safely control the power of the reactor. At one stage (at 12:20 on 26 April) the operators were no longer able to maintain the output of the reactor and it dropped to 30 MW(th) or less, but by 01:03 the output had been brought back to 200 MW(th) — again by violating a number of safety regulations.

"It is not known for certain what started the power excursion that destroyed the Chernobyl reactor."[44] It was chiefly due to defects in the design of this type of reactor, but "the human factor has still to be considered as a major element."[45] At a critical point in the experiment the power output of the reactor began to surge. The operators tried to stop the chain reaction manually by dropping the control and safety rods. It is likely that under the prevailing physical conditions of the reactor core and because of the "faulty design of the rods, the nature of which had been discovered" at another RBMK reactor (Ignalina in Lithuania) in 1983,[46] this last desperate action was a "decisive contributory factor." Within a few seconds power surged to a level estimated at one hundred times the nominal power of the reactor. The fuel ruptured and a steam explosion ensued, the 1000 tonne cover plate of the reactor lifted and cut all cooling channels. After two or three seconds there was a second explosion, possibly of hydrogen formed in a gas–steam reaction as the graphite burst into flames.

At a more general level: "The accident can be said to have flowed from deficient safety culture, not only at the Chernobyl plant, but throughout the Soviet design, operating and regulatory organizations for nuclear power that existed at the time."[47]

The European Commission, the IAEA and the WHO held a major conference — 'One Decade After Chernobyl' — in Vienna from 8 to12 April 1996 to sum up the consequences of the accident. As noted in Chapter 5, all the interested UN and regional agencies concerned co-operated to ensure that the findings of the conference were of the highest scientific order and authority and were as widely disseminated as possible.[48] The following paragraphs detail some of its conclusions (the quotations are from the summary of the conference results).[49]

In 1986, about 116 000 people were evacuated and an exclusion zone of 4300 square kilometres was established in Ukraine, Belarus and Russia.[50] Since 1990, a further 210 000 persons had been evacuated and resettled, causing hardship and social problems, a fall in the birth rate and migration to 'clean' areas, a drop in incomes, and dislocation of industry and farming. Enforced changes in lifestyle "make everyday life difficult and depressing."[51] In addition, 200 000 'liquidators' (e.g. firemen and military personnel) who helped to put out the fire at Unit 4 and to contain the effects of the accident had since dispersed. The accident, the measures taken in response, and the political economic and social changes of the past years had all led to a worsening in the quality of life and public health, further complicated by incomplete and inaccurate public information.[52]

A total of 237 persons were admitted to hospital with clinical symptoms attributable to radiation exposure. Of these, 134 suffered from acute radiation syndrome; 28 of them died within the first three months. Two more died at Unit 4 from other injuries. Fourteen of the 134 had since died, but their deaths did not correlate with the severity of their original radiation sickness and might therefore not be "directly attributable to radiation exposure."[53]

The only public health impact discovered so far was "a highly significant increase" in thyroid cancer in those exposed as children; about 800 cases since 1986. So far three children had died of the disease The increase was confined to children born or conceived before the accident. The incidence of thyroid cancer "drops dramatically" in children born more than six months after the accident. However, an increase in thyroid cancer "will most probably continue for several decades."[54]

There had been "significant health disorders and symptoms amongst the population affected by the Chernobyl accident such as anxiety, depression and various psychosomatic disorders attributable to mental distress" and psychosocial effects such as a feeling of helplessness and despair. Symptoms associated with mental stress "may be among the major legacies of the accident."[55]

"Among the 7.1 million residents of the 'contaminated' territories and 'strict control zones', the number of fatal cancers due to the accident is calculated...to be of the order of 6600 over the next 85 years, against a spontaneous number of 870 000 deaths due to cancer."[56] Except for thyroid cancer, future increases of cancer due the accident "would be difficult to discern." "While it is not possible to predict with certainty, ...the estimated number of thyroid cancers to be expected among those who were children in 1986 is of the order of a few thousand. The number of fatalities should be much lower than this if cancer is diagnosed in the early stage and if appropriate treatment is given."[57]

But "any estimates of the total number of fatal and non-fatal cancers attributable to the accident should be interpreted with caution in view of the uncertainties associated with the assumptions on which they must be based."[58]

In many contaminated areas "in view of the low risk associated with present radiation levels...the benefits of future efforts to reduce doses...would be outweighed by the negative psychological and economic impacts."[59]

The clinical impact on populations outside the former USSR had been assessed by the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), and it was small. UNSCEAR calculated that the highest European "regional average committed dose" over the 70 years to 2056 will be 1.2 mSv (millisieverts, the unit used for measuring radiation dose to the human body).[60] By comparison, natural background radiation results in an annual average dose of 2.4 mSv around the world — or over a lifetime of 70 years, about 170 mSv.

There had been no "sustained severe impacts on [non-human] populations or ecosystems," but "the possibility of long term genetic impacts and their significance remains to be studied."[61]

Some key foodstuffs (milk and green vegetables) originally had unacceptably high contamination rates, but in 1996 food produced by collective farms was below the maximum radiation level permitted by the FAO/WHO index. But game, berries and mushrooms "will continue to show levels of caesium-137 that exceed the Codex Alimentarius levels — in some cases greatly — over the next decades and are likely to be a major source of internal doses..."[62]

Action taken since 1986 has "essentially remedied the design deficiencies that contributed to the accident and "a repetition of the same accident scenario seems no longer practically possible," but requirements for eliminating design deficiencies not directly related to the Chernobyl accident "are lagging behind what is needed" because of the economic problems of the nations concerned.[63]

If the sarcophagus built around the ruin of the reactor were to collapse (and "in the long term...its stability and the quality of its confinement are in doubt") there could be "exposure to radiation of the personnel employed at the site." However, "even in the worst case, widespread effects (beyond 30 km away), would not be expected."[64]

Any assessment of the political impact of the accident must be speculative. It is conceivable that it weakened the Soviet system by aggravating the existing distrust of authority, helping to fuel the fires of nationalism and anti-Russian feeling in the non-Russian republics most affected by the accident. It appears to have led to a demand for greater openness — *glasnost* — and it surely thrust a grievous load on an economy that was already overstrained by the arms race and suffering from sclerosis.

Paradoxically, while the accident led some other countries promptly to put a stop to any expansion of nuclear power and even to dismantle existing nuclear power plants, it did not have the same impact in Russia, Ukraine, Belarus or other republics of the Commonwealth of Independent States. Certainly public confidence in nuclear power suffered a severe blow. But the Russian and Ukrainian programmes for building nuclear power plants are continuing, though at a much reduced pace; Armenia has reopened one of its two nuclear power reactors shut down in 1989 after a severe earthquake. Belarus is considering whether to build its first nuclear power plant[65] and Kazakstan may order several new plants, though no firm decision has been taken.[66]

There was particular public concern about radioactive contamination of food by fallout from the accident. This was aggravated by the very different rules that governments laid down about acceptable levels of radioactivity in various foodstuffs. “Strawberries which could be safely eaten in one country could be rejected in another...”[67] It was clear that the international and regional authorities concerned should seek agreement on common standards (‘intervention criteria’) for prohibiting or permitting the sale of food that might contain dangerous radioisotopes, and this they did in the next few years.

The accident did not put a stop to the Czech and Slovak nuclear power programmes, nor does it seem significantly to have affected the French programme. In fact, France has become an important exporter of nuclear generated electricity to most of its neighbours: to Italy which dismantled its four nuclear power plants, to Germany, Spain and Switzerland where formal or informal moratoriums on new plant orders are in force and to the United Kingdom which recently commissioned a large new plant but where no new orders are in sight. The USA has long since stopped ordering new plants and Canada has none on order.

The reactions of the Agency to the Chernobyl accident were prompt and helpful. In early May, upon his own initiative and at the invitation of the Government of the USSR, Director General Blix, accompanied by two senior IAEA officials, went to Moscow to discuss how the IAEA could obtain more comprehensive information about the nuclear accident, what the IAEA might do to enable governments and nuclear authorities to learn from the accident and how to get a discussion going on the nuclear safety measures required. Blix was the first non-Soviet individual to inspect (from the air) the site of the disaster. The IAEA also promptly made contact with national radiation protection authorities in most European countries to obtain a more complete picture of the accident and its immediate consequences. It arranged with other international organizations (WHO, WMO and UNSCEAR) for a systematic collection of data.

In May and June 1986, the Board of Governors approved the Secretariat’s proposals for:

— A meeting of nuclear experts from the USSR and the rest of the international nuclear community to review the accident, its causes and the measures that should be undertaken in response to it;
— The preparation of two international conventions on early notification of nuclear accidents and on assistance in the case of a nuclear accident;

— A special meeting of the General Conference to consider how to strengthen international co-operation in nuclear safety and radiological protection;
— A meeting of experts from Member States to review the IAEA's safety programme.

In July and August 1986, experts from Member States met in Vienna and with the help of the Secretariat drew up the texts of both conventions. At its special meeting in September (immediately before its regular session) the General Conference approved both conventions, thus setting a speed record for the preparation and approval of intergovernmental agreements. The Conference also agreed by consensus that "nuclear energy will continue to be an important source of energy..." and that "each country is responsible for ensuring the highest level of safety in its nuclear energy activities; that there is further scope for international co-operation in nuclear safety; and that the Agency has a central role in encouraging and facilitating such co-operation."

In late August 1986, the meeting of experts from the Soviet Union and other national nuclear authorities reviewed the causes and course of the disaster and the steps that should be taken to enhance the safety of other RBMK reactors. INSAG prepared a report on the results of the review and on actions to be taken.[68] The meeting was remarkable in many ways. It showed that there had been a dramatic change in the attitude of Soviet authorities who were quite free and frank about most (if not all) of the defects in the design of the reactor, in operating procedures and the grave deficiencies in the Soviet nuclear safety culture. As noted, there was still a tendency to blame the operators for the accident rather than the system in which they worked but there was no sense that the Soviet participants were attempting to hold back or distort information.

The 'Convention on Early Notification of a Nuclear Accident', to give it its official title, entered into force on 27 October 1986 and the 'Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency' entered into force on 26 February 1987. In 1987, Brazil made the first request for help under the latter Convention.[69]

In November an expert working group reviewed the Secretariat's proposals for expanding its work on nuclear power plant safety and in December the Board approved an expanded programme.[70]

The IAEA as well as WHO, FAO, UNSCEAR and the NEA individually and jointly addressed the problem of international standardization of intervention levels. In 1993, the IAEA published an interim report on the matter.[71] After circulation for comments to the Member States and interested international organizations, the IAEA issued the revised document in 1994.[72]

In the meantime (in 1989) the FAO/WHO Codex Alimentarius recommended international standards for radionuclide contamination of food moving in international trade.[73]

The FAO and IAEA jointly recommended plans to protect farming areas after a nuclear accident — in other words how to minimize the radiological doses that people, land and crops and livestock received from Chernobyl. The recommendations or guidelines were based partly on a Co-ordinated Research Programme of the IAEA and the European Union. The IAEA technical co-operation programme also launched projects in Belarus and Ukraine to reduce the uptake of dangerous radioisotopes by people and livestock. Farm land in Belarus, Ukraine and western Russia was reploughed and reseeded. Lime and potassium fertilizers were then applied to reduce the uptake of caesium-137 and strontium-90. Prussian Blue was fed to domestic animals and game as a means of lowering the levels of caesium-137. In Belarus and Ukraine farmers were encouraged to grow cash crops such as rape seed (of which the oil may be used as a lubricant) on 'contaminated' land.[74]

Special programmes

As for the surviving Chernobyl and other RBMK type reactors, the European Union, the World Association of Nuclear Operators (WANO), and the European Bank for Reconstruction and Development (EBRD), as well as the IAEA launched programmes or provided funds to improve the safety of particular plants or of all reactors of this type. Canada, France, Germany, Japan, Italy, Sweden, Switzerland, the United Kingdom and the USA launched similar bilateral programmes and Sweden took a particular interest in improving the safety of the Ignalina RBMK across the Baltic in Lithuania. The IAEA's role was to consolidate the results of these various programmes and to secure an international consensus on the improvements needed. The IAEA provided a basis for technical and financial decisions.

As late as autumn 1996 the general conclusion was that international help had "increased confidence that the major shortcomings and the required safety improvements of RBMK reactors have been identified." However, the extent to which the recommended improvements had been made varied considerably and much more had to be done to analyse the problems of specific plants.[75]

It was clear that much more money would be needed, particularly from Western governments and institutions, to put the recommendations into effect but it was by no means clear that the needed funds would be forthcoming.

The 'International Chernobyl Project'

The initiatives undertaken by the IAEA in 1986 greatly helped to deepen international understanding of what went wrong at Chernobyl and what should be done at the international level in order to prevent a recurrence of the disaster — and to react effectively to any major nuclear accident that might happen in the future. Blix's readiness to provide prompt and decisive leadership greatly enhanced his standing. His voice now carried considerable weight in Moscow and Bonn as well as in Washington and many other capitals.

It is relevant at this point to consider the subsequent follow-up to Chernobyl. In October 1989, the Government of the Soviet Union asked the IAEA to arrange for international experts to assess the concept that the USSR had evolved "to enable the population to live safely in areas affected by radioactive contamination" as a result of the accident and to evaluate "the effectiveness of the steps taken to safeguard the health of the population."[76]

The IAEA brought together a multinational team of experts from the three affected Soviet republics and from the Commission of the European Communities (now the European Union), FAO, ILO, UNSCEAR, WHO and WMO to form an International Advisory Committee in order to plan and monitor the 'International Chernobyl Project'. The Chairman of the Committee was Professor Itsuzo Shigematsu, Head of the Radiation Effects Research Foundation of Hiroshima. In February 1990, a meeting in Moscow formally approved the Project. The International Advisory Committee presented its report to an international conference in Vienna in May 1991.

The conclusions in the Project's report are for the most part similar to those of the 1996 conference 'One Decade After Chernobyl', some of the main conclusions of which have been listed earlier. By 1991, the abnormal incidence of childhood thyroid cancer had not yet become apparent but the Project report foresaw that in view of the doses reportedly received, "there may be a statistically detectable increase in the incidence of thyroid tumours in the future." As for other health impacts, the Project report noted that "the official data examined did not indicate a marked increase in the incidence of leukemia or other cancers." Critics complained that the Project did not examine the consequences of Chernobyl for the 'liquidators'. It was not asked to do so, and, if it had been, the task might have been very difficult since many of the persons concerned had long since dispersed to other parts of the Soviet Union.

Support of research

In the area of nuclear safety, the IAEA has supported research on:

— Radiation protection of workers, including development of techniques for the assessment of occupational exposure;
— Radiation protection of the public, including environmental radiation monitoring and studies on the behaviour of radionuclides in the environment;
— Protection of the patient in radiodiagnosis and radiotherapy, including methods for reduction of doses in diagnostic radiology;
— Biological and medical techniques for the diagnosis and treatment of overexposed individuals;
— Engineering safety, including the performance of safety related equipment at nuclear power plants, fire protection and seismic safety;
— Operational safety, including maintenance of safety related equipment at nuclear power plants;
— Methods for incident and accident analysis;
— Safety assessment methods and techniques;
— Safe transport of radioactive materials, including the testing of transport packages.

In September 1990, the IAEA, USSR, Ukraine and Belarus signed an agreement, sponsored by the Soviet Union, to establish a Chernobyl Centre for International Research on Post-Accident Conditions.

New safety programmes and services[77]

Well before Chernobyl, in fact for nearly thirty years, the IAEA's nuclear safety programmes had been achieving useful results. But Chernobyl radically changed the way in which Member States looked at the question of nuclear safety — at the pressing need for closer international co-operation, and hence at the Agency's work and its potential for raising safety standards and avoiding future accidents or mitigating their effects. Chernobyl also greatly increased interest in several existing safety programmes and demands for safety services, especially those that had been launched or substantially expanded after the Three Mile Island accident, and prompted the launching of new safety programmes and projects.

In the 1960s and 1970s, the IAEA helped its Member States, when so requested, to deal with practical problems of radiation protection and nuclear safety, including the safe handling of nuclear waste, but the bulk of its work lay, quite logically in those early days, in the preparation of internationally accepted standards which provided guidance for Member States and for the IAEA's own work.

The IAEA continued to set and revise standards throughout the 1980s and early 1990s, but after the Three Mile Island accident, and especially after Chernobyl, it focused increasingly on raising consciousness in Member States of the overriding importance of nuclear safety, and on practical steps to raise the levels of safety and radiation protection, both nationally and at particular nuclear plants. It did not wait for new problems to arise, but tried to anticipate them and took practical steps to avoid or minimize them.

Specifically, the IAEA sought to ensure that:

- — Effective national safety legislation, regulations and codes of practice were in force and took full account of recently approved basic safety standards;
- — National regulatory bodies were in operation and functioning effectively;
- — Radiation dosimetry services were being provided;
- — Programmes and procedures for coping with emergencies were in place;
- — Radiation sources were registered and licensed to ensure safe design and use;
- — Adequate programmes were in place for protecting workers, the public and the environment against radiation;
- — The Member States concerned could deal effectively with all issues arising in the design, construction and operation of nuclear plants (e.g. selection of safe and appropriate sites, management of severe accidents, fire safety).

To achieve these aims the IAEA focused its technical co-operation programme increasingly upon nuclear safety and radiation protection. It granted several hundred fellowships and organized numerous regional and inter-regional training courses and seminars. From 1990 onwards the IAEA carried out extensive programmes to help the countries of Eastern Europe and the former Soviet Union to improve the safety of the nuclear power plants of various designs, starting with the first generation 'water–water energy reactors — 440 MW(e)/230s' (WWER-440/230s).

In 1985, after extensive consultations with non-governmental bodies dealing with the civilian use of nuclear energy, the Director General established a new nuclear safety 'think tank', the International Nuclear Safety Advisory Group, or INSAG, to which we have already referred. INSAG consisted of 14 internationally renowned experts drawn from the nuclear industry, nuclear research and nuclear regulatory bodies. Its tasks were to advise the Director General on the principles on which to base safety standards and measures, provide a forum for exchanging information on general safety issues of international significance, identify and review important current safety issues and advise on those issues that require additional study and exchange of information.

From 1982 onwards the IAEA also methodically devised a growing range of specialized services or missions to help the authorities responsible for nuclear and radiation safety in Member States and the managers of nuclear plants.

It should be stressed that the services of these missions, like other components of the Agency's work in nuclear safety and waste management, are advisory and their conclusions have the status of recommendations to the Member State or institution concerned. However, if the report of the mission shows that there are glaring deficiencies in nuclear safety, the IAEA writes to the government concerned and strongly urges it to take the measures needed to remedy the deficiency. In short, although the missions are not regulatory they are as a rule influential and effective.

Underpinning the work of these missions was the growing body of IAEA sponsored international standards and safety criteria as well as the specialist advisory groups that kept these standards and criteria under review. These groups included the ICRP and the International Commission on Radiation Units and Measurements (ICRU), which are independent non-governmental organizations established before the Second World War.

The existing and new IAEA missions and their services are discussed below.

Operational Safety Review Teams — OSARTs — were started in 1982. They do not assess overall plant safety or compare the safety of different plants but rather review management, organization, operations, maintenance, technical support, radiation protection, chemistry and emergency planning. They draw on the best international safety standards and practices for plant operation and on INSAG's report on 'safety culture' (see below) as well as on the experience of the individual members of the team.

An OSART is typically composed of five or six nuclear safety experts from various countries and two or three from the staff of the IAEA itself. It spends about three weeks at the nuclear power plant and makes an in-depth review of the way in which the plant is being operated. The team sends the government concerned a report on its findings and its recommendations for improving safety at the plant.

In 1983, the first OSART went to the Republic of Korea,[78] in 1984 OSARTs went to Yugoslavia and the Philippines and in 1985 to Brazil, France, Pakistan and to the Philippines for a second visit.

Chernobyl brought about a sharp increase in the number of requests for IAEA missions, now increasingly from the industrialized countries. In 1986, there were six requests for OSARTs, four by industrialized countries (the Federal Republic of Germany, Finland, the Netherlands and Sweden; the other two by Mexico and the Republic of Korea). The number of OSART missions grew from 6 in 1986 to 11 in 1989 and then settled down to 5 to 7 a year from 1990 to 1995. By the end of 1995, 79 OSARTs and 31 follow-up missions had reviewed safety at 69 nuclear power plants in 28 countries. All but three Member States of the IAEA that have nuclear power reactors in operation (i.e. all but Belgium, India and Kazakstan) had received OSART missions.

Assessment of Safety Significant Events Teams — ASSETs — screen and analyse events related to nuclear safety that result from failures during the operation of nuclear power plants, and deficiencies discovered during routine surveillance and testing. Their aim is to help prevent or mitigate future accidents by learning the root causes of events of less safety importance. ASSETs may also be used to train plant personnel.

In 1986, the IAEA sent out its first ASSET.[80] By mid-1995, 19 Member States had requested 61 ASSETs for the analysis of safety related events (17 requested by Russia and 12 by Ukraine) and 28 States had asked for 66 'training' ASSETs (11 by Russia and 8 by Ukraine).

Engineering Safety Review Services — ESRS — provide advice on the engineering safety of operating or planned nuclear power reactors, for instance on an appropriate and safe choice of the site of the plant, protection against external hazards such as earthquakes, the management of accidents and the impact of ageing. Since few nuclear power plants are being built today, most ESRS have assessed or re-assessed the safety of existing plants, especially WWERs.

One fact that emerged from these assessments was that Soviet designed power reactors (WWER-440/230s, WWER-440/213s and RBMKs) are not designed to have a structural resistance to earthquakes. While those power plant components that come under pressure, such as the reactor vessel, are designed to withstand extreme loads, the superstructure housing the reactor, the turbines and emergency diesels, are designed as ordinary industrial buildings with little cross-bracing to resist earthquake induced stress. Hence about two thirds of the 99 ESRS that the IAEA sent to 24 countries from February 1989 to mid-1995 assessed seismic hazards at nuclear power plants in the former Soviet Union and Eastern Europe. Subsequently, a number of governments decided to strengthen the structures, systems and components of their nuclear power plants so as better to withstand seismic stress, namely Bulgaria (Kozloduy), Slovakia (Bohunice and Mochovce), Hungary (Paks) and Armenia (Medzamor). Pakistan arranged for a seismic review of the Chasnupp power reactor sold to it by China and under construction at Chashma since 1993. The mission also made a summary inspection of the Kanupp power reactor.

The International Peer Review Service for Probabilistic Safety Assessment — IPERS-PSA — was started in 1988. This service arranges for international teams of experts to carry out independent reviews of the 'probabilistic safety assessments' that Member States are making or have made of their nuclear power plants. By mid-1995, 35 such reviews had been made. They had focused increasingly on WWER reactors in Eastern Europe and in the former Soviet Union, but peer reviews had also been made in the Netherlands, the Republic of Korea, Sweden, Switzerland and China.

Integrated Safety Assessments of Research Reactors — INSARRs — as their name implies, assess the safety of research reactors. The IAEA began making such assessments in 1972, chiefly because they were required by a project or supply agreement, usually with a developing country, but several INSARRs have also been sent upon the explicit request of a Member State. INSARR missions examine the safety analysis reports drawn up for these agreements and check whether they are up to date. They also assess whether the reactor is being operated in conformity with IAEA guidelines, the way in which the reactor is being maintained, the training and qualification of plant personnel, and the way in which radiation protection is ensured. The missions observe the operation of the plant, if possible during startup and shutdown.

In 1987, INSARR missions visited research reactors in industrialized countries — Finland and Norway — for the first time.[81] By mid-1995, the IAEA had made 123 assessments in 37 Member States, with no charge if the beneficiary was a developing country. The peak years for assessments were 1982–1985 and 1987–1993 in response to explicit requests by Member States. The chief weak points detected included poor or out-of-date safety documents, lack of, or poor quality assurance programmes, and incomplete written procedures for maintenance, testing and inspection. As noted, if the IAEA discovers major deficiencies, for instance that the safety system is not working properly, it requests in writing that the INSARR's recommendations be implemented and INSARR checks that this is done.

In 1994, the IAEA began drawing up recommendations for safe practices based on the lessons learnt from previous accidents, as well as an inventory of large gamma irradiators, a list of safety issues to be checked by the regulatory authorities and plant managers and a worldwide survey of the safety of such plants, especially those provided by the IAEA. The IAEA also launched an international reporting system on accidents and unusual events.

Assessment of Safety Culture in Organizations Teams — ASCOTs — are designed to help Member States assess and improve their own nuclear 'safety culture'. Most of the 24 ASCOT services provided by early 1995 took the form of seminars explaining the concept of safety culture and indicating the best methods of assessing it. By that date there had been three IAEA reviews at nuclear power plants in the United Kingdom, the Netherlands and South Africa. The deficiencies noted during these reviews included inadequate statements of policy, especially failure to emphasize the overriding importance of safety, failure to ensure that all personnel were aware of the statements of policy, failure to include safety culture in training programmes, failure to appreciate good 'safety performance', infrequent checks by supervisors, absence of a questioning attitude amongst personnel, failure to encourage and reward the identification of safety problems and acceptance of superficial explanations of safety related events.

Finally, International Regulatory Review Teams — IRRTs — review the adequacy of national nuclear safety regulations and of the national system for applying them and assessing and enforcing their observance. The first IRRT visited Brazil in 1988.

The creation of WANO

In 1988–1989, the managers of nuclear power plants throughout the world formed an association in order to improve the operational safety of their plants by strengthening the links and the exchange of information between them. The World Association of Nuclear Operators chose London for its headquarters but held its first meeting in Moscow in May 1989. The first head of WANO was the late Lord Walter Marshall of Goring, an outstanding figure in the development of energy policy in the United Kingdom — as chief of the UKAEA and subsequently of the Central Electricity Generating Board — and a much respected member of the IAEA's Scientific Advisory Committee.[79]

Special help to Russia, Ukraine and other Eastern European countries

Chernobyl cast doubt not only on the safety of the RBMK reactor but also on that of certain other earlier Soviet reactors, in particular the WWER-440/230 power reactor. This is the older model of the standard Soviet 440 MW(e) light water nuclear power plant.[82]

On 21 September 1990, the General Conference approved a comprehensive resolution on nuclear safety.[83] It welcomed the Board's intention to convene in 1991 "a high level international conference on nuclear safety...to define the nuclear safety agenda for the decade," noted the consensus that the revised NUSS codes were suitable for use by or provided useful guidance to Member States in drafting or revising their own laws, recommended that Member States make full use of OSARTs and ASSETs, welcomed the Agency's International Nuclear Event Scale and endorsed the project for a comprehensive assessment of the radiological consequences of Chernobyl described earlier. It also endorsed "the proposed project for international assistance in assessing, following the request of several Member States, the safety of some of their nuclear reactors" — in other words, to assess the safety of the WWER-440/230 plants operating in the USSR and Eastern Europe (the design of the WWER-440 reactor is quite different from that of the Chernobyl (RBMK) type and resembles that of the US Westinghouse pressurized water reactor and similar power reactors in France, Germany and Japan, but the original WWERs lacked several of the safety features required in the West).

In the same year (1990), the IAEA sent missions to investigate problems with WWER-440 plants at Greifswald in the German Democratic Republic, Bohunice in Czechoslovakia (now Slovakia) and Kozloduy in Bulgaria.[84] Soon after reunification, the German Government decided to dismantle the five WWER-440/230 plants at Greifswald.

In 1992, the IAEA extended the safety programme to cover RBMK reactors [85] and in 1993 to cover the more modern WWER-440/213 and the larger (1000 MW(e)) WWER-1000 plants.[86] Thus by that year IAEA safety assessments were covering all Russian and Eastern European nuclear power plants. The IAEA co-ordinated its work with that of the G-24 nations — the Western countries — offering help to Russia, Ukraine and other countries in Eastern Europe to improve the safety of reactors of Soviet design.[87]

More recent work of INSAG

As noted above, in 1986 INSAG compiled a summary report (INSAG-1) on the 1986 meeting that the IAEA and the Soviet Union had held after the Chernobyl accident — the meeting at which Soviet participants had given such open reports on the accident. After 1986 a large body of new information emerged about the causes and course of the accident. This required a review of some of the conclusions reached in 1986. INSAG accordingly set to work on a new report, updating INSAG-1. It was published in 1992 as INSAG-7.

In 1988, INSAG completed a pioneering work on *Basic Safety Principles for Nuclear Power Plants* (INSAG-3), of which more than 8000 copies were distributed. *Nuclear Safety Fundamentals,*[88] based on INSAG-3, served as a starting point for the 'Convention on Nuclear Safety' completed in 1994.

By the end of 1996, INSAG had completed ten independent and useful reports containing recommendations to the IAEA and to the scientific, technical and regulatory community (INSAG's recommendations are *addressed to* and are not *by* the IAEA).

Completion of NUSS

In 1986, the IAEA completed the NUSS programme which it had begun in 1974. Under this programme the IAEA prepared 5 Codes and 55 Safety Guides for nuclear power plants.[89] The Guides provided advice on governmental organization for ensuring safety at such plants, on their siting, their design, their operation and quality assurance. The completion of NUSS marked the IAEA's continuing shift away from drafting guides relating to the safety of nuclear power plants to helping States to put them into effect. However, much work still had to be done in drafting guides on other matters such as radiation safety and the safety of radioactive wastes.

Safety problems of ageing reactors

By the end of the 1990s, more than 200 nuclear power plants will have been in operation for 20 or more years. An IAEA symposium in 1987 showed the growing interest of nuclear safety authorities in exchanging information about the problems that might be caused by the ageing of such plants. The problems of ageing also affect research reactors. In 1995, more than 40% of those operating around the world were more than 30 years old. Since 1972 and by the end of 1995, the IAEA had sent out 123 missions in 37 countries to assess the safety of research reactors.[90]

Basic safety standards and the linear dose–effect assumption

As already noted, the IAEA's basic safety standards for protecting workers and the public against excessive radiation are based chiefly on the recommendations of an independent scientific organization, the ICRP.[91] The IAEA first issued the standards in 1962, revised them in 1967 and again in 1981–1982.[92] In 1990, the ICRP published a new set of recommendations and in 1991 a joint secretariat of the international and regional agencies concerned, WHO, ILO, FAO, NEA and the Pan American Health Organization (PAHO) as well as the IAEA, began the revision of the IAEA's standards of 1982. One of the main changes introduced was a reduction in "occupational dose limits" — the maximum radiation dose to which it would be permissible to expose workers in nuclear occupations during one year.[93]

The Board approved the revised basic safety standards in 1994. They were subsequently endorsed or adopted by the Governing Bodies of all five co-sponsoring agencies (PAHO, FAO, WHO, ILO and the NEA). The adoption of the new basic standards made it necessary to review all IAEA documents in its 'Safety Series' to ensure that they were consistent with the new standards.

A fundamental assumption reflected in the standards is that at low doses the probability of harm to humans is in direct proportion to the radiation dose that the person receives. In other words it is assumed that there is no threshold dose below which no significant damage is done. Part of the reason for the linear dose–effect assumption is that no experimental evidence exists of the results of low exposures; in fact the main data available are from the survivors of Hiroshima and Nagasaki, who received high doses. These are then extrapolated down in a straight line on the premise of a linear dose–effect relationship. In the absence of evidence to the contrary this is regarded as a prudent assumption.

Recent fundamental research in molecular genetics and cellular biology and new epidemiological evidence has led to much debate on the effects of low doses and on the adequate control of such doses. This may have an effect on radiation protection standards, an issue of significance to the IAEA, WHO and other organizations that translate the ICRP's recommendations into these standards, and to the nuclear industry which must ensure that its workers and the public do not receive excessive radiation doses from their operations. The IAEA and WHO, in co-operation with UNSCEAR, will hold an international conference on the matter in Seville in November 1997.[94] Perhaps some more light will also be shed on the issue by the joint US–Russian research now being undertaken on the effects of lengthy exposures (over a wide range of lower doses) of workers and the public in the Mayak nuclear weapon complex in the Southern Urals (a nuclear weapon manufacturing centre in the former Soviet Union).[95]

The International Nuclear Event Scale

The IAEA's International Nuclear Event Scale (INES) classifies incidents and accidents at reactors on a scale that ranges from the most minor (Level 1) to the most severe (Level 7). Levels 1–3 are termed 'incidents', Levels 4–7 are 'accidents'; Chernobyl would have been a Level 7 accident. The scale was designed by an international group of experts convened jointly by the IAEA and NEA as an objective means of quantifying the severity of the consequences of a nuclear event and putting such events into proper perspective in order to establish a common understanding between nuclear experts, the media and the public.

INES is based on concepts first devised in France and Japan. In 1990, INES was accepted for a trial period. By the year's end 25 States had informed the IAEA that they were using the scale and undertook to inform the IAEA (for worldwide dissemination of their report) within 24 hours of any events of Level 2 or above on the INES scale. By mid-1997, 59 Member States were using INES.

Technical co-operation in nuclear safety

In the 1960s and 1970s, technical assistance in nuclear safety and waste management played only a relatively minor part in the Agency's technical co-operation programme. Thus, immediately after the Three Mile Island accident, nuclear safety accounted for only about 8% of the total programme while nuclear power accounted for nearly a third. In the years following Three Mile Island, the share of nuclear power began to decline while that of safety steadily increased to more than a quarter of the total. By 1995, the programme involved more than 150 national, regional and interregional projects.

In 1995, out of the 90 or so countries that were receiving assistance under the technical co-operation programme, 18 were operating nuclear power plants and the IAEA had substantially helped to improve their safety infrastructure and practices. For example, between 1980 and 1995 over 5000 persons were trained in nuclear safety.

The repercussions of Chernobyl and of the breakup of the Soviet Union gave the technical co-operation programme fresh impetus as the IAEA sought to help the States of Central and Eastern Europe deal with their nuclear safety and waste management problems. Many of them depended and still depend on nuclear power for a significant proportion of their electricity. The extreme case is Lithuania (83.44% — the highest proportion of nuclear generated electricity in the world). Others with substantial shares are Slovakia (44.53%), Bulgaria (42.24%), Hungary (42.30%), Slovenia (37.87%), Ukraine (37.8%) and the Czech Republic (20.1%).[96] Shutting down even older plants was thus likely to cause painful consequences for the economy and for the well being of the population, particularly in winter.

Technical assistance was given to Armenia, Bulgaria, the Czech Republic, Lithuania, Russia, Slovenia, Slovakia and Ukraine to upgrade the safety of WWER plants.[97] After Russia discontinued the former Soviet policy of requiring that all spent fuel should be returned to it, the problem of waste management in several of the countries became pressing.[98]

With support from the European Union and through the technical co-operation programme, the IAEA also helped Croatia, Hungary, Romania, Slovakia and Ukraine to prepare legislation covering nuclear safety and waste management and to establish effective regulatory bodies.[99] In 1994, the IAEA prepared a basic national and regional programme of assistance for Belarus, Estonia, Kazakstan, Latvia, Lithuania, Moldova and Uzbekistan, covering the infrastructure needed for radiation protection, nuclear safety and waste management.[100] The costs of upgrading the civilian nuclear infrastructure in the Soviet Union's successor States are far beyond the Agency's means. However, the Agency's work relating to RBMK and other Soviet reactors eventually attracted the attention of the G-7, G-24 and other donors.

The IAEA also worked with the European Union in sending out missions to several Eastern European countries, including Romania which was just about to start up its first nuclear power reactor.[101] Under what is known as a 'Model Project', the IAEA helped Slovakia to establish a nuclear regulatory body and gave similar help to Ukraine to apply international standards of radiation protection, nuclear safety and waste management.[102] The IAEA, together with the European Union, Japan, Spain and the USA, helped Bulgaria to improve the ability of two nuclear power plants at Kozloduy to withstand earthquakes.[103] It also helped Hungary to train staff and improve safety at the Paks nuclear power plant (see next paragraph) and Ukraine to reduce radioisotopes in the food of persons — particularly children — affected by Chernobyl.

A novel example of a model technical co-operation project was begun by the IAEA in Hungary in 1994.[104] The Hungarian Atomic Energy Commission decided to set up a training centre to improve the nuclear safety culture at Hungary's Paks nuclear power plant (which supplies more than 40% of Hungary's electricity). The centre was also expected to serve the training needs of seven other countries, including Finland, operating WWER-440/230, 440/213 or 1000 type nuclear power reactors. For this purpose it was decided to build a mock nuclear reactor from the unused parts of abandoned WWER power plants. The dummy has all the key components of a WWER-440/213 reactor, including the pressure vessel, steam generator, circulation pumps and piping which the IAEA bought after the German and Polish Governments took out of operation or cancelled plans to complete all nuclear power reactors of Soviet design.

In view of the number and diversity of the States and organizations involved in improving nuclear safety in Eastern Europe and in the successor States of the Soviet Union it was important to avoid duplication of work and gaps in assistance activities. To this end, in 1992 donor and recipient countries agreed to participate in a 'Nuclear Safety Assistance Co-ordination' body or NUSAC, established by the G-24 countries. The IAEA has acted as NUSAC's technical adviser.

Other recent technical co-operation projects may be briefly described. In 1994, the IAEA completed three significant interregional projects for technical co-operation to strengthen radiation safety by securing acceptance of the

IAEA's basic safety standards, to improve procedures for management of nuclear waste and to provide advice on the handling of emergencies and reduction of radiation exposures.

The first was an 11-year undertaking that assessed the status of radiation safety in 64 developing countries and recommended a number of improvements. Radiation Protection Advisory Teams (RAPATs) were the main vehicle used in this project. It was followed by a project designed to help all Member States to fully apply in due course the IAEA's basic safety standards.

The second interregional project involved the work of the IAEA Waste Management Advisory Programme (WAMAP). Over a period of eight years WAMAP missions advised 42 countries on the management of radioactive waste resulting from power and research reactors, uranium mining and milling and the use of radioisotopes.

The third project was to help developing countries deal with nuclear emergencies and to improve radiation protection in medical practice.[105]

A new hierarchy of safety standards and new advisory bodies

In 1989, following the substantial growth in the IAEA's safety related work, the Secretariat introduced a new structure for publications in the IAEA Safety Series. They were divided into four categories, the first and second to be submitted to the Board for approval and the third and fourth to be issued under the authority of the Director General.

— ***Safety Fundamentals:*** These are the 'primary texts' for other publications in the Safety Series. They state "the basic objectives, concepts and principles involved" but do not "...provide technical details and generally do not discuss the application of principles." Three Safety Fundamentals were issued from 1993 to 1996, namely, *The Safety of Nuclear Installations* (Safety Series No. 110, 1993), *The Principles of Radioactive Waste Management* (Safety Series No. 111-F, 1995) and *Radiation Protection and the Safety of Radiation Sources* (Safety Series No. 120, 1996) jointly sponsored by FAO, IAEA, ILO, NEA, PAHO and WHO.

As noted, the first document (*The Safety of Nuclear Installations*) provided the basis for the 'Convention on Nuclear Safety', which is more fully examined later.

— ***Safety Standards:*** These specify the basic requirements for ensuring the safety of particular activities or areas of application. They are mandatory for the IAEA's own operations and the operations it assists. The best known example is the *Regulations for the Safe Transport of Radioactive Material* (Safety Series No. 6).
— ***Safety Guides:*** These represent essentially recommended measures to ensure the observance of Safety Standards.
— ***Safety Practices:*** These give examples of methods that can be used to implement Standards and Guides.

In recent years, the Safety Series has been replaced by the 'Safety Standards Series' (with ***'Fundamentals', 'Requirements'*** and ***'Guides'***) and a more general 'Safety Reports Series'.

The Secretariat has recently created the following bodies to help prepare and review all documents:

— ***Advisory Commission for Safety Standards (ACSS).*** The top advisory body, consisting of senior government officials responsible nationally for establishing standards and regulations on nuclear safety, waste management and the transport of radioactive materials. It advises the Director General on the Safety Standards programme, ensures consistency and coherence, resolves issues referred to it by any of the other advisory committees and endorses the texts of Safety Fundamentals documents.
— ***Nuclear Safety Standards Advisory Committee (NUSSAC).*** Comprises senior officials technically expert in nuclear safety. It advises the Secretariat on, for instance, NUSS documents and seeks agreement on the texts of Safety Standards relating to nuclear power reactors.
— ***Radiation Safety Standards Advisory Committee (RASSAC).*** Performs similar functions in regard to radiation safety.
— ***Waste Safety Standards Advisory Committee (WASSAC).*** Performs similar functions in regard to the safety of nuclear waste.
— ***Transport Safety Standards Advisory Committee (TRANSSAC).*** Performs similar functions in regard to the transport of radioactive materials.

The 'Convention on Nuclear Safety' and progress towards a convention on nuclear waste

As noted in Chapter 5, the Secretariat had sought since the 1960s to persuade nuclear regulatory authorities and the nuclear industry, as well as members of the Board, of the need for an international convention on the safety of nuclear power. The Secretariat argued that such a convention would help to set minimum uniform and global standards for an activity that lay at the centre of the civilian uses of nuclear energy. It would also help to create public confidence, allay some of the widespread distrust and promote international commerce in nuclear power. It was surely an anomaly that the IAEA had been able to launch conventions dealing with physical protection, civil liability for nuclear damage and the liability of operators of nuclear ships, but had not attempted to draw up a convention dealing with the core issue.

For many years, the Secretariat's arguments fell on deaf ears. But, as we have seen, Three Mile Island and Chernobyl eventually led to a more receptive attitude towards proposals for expanding the IAEA's safety role.

From 2 to 6 September 1991, acting on a proposal by the European Union, the Agency convened an international conference on the safety of nuclear power. The conference reviewed nuclear power safety issues on which an international consensus was considered to be necessary and made recommendations for future national and international actions to this end. The conference's conclusions became part of the IAEA's contribution to the UN Conference on Environment and Development at Rio de Janeiro in 1992.[106] During the conference the German Minister for the Environment, Klaus Töpfer, put forward the idea of an international convention on nuclear safety, an idea that Hans Blix vigorously supported.[107]

In the same month (September 1991), the General Conference asked that a start be made on drafting the convention, and in December 1991 the Director General convened a group of experts to advise on the structure and content of such a convention.[108] Work on the document began in 1992[109] and in June 1994 the IAEA convened a diplomatic conference to consider and approve the draft. In September 1994, the Convention was opened for signature and it entered into force on 24 October 1996.

The 'Convention on Nuclear Safety' is the first international document that legally binds its parties to ensure the safety of land based civilian nuclear power reactors (it does not apply to military or marine power reactors). The fundamental principle of the Convention is that "...responsibility for nuclear safety rests with the State having jurisdiction over a nuclear installation."

The parties accept three categories of obligations. Each party must establish a legislative framework and independent regulary body, separate from any other body concerned with promoting and using nuclear energy (Articles 7 and 8). Safety must be ensured by a system of licensing, inspection and enforcement (Article 7). Each party must ensure fulfilment of the technical requirements for safe siting, design, construction and operation of the plant concerned throughout its lifetime (Articles 17–19).[110]

Each party must also arrange for a review of the safety of all the nuclear installations on its territory as soon as possible after the Convention enters into force for that party. If improvements are necessary to upgrade the safety of an installation the government is required to introduce them as a matter of urgency and if the upgrading is not possible the government must shut the plant down "as soon as is practically possible" (Article 6).

The parties must hold review meetings at intervals of not more than three years (Article 21.3), the first review meeting to take place within 30 months of the Convention's entry into force (Article 21. 2). Each party must submit to every review meeting a report on the measures it has taken to implement each of the obligations under the Convention (Article 5). The IAEA will provide the secretariat for the review meetings (Article 28).

As noted by Ambassador van Gorkom in his article in *Personal Reflections*, the nuclear safety convention, together with the two 1986 conventions on notification of nuclear accidents and on assistance to be given in the event of an accident, "...is an important step towards a comprehensive international safety regime." The next step, endorsed by the General Conference in September 1994, was the preparation of a convention on the safety of nuclear waste management.[111]

By 18 April 1997, the 'Convention on Nuclear Safety' had been ratified by 37 States. The States operating nuclear power reactors that had not ratified the Convention by that date were Armenia, India, Kazakstan, Pakistan, Ukraine and the USA, but most of them were expected to complete the process of ratification before the first review meeting of the parties to the Convention in April 1999.

Historical changes in the IAEA's approach to nuclear safety

We have noted that:

— The Statute's approaches to safeguards and to nuclear safety standards were very similar in that:

- Both were to apply to the Agency's own operations,

- Both were to apply to any "materials, services, equipment, facilities, and information made available by the Agency or at its request or under its control or supervision" and, if so requested, "to any bilateral or multilateral arrangement" or to any of a "...State's activities in the field of atomic energy".[112]
- Both were to be propagated by 'Agency projects' which would require the beneficiary State to undertake to accept safeguards which included "observance of health and safety measures prescribed by the Agency."[113]
- Compliance with both was to be verified by IAEA inspectors.[114]

— As noted in Chapter 4, it was expected that the IAEA would become the source to which States would normally turn for nuclear supplies. Agency projects, prescribing the application of mandatory IAEA health and safety standards and monitored by IAEA health and safety inspectors would thus become the norm for international transactions relating to the peaceful use of nuclear energy.[115] Had this happened the IAEA's safety standards would have become legally binding in much of the industrial as well as the developing world.

— It was therefore natural for the Prepcom to suggest in 1957 that "where possible, it would be convenient in practice to associate inspection under the safeguards functions, with inspections under the health and safety functions of the Agency."[116]

— In 1961, the Board decided to separate entirely the use of inspections to verify compliance with safeguards from those designed to verify compliance with safety standards.

— In 1976, the Board dropped the concept of health and safety inspections. It defined the Agency's "principal objective" to be that of providing "practical guidance and effective assistance." A State could "be allowed considerable latitude in applying its own system of safety standards and measures after the Agency has established that the system is adequate," and "the Agency may, in agreement with the State, send safety missions for the purpose of providing advice and assistance..."[117]

By 1995, the role of the IAEA was a far cry from that of the early 1960s, when the main IAEA activity was to study, compare and find common ground — or seek compromises — between the national regulations and the leading nuclear nations, and on that basis to draft international recommendations. This useful but somewhat passive approach came in for criticism that the IAEA was not doing enough to ensure that its recommendations were being adopted and applied by nuclear authorities in developing countries.

After Three Mile Island, and particularly after Chernobyl, the IAEA became proactive in nuclear safety, in launching binding international conventions and in providing a very broad range of services and assistance to help Member States maintain and enhance the safety of their nuclear activities. The IAEA was also actively engaged in helping States to establish and maintain an effective legal framework of nuclear safety, in helping them to improve nuclear safety at individual power and research reactors and in assessing the shortcomings — from the point of view of safety — of particular designs of nuclear plants.

Although, as Tadeusz Wojcik has pointed out in his essay in *Personal Reflections*, the group drafting the 'Convention on Nuclear Safety' declined to incorporate and make mandatory the standards of NUSS, the Convention does mark a step away from the prevalent concept of the 1960s and 1970s that international activities relating to nuclear safety must be purely advisory.

Waste management and disposal: A growing IAEA activity[118]

The management and disposal of nuclear and other radioactive wastes have become a pressing international concern and the subject of a major programme of the IAEA. The sources and causes of such waste illustrate the extent of the work to be undertaken. Nuclear waste is generated by:

- The nuclear fuel cycle (mining and milling of ore, conversion into yellow cake and uranium oxide, enrichment, fuel fabrication, operation of reactors, spent fuel storage, spent fuel reprocessing, disposal of waste and decommissioning of plants);
- The use of radiation and radioisotopes in medicine, industry and various branches of research;
- Production and testing of nuclear weapons;
- Accidents involving nuclear materials.

One of the main reasons why the use of nuclear power has caused widespread public concern is the fear that the nuclear waste it generates will eventually enter the human food chain or contaminate humanity in some other way. In 1982, the IAEA published a collection of excerpts from technical reports that authoritative national and international organizations had issued from 1975 to 1981. The reports were written by organizations that were nationally or internationally concerned with public health, science and the environment as well as those that might be regarded as being committed to nuclear energy.[119] All pointed to a similar conclusion — the means are available and have already been tested for solving the safety problems of disposing of radioactive waste from civilian nuclear activities. Public fears, inflated out of proportion by reports in the media, are a political and psychological problem to be solved by politicians and their advisors.

The IAEA cannot directly counter the public's concerns, but it has the authority to develop standards for the safe management and disposal of radioactive waste and it is able to help individual countries to deal with some of their waste management problems.

When the Agency began operating in 1958, nuclear waste still seemed in most countries a relatively distant problem. Low level waste from Western Europe was dumped in the depths of the Atlantic. The nuclear weapon States dealt, more or less in secret, with the waste that arose from their nuclear military industries. As noted elsewhere, in the 1960s and 1970s France and the United Kingdom used gas graphite reactors to produce their nuclear power. The spent fuel from these reactors was reprocessed in those countries (reprocessing was deemed necessary to avoid corrosion and leakage of radioactive materials). The high level waste produced by the reprocessing plants was stored at those plants. In the 1970s, France began building light water reactors. The spent fuel from these reactors was subsequently reprocessed at the La Hague plant which came into operation in 1976 and the resulting high level waste was stored in special facilities.[120]

In the late 1970s, under pressure from the Carter Administration, the US nuclear industry abandoned plans for reprocessing the spent fuel from its light water reactors. For many years their spent fuel has been stored at the reactors themselves or at special away-from-reactor storage facilities, pending a political solution to the controversial problem of finding permanent waste disposal sites.

The IAEA had little if any direct involvement in these waste management operations of the major industrial countries. Storage of spent fuel, reprocessing, waste management and disposal were undertaken or supervised by national authorities and ocean dumping was organized by the NEA until the practice was tacitly abandoned in 1982. Most of the IAEA's own work consisted of promoting research such as studying the effects of radioactivity in the sea, the exchange of information and helping countries — particularly but not only in the developing world — to deal with their nuclear waste problems. Marine studies were chiefly the work of the IAEA's Marine Environment Laboratory at Monaco (see Chapter 9), while at IAEA Headquarters radioactive waste management and disposal were for many years dealt with by the Divisions of Human Health and of Nuclear Safety. The ultimate aim of much of this work was to secure international consensus on the management of radioactive waste and to embody such consensus in recommended standards and codes of practice and eventually in legally binding instruments (conventions).

In the early days a technical problem that the IAEA faced in drawing up generally applicable standards for managing radioactive wastes was that the issues to be solved differed greatly from site to site, and often from country to country, depending on local geology, climate, population density, industrial infrastructure and communications, as well as national attitudes. A nation with large areas at its disposal, relatively empty of human occupation and having geological structures and other features that lent themselves to underground disposal (such as salt domes or extensive granite formations), obviously had an easier task than a small, highly populated nation whose geology was unsuitable. As a result, the process of setting internationally acceptable and uniform standards in this field has been more difficult and slower that that of setting standards for the safety of nuclear plants.

The Agency's numerous international conferences, symposia and seminars on waste management and related topics began in November 1959 with a landmark conference in Monaco on the 'Disposal of Radioactive Waste'. The conference, which was co-sponsored by UNESCO, helped to open the way to the establishment of the IAEA's laboratory in Monaco. The proceedings of the conference were the subject of the first IAEA publication on waste management and disposal (Safety Series No. 5). The next significant international meeting was a symposium in Vienna in October 1962 on the 'Treatment and Storage of High Level Radioactive Wastes'.

During the remainder of the 1960s and in the subsequent decades, the IAEA convened conferences, symposia and seminars almost every year, covering virtually all aspects of the management of waste from civilian nuclear and radiological activities. In 1975, the IAEA held three symposia on environmental problems — on the combined effect of radioactive and non-radioactive releases, on the effects of releases from nuclear plants into seas, rivers and the other aquatic systems, and on the effects of the releases of plutonium and other transuranic elements into the environment. This pattern continued during the remainder of the 1970s and early 1980s.

In 1983, the IAEA convened in Seattle the first Agency conference to cover the entire range of issues arising in waste management: technological, environmental, regulatory, institutional, legal, economic and social as well as policy issues. The conference attracted wide interest and attracted over 500 participants. In the same year the IAEA convened a technical committee on decontamination technology.

The IAEA's role under the sea dumping convention

As already noted, in 1972 a conference in London adopted the 'Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter' and the Convention referred to the IAEA as the competent body to define high level wastes that should not be dumped at sea. In 1975, the Board of Governors approved the definition of such wastes proposed by the Secretariat; the definition was revised in 1978 and again in 1986. In 1983, the parties agreed to a moratorium on all forms of sea dumping of radioactive wastes and in 1993 such dumping was formally prohibited. The ban entered into force in 1994.[121]

WAMAP, INWAC and RADWASS

In 1987, the IAEA established the Waste Management Advisory Programme (WAMAP) to help developing countries to set up their own systems for dealing with nuclear waste, and began sending out WAMAP missions.[122] In 1989, the IAEA set up an 18-nation expert committee (the International Radioactive Waste Advisory Committee, or INWAC) to advise it about its own programme and to oversee the preparation of internationally agreed basic standards for waste management (Radioactive Waste Safety Standards, or RADWASS). RADWASS was designed to cover the planning of waste management operations, preliminary disposal of waste, near surface disposal, geological (deep) disposal, treatment of waste from mining and milling and decommissioning of waste treatment plants.[123] In 1990, the Board approved the preparation of a series of RADWASS standards and the publication of a safety standard on *Safety Principles and Technical Criteria for Underground Disposal* *of High Level Radioactive Waste*. This document embodied the first international consensus on underground disposal. In September 1990, the General Conference adopted the *Code of Practice on the International Transboundary Movement of Radioactive Waste* and asked the Director General to monitor its application.

In 1994, the IAEA began a review of all its technical documents relating to waste management and disposal and prepared two basic documents, one a Safety Fundamentals on internationally approved principles of radioactive waste disposal and the second a Safety Standard on establishing a national programme for nuclear waste management.[124] Both documents were published in 1995.[125] In 1994, the IAEA began to help Member States systematically improve their waste management programmes. For this purpose the IAEA set out criteria in a document entitled *Minimum Acceptable Waste Infrastructure* to be used by developing States to evaluate such programmes.[126]

WATRP

In 1989, building on the experience gained in earlier advisory programmes, the IAEA launched a service for the 'peer review' of national waste management projects — the Waste Management Assessment and Technical Review Programme, or WATRP. The WATRP teams consisted of four or five waste management experts from different Member States who reviewed all relevant information and reported their findings to the State. Before the formal establishment of WATRP in 1989 the first (four) reviews had been carried out in Sweden from 1978 to 1987 and one in the United Kingdom in 1988 and they provided useful guidance for the formal launching of the service. The review in Sweden focused on research being done in that country on the handling and disposal of high level waste and spent fuel. The review in the United Kingdom focused on the NIREX programme for a deep level repository and specifically on safety and site assessment.

Since then WATRP missions have carried out reviews in the Republic of Korea in 1991 (criteria for a low and intermediate level disposal site), Finland in 1992 (overall nuclear waste management programme), the Czech Republic in 1993 (deep geological disposal), Slovakia in 1993 (a near surface disposal facility at the Mochovce power reactor), and Norway in 1994 (a combined storage and disposal facility for low and intermediate level waste).[127]

In 1996, the Agency arranged the review of a programme for the management of short lived waste at the Centre de l'Aube in France.[128]

In a related activity, at the request of the Nordic Council of Ministers and with the co-operation of Russia, the Agency held a seminar in May 1995 on nuclear waste management in the Russian Federation. The States concerned established a forum known as a Contact Expert Group under the auspices of the IAEA to promote co-operation in waste management.[129]

Other field activities

In the 1980s, the IAEA began to help Member States to clean up sites that had been contaminated by radioactivity, for instance by extensive mining operations. It also began assisting Member States in the safe decommissioning of nuclear reactors, and more recently in setting up centralized storage facilities for radium sources taken out of use (radium has almost entirely been replaced as a source of radiation in cancer therapy by the less dangerous caesium-137).

International convention on the safety of radioactive waste management

As previously noted, in 1994 the General Conference asked the Board and the Director General to begin preparing an international convention on safe nuclear waste management.[130] It was expected that the two basic documents already mentioned (the Safety Fundamentals and the Safety Standard) would provide source material for the convention.[131]

The groups of experts appointed to prepare the convention completed their task in April 1997 and on 28 April the Director General submitted a report to the Board enclosing the draft text of a 'Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management'. The Director General recommended that a diplomatic conference be convened on 1 September 1997 to adopt the convention and that it be opened for signature at the 29 September to 3 October 1997 (41st) session of the General Conference.

Technical co-operation

Since the late 1950s and early 1960s, the IAEA has provided substantial technical assistance to help its Member States establish the governmental institutions needed to deal with their waste management problems, enact and apply adequate safety standards and train the required personnel.

For instance, between 1991 and 1995 the IAEA held more than 20 training courses on various aspects of waste management.[132] The most recent interregional courses were on the methodology for the safety assessment of facilities for the near surface disposal of waste (USA, 1994) and on the management of radioactive waste from nuclear power plants (France, 1996). Between 1994 and 1996, regional courses were held in Africa (Egypt, 1994 and 1996, and South Africa, 1995), Latin America (Argentina, 1994, and Chile, 1996), South East Asia (Philippines, 1994) and Europe (Spain, 1995, Finland and the United Kingdom, 1996).

In recent years, there has been a substantial increase in the scope of the IAEA's technical co-operation projects relating to waste management in the former Soviet Union and Eastern Europe. For example, there is a design defect in many of the 45 operating light water (WWER-440) nuclear power plants of Soviet design — in addition to the design defects already mentioned in the section dealing with nuclear safety — that causes them to generate more nuclear waste than other comparable plants. Some of the 45 are nearing the end of their foreseen working life (five have already been decommissioned). In 1995, the IAEA completed a four year technical co-operation project on minimizing waste from these plants, and began another four year study of the decommissioning of WWER-440s.[133]

Co-operation between States in setting up waste disposal sites

To enhance safety, reduce costs and discourage nuclear proliferation it would be preferable to minimize the number of locations of high level nuclear waste and unreprocessed spent fuel. One obvious way of doing this would be to establish regional or multinational storage facilities. However, very few, if any, countries are prepared today to accept permanently another country's nuclear waste or spent fuel. There have been some exceptions; the Soviet Union required that spent fuel from any reactor that it had supplied be returned to it in order to ensure that the customer country did not extract the plutonium from the spent fuel and use it to make nuclear weapons. For similar reasons, this appears to have been US policy in regard to spent fuel originating from high enriched fuel of US origin.

In the late 1970s, the IAEA was invited by the governments concerned to arrange for the disposal in Egypt of high level waste that would originate in the Zwentendorf nuclear power plant then under construction in Austria and that no province in Austria would accept. The attempt had to be hastily abandoned when the Egyptian media heard about it and raised a public outcry. This experience shattered any illusion that poorer countries might be more willing to serve as depositories for nuclear waste if they were adequately paid for their services.

A special problem is faced by countries that use nuclear techniques only in research, medicine, agriculture and industry and lack adequate facilities for managing the resulting low and intermediate level waste. In 1994, the Agency began to look into the feasibility of a regional arrangement for dealing with spent radium sources in Africa.[135] If such a project could be launched it would set a useful precedent and hopefully open the way to other arrangements for regional co-operation.

The legacy of nuclear weapon programmes

Chiefly as a result of the nuclear arms race — and the end of the Cold War — it has been disclosed that the world's most serious nuclear waste problems are in the former Soviet Union and the USA. They arise largely from the practices that the two nations followed and the risks they took in forging ahead with their nuclear weapon programmes. In the Soviet Union, for instance, nuclear waste was discharged into rivers and oceans and directly into the ground, the navy scuttled obsolete nuclear warships or dumped unwanted nuclear reactors in the Kara Sea and Western Pacific, large areas were polluted by the mining and milling of uranium, nuclear explosive devices used in engineering projects left behind contaminated soil and water, and liquid waste from marine reactors was stored in rusting and overfilled tanks or dumps.[136] The problems of the USA appear to be concentrated chiefly in the plants used for producing fissile material and manufacturing nuclear weapons, associated waste storage sites and the local and regional environment. The costs of cleaning up the US sites and disposing of their nuclear wastes have been estimated at as much as $189 to $265 billion over 70 years, and probably more.[137]

In 1993–1995, at the request of the Government of Kazakstan, the IAEA surveyed the extent of radioactive contamination of 19 000 square kilometres of land at Semipalatinsk where the USSR tested nuclear weapons for 40 years from 1949 until 1989, including atmospheric and surface tests until 1962. Five of the warheads misfired and instead of exploding, scattered plutonium around the test site. The preliminary conclusions of the survey were that the dose to local populations in adjoining settlements was, nonetheless, very low and that there was no need for concern, but that sites with high dose rates should not be reoccupied.[138]

From 1993 to 1996, the IAEA carried out a comprehensive study of the impact of extensive dumping of radioactive waste in the Arctic, the 'International Arctic Seas Assessment Project'. The main conclusions of the study were that "the current radiological risks presented by the dumped wastes are negligible, and that the future risks to population groups most likely to be exposed are also small. No justification was found on radiological grounds for instituting a programme of remedial action." However, a reassessment of the situation was recommended if current military restrictions over the fjords of Novaya Zemlya, where much of the waste was dumped, are removed.[139]

In 1994 and 1995 the IAEA also participated in the Japan–Republic of Korea–Russian Federation expeditions to dump sites in the Far Eastern seas.[140] The final report of the study is to be issued in 1997.

In 1995, France asked the IAEA to assess the radiological effects of nuclear weapon tests France had carried out on the atolls of Mururoa and Fangataufa in the South Pacific.[141] In mid-1996, the IAEA arranged, as a first step, for the monitoring of the marine and terrestrial environments, in other words the seas and sea-bed around the atolls and the atolls themselves.

This brief description illustrates the extent to which the IAEA's activities in radioactive waste management have grown from their very modest beginnings in the late 1950s and early 1960s. The importance and scope of this work is likely to increase as more waste is generated by nuclear power plants throughout the world, more installations are decommissioned and if the IAEA continues to be called upon to assist in dealing with the legacy of discontinued military programmes.

Summing up

The overwhelming weight of independent professional opinion is that we have the technical means to isolate radioactive wastes for as long as may be necessary to ensure that they have no harmful impact on humans or their environment. This conclusion is based on nearly 50 years of dealing with radioactive wastes, on decades of careful analysis and scientific discussion, as well as on the great amount of work done by national and international organizations, including the IAEA. Several of the organizations that share this conclusion have no institutional interest in promoting the use of nuclear energy. Nonetheless, such is the general and deep seated fear of radiation that the man or woman in the street remains unconvinced and apprehensive. One result is that in most countries having civilian or military nuclear activities it has not yet been possible to reach agreement on disposal sites, let alone on a regional site that would serve a group of countries.

From a narrow technical point of view the absence of final decisions on underground disposal sites has certain advantages. Most of the radioactive isotopes in waste decay very rapidly and there are arguments in favour of keeping the waste in surface storage as long as possible. However, storage sites at reactors are steadily filling up and finding away-from-reactor sites is not always easy. Sooner or later the nettle must be grasped — permanent solutions must be found not only for waste originating in civilian activities but for the more formidable problem of disposing of the wastes left behind by more than five decades of producing nuclear weapons.

The physical protection of nuclear material

From the start of what used to be called the atomic age, nuclear scientists and nuclear establishments have been aware of the danger that nuclear material might fall into the wrong hands and be used by criminals as a threat to inspire terror, or even as a weapon (although for a variety of reasons the latter is highly unlikely). However, governments at first tended to take the view that this was a problem of criminal justice to be dealt with by national authorities responsible for internal security, and not by international agreement. The issue did not arise during the eight- and twelve-nation negotiations in Washington in 1955–1956 and it was not addressed while drafting the Statute, or by the Statute Conference, or the Prepcom.

As the IAEA's safeguards programme expanded in the late 1960s, the Secretariat began to ask what role the IAEA might usefully play in this context. When the Safeguards Committee (1970) agreed on the contents of the standard NPT safeguards agreement it prescribed that each non-nuclear-weapon State should "establish and maintain a system of accounting for and control of all nuclear material subject to safeguards under the Agreement."[142] While responsibility for establishing the State's system of accounting and control lay with the governments concerned, it seemed appropriate for the IAEA to give guidance on the minimum requirements to be met for the physical control of nuclear materials. The first reaction of some Western European delegations to the Secretariat's soundings was negative; this was not a matter for the IAEA, but in 1972 the Director General was able to issue a set of internationally agreed recommendations.[143] The IAEA's original recommendations were revised in 1977, more extensively in 1989 and again in 1993.[144]

The standard NPT safeguards agreement does not refer directly to physical protection, but in negotiations with a number of States not party to the NPT during the 1970s the Secretariat was able to include a requirement that the State concerned should, at a minimum, apply the IAEA's recommendations in its own nuclear activities. The Nuclear Suppliers' Group Guidelines published in 1978 also recommended that the supplier States should require their customers to apply, at a minimum, the recommendations of the IAEA.

In 1974, the Secretariat began studying the need for a binding international convention on physical protection. The concept attracted broad support at the first NPT review conference in 1975. In 1977, an Advisory Group set up by the Director General concluded that there was a need for a convention and that it should cover the protection of nuclear material during international transport. In the same year (1977) the USA provided the IAEA with a draft text of such a convention and in 1978 and 1979 meetings of governmental representatives and subsequently of a drafting committee completed work on the draft. One of the two main problems that arose during the discussion of the draft was whether the convention should cover nuclear material during international transport only or whether it should also relate to the domestic use of nuclear material. It was agreed that the most urgent need was to ensure that nuclear material was adequately protected when it was being transported across national frontiers, but that the provisions of the convention requiring the parties to co-operate in protecting and recovering material, and in extraditing and punishing offenders, should also apply to material in domestic use, storage and transport. The other main problem related to the participation of EURATOM and allocation of responsibilities between EURATOM and its member states.[145]

Accordingly, the 'Convention on the Physical Protection of Nuclear Material' is explicitly designed to protect such material against criminal acts while it is in international transport, but it also requires its parties to make such acts punishable under national law, whether they involve nuclear material in international transport or in domestic use, storage or transport.[146]

The Convention was opened for signature on 3 March 1980. However, almost seven years elapsed before it acquired the 21 ratifications needed to bring it into force — on 8 February 1987. By 28 February 1997, 57 States had brought the Convention into force.[147] They included all members of the European Union and other European States, the USA, the Russian Federation, Japan, China and most other producers and suppliers of nuclear material.

The parties met in September 1992 to review the implementation of the Convention and its adequacy. Since the breakup of the Soviet Union there had been growing concern about the smuggling of nuclear and other radioactive materials out of its successor States. At the review conference the parties affirmed their full support for the Convention as it stood, noting that it continued to provide a sound basis for protecting nuclear material in international transport as well as an appropriate framework for States to co-operate in such protection, in recovering and securing the return of stolen nuclear material and in penalizing persons who commit criminal acts involving nuclear material.[148]

Liability for nuclear accidents

In the late 1950s and 1960s, the OECD's ENEA sponsored a 'Convention on Third Party Liability in the Field of Nuclear Energy' which was opened for signature in Paris on 29 July 1960. The Convention was designed to regulate and harmonize the laws in force in ENEA member countries concerning third party liability and insurance against atomic risks, for instance who should be held liable in the event of a nuclear accident and what should be the limits to his or her liability. The Convention embodied the principle that the operator should bear sole responsibility for the financial consequences of a nuclear accident, thus averting complex litigation if an accident should occur.

At about the same time that the ENEA began work on its Convention, and following ENEA's example, the IAEA promoted the conclusion of a fundamentally similar international convention for the IAEA's Member States, but it took a good deal longer to reach agreement in Vienna than in Paris. The IAEA convention also embodied the concept of absolute operator liability. ENEA's convention was open to members of the OECD, the IAEA's was open to all members of the Agency, the United Nations and the UN specialized agencies, including those States that were also members of ENEA. Both conventions dealt only with land based civilian plants, including related transport of nuclear substances. In April–May 1963, an international conference approved the 'Vienna Convention on Civil Liability for Nuclear Damage', and it was opened for signature on 21 May 1963.[149]

This was an instance of quite unnecessary duplication between the IAEA and ENEA, partly due to Sterling Cole's annoyance with the ENEA for having taken the lead in a matter in which he had a special interest, but ENEA must also take responsibility for sponsoring a Convention that was originally open only to Western European nations. There were several differences of detail and some of substance between the two Conventions and for many years legal officers from both agencies would meet in Paris or Vienna to seek uniformity in interpretation. This was an exercise of little practical value since, for a number of years, none of the States having a significant nuclear power programme had acceded to the Vienna Convention.

Despite the similarities between the Paris and Vienna Conventions, until recently they operated in isolation from each other. In 1988, a diplomatic conference convened by the IAEA and the NEA adopted a Joint Protocol which combined the two Conventions into one extended liability regime.

In the early 1960s, the International Maritime Committee and the IAEA elaborated a 'Convention on the Liability of Operators of Nuclear Ships', which was adopted at the 11th session of the 'Diplomatic Conference on Maritime Law' sponsored by the Belgian Government with the assistance of the Agency. The Convention was opened for signature on 25 May 1962. In November–December 1971, the IAEA together with the NEA and the Intergovernmental Maritime Consultative Organization (IMCO, now the International Maritime Organization) convened a conference to draw up a similar convention on civil liability in relation to the maritime carriage of nuclear material. The convention embodied the same principle as the earlier conventions, namely that the plant operator should bear sole responsibility for the consequences of an accident, thus making carriers less reluctant to accept nuclear material.

NOTES

1 Now reclassified as 'Fundamentals', 'Requirements', 'Guides' and 'Safety Reports'.

2 The IAEA also:

— Provided nuclear safety training.
— Carried out nuclear safety reviews.
— Designed tests of the safety of packages, casks and containers transporting nuclear material. It subsequently developed internationally accepted standardized casks, e.g. for transporting irradiated fuel.

— Sought to ensure accurate measurements of doses administered to patients receiving radiation therapy.
— Sponsored regional and international co-operation and agreements on emergency assistance.
— Set up a health and safety and waste management advisory service (with ILO and FAO) and helped Member States to set up their own protection and monitoring services.
— Set up another advisory service to review the safety of proposed movements of irradiated fuel.
— Helped Member States measure radioactive contamination of the atmosphere.

[3] *IAEA Statute*, Articles XII.A.2, XII.A.5 and XII.C.
[4] Document INFCIRC/18, p. 7, para. 31.
[5] SZASZ, P.C., *The Law and Practices of the International Atomic Energy Agency*, Legal Series No. 7, IAEA, Vienna (1970) 695.
[6] RAINER, R. H., SZASZ, P.C., *The Law and Practices of the International Atomic Energy Agency: 1970–1980, Supplement 1 to the 1970 Edition of Legal Series No. 7*, Legal Series No. 7-S1, IAEA, Vienna (1993) 411.
[7] To prepare a manual or set of safety recommendations or standards, the Secretariat would usually write the first draft, possibly with the help of consultants. It would then circulate the draft to authorities or experts in Member States for their comments, convene a panel of experts to review the draft and the comments made by national authorities, and prepare a final draft, which might again be circulated for final comments or issued as an IAEA recommendation. The most important recommendations might require formal approval by the Board.
[8] Document INFCIRC/18. These measures were revised in 1976 and issued as document INFCIRC/18/Rev. 1. See also document GC(40)INF/5, Attachment, Part B.
[9] *Annual Report of the Board of Governors to the General Conference 1 July 1960–30 June 1961*, GC(V)/154, IAEA, Vienna (1961), p. 25, paras 167–168. The Transport Regulations have been comprehensively revised five times, in 1964, 1967, 1973, 1985 and 1995 (see GC(40)INF/5, Attachment, Part B, p. 1).
[10] Amongst those who did so were the UN authorities responsible for preparing international regulations on the transport of dangerous goods, the European Agreements on the International Carriage of Dangerous Goods by Road and by Inland Waterways, the International Convention on Transport of Goods by Rail, and the International Air Transport Association (*Annual Report of the Board of Governors to the General Conference 1 July 1961–30 June 1962*, GC(VI)/195, IAEA, Vienna (1962), p. 14, para. 87; *Annual Report of the Board of Governors to the General*

Conference 1 July 1964–30 June 1965, GC(IX)/299, IAEA, Vienna (1965), p. 37, para. 158).

11 *Basic Safety Standards for Radiation Protection — 1982 Edition*, Safety Series No. 9, IAEA, Vienna (1982).

12 *Annual Report for 1982*, GC(XXVII)/684, IAEA, Vienna (1983), p. 40, para. 158.

13 The revision was sponsored by the IAEA jointly with several other UN and regional agencies (FAO, ILO, OECD/NEA, PAHO, WHO) — see GC(40)/INF/5, Attachment, Part B, pp. 1–2.

14 COLE, S., "The work of the International Atomic Energy Agency", *Nuclear Power* **5** 45 (1960) 78.

15 *Annual Report of the Board of Governors to the General Conference Covering the Period from 1 July 1958 to 30 June 1959*, GC(III)/73, IAEA, Vienna (1959), p. 44, para. 206.

16 *Annual Report of the Board of Governors to the General Conference 1 July 1959–30 June 1960*, GC(IV)/114, IAEA, Vienna (1960), p. 5, para. 15(e).

17 The agreement was published as document INFCIRC/27.

18 *Annual Report of the Board of Governors to the General Conference 1 July 1963–30 June 1964*, GC(VIII)/270, IAEA, Vienna (1964), p. 26, para. 125.

19 FISCHER, D.A.V., *Stopping the Spread of Nuclear Weapons: The Past and the Prospects*, Routledge, London (1992) 262. In 1979, a dam break at Morvi in India reportedly killed some 12 000 people.

20 *Annual Report 1 July 1970–30 June 1971*, GC(XV)/455, IAEA, Vienna (1971), p. 8, para. 13. In this context the IAEA and WHO began studying the feasibility of a register of significant disposals of radioactive waste into the environment. However, it was not until 1991 that the IAEA began to publish inventories of disposals of solid radioactive wastes into the marine and terrestrial environments.

21 *Annual Report 1 July 1970–30 June 1971*, p. 40, para. 102(a).

22 *Annual Report of the Board of Governors to the General Conference 1 July 1961–30 June 1962*, p. 15, para. 91; and *Annual Report of the Board of Governors to the General Conference 1 July 1962–30 June 1963*, GC(VII)/228, IAEA, Vienna (1963), p. 13, para. 97.

23 See the statement by the Governor for Denmark, GOV/OR.649, para. 100.

24 *Annual Report 1 July 1972– 30 June 1973*, GC(XVII)/500, IAEA, Vienna (1973), p. 2, paras 9–11. A conference in London in November 1972 drew up a 'Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter'. This designated the IAEA as the competent international body for defining the high level nuclear waste that must not be dumped at sea.

25 *Annual Report for 1979*, GC(XXIV)/627, IAEA, Vienna (1980), p. 22, para. 78.

26 This summary of the evolution of NUSS is based on Tadeusz Wojcik's article in *Personal Reflections*.

[27] *Annual Report for 1979*, p. 3, paras 2–3. The cause of the accident was a faulty valve and a series of misunderstandings by the plant operators.

[28] The main findings of the experts are given in Annex III to document GOV/1948 of 20 June 1979.

[29] The texts of the letters from these States are reproduced in document INFCIRC/270 of June 1979.

[30] *Annual Report for 1979*, p. 22, paras 75–78. The experts also recommended that the IAEA should: hold and take part in specialized meetings on the consequences of the accident; expand the NUSS programme; expand technical assistance in nuclear safety; increase its own ability to provide emergency help; and that Member States should: promote a freer and fuller exchange of the results of safety research; permit the sale/purchase of a nuclear power plant only if an accident emergency plan existed; periodically test their own emergency plans; invite the IAEA to review their safety activities and follow up the Agency's recommendations.

[31] The USA expressed strong reservations about the need for "...international agreements on nuclear safety" because of its belief that nuclear safety and regulatory matters were primarily national responsibilities (GOV/OR.532).

[32] WOJCIK, T., in *Personal Reflections*.

[33] *Annual Report for 1980*, GC(XXV)/642, IAEA, Vienna (1981), p. 4, para. 6.

[34] Document GOV/OR.539, para. 11.

[35] INPO subsequently served as the model for the World Association of Nuclear Operators with its headquarters in London.

[36] *Annual Report for 1984*, GC(XXIX)/748, IAEA, Vienna (1985), p. 36, para. 166.

[37] In other words, 24 of the 25 Member States that were operating nuclear power reactors had joined the IRS.

[38] Information provided by the IAEA, Division of Nuclear Installation Safety, Department of Nuclear Safety.

[39] *Annual Report for 1982*, p. 9, para. 18.

[40] The official titles of these projects or the reports on them are:

- *Summary Report on the Post-Accident Review Meeting on the Chernobyl Accident*, Safety Series No. 75-INSAG-1, IAEA, Vienna (1986).
- *The Chernobyl Accident: Updating of INSAG-1*, Safety Series No. 75-INSAG-7, IAEA, Vienna (1992).
- *The International Chernobyl Project: An Overview*, Report by an International Advisory Committee, IAEA, Vienna (1991).
- *One Decade After Chernobyl: Summing up the Consequences of the Accident* (Proc. EC/IAEA/WHO Int. Conf. Vienna, 1996), IAEA, Vienna (1996).

[41] "In 1986...the Soviet view presented at the Vienna meeting...laid blame almost entirely on the actions of the operating staff" (*The Chernobyl Accident*, Safety Series No. 75-INSAG-7, p. 24, para. 6).

[42] Ibid., p. 23, para. 3.

[43] However, for about 11 hours during this period the reactor was retained at 51% of its power output so as to provide electric power requested by the regional grid — in other words, the experiment was effectively suspended for 11 hours.

[44] *The Chernobyl Accident*, Safety Series No. 75-INSAG-7, p. 23, para. 4.

[45] Ibid., p. 24, para. 6.

[46] No steps had, however, been taken to correct these faults and information about them had not been disseminated, ibid., p. 23, para. 4.

[47] Ibid., p. 23–24, para. 5.

[48] *One Decade After Chernobyl*. The Conference was jointly sponsored by the European Commission, the IAEA and WHO and was held in co-operation with the UN, UNESCO, UNEP, UNSCEAR, FAO and NEA. The President of the Conference was Angela Merkel, German Minister for the Environment.

[49] The quotations are taken from *One Decade After Chernobyl*, Summary of the Conference Results.

[50] Ibid., p. 4, para. 4.

[51] Ibid., p. 12, paras 39–42.

[52] Ibid., p. 13, para. 44.

[53] Ibid., p. 6, para. 12.

[54] Ibid., pp. 7–8, paras 15–22.

[55] Ibid., p. 10, para. 29; and p. 17, para. 66.

[56] Ibid., p. 9, para. 26.

[57] Ibid., p. 16, para. 62.

[58] Ibid., p. 16, para. 60.

[59] Ibid., p. 17, para. 67.

[60] Ibid., p. 6, para. 11.

[61] Ibid., p. 11, para. 33.

[62] Ibid., p. 12, para. 37.

[63] Ibid., pp. 13–14, paras 48 and 50.

[64] Ibid., pp. 14–15, para. 54.

[65] GRUSHA, N., "Belarus pinpoints potential N-plant sites", *NucNet*, No. 38 (23 January 1997).

[66] "Kazakhstan: Government to consider nuclear power development programme", Interfax News Agency (19:59 GMT, 22 January 1997), *BBC Monitoring Summary of World Broadcasts*, 31 January 1997.

[67] Opening address by Hans Blix, *One Decade After Chernobyl*, p. 22.

[68] *Summary Report on the Post-Accident Review Meeting on the Chernobyl Accident*, Safety Series No. 75-INSAG- 1.

[69] In the town of Goiânia, a series of events brought the remnants of the source of a caesium-137 teletherapy unit (for treating cancer) into the hands of a junk dealer. He noticed that the source material, which was in the form of a highly soluble salt, caesium chloride, glowed blue in the dark and he distributed fragments of the source to the families of fascinated friends and relations. They were thus exposed to heavy, and in four cases lethal, doses of radiation and there was also widespread contamination of the environment. The authorities considered it necessary to monitor 112 000 persons, of whom 249 were found to be contaminated internally or externally. The IAEA and several countries provided emergency aid to Brazil.

[70] These and other actions that the IAEA took in 1986 immediately after the Chernobyl accident are described in the *Annual Report for 1986*, GC(XXXI)/800, IAEA, Vienna (1987), p. 9, paras 6–15.

[71] RICHARDS, J.I., et al., "The FAO response", in *One Decade After Chernobyl*, pp. 132 and 141.

[72] INTERNATIONAL ATOMIC ENERGY AGENCY, *Intervention Criteria in a Nuclear or Radiation Emergency*, Safety Series No. 109, IAEA, Vienna (1994).

[73] FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS/ WORLD HEALTH ORGANIZATION, "Guideline levels for radionuclides in foods following accidental nuclear contamination", *Codex Alimentarius, General Requirements*, Section 6.1, Joint FAO/WHO Food Standards Programme, Rome (1989).

[74] RICHARDS, J.I., et al., in *One Decade After Chernobyl*, pp. 133–141.

[75] LEDERMAN, L., "Nuclear safety aspects: Special report on Chernobyl", *IAEA Bulletin* **38** 3 (1996) 44–47.

[76] *Annual Report for 1989*, GC(XXXIV)/915, IAEA, Vienna (1990) 4.

[77] Most of the contents of this section are based on an informative document issued by the Director General to the General Conference on 4 September 1995, "Measures to Strengthen International Co-operation in Nuclear Safety, Radiological Protection and Radioactive Waste Management", GC(39)INF/8.

[78] *Annual Report for 1983*, GC(XXVIII)/713, IAEA, Vienna (1984), p. 37, para. 160.

[79] Lord Marshall also served for many years as a member of the IAEA's Scientific Advisory Committee, where he was much respected for his forthrightness, and was very popular for his sharp sense of humour.

[80] *Annual Report for 1986*, p. 27, para. 180. The team tested the methodology of the ASSET programme at the Krško nuclear power plant in Yugoslavia (Krško is now in Slovenia).

[81] *Annual Report for 1987*, GC(XXXII)/835, IAEA, Vienna (1988), p. 40, para. 179.

[82] The design defects of the WWER 440/230 reactor included: embrittlement of the reactor pressure vessel; limited capability for cooling the reactor core in an emergency; insufficient redundancy of safety features; deficient instruments and controls; insufficient protection against internal and external hazards; and lack of containment in the event of a severe accident. (HOLBERTSON, S., "But really how safe is safe?", *Financial Times* (22 December 1996).) One problem found to be common to all WWER plants was inadequate fire protection and inadequate capacity to fight fires (*Annual Report for 1995*, GC(40)/8, IAEA, Vienna (1996) 42).

[83] Document GC(XXXIV)/RES/529.

[84] There had been particular concern in neighbouring countries about the safety of the WWER-440/230 plants at Bohunice and Kozloduy. Since a referendum in which Austrian voters decided by a very narrow majority — 51 to 49% — not to start up Austria's only nuclear power plant (at Zwentendorf in Lower Austria), the Austrian media and public had become more outspokenly opposed to nuclear power than almost any other country in Europe and on one occasion the Austrian Minister for the Environment proposed (apparently without consulting her Government) that the IAEA should leave Austria unless all reference to the promotion of nuclear energy was deleted from its Statute. Concern about nuclear safety has affected Austrian relations with the Czech Republic and Slovakia, which operate nuclear plants of Soviet design.

[85] *Annual Report for 1992*, GC(XXXVII)/1060, IAEA, Vienna (1993) 117.

[86] *Annual Report for 1993*, GC(XXXVIII)/2, IAEA, Vienna (1994) 136–137.

[87] The assistance that the G-24 nations offer is channelled through their Nuclear Safety Assistance Co-ordination Secretariat with which the IAEA co-ordinates its own relevant programmes.

[88] As explained later, these documents are the primary texts for other publications in the IAEA's Safety Series.

[89] The Agency has since revised the five Codes and some of the Safety Guides.

[90] *Annual Report for 1995*, pp. 41–42.

[91] The international basis of the standards is "advice provided by the International Nuclear Safety Advisory Group (INSAG)...estimates made by the United Nations Scientific Committee on the Effects of Atomic Radiation...and the recommendations made by a number of international bodies — principally the International Commission on Radiological Protection" (GC(40)INF/5, Attachment, Part B, p. 2, para. 7).

[92] *Annual Report for 1981*, GC(XXVI)/664, IAEA, Vienna (1982), p. 42, para. 135; *Annual Report for 1982*, p. 40, para. 158.

93 *Annual Report for 1991*, GC(XXXVI)/1004, IAEA, Vienna (1992) 85.
94 IAEA document IAEA-CN-67 (First Announcement of the Conference).
95 Speech by NRC Commissioner Greta Joy Dicus, Joint American–Russian Radiation Health Effects Research, Joint Meeting of the American Nuclear Society, Washington, DC Section and the Health Physics Society, Baltimore–Washington Chapter, 16 January 1997.
96 *IAEA Bulletin* **39** 1 (1997) 44.
97 *Technical Co-operation Report for 1995*, GC(40)/INF/3, IAEA, Vienna (1996), p. 25, para. 97.
98 *The Agency's Technical Co-operation Activities in 1992*, GC(XXXVII)/INF/3, IAEA, Vienna (1993), pp. 21–22, para. 85.
99 *Technical Co-operation Report for 1995*, p. 25, paras 98–102.
100 *The Agency's Technical Co-operation Activities in 1994*, GC(39)/INF/3, IAEA, Vienna (1995), p. 34, para. 115.
101 *Technical Co-operation Report for 1995*, p. 25, para. 99.
102 Ibid., p. 25–26, paras 100–102.
103 Ibid., p. 26, para. 103.
104 *The Agency's Technical Co-operation Activities in 1994*, p. 31, para. 105.
105 *Technical Co-operation Report for 1995*, Supplement, p. 144.
106 "International safety conference: Strategy for the future," *IAEA Yearbook 1992*, IAEA, Vienna (1992) D45.
107 *Convention on Nuclear Safety*, Legal Series No. 16, IAEA, Vienna (1994) 102.
108 *Annual Report for 1991*, p. 96.
109 *Annual Report for 1992*, p. 117; and *Annual Report for 1993*, p. 118.
110 Parties must establish a regulatory body which must be functionally separate from any body that is concerned with the promotion or utilization of nuclear energy. Prime responsibility for safety must rest with the holder of the licence for a nuclear plant. Parties must ensure that adequate financial resources and qualified staff are available for each nuclear plant throughout its life and for carrying out all safety related activities. Parties must also ensure "that the capabilities and limitations of human performance" are taken into account and quality assurance programmes are established and implemented. Comprehensive safety assessments must be carried out before the construction and commissioning of a nuclear plant and throughout its life. Radiation exposures must be kept "as low as reasonably achievable" and never above the national dose limits. There must be routinely tested emergency plans for each plant.
111 *Annual Report for 1994*, GC(39)/3, IAEA, Vienna (1995) 47.
112 *IAEA Statute*, Articles III.A.5 and III.A.6.

[113] *IAEA Statute*, Articles XI.F.4 and XII.A.2.

[114] *IAEA Statute*, Article XII.A.6.

[115] The Project Agreement to be concluded under Article XI of the Statute would include an undertaking by the State that "the project shall be subject to the safeguards provided for in Article XII", which, as noted, includes health and safety measures.

[116] Document GC(I)/1, p. 22, para. 85.

[117] Document INFCIRC/18/Rev. 1, paras 2.2, 2.3 and 5.1. The Agency's health and safety standards did remain obligatory for any 'assisted operation' or other operation to which the IAEA was requested to apply them, but no provisions were made for verifying compliance.

[118] Until the end of 1995, nuclear power, nuclear fuel cycle and waste management, nuclear safety, and scientific and technical information were handled by four Divisions in the same Department of Nuclear Energy and Safety. In a subsequent reorganization, responsibility for nuclear installation safety and radiation and waste safety was allotted to two Divisions in the new Department of Nuclear Safety. The new organization, besides being more rational, underlines the increasing importance of nuclear safety.

[119] "Radioactive waste storage and disposal", excerpts from *Major Technical Reports by National and International Organizations, 1975–1981*, document IAEA/PI/B.3E, IAEA, Vienna (1982). The following are a few of the 24 excerpts: At the IAEA 'International Symposium on the Underground Disposal of Nuclear Waste', held in Helsinki in July 1979, the Canadian participants noted that "The key to the acceptance of the disposal concept by regulatory and licensing authorities and by the public is proof of the safety of the system... The general conclusion at this time is that the multiple barriers can provide sufficient protection for man and the environment." INFCE recorded a similar conclusion in February 1980 and the European Regional Office of WHO stated in 1981 that: "Methods for the management and interim storage of high-level radioactive wastes are operational and well proven." Similar conclusions were reached by many other scientifically authoritative organizations, including the relevant committees and study groups of the US Nuclear Regulatory Commission, the US National Academy of Sciences, the American Physical Society and Judge B. Flowers (Chairman of the UK Royal Commission on Environmental Pollution), as well as German, Swedish and Danish technical bodies dealing with nuclear safety.

[120] The United Kingdom's first light water reactor and plant for the reprocessing of light water spent fuel came into operation in 1994.

[121] *Annual Report for 1993*, p. 40.

[122] *Annual Report for 1987*, p. 10, para. 13.
[123] *Annual Report for 1989*, p. 29.
[124] *Annual Report for 1994*, p. 7.
[125] *Annual Report for 1995*, p. 17.
[126] *Annual Report for 1994*, p. 48.
[127] *Annual Report for 1993*, p. 43; and *Annual Report for 1995*, p. 17.
[128] *Annual Report for 1996*, GC(41)/8, IAEA, Vienna (1997) 15.
[129] *Annual Report for 1995*, p. 4.
[130] *Annual Report for 1994*, p. 47.
[131] *Annual Report for 1995*, p. 17.
[132] *Annual Report for 1996*, p. 13.
[133] *Annual Report for 1995*, p. 16.
[134] *Annual Report for 1994*, pp. 49–53.
[135] Ibid., p. 7.
[136] A British assessment comments that Murmansk "is the site of one of the world's most unstable nuclear facilities. Lying in shallow waters nearby are about 100 decommissioned nuclear powered submarines and icebreakers with their burnt-up fuel and highly radioactive, obsolete reactors still intact. At sea, the Soviets had dumped 20 reactors, seven of them still containing spent nuclear fuel." LAND, T., *Russia: Arctic Nuclear Clean-up Action*, Insurance/Investment, Lloyd's List 2/4/97.
[137] RENNER, R., "U.S. nuclear cleanup shows signs of progress", *Environmental Science and Technology/News* **31** 3 (1997) 135–137A.
[138] *Annual Report for 1995*, p. 37.
[139] *Annual Report for 1996*, p. 14. The quotation appears to be from the text of the report.
[140] Ibid., pp. 14–15.
[141] Ibid., p. 15.
[142] Document INFCIRC/153, para. 7.
[143] Document INFCIRC/225.
[144] The 1989 revision reflected mainly "the international consensus established in respect of the Physical Protection Convention; the experience gained since 1977; and a wish to give equal treatment to protection against theft of nuclear materials and protection against sabotage of nuclear facilities" (preface to INFCIRC/225/Rev. 2). The changes made in 1993 were chiefly of a technical character (preface to INFCIRC/225/Rev. 3).
[145] The evolution of the Convention is described in RAINER, R.H., SZASZ, P.C., *The Law and Practices of the International Atomic Energy Agency: 1970–1980*, pp. 448-456.

[146] The text of the Convention is reproduced in document INFCIRC/274/Rev. 1.

[147] Document INFCIRC/274/Rev. 1/Add. 6.

[148] Communication of 12 February 1997 to the author from John Rames, Deputy Director of the IAEA Legal Division.

[149] *Annual Report of the Board of Governors to the General Conference 1 July 1962–30 June 1963*, p. 13, para. 97.

Chapter 8

NUCLEAR SAFEGUARDS

Safeguards in Western Europe: What role for the IAEA?

Despite the importance that the negotiators of the Statute had assigned to the IAEA's safeguards, the 1957 Initial Programme of the Preparatory Commission (Prepcom) contained, as we have seen, only a rather perfunctory reference to this crucial aspect of the IAEA's work.[1] The chief reason for the Prepcom's sparse treatment of the subject was the wide gap between the views of the West, the Soviet Union and several leading developing countries about the proper role, scope and coverage of IAEA safeguards. Hence the difficulty of forecasting with any degree of assurance what safeguards tasks the IAEA would have to undertake during its first years and what resources it would need. There was also relatively little discussion of safeguards at the first General Conference in October 1957 or during the first few meetings of the Board.

In the late 1950s, and indeed for many years afterwards, there were no serious proposals for applying IAEA safeguards in the three nuclear weapon States of the time, or in Eastern Europe.[2] Hence, the main open question was what the scope of IAEA safeguards would be in Japan and the developing countries and, above all, in Western Europe, which was the only region outside North America and the Soviet Union in which plans were being laid for the large scale use of nuclear energy.

Sterling Cole was a vigorous supporter of IAEA safeguards. The first major issue he had to address was what role they would play in the six countries of the European Communities, as the European Union was then called. Since the USA was the world's leading country in all aspects of nuclear energy and the main political and economic support of Western Europe, it was bound to have a decisive influence in determining the answer to this question, and Cole would do his utmost to persuade Washington to support the IAEA's cause.

On 29 May and 12 June 1958, EURATOM and the USA initialled a memorandum of understanding and two agreements relating to their joint nuclear power programme.[3] The "Agreement for Cooperation"[4] set a target for the construction by the end of 1963 of nuclear power plants having an aggregate capacity of 1000 MW(e). EURATOM undertook to establish and apply a safeguards and control system to ensure the exclusively peaceful use of nuclear material, equipment and devices transferred by the USA to the European Commission States and of any nuclear material derived from the use of transferred items.

Article XII of the "Agreement for Cooperation" made two references to IAEA safeguards. The first provided that "...in establishing and implementing...[EURATOM safeguards]...the Community is prepared to consult with and exchange experiences with the International Atomic Energy Agency with the objective of establishing a system of safeguards and control, reasonably compatible with that of the International Atomic Energy Agency."[5] The principles that would govern the EURATOM system were set out in an annex. This followed closely the wording of Article IX of the IAEA Statute and included a commitment by EURATOM to "establish and require the deposit" in EURATOM's facilities of any surplus fissile material (cf. IAEA Statute, Article XII.A.5). The annex explicitly provided that these principles were "compatible with and based on" Article XII of the IAEA Statute.[6]

The second reference provided that "in recognition of the importance of the International Atomic Energy Agency" the USA and the European Commission "will consult with each other from time to time to determine whether there are any areas of responsibility with regard to safeguards and control and matters relating to health and safety in which the International Atomic Energy Agency might be asked to assist."[7]

The US–EURATOM "Agreement for Cooperation" had been in gestation since the appointment of the 'three wise men' in November 1956. As Chairman of the US Joint Committee on Atomic Energy, Cole must have been aware of the US negotiations with EURATOM and he understood the far reaching implications that the Agreement would have for the IAEA. On 12 May 1958, he sent off an angry telegram to the Chairman of the US Atomic Energy Commission, Admiral Lewis Strauss, expressing his dismay at the way the negotiations were going, and on 18 May he followed up with a telegram to President Eisenhower. The US Governor, Robert McKinney, was even more forthright, telegraphing Secretary of State Christian Herter that unless a compromise was reached between the Agency and EURATOM "we might just as well consider the IAEA finished and its basic purpose destroyed, along with the entire Atoms for Peace Program which we initiated in 1953."

Battle was joined at a hastily arranged meeting in Washington on 6 June 1958. Strauss supported Cole. EURATOM should not be given the right of self-inspection; other regions might be encouraged to form their own atomic organizations as a means of evading international inspection.[8]

But it was all to no avail. In the deepening shadows of the Cold War the State Department and the President believed that the USA had an overriding interest in strengthening Western European institutions. NATO would be the atomic shield behind which Western Europe, poor in coal and still totally dependent on imported oil, "could establish nuclear powered self sufficiency through EURATOM."[9] Moreover, EURATOM had already developed and was applying a comprehensive safeguards system while the IAEA still had no system and was not applying safeguards anywhere. Perhaps the most important consideration for the USA, however, was that US support for EURATOM and for European integration would help to bind a peaceful and democratic Germany into Western Europe, to set a term to the ancient enmity between Germany and France, and to underpin a stable Western Europe whose divisions had led to two world wars during this century.

The US–EURATOM "Agreement for Cooperation" was signed on 8 November 1958 and entered into force on 12 February 1959.[10] It had the immediate effect of excluding the application of IAEA safeguards from most of Western Europe and they remained excluded until 1978.[11] Eastern Europe and the USSR would also exclude the IAEA's inspectors — in fact any international inspectors.[12] But the most serious consequence of the US–EURATOM Agreement, at least for IAEA safeguards, was that the Soviet Union would now be denied all oversight of the nuclear industry of the nation it distrusted the most, the Federal Republic of Germany. The Soviet Union would thus have no incentive to help in the development of the IAEA's safeguards system. Instead, the Soviet Union found it in its interest to side with the opponents and critics of safeguards in the developing countries, especially India.[13]

IAEA safeguards: The first small steps

On 27 June 1958, after much debate, the Board of Governors rejected by a vote of 17 to 6 an Indian proposal backed by the Soviet Union, its allies, and Egypt and Indonesia "to decide against establishing a Division of Safeguards for the present."[14] In the next month Sterling Cole appointed a Canadian physicist, Roger Smith, as the first member and Director of the IAEA's Safeguards Division.[15]

Japan was soon to be the first nation in which the IAEA would apply safeguards — to the Japanese JRR-3 research reactor and to its fuel of natural uranium that Canada had, in effect, donated.[16] The Canadian and Japanese aim was to breathe life into the safeguards provisions of the Statute and break out of the impasse in the Board. In January 1959, after several days of discussion and despite the vigorous opposition of some Governors, the Board approved by a vote of 16 to 2 with 4 abstentions a set of ad hoc safeguards for the JRR-3 reactor.

It was clear that if ad hoc safeguards had to be devised for each future transfer, the conclusion of even minor agreements would be time consuming and controversial.[17] Hence, in May 1959, on the proposal of a number of Governors, the Secretariat presented the Board with a set of general safeguards principles entitled 'The Relevancy and Method of Application of Agency Safeguards' and another of detailed 'Draft Regulations for the Application of Safeguards'. Both documents dealt with the role of safeguards and inspection in ensuring nuclear safety as well as in seeking to prevent the diversion of nuclear plant and material to military use.[18]

Although the Statute had dealt with both the IAEA's roles in the same Article,[19] the Board soon decided that they should be addressed separately. On 26 September 1959, after several revisions of the Secretariat's proposals and the redrafting of the relevant document by an ad hoc committee of the Board, the Board provisionally approved a set of principles relating only to safeguards against military use. The principles defined the types of equipment that could be safeguarded, the types of Agency assistance that would trigger safeguards, the amounts of nuclear material that could be supplied without invoking safeguards, as well as general principles and objectives for implementing safeguards.[20] On the basis of these principles the Secretariat then prepared a set of 'Procedures for the Attachment and Application of Agency Safeguards against Diversion'.

In January 1960, the Board discussed procedures for applying safeguards to reactors smaller than 100 MW(th) (in other words, chiefly research and experimental reactors) and referred the matter, together with the provisionally approved principles and the set of 'Procedures' drafted by the Secretariat, to a committee of experts meeting under the chairmanship of Dr. Gunnar Randers, Director of the Norwegian Atomic Energy Institute (Institutt for Atomenergi). The Board directed the 'Randers Committee' to combine the two documents and to clarify and simplify them.[21]

The Board provisionally approved the Randers Committee's proposals on 7 April 1960 and submitted them to the General Conference by an ambiguous decision that left open the question whether the Conference was being asked to approve them or simply to discuss and comment on them. After a heated debate the General Conference voted 43 to 19 with 2 abstentions to take note of the Board's text and invited it, before giving effect to the text, to take into account views expressed in the Conference.[22] Following these convoluted procedures and despite Indian and Soviet opposition and lukewarm French support, the Board approved, on 31 January 1961, the principles and procedures for applying safeguards to reactors up to 100 MW(th).[23]

Thus, after much labour and amid much controversy, the first IAEA safeguards system finally saw the light of day. The system was complex. For instance, it distinguished between items to which safeguards were permanently *attached* — e.g. a reactor placed under safeguards — and an item to which safeguards were temporarily *applied* — e.g. a plant that temporarily contained safeguarded fuel.

In June 1961, after 18 months of discussion and several reviews, the Board also approved the 'Inspectors' Document', which laid down the procedures to be followed in designating inspectors and the rules that should govern their conduct when carrying out inspections.[24] The document required that the designation of an inspector to serve in any State must be approved by the government of that State, which would have the right to withdraw its approval at any time. If the State repeatedly rejected an inspector proposed by the Director General, he might refer the matter to the Board. Except in the case of an incident requiring a 'special inspection', at least one week's notice was to be given of each inspection; the notice must include the name(s) of the inspector(s), the place and time of arrival in the State concerned, and the items to be inspected. The State might require that the inspector be accompanied by its own officials, but this must not cause undue delay. Inspectors must enter and leave the State at points and follow routes designated by the State, the State must be informed of the results of each inspection and, if it disagreed with the inspector's findings, it might raise the matter in the Board.

The lengthy prior notice that had to be given before an inspection and the constraints placed on the inspector's freedom of movement during an inspection reflected the hesitations of many Board members. It was clear that many governments were taken aback, even shocked, by the idea that foreign inspectors, working for an international agency, must be allowed to intrude into their territories. What was more, governments were being asked to allow foreigners to inspect what were, at that time, the most advanced and sensitive research and industrial activities. Every precaution must be taken against disruption of those activities and industrial and military espionage! National concerns were sharpened by the fact that the nuclear weapon States of the time (France, USSR, the United Kingdom and the USA) and other leading industrialized nations, e.g. the European Community, as well as the allies of the Soviet Union in Eastern Europe, would be exempt from IAEA inspection.

The Inspectors' Document applied to inspections carried out under the IAEA's first and second safeguards systems (INFCIRC/26 of 1961 and INFCIRC/66/Rev. 1 and Rev. 2 of 1965–1968). For States that accepted comprehensive ('full-scope') safeguards, that is to say, for parties to the NPT or to regional treaties that require such safeguards, the Inspectors' Document was superseded by the somewhat less constraining inspection procedures (but even more restrictive access within nuclear plants) set forth in the NPT safeguards document (INFCIRC/153 of 1971).

The Board also decided that all IAEA inspectors must be full time officials of the IAEA (not, for instance, national officials temporarily seconded to the IAEA by Member States) and that the Director General should appoint a member of the staff of the IAEA as an inspector only after the appointment had been approved by the Board. In practice the Board has invariably concurred in the Director General's nominations, but Governors have frequently complained about the geographical balance of the inspectorate and urged that more nationals from developing countries should be appointed as inspectors.

In 1961, the IAEA received further signs that its safeguards function was at last being taken seriously. As far back as September 1958, at the second General Conference, Japan had proposed that the programmes being carried out under the USA–Japan nuclear co-operation agreement be placed under IAEA safeguards. The USA had agreed to the Japanese proposal "when the Agency is prepared to undertake this service."[25] In 1961, the USA, Canada and Japan proposed consultations about substituting the IAEA for bilateral safeguards under the USA–Japan and Canada–Japan agreements.[26]

In 1962, the IAEA made its first safeguards inspection, verifying the design of a zero power research reactor in Norway. In the same year the IAEA concluded agreements to apply safeguards to research reactors in Pakistan and Yugoslavia, and in what was then called 'the Congo, Leopoldville', later Zaire and now the Democratic Republic of the Congo. At the invitation of the US Government, the IAEA also arranged to apply safeguards to three US research reactors and one power reactor so as to test its procedures on plants of different design and function.[27]

The first extensive safeguards system: INFCIRC/66 and its 'revisions'

In February 1963, the Board was able to agree, without a dissenting vote, that the existing safeguards system (INFCIRC/26) — applicable to reactors rated at less than 100 MW(th) — should be extended to cover reactors of any size. This would enable the IAEA to apply safeguards to the power reactors that Canada and the USA were selling to India and that the United Kingdom was selling to Japan.[28] This may explain why India, despite its earlier sharp criticism of INFCIRC/26, did not object to its extension to larger reactors.

As has been noted in Chapter 5, June 1963 brought a breakthrough of major importance. The Soviet Union joined the other members of the IAEA Board in approving (provisionally) the revised version of INFCIRC/26 and, at the same time, in calling for a general review of the safeguards system. In explaining his vote, Ambassador Vassily Emelyanov informed a startled audience that, as the Governors knew, the Soviet Union had always regarded the application of safeguards as the most important task of the Agency.[29] This dramatic change may have taken the Board by surprise but it was very welcome to the IAEA Secretariat and to the governments that had supported IAEA safeguards from the start.

The Board referred the revised version of INFCIRC/26 (covering reactors of any size) to the General Conference, which adopted a resolution endorsing it by 57 votes in favour, 4 against and 6 abstentions. In February 1964, the Board gave its final approval to the extension (issued as document INFCIRC/26, Add. 1) and set up a working group, again under the chairmanship of Gunnar Randers, to carry out the review of the system.

The polemics that had dominated the initial discussion of INFCIRC/26 had resulted in "one of the most convoluted pieces of verbal expression in history" which "few people could comprehend, except in long discussion with the handful that did."[30] In contrast, the working group now undertook a business-like revision of INFCIRC/26, studying how the system could be made to work most effectively and how its provisions could be most simply articulated.[31] The new system that emerged (INFCIRC/66) was completed within a year and provisionally approved by the Board in February 1965 by a vote of 22 in favour, none against and 2 abstentions[32] and unanimously endorsed by the General Conference in September 1965. The Board promptly gave its final approval, also unanimously.[33]

During the next four years, and largely as a result of the new Soviet attitude, it became possible to draw up a safeguards system that would apply not only to all sizes of nuclear reactors (INFCIRC/66 of June 1965), but also to reprocessing plants (INFCIRC/66/Rev. 1 of 1966) and to fuel fabrication plants (INFCIRC/66/Rev. 2 of June 1968). Unanimity was also achieved when the Board approved the two new documents. The Board referred both extensions of the system to the General Conference, but for the latter's information rather than its endorsement.[34]

With a nearly complete safeguards system in prospect and a steady expansion of the IAEA's ability to apply effective safeguards, the USA (with the United Kingdom following suit) decided that it would henceforth insist on IAEA safeguards on all nuclear plants and material covered by new or amended bilateral co-operation agreements, except those with EURATOM.[35] Every bilateral partner of the USA, except Japan, at first objected strenuously to the application of IAEA in place of US safeguards, apparently preferring the US inspectors, with whom they were on friendly terms, to the unknown officials of the IAEA who might be nationals of a State with which their relations were strained or hostile.[36] However, many co-operation agreements were coming up for amendment and this, together with the fact that the partner nations still depended on the USA for nuclear supplies, provided the USA with enough leverage to induce them, however reluctantly, to accept the new US policy.[37]

The first significant result came soon after June 1963, when the Soviet Union had reversed its attitude to IAEA safeguards. On 23 September 1963, the USA, Japan and the IAEA signed an agreement placing under IAEA safeguards all nuclear plants and fuel of US origin in Japan. The list included two large reactors (one a demonstration power reactor) and 11 smaller reactors and critical facilities. In the same month the United Kingdom and Japan informed the IAEA that they would follow suit with plants and fuel of British origin in Japan. This would bring under IAEA safeguards the Tokai-1 585 MW(th) power plant, due to come into operation in 1965.[38]

The experience gained in applying INFCIRC/66 safeguards did much to equip the IAEA for the challenging task that lay ahead, namely to verify the obligation accepted by non-nuclear-weapon States under the NPT to place virtually all their nuclear material under IAEA safeguards.[39]

Seven years later, when the Board approved the NPT safeguards system (INFCIRC/153), all non-nuclear-weapon States party to the NPT were required to negotiate safeguards agreements based on that system.[40] The safeguards required by agreements they had concluded under INFCIRC/66 and its revisions were placed in suspense — after obtaining the consent of the nuclear supplier if it was party to the agreement.[41] INFCIRC/66 safeguards continued to apply to plant and material in States that did not adhere to the NPT or to the regional treaties that required comprehensive safeguards. At the end of 1995, INFCIRC/66 safeguards still applied to certain nuclear plants in four States not party to the NPT or the Tlatelolco Treaty (India, Israel, Pakistan and Cuba) and in one other non-nuclear-weapon State party to the NPT that had not yet concluded a full-scope safeguards agreement (Algeria).

The change in the Soviet attitude did not only clear the way to a prompt extension of the range and coverage of INFCIRC/66/Rev. 2 safeguards. With both superpowers squarely behind IAEA safeguards, the system gained in authority and legitimacy. By 30 June 1964,[42] the IAEA had concluded safeguards agreements with 11 States covering 36 nuclear reactors. By 30 June 1970, the Board had approved agreements with 32 States covering 68 research reactors, 10 power reactors, 2 pilot reprocessing plants and 2 other fuel cycle plants.[43] The safeguards budget rose from $354 000 in 1965 to $1 272 000 in 1970.

There has been much speculation as to what lay behind the Soviet change of attitude in 1963. Bertrand Goldschmidt ascribed it chiefly to the détente between the USSR and the USA that followed the 1962 Cuban missile crisis and that bore fruit in the conclusion of the Limited Test Ban Treaty of 1963.[44] Another contributing factor may have been the fact that the Soviet Union had burned its fingers in China. In describing the Soviet contribution to Chinese nuclear weapons, first tested in 1964, Khrushchev (not always a reliable witness) wrote that: "Before the rupture in our relations, we'd given them almost everything they asked for. We kept no secrets from them. Our nuclear experts co-operated with their engineers and designers who were busy building an atomic bomb. We trained their scientists in our own laboratories." He added that a prototype bomb had already been packed and was awaiting transport to China. The shipment was cancelled only at the last moment.[45] When Sino–Soviet relations turned from friendship to hostility the Soviet Union must have become bitterly aware of the fact that it had helped China to acquire a nuclear arsenal, part of which would now be targeted on the Soviet Union itself. But while the improvement in US–Soviet relations and the Soviet Union's sobering experience in China may have contributed to its changed attitude to IAEA safeguards, there is no doubt that the underlying cause of the change was Soviet concern about the Federal Republic of Germany and its emerging nuclear programme. It had become clear that stronger international safeguards would serve the interests of the Soviet Union, even though it was by no means certain in 1963 that IAEA safeguards would one day be applied in the Federal Republic of Germany.

Other developments of safeguards interest during the 1960s included the following:

— Joint notifications to the IAEA were made by Israel and South Africa of deliveries to Israel of uranium oxide amounting to ten tonnes. The notifications were made in 1962 and 1963. The material was not placed under safeguards but was supplied under a commitment that it would be used solely for peaceful purposes.[46]
— In August 1965, the IAEA convened the first international symposium on the management of nuclear materials.[47]
— In the mid-1960s, the IAEA launched a new programme of research support designed to improve the efficacy and cost effectiveness of safeguards. By 1970, the contribution of the IAEA to such research contracts exceeded $100 000,[48] but by far the larger share of the costs was borne by the handful of Member States in which the research was carried out, including the USA, Japan, the Federal Republic of Germany, the Soviet Union, Spain, Belgium and the United Kingdom.
— In August and September 1967, the IAEA carried out its first inspection at a reprocessing plant and its first use of 'resident inspection'. The fuel being safeguarded was ten tons of irradiated low enriched uranium from the Yankee power plant and the reprocessing plant was at West Valley in New York State. Ten inspectors took part in the exercise, which was designed to test the procedures for accounting for all declared nuclear material. The proportion of nuclear material unaccounted for was less than 0.3% of total throughput.[49]
— In 1969, the IAEA held the first training course for its inspectors.[50]

Safeguards under the NPT

At the 1966 General Conference, Poland and Czechoslovakia offered to accept comprehensive IAEA safeguards if the Federal Republic of Germany would do the same.[51] Norway went further, proposing that all States not already possessing nuclear weapons should place their entire programmes under safeguards. These were echoes of the discussions going on in Geneva about the NPT, and were harbingers of a new safeguards regime.

As the NPT drew closer, the IAEA began to prepare for the impact it would have on the Agency's safeguards. In 1969, the Agency established a second Division in the Safeguards Department, devoted exclusively to safeguards research and development. The Director General also appointed a Secretariat working group to prepare the draft texts of articles of the comprehensive safeguards agreement that, by Article III.1 of the NPT, non-nuclear-weapon States would be required to conclude with the Agency. The group drew up a complete draft agreement which subsequently provided the basis for a 'dry run' negotiation with Finland.[52]

From 1967 until 1969 the IAEA drew on the services of numerous experts to analyse systems for safeguarding the fuel cycle of a State having a sophisticated nuclear industry.[53] From this work the concept of a 'material balance area' (MBA) emerged as fundamental for accounting for nuclear material. For instance, the MBA would be used to help determine:

— What information on the design of a nuclear plant was needed for a review for safeguards purposes,
— What records and reporting system were needed for safeguards,
— What inspection procedures should be followed and what should be the relationship between inspections, records and reports.[54]

The experts also helped to translate the concept of material accountancy into detailed guidelines for quantifying the results of inspections and to address crucial safeguards issues such as 'material unaccounted for',[55] the desirable frequency of physical inventories (taking stock of nuclear material in each MBA) and for safeguarding scrap and discarded material.[56]

It was clear that the main technical problem that safeguards would have to face would be the accurate measurement of nuclear material when it was being processed in bulk form (e.g. as a liquid, gas or powder). Highly accurate measurement of plutonium would be particularly difficult when spent nuclear fuel was being reprocessed, fresh fuel containing plutonium was being fabricated, or separated plutonium was in storage. The Federal Republic of Germany, the USA, the USSR and the United Kingdom studied and carried out experiments to help determine how to apply safeguards effectively in reprocessing plants.

In 1970, the IAEA convened a symposium on safeguards techniques at the Nuclear Research Centre in Karlsruhe, Federal Republic of Germany. Many of the safeguards concepts embodied in the Preamble to the NPT, and eventually in the NPT safeguards system (INFCIRC/153), were attributed to the work of the leaders of the Karlsruhe Centre, Professors Wolf Haefele and Karl Wirtz.

The 'Safeguards Committee (1970)'

On 6 April 1970, a little over four weeks after the NPT entered into force, and after some vigorous controversy, the Board established a committee open to all the Member States of the Agency to advise it, as a matter of urgency, on the safeguards agreement that each non-nuclear-weapon State party to the NPT must conclude with the IAEA.[57] All Member States were invited to submit their views; 31 did so and 48 took part in the committee's work. The urgency of the committee's task stemmed from the tight timetable that the NPT had set for the negotiation and entry into force of such agreements. The non-nuclear-weapon States had already ratified the NPT when it entered into force on 5 March 1970 were required by the Treaty to begin the negotiation of their safeguards agreements within 180 days after that date, i.e. by 1 September 1970, and to conclude the agreements within 18 months after the day on which their negotiations began.[58]

On 11 March the Director General sent a circular letter to Member States[59] inviting comments on a draft of a model NPT safeguards agreement that the Secretariat had prepared after exploratory discussions with a Finnish delegation (Finland was eager to conclude its safeguards agreement as soon as possible). The Secretariat's draft was based on the existing safeguards system (INFCIRC/66/Rev. 2) but modified to take account of the requirements of the NPT as the Secretariat understood them.

The 31 replies to the Director General's letter showed that a number of new safeguards concepts would have to be introduced to take account of the provisions of the NPT, in particular the principle enunciated in the Preamble to the Treaty "of safeguarding the flow of source and special fissionable material by the use of instruments and other techniques at certain strategic points." Subsequently, at the request of the Board, the Director General submitted a document to the Safeguards Committee outlining the possible two part framework of a standard safeguards agreement, a framework that the Committee subsequently approved. The first part would specify the fundamental rights and obligations of the parties and the second, the technical principles and procedures to be applied. The Director General's paper highlighted some important points.[60] Amongst them were that each non-nuclear-weapon State should maintain a national system to account for and control safeguarded nuclear material, that it would be necessary to specify procedures for withdrawing nuclear material from peaceful uses to military activities not prohibited by the Treaty (such as nuclear powered naval vessels) and that processes that merely changed the chemical or isotopic composition of nuclear material (reprocessing and enrichment) were not intrinsically military and hence were subject to safeguards. The affirmation that reprocessing and enrichment were not intrinsically military meant that a non-nuclear-weapon State party to the NPT could not have a complete unsafeguarded military fuel cycle, while the specification of detailed formal procedures for withdrawal of nuclear material meant that the State could not withdraw material from safeguards simply by making a declaration that it intended to use the material in a 'permitted' military use.[61]

The Committee met for the first time on 12 June 1970, under the chairmanship of Kurt Waldheim, subsequently Secretary General of the UN and President of Austria. Dr. Waldheim soon left for his new post as Austria's Permanent Representative to the United Nations and passed the chair to one of the two vice-chairmen, Dr. Bruno Straub of Hungary, who did an outstanding job and confounded the misgivings of some NATO States about the wisdom of appointing a scientist from a Socialist country to such a sensitive post. The other vice-chairman, Dr. Joe Quartey of Ghana, ably stood in for Dr. Straub when the latter had to return to Budapest.

Despite a wide divergence of approach amongst its participants and the complexity of the task before it, the Committee completed its work in eight months — by 10 March 1971.[62]

Two of the three nuclear weapon States then party to the Treaty (the USA and the USSR) as well as Canada and most Eastern European States generally pressed for rigorous safeguards and, accordingly, for extensive rights of access for the IAEA and its inspectors and, in particular, for the Agency's right *independently* to verify that no diversion of nuclear material was taking place.[63] The leading industrial non-nuclear-weapon States pressed successfully for a more systematic and detailed statement than in INFCIRC/66 of the technical approach to be followed in applying safeguards — an approach that drew upon a systems analysis prepared by the Karlsruhe Centre and upon the language of the NPT itself.[64]

It was obvious that since NPT safeguards would apply to the entire fuel cycle of the States concerned, the new system should be able to verify the flow of nuclear material through that cycle in a way that had hitherto been impossible when safeguards applied only to individual nuclear plants or to shipments of fuel.[65] This would permit the IAEA to reduce the use of inspectors and maximize the use of instruments.

The EURATOM delegations succeeded in sustaining the principle, implicit in the NPT, that safeguards should be applied only to nuclear material (and not, as provided in INFCIRC/66, also to plant and equipment) and in limiting the access of inspectors, during routine inspections, to previously agreed 'strategic points'. In simple language, this meant that IAEA inspectors would normally — i.e. during routine inspections — verify only nuclear material at locations that had been declared by the State[66] and would do so by access that would be limited to pre-defined strategic points in the plant concerned — but the strategic points would be so defined as [all] the points necessary for the Agency to accomplish its task of applying safeguards to all nuclear material in the State. (The concepts of verifying the flow of nuclear material and of focusing on 'strategic points' were already reflected in the Preamble of the NPT itself, but in non-binding language and in terms of furthering the application of this concept.)

The EURATOM delegations accepted, however, that there would be no limit on the IAEA's access rights if the Board considered that a 'special inspection' was needed, and the State gave its agreement, or if the Board decided that a special inspection was urgent and essential to verify non-diversion.[67] Similarly, the IAEA would, in effect, have free access when it carried out so-called ad hoc inspections (chiefly to verify the State's Initial Report on its holdings of nuclear material).[68]

The Committee agreed on the principle, already accepted during the negotiation of the NPT, and again proposed by the Director General, that each non-nuclear-weapon State party to the NPT must establish and maintain a national (or in the case of EURATOM a regional) system of accounting for and control of nuclear material required to be placed under safeguards.[69] It was also agreed that the IAEA's safeguards be applied so as to verify "findings of the State's system" (Japan first proposed, unsuccessfully, that the IAEA should only verify "the implementation of the control of nuclear materials by the State", and not the findings of the State's system) and that the IAEA should take due account of the technical effectiveness of that system.[70] However, Japan and the EURATOM non-nuclear-weapon States accepted that the IAEA's verification should also include, amongst other activities, its own "independent measurements and observations" (and should not be limited to verifying the findings of the State's system), a principle upon which the USA, USSR and others successfully insisted. The IAEA would thus have the right to verify, *independently*, by means of its own choice, that there had been no diversion of nuclear material.

The exporters of uranium succeeded in exempting uranium concentrates from inspections; but the Committee agreed that exports and imports, even of uranium ore, should be notified to the IAEA, and that such notification was itself a form of safeguards.[71]

In March 1971, the 'Safeguards Committee (1970)' forwarded to the Board a 116 paragraph outline of a comprehensive safeguards agreement. The Board promptly approved it as a basis for negotiations (INFCIRC/153), with dissent only on one issue, a French reservation subsequently withdrawn, relating to the apportionment of the costs of safeguards. On a related issue the Board accepted the Committee's recommendation that the cost of safeguards should continue to be met from the regular (i.e. assessed) budget, but that the method of assessing contributions should be revised to limit the share of safeguards costs to be borne by poorer countries.

NPT safeguards agreements with EURATOM and Japan

The non-nuclear-weapon States party to the NPT now began the negotiation, usually in Vienna, of the safeguards agreements required by the Treaty. The Agency's *Annual Report* covering the 12 months up to 30 June 1971 noted that, by that date, 29 agreements were already under negotiation. However, the main challenges lay ahead, namely reaching agreement with EURATOM and its five non-nuclear-weapon States on the safeguards to be applied in those States, and then reaching agreement with Japan. The five EURATOM States and Japan had made it clear that they would not ratify the NPT until they knew precisely what obligations they would be required to accept under their agreements. The implication of this stance was obvious: they were not prepared to accept an agreement under which the IAEA would simply apply in their territories the safeguards approved by the Board in document INFCIRC/153.

The EURATOM States had apparently agreed to a joint directive for their negotiators (a 'mandate') under which they would propose that responsibility for applying the safeguards required by the NPT be assigned to EURATOM itself, while the IAEA would merely verify by 'spot checks' ('Stichproben') that EURATOM was applying effective safeguards.[72] Japan, fearing that it would be discriminated against, was intent on obtaining an agreement virtually identical to that with EURATOM. The IAEA's negotiators were aware of Japan's negotiating position, which Japanese officials had hinted at on a number of occasions. However, when the negotiations with EURATOM began, the IAEA team was not aware of the somewhat curious mandate that the EURATOM ministers had agreed upon. The proposition that EURATOM would be responsible for applying safeguards pursuant to the NPT had no basis in the Treaty and was, of course, unacceptable to the IAEA.

After lengthy and difficult negotiations the two agencies were able to conclude an agreement in terms of which each would apply its own safeguards (based on INFCIRC/153 in the case of the IAEA and, in practice, based largely on the same document in the case of EURATOM). In all cases the number of person-days to be spent by EURATOM inspectors at a particular nuclear plant would exceed the number spent by IAEA inspectors. The core of the agreement based on INFCIRC/153 would be amplified by a protocol that would mesh together the two safeguards operations and seek to avoid unnecessary duplication. The agreement that the IAEA eventually negotiated with Japan resembled that with EURATOM with the significant difference, however, that the implementation of the Protocol to the agreement with Japan would be contingent upon Japan devising and operating a national system as technically effective and functionally independent as that of EURATOM. The Japanese were satisfied with this contingent commitment, interpreting it as an assurance that they would not be discriminated against, and the door was thus opened for the Diet's ratification of the NPT.

The IAEA negotiators maintained that the special safeguards arrangements with EURATOM and Japan were based solely on technical and organizational grounds. This was a convenient fiction; in fact, the arrangements were necessary to secure EURATOM (and particularly German) and Japanese ratification of the NPT.[73]

Negotiation of the safeguards agreement with EURATOM and its five non-nuclear-weapon States came to a formal end when the Director General and the representatives of EURATOM and its five non-nuclear-weapon States signed the agreement on 5 April 1973. The five States simultaneously ratified the NPT on 2 May 1975. However, at least some of them still had to pass enabling legislation or take other legal action before IAEA inspectors could enter their nuclear plants for inspection purposes. Hence, the safeguards agreement came into force only on 21 February 1977. And it was not until March 1979 that certain outstanding problems about important 'facility attachments' were resolved and the Governor from France, speaking on behalf of the European Community, could welcome "the happy outcome of the negotiations," and that the Board could now turn its full attention to other matters.

Japan ratified the NPT on 8 June 1976, and its safeguards agreement came into force on 2 December 1977.

One of the understandings associated with Japan's negotiation of its safeguards agreement was that the IAEA would set up a senior committee to advise the Director General on safeguards matters. The Director General informed the Board on 21 May 1975 that he was appointing the members of a 'Standing Advisory Group on Safeguards Implementation' (SAGSI).[74] The group would deal with questions that he or the Board or the group's own members submitted to it. The members of SAGSI would serve in their personal capacity, but the Director General would consult their governments before appointing them. In practice, SAGSI's recommendations have reflected the collective views and policies of the nations that are most concerned with the application of safeguards.

One of SAGSI's first tasks was to propose the framework for an annual report to the Board, the *Safeguards Implementation Report* (SIR), in which the Secretariat would analyse each year the results obtained in applying safeguards and the problems encountered.[75] The circulation of the SIR was and is officially restricted to Member States and the Secretariat, but it has often been 'leaked' and critics have selectively used its analyses as a weapon to discredit IAEA safeguards.

Until 1975, the safeguards agreements that the IAEA concluded with countries that were not parties to the NPT required the country concerned to undertake not to use any safeguarded item in such a way as to further any military purpose. This was the formula used in the IAEA's Statute.[76] As early as 1955 there had been debates as to what not furthering a military purpose meant in practice. During the Washington discussions on the Statute, Bertrand Goldschmidt had asked facetiously whether it meant that the electricity from a nuclear power plant should not be supplied to a barracks housing female soldiers. The growing interest in the use of nuclear explosions for peaceful purposes further muddied the waters. Why should a non-nuclear-weapon State be barred from manufacturing and detonating a 'peaceful' nuclear device?

The text of the NPT was unambiguous in this respect. It did not prohibit the use of nuclear energy for military purposes such as the propulsion of warships, but it did prohibit non-nuclear-weapons States from acquiring nuclear weapons or any *other nuclear explosive devices.* The reason for prohibiting all nuclear explosive devices was — and still is — that there is no significant technological difference between a nuclear device used for a military or a civilian purpose. In fact in a number of cases the prototype of a plutonium bomb has been a nuclear explosive device such as that used at Alamogordo in the 1945 'Trinity' test or the device that India used at Pokharan.

In 1974, after India had declared that the Pokharan explosion was for 'peaceful' purposes, and since Argentina and Brazil were contending that, under the Tlatelolco Treaty, they were permitted to make and detonate 'peaceful' nuclear explosives, it was clearly necessary to ensure that there was no such ambiguity in any IAEA safeguards agreement concluded with a non-nuclear-weapon State that was not party to the NPT or that had not renounced the acquisition of any nuclear explosive devices in another legally binding manner. In 1975, the IAEA was negotiating a safeguards agreement with Spain, which had not yet acceded to the NPT.[77] The IAEA Secretariat proposed that the agreement should explicitly preclude the use of the safeguarded material not only in a nuclear weapon, but also in any other form of nuclear explosive device (as well as for any other military purpose). The Spanish negotiators were reluctant to be the first to depart from the formula used until then in all safeguards agreements (an undertaking that the items covered by the agreement would not be used to further "any military purpose"). It was eventually agreed that the old formula would be retained in the text of the agreement, but that the text would be amplified by an exchange of letters which would be brought to the attention of the Board of Governors. In this exchange of letters Spain would agree in writing that the old formula meant that the nuclear material covered by the agreement might not be used in any form of nuclear explosive device (as well as that it might not be used for any other military purpose). The Board approved the agreement and the Director General announced that in future the commitment not to use safeguarded material in any form of nuclear explosive would be made explicit in the agreement itself rather than in an exchange of letters.[78]

Accordingly, all subsequent safeguards agreements with non-nuclear-weapon States not party to the NPT are — like those with parties to the Treaty — quite unambiguous on this point. As will be seen in Chapter 9, this issue spilled over into the Board's discussion of a revision of the 'Guiding Principles and General Operating Rules' governing the provision of technical assistance by the Agency.

Unique agreements with Brazil, Pakistan and the Republic of Korea: The Nuclear Suppliers' Group Guidelines

In the mid-1970s, when the main nuclear suppliers, meeting in London, were standardizing and tightening their export rules, the IAEA concluded safeguards agreements that, for the first time, were specifically designed to cover the transfer of nuclear technology. The agreements were designed to safeguard the reprocessing plants that France was selling to the Republic of Korea and to Pakistan, and the nuclear power plants and the enrichment and reprocessing technology that the Federal Republic of Germany was selling to Brazil.[79] The agreements contained many novel features designed to ensure that the transfer of technology foreseen by the agreements would not help the importing country to acquire nuclear weapons.

But Brazil and Pakistan had not joined the NPT and seemed unlikely to do so; in other words, neither nation had formally renounced nuclear weapons and, at that time, neither seemed likely to do so. The Republic of Korea was a party to the NPT, but as subsequent events were to show, it was located in a region of the world where the political incentive to acquire nuclear weapons was strong.[80]

The sales seemed to confirm the worst fears of the Carter Administration. The President despatched Vice-President Walter Mondale to Bonn to persuade Chancellor Helmut Schmidt to abandon the German–Brazilian agreement, Deputy Secretary of State Warren Christopher to Brazilia to persuade the Brazilian Government to do likewise, and Henry Kissinger to Seoul and Paris to persuade President Valéry Giscard d'Estaing to cancel the impending French sales.

Mondale and Christopher travelled in vain. The Brazilian sale was the nuclear deal of the century for the Federal Republic of Germany. It called for the construction of eight large German designed nuclear power reactors and for the transfer of reprocessing technology, as well as of the so-called 'jet nozzle' enrichment technology developed by the German scientist, Dr. Erwin W. Becker. The Brazilians were equally committed to the contract and the prestige of the Brazilian Government was at stake.

Kissinger was more successful. Under powerful US pressure, the Republic of Korea soon cancelled its contract with France — the French, naturally, did not actively help to secure the cancellation, but did not object, and this was very helpful.[81] President Giscard d'Estaing was persuaded to cancel the French contract with Pakistan, but not before the blueprints of the reprocessing plant had been handed over to the Pakistanis. The cancellation cost the French Government dear in compensation to French firms whose contracts had to be broken.

In the end the German–Brazilian deal turned out to be equally, if not more, disappointing to the two governments and to the exporting companies. The Becker enrichment process proved to be uneconomic and the Brazilians eventually abandoned it. The German reprocessing technology was transferred to Brazil, but not put to use. The German and Brazilian construction companies, Siemens and NUCLEBRAS, started work in 1976 on one of the eight nuclear power reactors envisaged under the agreement. It will be the only one to see the light of day, but will not be completed until 1999, 23 years after construction started, and then only at vast expense: recent estimates range from \$7 billion to \$10 billion.[82] And the uranium that Brazil was expected to supply to the Federal Republic of Germany did not materialize. A wag at the IAEA described the agreement as an undertaking to supply a nuclear technology that did not quite work in return for uranium that did not quite exist.

The three safeguards agreements incorporated the new requirement of the London guidelines that 'sensitive' nuclear technology as well as sensitive nuclear hardware should be subject to IAEA safeguards when it was exported to a non-nuclear-weapon State.[83] In other words, if an importing country replicated the technology that was embodied in imported 'sensitive' hardware, that country would be legally obliged to place the plant incorporating the replicated technology under IAEA safeguards. The same requirement would apply if the importing country bought the blueprint for a 'sensitive' plant, built it under IAEA safeguards, and then replicated it at a later date. Even if the importing country did not use the originally imported design but simply built a plant using "the same or an essentially similar physical or chemical process" within a set period of time after the transfer of the original design (20 years in the case of the Brazilian–German agreement), it would have to inform the IAEA and put the plant under safeguards. This concept seems far fetched, and it has never been tested. Obviously its effectiveness would and will depend largely on the good faith of the importing country in reporting to the IAEA any plant that it replicated (or, perhaps, on the results of intelligence provided to the IAEA).

But even if the importing country acts in good faith, the indirect benefits it will derive from acquiring and operating an imported sensitive plant may help it to plan and carry out a parallel unsafeguarded military programme.

For instance, the feedstock for most enrichment processes is a highly corrosive gas, uranium hexafluoride. Engineers trained in using the Becker 'jet nozzle' process would gain valuable knowledge and experience in producing and using uranium hexafluoride as the feedstock for the quite different gas centrifuge enrichment process in a parallel unsafeguarded programme. It has been reported that this was precisely what happened in Brazil before it renounced plans for making nuclear weapons and concluded the ABACC agreement (see below).

As noted, the 1978 Non-Proliferation Act required the US Government to seek to renegotiate almost all its agreements for peaceful nuclear co-operation with other nations. It will be recalled that the IAEA was the nominal supplier to Yugoslavia of a US (Westinghouse) power reactor at Krško (now in Slovenia) and its fuel. When the USA informed the Yugoslav Government that the existing agreement would have to be renegotiated the Yugoslavs decided to appeal to the IAEA for support in resisting US demands. A Yugoslav delegation of five or six federal ministers and ambassadors descended on the IAEA and angrily denounced both the US Government and the Nuclear Suppliers' Group (NSG) Guidelines. Director General Eklund subsequently took up the matter with Vice-President Mondale who was visiting Vienna on other US business, but to no avail; the Vice-President could not change the requirements of the US Non-Proliferation Act. The incident was an uncomfortable illustration of the risk that the IAEA ran if it was presented (on paper) as the legal supplier of nuclear plant and fuel when, in fact, the true supplier held all the cards.

Regional fuel cycle centres

Another promising safeguards concept that came in for much attention in the mid-1970s was the multinational or regional fuel cycle centre. Like so many other non-proliferation initiatives at that time, the idea was first promoted by Washington — perhaps encouraged by the success of a European model of such a centre in the OECD's ENEA-sponsored multinational (Western European) EUROCHEMIC reprocessing plant. The object would be to induce governments to build and operate multinational or regional rather than national reprocessing or enrichment plants. It was assumed that in such plants the misuse or diversion of nuclear material would be improbable; the participating nations and the members of the multinational staff would keep an eye on each other and collusion could be ruled out.

After wide ranging consultations, the IAEA published a comprehensive study of the way in which such centres could be set up and the benefits they could offer.[84] But there were no takers. The problems to be overcome in establishing and running a multinational commercial reprocessing enterprise were perceived to be overwhelming. Above all, the political will to set up such enterprises was lacking. Pierre Huet was the first Director General of the ENEA and under his direction the organization succeeded in launching three multinational nuclear enterprises. At his farewell dinner in the early 1970s, Huet analysed the factors that determined success or failure in such ventures. Chief amongst them were the political will driving the project, its intrinsic scientific or technical interest and the extent to which it was still far from being a commercial undertaking. EUROCHEMIC had succeeded in getting the support of governments because it was a pilot, not a commercial plant. If, however, there was a prospect of early profit, governments would go for a purely national investment. This, he implied, was why NEA's recent soundings about the possibility of a joint Western European fast breeder reactor and a joint nuclear merchant ship had failed. Instead, each of the leading nuclear nations was building its own prototype breeder and the Germans were building the *NS Otto Hahn*. The golden years for joint European ventures in nuclear R&D were past and it was time for Huet to leave. History appears to lend Huet support; in a shrinking market and with shrinking funds available for research there have been mergers between existing nuclear corporations, but the only major new joint enterprise, struggling to get aloft — the International Thermonuclear Experimental Reactor (ITER) project — is still very far from being a commercial undertaking.[85]

Reporting of nuclear exports

All safeguards agreements concluded under the 1965–1968 system (INFCIRC/66/Rev. 2) required the States concerned to notify the IAEA of exports or imports of nuclear material required to be safeguarded under the agreement, but in other cases such notifications were not necessarily made to the IAEA, for instance under the US–EURATOM agreement and under other bilateral agreements.

In April 1965, the USA voluntarily undertook to inform the IAEA of all its transfers of nuclear material and the Director General subsequently consulted other principal suppliers about setting up an international transfer register. In 1966 and 1967, Canada and Norway agreed to notify the IAEA of all their transfers of nuclear material.[86]

In July 1974, three of the five nuclear weapon States, namely the United Kingdom, the USSR and the USA, undertook to notify the IAEA in advance of their transfers of nuclear material to any non-nuclear-weapon State if the amount to be exported exceeded one effective kilogram. France followed suit in 1984 and China in 1991.

The notification to the IAEA would include the name of the organization or company in the nuclear weapon State that would prepare the material for export, a description of the material, and, where possible, the quantity and composition of the material and its destination State and organization or company. The notification would be promptly confirmed after the export took place and the confirmation would indicate the actual quantity and composition of the material and the date of shipment.

The five nuclear weapon States also undertook to provide similar notifications about their imports of nuclear material if the material had been under IAEA safeguards in the country of origin before it was imported. Notifications of imports would identify the originating State and organization, describe the material being imported and be sent to the IAEA as soon as possible after the receipt of the material.[87]

After 1970, when a non-nuclear-weapon State adhered to the NPT, its standard NPT safeguards agreement required it to give the IAEA advance notifications of all such transfers.[88] On becoming party to the Treaty, a nuclear weapon State also accepted the obligation not to export nuclear material and specified nuclear equipment unless the nuclear material or equipment would be placed under IAEA safeguards; this obligation applied only to exports to non-nuclear-weapon States.[89]

In the aftermath of the Gulf War and the disclosure of the Iraqi Government's clandestine procurement of nuclear and dual-use equipment and material, the IAEA, acting on a proposal of the European Union, established a 'universal reporting system'[90] under which participating nations would voluntarily agree to notify the IAEA of all transfers of specified nuclear equipment and non-nuclear as well as nuclear material. 'Programme 93 + 2', discussed later in this chapter, would impose a legally binding obligation (in the form of a protocol to existing comprehensive safeguards agreements) to make such reports. The Board approved the protocol in May 1997.

After the Gulf War, the NSG Guidelines were amended to enjoin members of the NSG to require comprehensive safeguards as a condition of their nuclear supplies to non-nuclear-weapon States. As of the end of 1995, the States whose imports would be affected by this recommendation were India, Israel and Pakistan since all other non-nuclear-weapon States likely to import nuclear plant or material from members of the Group were parties to the NPT or to the Tlatelolco Treaty.

The Tlatelolco Treaty

After the 1962 Cuban missile crisis the leading Latin American countries, with Mexico in the van, were resolved to ensure that the region would remain permanently free from the threat of nuclear war and to prevent a second deployment of nuclear weapons in Latin America.

On 14 February 1967, the delegates of 21 Latin American countries, meeting in Mexico City, opened for signature the 'Treaty for the Prohibition of Nuclear Weapons in Latin America', or the 'Tlatelolco Treaty', so named after the part of Mexico City where the Ministry of Foreign Affairs is located and where the negotiation of the Treaty had taken place.[91]

In June 1968, the Board of Governors approved a comprehensive safeguards agreement with Mexico, the first such agreement to be concluded under the Tlatelolco Treaty, and also the first to apply safeguards to the entire nuclear fuel cycle of any nation outside the European Union. The agreement was necessarily based on INFCIRC/66/Rev. 2. It entered into force on 6 September 1968 and its application was suspended in 1973 after Mexico joined the NPT and concluded a safeguards agreement pursuant to both the NPT and the Tlatelolco Treaty.[92]

The experience gained in drawing up the Tlatelolco Treaty was helpful to the negotiators of the NPT and of other treaties creating other nuclear weapon free zones. To give an example, the Tlatelolco Treaty requires its parties to conclude agreements for the application of IAEA safeguards on all their nuclear activities and sets time limits for concluding those agreements, requirements that are repeated in the NPT and in later regional treaties.

However, the Tlatelolco Treaty also contains ambiguities that the negotiators of the NPT were careful to avoid. For instance, the Tlatelolco Treaty could be interpreted as permitting its parties to acquire and use nuclear explosives for peaceful purposes or, alternatively, of prohibiting them from doing so. Article II of the NPT and corresponding clauses in most other regional treaties explicitly prohibit non-nuclear-weapon States from acquiring any type of nuclear explosive device and Article V of the NPT stipulates that peaceful nuclear explosions may only be made and used by the five recognized nuclear weapon States (but that a non-nuclear-weapon State party to the NPT should have equal access to the 'benefits' of such explosions — by arranging with a nuclear weapon State to carry out a nuclear explosion on behalf of the non-nuclear-weapon party).

Nearly all other Latin American States shared Mexico's view that the Tlatelolco Treaty did not permit its parties to acquire or use any form of nuclear explosive device. Most of their comprehensive safeguards agreements with the IAEA were designed to satisfy their obligations under both the Tlatelolco Treaty and the NPT and the agreements explicitly prohibit the acquisition of any form of nuclear explosive device. But the two States that had the most advanced nuclear programmes in Latin America, Argentina and Brazil, took the opposite view, at least until the late 1980s. For more than 20 years Brazil refrained from bringing the Tlatelolco Treaty fully into force,[93] Argentina and Chile refused to ratify it and Cuba to sign it. Finally, after major changes in nuclear policy, Argentina, Brazil and Chile became parties to the Tlatelolco Treaty in 1994 and Cuba signed it in 1995.[94]

The Rarotonga Treaty of 1986 creating a nuclear weapon free zone in the South Pacific, the Pelindaba Treaty creating such a zone in Africa and opened for signature in Cairo in 1996, and the Bangkok Treaty creating a similar zone in South East Asia and opened for signature at the end of 1995, explicitly proscribe all forms of nuclear explosives and assign chiefly to the IAEA the task of verifying compliance with this prohibition.

The bombing of the Tamuz reactor in Iraq: The implications for IAEA safeguards

On Sunday 7 June 1981, Israeli aircraft destroyed Tamuz 1, the 40 MW(th) materials testing reactor that France had built for Iraq at the Tuwaitha research centre south of Baghdad and which the French had originally named 'OSIRAQ'. The reactor was not yet in operation. France had delivered only 12.3 kg of 93% enriched uranium, half the first load of fuel assemblies. The fuel was stored separately from the reactor in the pond of another facility — Tamuz 2 — a low power (500 kW(th)) French built research reactor used for Tamuz 1 core configuration experiments, which was located in the building immediately adjoining the Tamuz 1 complex. The Israeli air raid destroyed

Tamuz 1, but Tamuz 2 and the enriched uranium it contained were left unscathed. Before the attack, the Tamuz 1 fuel assemblies had been used to fuel Tamuz 2 for a short period and had consequently become radioactive. This had rendered the 12.3 kg high enriched uranium contained in the fuel assemblies hazardous to handle in the absence of a dedicated reprocessing facility.

Uranium enriched to 93% can be used directly in a nuclear weapon. However, SAGSI, the IAEA's safeguards advisory group, estimated in 1977 that a 'beginner' country would need about twice the amount France had delivered, or 25 kg of uranium enriched to about 90% or more, to make its first bomb.[95]

Reactors fuelled with high enriched uranium produce an insignificant amount of plutonium in the reactor fuel itself. To justify the attack Israel contended that Iraq nevertheless planned to use the reactor to make an arsenal of plutonium weapons. Israeli spokesmen also argued that it was crucially important to strike before the reactor went critical, since if its contents were blown apart later, radioactive debris might fall on Baghdad. They circulated an informal paper depicting the elaborate plan that they claimed the Iraqis would follow to produce the plutonium. The Israelis alleged that between the visits of IAEA inspectors the Iraqi operators would surround the core of the reactor with a blanket of natural uranium. The blanket would be put in place as soon as the inspectors had left and removed just before they returned for the next inspection. While the blanket was in place the reactor would be run at full capacity, building up plutonium in the blanket.[96] When sufficient plutonium had accumulated in the blanket the Iraqis would remove and reprocess it to separate the plutonium.

The Israelis had learned that the IAEA was inspecting the reactor only twice a year. This inspection frequency was considered adequate by the IAEA as long as only half the fuel had been delivered to the reactor. But once France had delivered the full 25 kg of 93% enriched uranium to Tamuz 1 it would have become theoretically possible for Iraq to make a bomb (and to do so relatively quickly). The IAEA would then inspect the reactor more frequently and indeed envisaged doing so every two weeks.[97]

According to Professor Hans Gruemm, the head of the IAEA's Department of Safeguards at that time, the Israeli scenario was seriously flawed, and not only in its assumption that the IAEA would continue to inspect the reactor only twice a year. Surrounding the core with a natural uranium blanket would have required the installation of conspicuous hardware easily visible to the IAEA's inspectors. The Israeli scenario would also have required the Iraqi operators to make numerous movements of the components of the blanket that would have been detected by IAEA inspectors and by the automatic surveillance cameras which were to be installed at the reactor. To produce enough plutonium for one or two bombs a year, France would have had to supply several cores of new fuel a year. Moreover, the French authorities disclosed (after the Israeli attack) that their agreement with Iraq provided for a joint French–Iraqi committee to direct a ten-year research programme for the reactor and for French engineers to remain at the reactor for several years.

In the author's view, despite the Israeli scenario, any Iraqi attempt to produce a significant quantity of plutonium would have been detected, not only because, according to Professor Gruemm, the IAEA planned a substantial increase in inspection frequency, but also because of the French–Iraqi joint research programme. However, with hindsight, it is obvious that the Iraqi Government did plan to make the bomb. Israeli suspicions of Iraqi intentions may have been further sharpened by the fact that Iraq had imported large quantities of yellow cake which could have been processed to provide the natural uranium for the blanket that, according to the Israeli scenario, was to be placed around the reactor core, and by the fact that Iraq had bought hot cells from Italy (which it later used for the clandestine separation of small quantities of plutonium). It is obvious that the French authorities were also suspicious of Iraq's intentions; hence the precautions that the French took to make it difficult for the Iraqi operators to tamper with the fuel for Tamuz 1 (irradiation of the first half of Tamuz 1's fuel, to be inserted into the reactor before the second half arrived, and the joint French–Iraqi research programme).[98] A critical observer would also question the wisdom of providing such a powerful and sophisticated reactor to a country that had virtually no civilian use for it. This was not, however, a question that the IAEA Secretariat had the authority to raise.

The inspectors that the IAEA had chosen for Iraq and that Iraq had accepted under the procedure for designating inspectors[99] may have only worked by the book, but even if they had been much more curious it is doubtful whether they would have been much the wiser about what was going on at the Tuwaitha centre. The site was very large, the reactors and the associated facilities under safeguards as well as the entrance to the reactor site, were at one end of the centre and much of the rest of the centre, where important parts of the Iraqi nuclear weapon programme were carried out, was hidden by a large berm — a high earthen dike — which was an internal extension of the berm that surrounded the entire centre. Only by flying over the site at a low altitude would it have been possible to obtain a picture of the extensive operations under way.[100]

The IAEA Secretariat's deployment of its limited number of inspectors was perhaps defensible before Tamuz 1 came into operation. Taking into account the highly enriched fuel that the USSR had supplied for a small Soviet research reactor, Iraq had enough material in 1980 and 1981 for a single weapon, i.e. enough to permit 4–12 inspections a year (or even 26, according to Professor Gruemm's article, while the fuel was not irradiated) and not the two that were being made. However, the IAEA calculated the frequency of its inspections in Iraq on the basis of the amount of nuclear material in each reactor rather than the total amount and characteristics of nuclear material in that country. To an observer, this did not make sense politically — a country wishing to make a nuclear weapon as quickly as it could would use all the fissile material available to it, irrespective whether it was in one reactor or divided amongst two or more reactors or stores. Such an 'abrupt' diversion of all high enriched uranium in the State would, of course, have been detected at the next inspection.

In fact, according to reports that emerged 14 years later (in 1995), this is precisely what the Iraqi Government had planned to do in the form of a 'crash programme' when it was under duress during the 1991 Gulf War. Immediately after the IAEA had carried out one of its twice a year inspections the Iraqi Government had apparently planned to divert and re-enrich the Soviet supplied uranium (which was somewhat less highly enriched than the French), then meld it with the French uranium and make a single nuclear warhead or explosive device. For a number of reasons the scenario was implausible, but it did underline the desirability of taking account of all fissile material in a State when determining the frequency of IAEA inspections. This issue is re-examined in the section 'The challenge of Iraq'.

1981: Strengthening safeguards at nuclear power plants in Pakistan and India

In September 1981, the Director General was obliged, for the first time, to inform the Board of Governors that the IAEA was unable to verify that nuclear fuel was not being diverted from safeguarded nuclear plants.[101] The plants were identified as a CANDU reactor in India and the Kanupp (Karachi Nuclear Power Plant) reactor in Pakistan, both under IAEA safeguards.

For the first few years of its operation Kanupp used Canadian fuel which had come under IAEA safeguards before it left Canada. The IAEA therefore knew at that time precisely how much uranium was being shipped from Canada to be loaded into Kanupp.[102] However, Pakistan was now able to provide its own fuel and, unless additional safeguards measures were applied, the IAEA would not be able independently to verify — to know with a reasonable degree of assurance — how much fuel was being loaded into and irradiated in Kanupp. Pakistan objected, however, to the additional safeguards measures proposed by the IAEA on the grounds that they were not foreseen in the safeguards agreement covering the Kanupp reactor.[103] In his statement to the Board concerning Pakistan's unwillingness to accept additional safeguards, the Director General stressed that he was not reporting a breach of a safeguards agreement. Nonetheless, his report caused a stir and brought pressure on Islamabad, and on India where a similar problem had arisen. In due course both governments reached agreement with the IAEA Secretariat on additional safeguards and in June 1982, nine months after the Director General had first raised the matter in the Board, he was able to inform the Board that: "In these two cases there has been significant progress since the end of 1982 and the technical safeguards measures implemented at the plants in question now enable the Agency once more to perform effective verification."[104]

Safeguards in nuclear weapon States: Breakthroughs in the USSR and China

In June 1982, at the United Nations Second Special Session on Disarmament (UNSSOD), Andrei Gromyko, the Minister of Foreign Affairs of the USSR, announced that the Soviet Union was ready to place certain nuclear plants under IAEA safeguards.[105] This signalled the beginning of an important change in Soviet policy. Until then the Soviet Union had usually rejected any proposal that would have permitted foreign inspectors into its territories, claiming that they would simply serve as a cloak for Western espionage or, in the case of IAEA inspectors, that applying safeguards in a nuclear weapon State made no contribution to non-proliferation. There had been some exceptions. The Soviet Union's counterproposal to the Baruch Plan had implied some willingness to accept international inspection but, like the Baruch Plan itself, the Soviet proposals were submerged by the Cold War. During the discussions of a comprehensive test ban treaty in the 1970s, the Soviet Union had been prepared to accept a limited number of inspections per year, but after President Reagan's election victory in November 1980, President Carter had suspended US participation in these discussions, and in 1982 Reagan had formally terminated US involvement. Now, in the same year, the Soviet Union was volunteering for the first time to accept IAEA safeguards, in other words, to accept regular on-site inspection of Soviet nuclear plants by non-Soviet citizens. This was the first harbinger of an eventual movement towards a number of disarmament initiatives including the Intermediate-Range Nuclear Forces Treaty, the Strategic Arms Reduction Talks and the Comprehensive Test Ban Treaty. In May 1983, the IAEA began negotiation of the safeguards agreement with the USSR and on 10 June 1985, the IAEA–USSR agreement entered into force.[106]

As noted, in 1988 China also concluded an agreement to implement its offer to place certain of its nuclear plants under IAEA safeguards; the agreement entered into force on 18 September 1989.

Nuclear submarines

In the 1960s, when the NPT was being negotiated, it was reported that Italy was planning to build a nuclear powered naval tender and that the Dutch navy was interested in building nuclear submarines. Since the IAEA would not be allowed to inspect warships (and it was doubtful whether it had the authority do so under its Statute) it was agreed that safeguards in NPT non-nuclear-weapon States would apply only to nuclear material 'in peaceful nuclear activities'. These States were prohibited from acquiring or seeking to acquire nuclear explosive devices of any kind but, as we have noted, they could use nuclear material for non-explosive military purposes such as the engines of warships.

It was generally recognized that this was a serious loophole in the safeguards prescribed by the Treaty. A State might simply refuse access to IAEA inspectors, claiming that the material they wanted to inspect was destined for a naval reactor, or that the reactor they wanted to look at was the prototype of a submarine engine. The Director General had drawn the attention of the Safeguards Committee (1970) to the problem. The Secretariat had done its best to block the loophole by proposing several conditions to the Committee (which it accepted and incorporated into INFCIRC/153) that the State concerned would have to comply with before withdrawing nuclear material from safeguards for non-explosive military use.[107] For nearly 20 years nothing more was heard of the Italian and Dutch plans, nor of any other proposals by non-nuclear-weapon States to build nuclear propelled naval vessels. It appeared that the loophole in the NPT was becoming a dead letter. In 1987, however, the Canadian Government made the surprising announcement that it planned to acquire a flotilla of nuclear submarines and to spend several billion dollars in doing so. The announcement was all the more surprising coming from a strong supporter of the NPT, of IAEA safeguards and of non-proliferation in general. In fact, Canada was the only nation, in the late 1940s and 1950s, that had access to the technology and the material needed to obtain plutonium for a nuclear weapon and had deliberately refrained from doing so.

Seeing the possibility of very lucrative contracts, the United Kingdom, France and the USA appeared to be ready to overlook the repercussions that the first use of the loophole in the NPT might have on the credibility of IAEA safeguards, and appeared eager to provide Canada with its nuclear flotilla or the reactors and fuel it would need. However, in 1989 the Canadian Government had second thoughts and abandoned the project.

Since then, and indeed before then, there have been reports, from time to time, that Brazil and India, neither of which was party to the NPT, were planning to build nuclear submarines. In the 1980s, the Brazilian navy is said to have operated an unsafeguarded enrichment plant, while the Soviet Union leased an old nuclear submarine to India, reportedly to train an Indian submarine crew. It appears that these plans have not made significant progress since then. All nuclear material in Brazil has been placed under IAEA safeguards in accordance with the safeguards agreement concluded between Argentina, Brazil, ABACC and the IAEA, but that agreement still leaves the ‘submarine loophole’ open.

The challenge of Iraq

In 1990, when Iraq invaded Kuwait, Iraqi scientists had been operating a small (5 MW(th)) research reactor that the Soviet Union had supplied in the 1960s.[108] The reactor’s high enriched uranium fuel had been under IAEA safeguards since February 1972 when Iraq’s NPT safeguards agreement came into force.[109] Another stock of high enriched uranium was also under IAEA safeguards, namely the fuel supplied by France for the large (40 MW(th)) 'OSIRAQ' reactor that Israel destroyed in 1981. There were certain other nuclear materials under safeguards at the Tuwaitha nuclear centre near Baghdad, including depleted uranium supplied by Germany and some 30% enriched and low enriched uranium.[110]

Before the Gulf War there were reports that Iraq had also obtained from abroad (chiefly Germany) several components of a plant to manufacture gas centrifuges to enrich uranium for nuclear weapons, and components of the centrifuges themselves. It was widely assumed that Iraq would take several years to master gas centrifugation, a very demanding technology. In the early months of 1991, however, a defecting Iraqi scientist made the seemingly incredible claim that Iraq was clandestinely developing another technology for enriching uranium; namely, electromagnetic isotope separation, a technology the USA had initially used during the Second World War but had subsequently abandoned in favour of the more efficient and economical gaseous diffusion process.[111]

The invasion of Kuwait and its consequences

On 2 August 1990, Iraq invaded and began the annexation of Kuwait. This act of aggression was the culmination of a territorial dispute whose origins lay in the history of the Ottoman Empire, in Kuwait's semi-autonomous status in that Empire, and the creation of Iraq after the First World War. The United Nations Security Council promptly condemned the invasion and during the months that followed the Council adopted two key resolutions:

— Resolution 661 of 6 August 1990, which imposed sanctions on Iraq;
— Resolution 678 of 29 November 1990, which authorized "all necessary means" to evict Iraq from Kuwait.

Under US leadership a 'United Nations Coalition' was rapidly established to confront the Iraqi aggression. After building up its forces and allowing for last minute diplomatic efforts to defuse the crisis, the Coalition began aerial bombardment of Kuwait and Iraq on 16 January 1991 and launched a ground offensive on 24 February 1991. The Coalition suspended offensive combat operations on 27 February 1991, having successfully evicted Iraqi forces from Kuwait.

In the immediate aftermath of the conflict, the Security Council passed three further key resolutions:

— Resolution 687 of 3 April 1991, which defined the post-Gulf-War mission that the IAEA was invited to undertake in relation to Iraq's nuclear activities and potential. At the same time the Council established the United Nations Special Commission — UNSCOM — with a similar mandate in relation to Iraq's chemical and biological weapons and missiles above a specified range and throw weight;
— Resolution 707 of 15 August 1991, which demanded that Iraq comply with the obligations it undertook when it accepted Resolution 687 on 6 April 1991, and that it make a "full, final and complete disclosure" of all aspects of its nuclear programme;
— Resolution 715 of 11 October 1991, by which the Council accepted the IAEA's plan for future continuous monitoring and verification in Iraq.

The IAEA's missions under Resolution 687

Resolution 687 assigned to the IAEA several missions in Iraq:

— To carry out "immediate on-site inspection of Iraq's nuclear capabilities";
— To develop a plan "for the destruction, removal, or rendering harmless" of Iraq's "nuclear weapons or nuclear-weapon-usable materials or any subsystems or components or any research, development, support or manufacturing facilities related to..." either the weapons or the nuclear weapon usable materials. In addition, the resolution invited the Agency to take Iraq's nuclear weapon usable materials into custody for eventual removal. The IAEA was also asked to confirm that all nuclear material and nuclear activities in Iraq had been brought under its safeguards to develop a plan for "future ongoing monitoring and verification of its [Iraq's] compliance" with its undertakings not to use, develop, construct or acquire any of the proscribed items.

The IAEA's privileges and immunities in Iraq

In May 1991, in an exchange of letters with Rolf Ekeus, the Executive Chairman of UNSCOM, Iraq agreed that the IAEA's inspectors would have the rights set forth in the relevant conventions of the United Nations and the specialized agencies. They would also have a unique and far-reaching series of additional rights; for instance, they would have:

— Unrestricted freedom of entry into and exit from Iraq and unrestricted freedom of movement in Iraq, without prior notification to the Iraqi authorities;
— Unrestricted access to Iraqi facilities;
— Authority to request, receive, examine and copy or remove records, data, information and photographs;
— Authority to designate any site for observation, inspection or monitoring;
— Authority to take samples, to photograph and to videotape.

These privileges and immunities proved to be essential for the fulfilment of the IAEA's missions in Iraq.

The IAEA's Action Team

Director General Blix immediately established an 'Action Team' to carry out the IAEA's mission under his direction, and appointed Maurizio Zifferero, a former IAEA Deputy Director General, to lead the Team.[112] The Action Team was not incorporated into the IAEA's Department of Safeguards, but reported directly to Blix, and the work that the IAEA undertook in Iraq was not regarded as the application of safeguards under Iraq's NPT agreement with the IAEA, but as a special operation carried out under the authority of the Security Council's resolutions.

The Action Team carried out 32 inspections in Iraq from 15 May 1991 until 1996, namely eight in 1991, and eight again in 1992, six in 1993, six in 1994, two in 1995, and two in 1996. In August 1994, the Action Team established a permanent presence in Iraq, namely the 'Nuclear Monitoring Group'. This enabled the IAEA to decrease the number of inspection missions sent from Vienna and increase local inspection and make it more pervasive and methodical.

The Team carried out its work according to an IAEA plan which the Security Council approved on 11 October 1991 in Resolution 715. In accordance with this plan the IAEA's task would be:

— To discover all forbidden elements of the Iraqi programme. The IAEA was to ascertain the full extent of Iraq's past nuclear programme and, in so doing, verify the accuracy and completeness of the "full, final, and complete disclosure" of that programme that Iraq was required to make.

— To destroy or remove or render harmless all the forbidden elements of Iraq's programme. This involved, for instance, destroying facilities built for forbidden purposes, shipping all nuclear weapon usable material out of Iraq and placing all critically important machine tools under IAEA seals.
— To arrange for the continued monitoring and verification of Iraq's activities. This included continuing inspection of sites declared by Iraq to have been associated with the former programme, interviews with Iraqi engineers and scientists to verify their current employment, and taking and analysing environmental samples for evidence of nuclear activities.

No term was set for the completion of the IAEA's mission in Iraq.

Unveiling Iraq's clandestine nuclear weapon programme

Relations between Iraq and the IAEA passed through four phases. Until September 1991, Iraq consistently attempted to deny access to IAEA inspectors. From then until November 1993, Iraq generally did not physically impede inspections, but failed to provide accurate accounts of its prohibited programmes and refused to accept "on-going monitoring and verification". From November 1993 until August 1995, Iraq co-operated in establishing the mechanisms for ongoing monitoring but still failed to disclose fully the extent of its prohibited programmes. The fourth phase began in August 1995 with the defection of General Hussein Kamel to Jordan and Iraq's disclosure of a vast cache of documents that Kamel had purportedly stored at the 'Haidar House Farm'. The Iraqi authorities turned the documents over to the IAEA.

In June 1991, when IAEA inspectors arrived at previously designated sites, the Iraqi authorities denied them access. However, the inspectors observed that the Iraqis were loading lorries with components of electromagnetic isotope separation devices and carrying them off. (The Action Team subsequently recovered these components.) This inspection thus confirmed that Iraq had engaged in an extensive uranium enrichment programme. The inspectors also discovered a small quantity of separated plutonium. Neither the enrichment programme nor the plutonium had been referred to in the supposedly "full, final and complete" declaration that Iraq had made about its programme on 18 April 1991.

In September 1991, Iraq confiscated a number of documents that had been seized by an IAEA inspection team led by David Kay, the Agency's chief inspector for the sixth mission in Iraq. When the inspectors refused to turn over other documents, they were compelled to stay in a parking lot for four days. The documents seized during this inspection provided a much fuller picture of the Iraqi nuclear programme and demonstrated once again that Iraq's "full disclosure" had been neither full nor complete.

The seven inspections that the IAEA had carried out by the end of October 1991 revealed that Iraq had undertaken three separate clandestine programmes to enrich uranium using chemical exchange and a gas centrifuge as well as electromagnetic isotope separation techniques. The inspections also provided conclusive evidence of a programme designed to produce implosion-type nuclear weapons. It was also clearly linked with work on surface to surface missiles. In Ekeus' first report to the Security Council he estimated that within as little as 12–18 months Iraq could have had sufficient fissile material for a nuclear device, and noted the "failure of Iraq, particularly in the nuclear field, to adopt the candid and open approach to the disclosure of its capabilities."

On 12 March 1992, Iraq provided Blix with a revision of its "full, final and complete disclosure" and provided yet another version on 5 June 1992, but the IAEA found both documents inadequate.

In August, September and November 1992, the Action Team carried out a radiometric/hydrological survey of Iraq's main bodies of fresh water (rivers, lakes and canals) which provided a baseline for twice yearly sampling of the water bodies, designed to detect isotopic evidence of the existence of any undeclared nuclear facility. By the end of 1996, no such evidence had been found.[113]

By mid-June 1993, the IAEA had inspected 75 sites. These confirmed the picture that the Action Team had perceived in 1991 of broad based programmes for enriching uranium and for producing nuclear weapons. However, it still remained doubtful whether the picture was complete.

By September 1994, the IAEA had carried out 26 inspections in Iraq totalling more than 2500 inspector-days and comprising 634 visits to 151 sites. The inspectors and support staff had come from 35 nations. The results achieved were significant:

— The IAEA had pieced together a reasonably complete picture of Iraq's vast clandestine nuclear programme which, apparently, had begun in 1981.

— The second task assigned to the IAEA by Resolution 687 was also well in hand. The Action Team had supervised the systematic destruction of forbidden facilities, technical buildings and equipment, including over 1900 individual items, 600 tonnes of special alloys and buildings with a surface area of some 32 500 square metres. Iraq could no longer produce material for use in nuclear weapons nor the weapons themselves. The nuclear weapon usable materials under IAEA safeguards in Iraq before the Gulf War had been found untouched and had been removed from Iraq. In addition, the fissile material clandestinely produced by Iraq, including a few grams of separated plutonium, had been shipped abroad.
— By the end of 1996, the IAEA's "ongoing monitoring and verification" included periodic radiometric surveys of Iraq's main surface water bodies, routine no-notice inspections of relevant industrial plants, the use of video equipment for the surveillance of critical dual use equipment and a significant permanent presence in Iraq.

Analysis of the documents seized in 1991 and those handed over to the IAEA in August 1995 increased confidence in the accuracy of the IAEA's assessment of the clandestine programme, and provided the means to verify independently many of Iraq's declarations. They provided a wealth of information regarding the following areas:

— Iraq's use of electromagnetic isotope separation to produce enriched uranium;
— Chemical enrichment by liquid–liquid extraction and solid–liquid ion exchange;
— Gaseous diffusion enrichment;
— Research aimed at lithium-6 production;
— Design of facilities to handle large amounts of tritium;
— Weaponization (knowledge, techniques, technologies and engineering activities required to construct a nuclear explosive device capable of being delivered to a target and achieving a nuclear yield, assuming that the needed fissile material is available);
— Organizational structure of 'Petrochemical Project 3' (PC3) — the front organization in charge of Iraq's covert programme;
— Identification of eight specific sites associated with PC3 activities;
— Procurement and foreign suppliers;

— Details of the 'crash programme' in which Iraq had planned to use the enriched fuel of the Soviet and French reactors to make a single nuclear explosive device;
— Details of the centrifuge enrichment effort, including the activities at the Engineering Design Centre, details of the centrifuge enrichment project's procurement network and foreign assistance.

By the end of 1996, most of the Action Team's work consisted of ongoing monitoring and of increasing the effectiveness of such monitoring, thus enabling the IAEA to detect any indication that Iraq was reviving its nuclear programme. The IAEA was also still assessing the accuracy of Iraq's "full, final and complete declaration".

Disposal of nuclear material

The Agency recognized that nuclear weapon usable material could not be destroyed or rendered harmless in Iraq and its first priority was to account for and ship such material out of the country. All unirradiated fuel was shipped out by the end of November 1992. The approximately six grams of plutonium discovered by the inspectors in 1991 were removed from Iraq by the end of November of that year.

By mid-June 1993, all the nuclear materials under safeguards before the Gulf War had been accounted for. The only known nuclear weapon usable material remaining in Iraq was the high enriched uranium in irradiated reactor fuel assemblies, which were under IAEA seal until they could be removed from the country.

By the end of February 1994, all known remaining high enriched uranium fuel had been shipped to Russia, where it would be reprocessed.[114] The nuclear material remaining in Iraq consisted of depleted, natural and low enriched uranium in sealed storage under IAEA control.[115] However, it had not been possible to confirm that the Iraqi declarations of unsafeguarded nuclear material were complete.

Violation of the IAEA–Iraq safeguards agreement: The findings of the Board

Iraq's clandestine programme was clearly a massive violation of its obligations under the NPT and under its safeguards agreement, which called upon it to accept IAEA safeguards "on all source or special fissionable material...within its territory, under its jurisdiction or carried out under its control anywhere."[116] According to French and other estimates, the programme involved many thousands of people and, if it had been carried out in an industrialized country, it would have cost more than ten billion dollars.[117]

On 18 July 1991, a special meeting of the IAEA Board of Governors declared that Iraq had violated its safeguards agreement with the IAEA. The Board's resolution was sponsored by 17 States, including the five permanent members of the Security Council, and was opposed only by the Iraqi delegation (Iraq happened to be serving on the Board). This was the first finding of a violation of an agreement since the IAEA began applying safeguards in 1959. As required by the IAEA's Statute, the Board reported its finding to the Security Council and General Assembly, as well as to all Member States of the IAEA.

As noted, IAEA inspectors also discovered that Iraq had clandestinely separated a small amount of plutonium. In the light of this revelation, the IAEA's Board concluded on 11 September 1991 that Iraq was guilty of a second breach of its safeguards agreement.

On 20 September 1991, the IAEA General Conference adopted a resolution strongly condemning Iraq's non-compliance with its non-proliferation obligations, including those contained in its safeguards agreement with the IAEA. The resolution was adopted by 71 votes to 1 (Iraq). There were seven abstentions (Algeria, Cuba, Jordan, Libya, Morocco, Namibia and Sudan).[118]

It has been noted earlier that, after Hussein Kamel's defection to Jordan in August 1995, the Iraqi authorities disclosed that their Government had planned a 'crash programme' to assemble a single nuclear explosive device. This constituted yet another violation of the safeguards agreement. Iraq's delay in disclosing these plans and turning over all documents and materials relating to its covert activities also violated its obligations under the relevant resolutions of the Security Council.[119] A further chilling finding was that Iraq had separated a small amount of lithium-6, which is used in the manufacture of hydrogen weapons.

The formal finding of the Security Council

It was not for the IAEA to decide whether Iraq had violated its obligations as a party to the NPT. This, however, was the finding of the Security Council on 15 August 1991. Acting under Chapter VII of the United Nations

Charter, the Council found that Iraq had acted in violation of its obligations under the NPT and that its breach of the Treaty constituted a threat to peace and international security.[120] The decision also created a precedent, namely of the Security Council serving as the international body to determine whether a party had violated the NPT. In a sense the Council thus became the guardian of the Treaty, but, as we shall see, it was more hesitant in fulfilling this role two years later in the case of the Democratic People's Republic of Korea (DPRK, or North Korea).

The implications for IAEA safeguards of Iraq's covert programme

In July 1991, Dr. Blix, referring to the IAEA's experience in Iraq, told the IAEA Board of Governors:

> "...I conclude that the lesson to be learnt from the present case is that a high degree of assurance can be obtained that the Agency can uncover clandestine nuclear activities if three major conditions are fulfilled: first that access is provided to information obtained, inter alia through national technical means, regarding sites that may require inspection; second, that access to any such sites, even at short notice, is an unequivocal right of the Agency; and third, that access to the Security Council is available for backing and support that may be necessary to perform the inspection."[121]

The background to Blix's conclusion that "...access to any such [suspect] sites, even at short notice, is an unequivocal right of the Agency" was that, in Iraq, the safeguards that the IAEA had applied during *routine inspections* had been adequate to verify that there had been no significant diversion of nuclear material from the *declared* Iraqi programme.[122] However, *routine inspections* of declared material and plants did not and could not detect Iraq's clandestine programmes, which had made no use of nuclear material that Iraq had declared to the Agency under its safeguards agreement.[123]

A hitherto unused set of provisions permitting unrestricted access, included in all comprehensive NPT safeguards agreements, gave authority to the IAEA to carry out *special inspections* at *additional locations* in the State concerned,[124] if the IAEA considered that the information provided by the State was "...not adequate for the Agency to fulfil its responsibilities under the agreement"[125] — for instance if the IAEA believed that the State was hiding material that should be placed under safeguards, and the IAEA could therefore not fulfil its obligation under paragraph 2 of the standard agreement "...to ensure that safeguards will be applied...on all source or special fissionable material...within the territory of the State, under its jurisdiction, or carried out under its control anywhere..." The agreements set no limits to the IAEA's access when it carried out such special inspections; in such circumstances the inspectors *would have access to any place in the State concerned.* In effect, this reflected Article XII.A.6 of the IAEA Statute under which IAEA inspectors "...have access at all times to all places and data..."

Before it carried out a special inspection at an additional location, the IAEA would have to get the agreement of the State concerned. However, if the State refused, the Board could order the State to admit the inspectors forthwith.[126] If the State again refused the Board could and, in all probability, would report to the Security Council, the General Assembly and all the IAEA Member States that "...the Agency is not able to verify that there has been no diversion..."[127]

Until the Gulf War the IAEA had no occasion to make special inspections at 'additional' locations. If the IAEA were to make use of such inspections in the future, they could enable it to detect the presence of undeclared material (or undeclared plants for which no design information had been submitted to the IAEA). Or, if the State refused the inspection, it would ipso facto incriminate itself. This was what was soon to happen in the DPRK.

Even the widest powers of inspection would be of little avail unless the IAEA knew where to look. But a UN agency cannot operate like a secret service. How could the IAEA be put on the track of a suspect activity? Improving the flow of unclassified data to the IAEA and of the IAEA's own processing and analysis of such data, would be useful, but the IAEA should also have access to relevant data gathered by 'national technical means', including satellites.

Until 1991, governments had been loath to provide intelligence data to any international organization for fear of disclosing sources or of revealing the detection capability of their satellites. In the case of Iraq, the USA accepted this risk when it told the UN Commission and the IAEA where to look for suspect plants. It was to do so again in the case of the DPRK.

In Chapter 3 it was noted that, in the mid-1950s, the negotiators of the Statute foresaw that in applying its safeguards the IAEA might need direct access to the Security Council, and that negotiators had put in place the legal basis for such access.[128] The relevant clauses of the Statute were activated for the first time (in both directions) by the Gulf War. Whether the Council would give its backing and support to future special inspections to locations not declared by the State concerned would depend chiefly on whether the five permanent members of the Council could maintain the cohesion they forged in dealing with Iraqi aggression. This cohesion was later put to the test in the case of the DPRK.

How long would Iraq have needed to make nuclear weapons?

Did the Gulf War prevent the emergence of another nuclear weapon State? Rolf Ekeus estimated in 1991 that within as little as 12–18 months Iraq could have had sufficient fissile material for a nuclear device. However, any such estimate is subject to a wide range of uncertainties, each of which could be a factor for delay. The uncertainties include, for instance, whether the two electromagnetic isotope separation plants that Iraq was completing, and their numerous auxiliary facilities, would have been able to operate at full planned capacity and without breakdown from the first day of operation, whether there would have been adequate feedstock and other materials needed by the plants, and whether the electricity supply would have been adequate and reliable. Related questions were whether during those 12–18 months, Iraq would have mastered the technology of making nuclear explosives and the means of manufacturing and detonating them at their designed yield, and would have acquired effective means of delivery. Being able to produce fissile material would have been crucial for Iraq's progress towards a nuclear arsenal, but not, by itself, enough to make it a de facto nuclear weapon State.

A group of nuclear weapon designers from the USA, Russia, the United Kingdom and France met at IAEA Headquarters in April 1992 to examine the documents that, by that date, IAEA inspectors had collected in Iraq. According to a press report, the weapon experts concluded that the Iraqi Government "...faced such significant bottlenecks that [it] was at least three years and possibly more from acquiring [its] first crude nuclear weapon."[129]

There was, however, no escaping the fact that the first breach of an IAEA safeguards agreement had been by the use of unsuspected and unwatched clandestine plants, and not by diverting declared material and cheating the IAEA's material accountancy. The IAEA was seen by many as having failed its (presumably) first diversion detection test; it had patently been unable to detect a large and longstanding undeclared programme.

Without the Gulf War, the IAEA might not have discovered the programme until the Iraqi Government openly demonstrated that it had acquired the bomb.[130] While this judgement would have been unduly harsh — the Director General, his staff, the Action Team and the Board of Governors acted swiftly and decisively and dealt effectively with a new and unforeseen challenge — there was no doubt that a fundamental review and redirection of the existing IAEA safeguards system was essential. It is to the credit of the IAEA that this review was promptly undertaken and first applied in the case of the DPRK. The Iraqi experience also led eventually to the redirection of IAEA safeguards undertaken from 1993 to 1997 in 'Programme 93 + 2'.

Other lessons from the Gulf War and its aftermath

It has been noted that the IAEA safeguards guidelines assume that a 'beginner' State would require 25 kilograms of uranium (enriched to more than 90% in uranium-235) or 8 kilograms of plutonium (plutonium-239) to make its first nuclear weapon. These are defined as a 'significant quantity', the absence of which safeguards should have 'a high probability' of detecting.[131] Iraq's total holdings of high enriched uranium were more than 25 kilograms, but they were distributed between two separate reactors. However, as already noted, the frequency of the IAEA's inspections was geared to the quantity of material in a particular plant and did not take account of the total amount in the country or even in a particular nuclear centre. The amount of material in each of the two reactors at the Tuwaitha centre was less than a significant quantity, and in each case some or all of the fuel had been irradiated. Presumably this explains why there were only two inspections each year in Iraq, although the reactors were in the same centre and their fuel could have been amalgamated to provide enough fissile material for a nuclear weapon — as the Iraqi authorities planned to do in the crash programme whose existence came to light only in 1995. It should be noted, however, that the distribution of fissile material that occurred in Iraq in the 1980s was or is found in only a few other centres and the IAEA has increased inspection frequency in these cases.[132]

If the total amount of safeguarded material in a country, or at least in one of its research centres, amounts to a significant quantity — in other words, is enough to make a bomb — should not this determine the minimum number of inspections in that country? This would have meant at least four inspections a year in Iraq in the years before the Gulf War.[133] This might not have enabled the IAEA to detect undeclared activities, but it would have enabled the IAEA to detect, within three months instead of six, any Iraqi attempt to carry out the planned crash programme.

Another way of increasing inspection frequency would be to substantially reduce the amount of high enriched uranium and plutonium defined as a 'significant quantity'. The present values are derived from a UN study of the mid-1960s and it is widely believed that, today, nations with a moderately sophisticated nuclear programme could produce smaller nuclear explosive devices with smaller amounts of plutonium or high enriched uranium.[134] Reducing the significant quantities might have increased the inspection frequency in countries such as Iraq from twice a year to as much as once a month. Changing the definition would, of course, have effects throughout the safeguards operations in all countries in which safeguards are applied and it would also have significant budgetary consequences. It would also make it more difficult for the IAEA to attain its technical goal of being able to detect in a timely fashion the diversion of a significant quantity of nuclear material.[135]

There are, no doubt, still more lessons of the Gulf War that have to be studied. One is already clear. The problems that the IAEA and the NPT regime faced in Iraq were not unique to nuclear non-proliferation. Any other global arms control or disarmament treaty, for instance the Chemical Weapons Convention, the Biological Weapons Convention and the Comprehensive Test Ban Treaty, could run into similar problems.

The Iraqi case showed that a determined and authoritarian State with very large financial resources and a skilled and dedicated nuclear establishment could defy its obligations under the NPT and evade detection for many years. This evasion may have been helped by the fact that, during the Iran–Iraq war, Western governments tended to tilt towards Iraq, which also received support from the Soviet Union. Whether the clandestine programme would have remained undetected, once the large electromagnetic isotope separation plants went into full production, is an open question. So, too, is the question of the uniqueness of Iraq's circumstances — its internal political structure, its technical and financial resources and its regional and international political environment. What is not open to question is that, even if the physical aspects of the Iraqi programme have been completely eliminated, it nevertheless left Iraqi scientists and engineers with an invaluable store of practical knowledge about the production and processing of fissile material and the construction of a nuclear warhead.[136]

The world is unlikely ever to have a completely effective non-proliferation regime or safeguards that are completely foolproof. That is, of course, no reason for taking safeguards out of the hands of the IAEA as some suggested after the Gulf War; rather it underlines the continuing need to strengthen the regime and to enhance the efficacy of the IAEA's operation, as the IAEA has sought to do in its 'Programme 93 + 2' which will shortly be described.

The 1992 IAEA–EURATOM partnership approach

In carrying out the 1973 IAEA–EURATOM safeguards agreement (INFCIRC/193), there had been much friction between the two agencies and unnecessary duplication of work. In 1977, the two agencies agreed to use 'joint teams' of IAEA and EURATOM inspectors to inspect plants handling sensitive nuclear materials in bulk form such as liquids, gases and powders in the expectation that this would obviate unnecessary duplication of work, but this had not been the result. One of the tenets of the 1973 agreement was that the IAEA would inspect a plant in a EURATOM non-nuclear-weapon State substantially less frequently than a similar plant in a non-EURATOM non-nuclear-weapon State.[137] In practice the opposite had often happened. For instance, at an informal safeguards meeting convened by Director General Blix in the early 1990s, it was disclosed that the amount and frequency of inspection at a particular fuel fabrication plant in the European Union was at least three times that at a similar plant in Japan.

In some cases — though not in this particular instance — this waste of effort was due to the 'theological' attachment of both agencies to certain safeguards doctrines, for instance that there must be no delegation of responsibility by one agency to the other, which meant that each must have its own inspectors present at each task undertaken during an inspection.

In 1992, the IAEA Director General and the Commissioner responsible for nuclear energy in the European Union signed an agreement for a 'new partnership approach'[138] in implementing the 1973 agreement. The new approach set aside both the previously agreed 'principle of observation'[139] and the concept of 'joint teams'. These were replaced by new co-operative arrangements, one of which was the rule of 'one job, one person' — if the verification of a particular activity required the presence of two inspectors, one person from each agency would do the job, provided that each organization would still be able to draw its own independent conclusion (as to whether all nuclear material remained under safeguards or was satisfactorily accounted for).[140]

The two agencies also agreed to co-operate in research and training, to make use of each other's laboratories and other resources, and to make more use of techniques that do not require the physical presence of inspectors. The IAEA expected that the new agreement would enable it to reduce the amount of routine inspection in the non-nuclear-weapon States of the European Union by one half to two thirds.

There has, in fact, been a substantial reduction in the amount of IAEA inspection in the States concerned. From 1991 to 1995, the total number of person-days that inspectors spent in these countries declined from about 3000 to 1200, of which about 700, according to estimates provided by the Secretariat, were, however, attributable to the closing of some large nuclear plants.[141] Even before the agreement on the partnership approach, the 1989 decision to abandon the construction of its large reprocessing plant at Wackersdorf in Bavaria may have caused much regret in the German nuclear industry, but it substantially reduced forecasts of the amount of IAEA inspection in the EURATOM non-nuclear-weapon States. In the mid-1990s, the abandonment of plans to produce MOX fuel at Hanau presumably had a similar effect.[142]

The DPRK's violation of its NPT safeguards agreement with the IAEA

On 12 December 1985, the DPRK acceded to the NPT. It has been widely reported that the USSR made such accession a condition for the supply of the Soviet power reactors that the DPRK was anxious to obtain as a first step in a nuclear power programme. (The Soviet power reactors did not materialize.)[143]

Article III.4 of the NPT stipulates that a non-nuclear-weapon State acceding to the Treaty must bring into force a comprehensive safeguards agreement with the IAEA not later than 18 months after its accession. Despite mounting criticism, especially at the 1990 conference on the review of the NPT, but also at meetings of the IAEA, the DPRK took no action to fulfil this requirement — on the contrary it attempted to set a number of political conditions before it would conclude the agreement. Finally, on 10 April 1992, nearly five years overdue, the DPRK brought its safeguards agreement into force.[144]

The agreement required the DPRK to send the IAEA an 'Initial Report' on all nuclear material to be subject to safeguards in the country.[145] The DPRK submitted its report on 4 May 1992. It contained some surprises. Until then the IAEA had only been officially aware of the existence of a single Soviet supplied research reactor (5 MW(th)) and a critical assembly which the DPRK had placed under IAEA safeguards in July 1977. Besides this small plant, the Initial Report listed a 5 MW(e) graphite moderated Magnox type reactor, a fuel fabrication plant, a 'radiochemical laboratory' (in reality, a reprocessing plant) and two much larger Magnox reactors of 50 MW(e) and 200 MW(e) under construction. The three Magnox reactors had been or were being built by the DPRK itself. They were essentially similar to the reactors that the United Kingdom had used in the 1950s to produce the plutonium for its first warheads and to generate its first nuclear electricity. The 50 MW(e) reactor was due for completion in 1995. It would have been able to produce as much as 40–50 kilograms of plutonium a year, enough for five to ten nuclear warheads.[146]

The DPRK authorities also showed the IAEA a small amount of plutonium (less than 100 grams) which, they said, had been extracted from damaged fuel rods discharged from the 5 MW(e) reactor. They maintained that this plutonium was all that they had separated, and that they had conducted only a single reprocessing operation, or 'campaign', in 1990. The IAEA's analyses showed, however, that there had been several reprocessing campaigns.[147] This implied that the DPRK had separated more plutonium than it had stated in its Initial Report. Whether the undeclared plutonium amounted to grams or kilograms could only be ascertained after further and more probing investigations. Analysis of the waste that the DPRK provided to the IAEA showed a mismatch between it and the plutonium the DPRK had presented.

At the same time the USA provided the IAEA with satellite images showing two structures that had not been listed in the DPRK's Initial Report. Both were the type of facility in which nuclear waste is customarily stored. It was clear that the DPRK authorities had attempted to disguise the function of the two facilities by planting trees and using other camouflage.

If the IAEA was able to measure and analyse any nuclear waste that might be in these facilities, the analysis could shed more light on the question of how much plutonium the DPRK had actually separated. Accordingly, the IAEA asked to visit the two facilities; the DPRK refused on the grounds that the buildings were military installations. Director General Blix then formally demanded a 'special inspection', a demand that was promptly rejected.[148] On

25 February 1993, the Board formally endorsed Blix's request and set a term of three months for the DPRK to comply. On 12 March 1993, the DPRK responded, giving notice that it intended to withdraw from the NPT. On 1 April 1993, the Board found that the DPRK was in breach of its safeguards agreement and reported the breach to the Security Council which, on 11 May, by a vote of 13 in favour, none against and two abstentions (China and Pakistan) decided "to invite" the DPRK to fulfil its obligations under its safeguards agreement.

On 11 June 1993, one day before its notice of withdrawal from the NPT was due to take effect, the USA persuaded the DPRK to suspend the 'effectuation' of its withdrawal and to accept normal IAEA inspection of the seven sites it had declared in the Initial Report. But during the remainder of 1993 and the first half of 1994 the DPRK continued to frustrate and harass IAEA inspections.[149] In 1994, the IAEA proposed that when the irradiated fuel from the 5 MW(e) reactor was discharged it should be done in a way that would permit the IAEA to verify the history of the reactor core and thereby help solve the question whether the DPRK had separated more plutonium than it had declared. In May 1994, the DPRK rejected the IAEA's proposal and hastily discharged the fuel in such an unstructured way as to make any historical analysis of the core virtually impossible.

On 10 June 1994, the IAEA Board of Governors decided to suspend all IAEA technical assistance to the DPRK. The latter responded on 13 June by giving notice of its withdrawal from the Agency. On 16 June 1994, the USA proposed that the Security Council should impose a series of increasingly onerous sanctions on the DPRK. The DPRK repeated an earlier warning that sanctions would mean war. The USA declared that it would not be deterred by threats. Tension mounted.

At this stage — on 17 June 1994 — former President Jimmy Carter stepped in and went to Pyongyang to discuss the crisis with Kim Il Sung himself. Carter came back with conciliatory messages. If the USA was prepared to meet the DPRK on certain points (e.g. diplomatic recognition, an assurance that the USA would not attack the DPRK and access to US nuclear power technology), the DPRK would be prepared to refrain from refuelling the operating reactor and to refrain from reprocessing the spent fuel, perhaps stop the construction of the larger reactors, and allow the IAEA to keep its inspectors in the DPRK. Hardly had the USA responded to this overture by resuming high level discussions with the Government of the DPRK when the latter announced that Kim Il Sung was dead.

On 5 August 1994, 'high level talks' reopened in Geneva and on 18 October the two delegations announced that they had been able to concur in a so-called "Agreed Framework", which they signed three days later. On 4 November 1994, the Security Council asked the IAEA to carry out the tasks assigned to it in the "Agreed Framework" and on 11 November 1994, the IAEA Board authorized the Director General to do so.

Under the "Agreed Framework":

- The DPRK would freeze its existing nuclear programme and accept international verification of all existing plants;
- The IAEA would verify compliance with the freeze and would continue to inspect 'unfrozen' activities;
- The DPRK would eventually dismantle all the 'frozen' plants;
- The two governments would seek methods of storing the fuel from the 5 MW(e) reactor and disposing of it in a way that "does not involve reprocessing" in the DPRK;
- The USA would put together an international consortium to arrange financing ($4 billion) for and the supply of two 1000 MW(e) light water reactors;[150]
- Dismantling of the DPRK's plants would be completed "when the LWR project is completed" (target date: 2003);
- The USA would arrange for the supply of heavy oil to "offset the energy foregone due to the freeze" of the DPRK's graphite moderated reactors;
- Both nations would ease trade restrictions and move toward establishing diplomatic relations;
- The USA would provide formal assurances to the DPRK "against the threat of use of nuclear weapons by the USA";
- The DPRK would "consistently take steps" to implement the North–South Korean agreement on denuclearizing the peninsula;
- The DPRK would remain party to the NPT and "would allow implementation of its safeguards agreement under the Treaty";
- When a significant portion of the light water reactor project was completed, but "before delivery of key nuclear components", the DPRK "will come into full compliance with its safeguards agreement...including taking all steps that may be deemed necessary by the IAEA, following consultations with the Agency with regard to verifying the accuracy and completeness of [the DPRK's] Initial Report on all nuclear material in [the DPRK]."

It should also be noted there was no mention in the "Agreed Framework" of the DPRK rejoining the IAEA.[151]

The framework stipulated that a US-led consortium would finance the light water reactors. It was later reported that more than $2 billion of the estimated $4 billion cost of the reactors would be borne by the Republic of Korea, which would also provide the plants. Most of the remaining costs would be borne by Japan and the USA; other Western States would contribute minor shares.

It will be noted that full implementation of the "Agreed Framework" would require at least ten years. Inspection of the two suspect waste storage facilities and full DPRK compliance with its safeguards agreement would not take place until a significant portion of the light water reactor project had been completed. This was interpreted as meaning that, in practice, at least five to seven years would elapse before the IAEA could have access to the waste stores, as well as to any other location or information needed for verifying the completeness and correctness of the DPRK's initial declaration.

In most of the world the "Agreed Framework" was greeted with a sigh of relief. The danger of a second Korean war had been averted. The Republic of Korea and the DPRK would establish technical co-operation at all levels, opening up the reclusive North to engineers and technicians from abroad. Supporters of the Framework maintained that it was not based in any way on trust; that it would be most strictly verified and that if the DPRK were to deviate in any way from its terms all commitments for the supply of nuclear technology and fuel oil and the establishment of diplomatic relations would immediately lapse. The light water reactors would also make the DPRK dependent on supplies of foreign (low enriched) nuclear fuel for a large part of its electricity production.

There was, however, some sharp criticism in the USA. Critics alleged that the DPRK had negotiated by far the better deal, including 2000 MW(e) of modern nuclear power reactors, a substantial quantity of fuel oil and progress towards diplomatic recognition in return for stopping to do something that it should not have done in the first place and scrapping some obsolete nuclear plant, and that it would encourage other States to follow the DPRK's example. But no one seemed able to come forward with a credible alternative and, in the end, most of the critics seemed reluctantly to accept it.

The IAEA itself was clearly not happy that there would be a delay of at least five years before it could be assured of full implementation of the DPRK's safeguards agreement and, in particular, before it could inspect the two suspect sites and fully verify the DPRK's Initial Report. The main cause of the lengthy and frustrating dispute had been the IAEA's first attempt to exercise its right to carry out a 'special inspection' at an undeclared location and the DPRK's prompt rejection of the IAEA's request. The IAEA's rights of inspection had hardly been strengthened by the "Agreed Framework". And what was the IAEA likely to find in 1999 when it is finally allowed to inspect the two facilities?

But if the "Agreed Framework" had, in fact, persuaded the DPRK to abandon a nuclear weapon programme, and if the concessions made had averted a proliferation chain reaction in North East Asia, the price seemed worth those concessions.

The IAEA had come in for much criticism for its failure to detect Saddam Hussein's secret nuclear weapon programme. It had since re-examined its safeguards system and by mid-1997 introduced a series of major changes. In the DPRK, several of the IAEA's new approaches had been successfully put to the test:

— Using sophisticated analytical techniques, the IAEA had detected a mismatch between the plutonium that the DPRK presented to it as products or in waste. This led the IAEA to conclude that the DPRK had understated the amount of plutonium it had separated.
— The IAEA's Board of Governors had formally reaffirmed the IAEA's right, in the context of comprehensive safeguards agreements, to carry out special inspections at undeclared locations. The DPRK's rejection of such inspections deepened suspicions of its programme (but so far the DPRK had successfully resisted any special inspection of an undeclared site — or such a special inspection at any site).
— The IAEA had been provided with satellite images of sufficiently high quality to convince its Board of the probable existence of undeclared nuclear waste stores. This also established a useful precedent for IAEA access to national intelligence.
— The Board had shown that it was able to take prompt and decisive action, confirming within four days the Director General's demand for a special inspection and thrice finding that the DPRK had been in breach of its safeguards agreement and reporting the breach to the Security Council.
— For the first time (except in the abnormal circumstances of Iraq) the Board had made use of the IAEA's direct line to the Security Council to draw the Council's attention to a deliberate and significant violation of a safeguards agreement.[152]

At the end of 1995, however, the IAEA was still not able to verify the completeness of the DPRK's Initial Report, and the DPRK was still in formal breach of its safeguards agreement, as the General Conference noted in September 1995. Moreover, the 'special inspection' procedure had been shown to be very confrontational.

These are serious issues. Perhaps even more serious was the demonstration that, so far at least, the Security Council has been reluctant to fulfil the commitment implicit in its 31 January 1992 declaration that its members considered the proliferation of all weapons of mass destruction to constitute a threat to international peace and security, and that its members "will take appropriate measures in the case of any violations notified to them by the Agency." While it might be difficult to maintain that the DPRK had 'proliferated', there was no doubt that it had violated its safeguards agreement and Article III of the NPT. If the DPRK had been able to continue its previous course with relative impunity, it would have called into question not only the effectiveness of IAEA safeguards in deterring proliferation, but also the enforcement authority of the Council itself. More broadly, there could have been doubts about the ability of the international community effectively to require or enforce compliance with any multilateral arms control treaty — such as the Chemical Weapons Convention — as well as with the NPT.

For US policy makers the choice was to accept that the DPRK would continue both its reactor construction programme and the separation of more plutonium at the reprocessing plant, or pay the price needed to put a stop to and eventually reverse these programmes. In effect, the USA decided that it could live with the uncertainty about how much plutonium the DPRK had separated — how much more than the amount it had declared — but that it could not accept the continued separation of plutonium, even if it were made legal by being fully declared and placed under safeguards. Thus, in effect, the USA paid the price for the cessation of the plutonium separation programme. But as long as the reprocessing plant remained in place, the DPRK retained some residual leverage.

'Programme 93 + 2'

In 1991 and 1992, Director General Blix secured three of the measures that he deemed essential if the IAEA were to be able to detect another attempt to run a clandestine nuclear weapon programme by a State subject to comprehensive safeguards; in other words, if another State tried to follow the example of Iraq:

— The Board reaffirmed the IAEA's right to carry out a special inspection anywhere in a State that had accepted comprehensive safeguards if this were necessary to confirm that all nuclear material that should be under safeguards had been reported to the IAEA. The Board added that it expected such special inspections to be infrequent. (This reaffirmation was made before and independently of the IAEA's dispute with the DPRK.)
— As Blix put it, the IAEA could not scour the territories of the numerous non-nuclear-weapon States party to the NPT (now more than 180) "in a blind search" for undeclared nuclear plants or material. The right to carry out special inspections would not be of much practical value unless the IAEA knew where to look. The Board concurred in a series of proposals to ensure that the Agency would have more extensive information about the nuclear activities and plans of the States concerned, including access to the results of national intelligence operations.
— The third essential measure was to secure the backing of the Security Council if a nation blocked effective verification of its safeguards agreement with the IAEA. As noted, on 31 January 1992 the President of the Council declared — on behalf of its members, represented at the meeting in question by their heads of State or government — that the Council considered the proliferation of all weapons of mass destruction to be a threat to international peace and security and that its members would take appropriate measures in the case of any violation reported by the IAEA. However, the Council did not recast the President's statement into a more formal and binding commitment.

Environmental sampling

In Iraq the IAEA had tried out a promising new and highly sensitive analytical technique using 'environmental samples' of various materials. This can be very useful in detecting whether undeclared nuclear material exists or undeclared activities (in particular, reprocessing of spent fuel) have taken place.[153] In the DPRK, sensitive analyses of samples taken by IAEA inspectors were used to detect the existence of nuclear material that the authorities had not declared to the IAEA; as noted, they had not told the IAEA the truth about the amount of plutonium they had separated.

More extensive reporting

Non-nuclear-weapon States party to the NPT were already required by their comprehensive safeguards agreements to notify the IAEA of all their exports of nuclear material.[154] The nuclear weapon States had made a similar commitment in regard to exports of nuclear material that should be placed under safeguards in the importing State.[155]

In February 1993, acting on a proposal made by the European Union, the IAEA established a more extensive reporting system under which States would notify the IAEA of all exports and imports of nuclear material and exports of specified equipment and non-nuclear material. The first aim was to provide the IAEA with complete information regarding the non-nuclear-weapon State's holdings *of nuclear material*. The second aim was to identify nuclear activities planned or carried out by a State for which it would need certain *specialized equipment* or *non-nuclear material*, such as heavy water.

Participation in the reporting scheme was voluntary.[156] The European Union States provided the additional information on exports of nuclear material via EURATOM, but they reported individually and direct to the Agency on exports of specified equipment and non-nuclear material.

Verification of the completeness of State declarations

It will be recalled that in verifying compliance with comprehensive safeguards agreements IAEA inspectors had essentially confined their focus, during routine inspections, to *the nuclear material at locations that had been declared* by the State (but the agreement required the State to notify all material in peaceful uses). The IAEA's inspectors would verify the State's reports on its stocks of nuclear material and changes in those stocks ("inventory change reports") chiefly by access limited to a number of pre-defined strategic points in the plant concerned.[157]

The 1971 system was thus largely one of auditing the State's nuclear material accounts, and it had worked well in regard to locations and nuclear material that had been reported to the IAEA.[158] The IAEA's experience in Iraq and the DPRK had shown, however, that it was essential that the Agency should go beyond auditing the State's nuclear accounts. The Agency must be able to assure itself that the State's declarations were also *complete* — that the State had reported all its nuclear material. For this purpose the IAEA would need access to more information and routine access to additional locations.

The IAEA had gained valuable experience from its first comprehensive assessment of the completeness of a State's declaration — namely that made in South Africa after it had acceded to the NPT in 1991.

Progress has been made in achieving a number of these aims. In 1995, the Board authorized the Secretariat to put into effect those elements of the 'Programme 93 + 2' that did not require additional legal authority. In May 1997, the Board approved a protocol, to be added to existing comprehensive safeguards agreements, which will provide the legal authority for several safeguards measures that go beyond the existing system, for instance, access by the IAEA to more information about a State's nuclear activities, more intensive inspections, including access beyond previously agreed 'strategic points' in a safeguarded plant, access to any installation within the perimeter of a nuclear site, and access to plants engaged in nuclear related activities such as those manufacturing components of enrichment plants. The changes foreseen in the protocol are also designed to make safeguards under comprehensive agreements more cost efficient.

In 1993, the Director General decided to codify the results of the IAEA's negative experiences in Iraq and the DPRK and its positive experience in South Africa. The task would also take into account the limitations placed on the IAEA's budget by the 'zero growth' rule, and its purpose would also be to strengthen and improve the cost efficiency of the safeguards system. It was expected that the Secretariat would present its proposals to the Board in 1995, hence the project's name, 'Programme 93 + 2'.[159] Some of its main proposals for greater access, and the rationale for proposing them, are given below.

(1) Additional access in declared plants. The IAEA's experience had shown that it might need to carry out inspections in a declared plant at locations other than those defined beforehand as 'strategic points'. As has been noted, there was no limitation on access when the IAEA carried out a 'special inspection', but experience with the DPRK had also shown that demanding a special inspection could lead to a highly charged political confrontation. If the IAEA needed to go beyond strategic points it should have the right to do so in the course of a routine inspection.[160]

(2) Additional access at a nuclear site. The nuclear research centre at Tuwaitha in Iraq contained more than 80 structures besides the two safeguarded research reactors, their fuel stores and a pilot fuel fabrication plant. Under the rules of the 1971 system (INFCIRC/153), these structures were not accessible

to IAEA inspectors carrying out routine inspections since they had not been identified as nuclear facilities or as containing nuclear material subject to safeguards. It subsequently emerged that some of these structures had housed activities central to the clandestine Iraqi nuclear weapon programme. To avoid a repetition of the Iraqi experience, the IAEA Secretariat felt it essential to have information about the declared functions of all buildings within the perimeter of a nuclear site as well as a right of access to verify their declared functions. If necessary, access to such structures might be 'managed' to permit the plant operator to protect commercially sensitive information.[161]

(3) Access to certain types of plant not containing nuclear material. It would also be essential for the IAEA to have information about, and a limited right of access to, plants in the State that were engaged in activities related to the nuclear fuel cycle, but that did not contain any nuclear material, such as plants that manufactured — or could manufacture — the components of an enrichment facility. An undeclared plant of this type could clearly imply a clandestine nuclear programme.

(4) Cost efficient safeguards. 'Programme 93 + 2' was designed to be more cost efficient and not only to make the IAEA better able to detect diversion at declared facilities (i.e. to strengthen 'classic' safeguards) and detect clandestine programmes. Economy of operation was essential in view of the IAEA's severely limited budget and steadily expanding safeguards responsibilities. By giving safeguards sharper teeth and focusing them on those plants where it might be easier to divert fissile material, the IAEA, it was hoped, could reduce inspection in run-of-the-mill plants, such as light water power reactors.

(5) Board approval and implementation. The Board formally endorsed the launching of 'Programme 93 + 2' in December 1993 and reviewed the programme as it evolved throughout 1994. These efforts were directly supported by SAGSI and by a number of Member States that worked with the Secretariat to test the measures proposed in the programme. In March 1995, the Board endorsed the general direction of the programme and reaffirmed that the safeguards systems should be so designed as to provide assurances regarding both the correctness and the completeness of the declarations that States were required to make about their nuclear materials.[162] In May 1995, the NPT Review and Extension Conference similarly gave its general blessing to the programme.

The Secretariat considered that the Board's approval could best be obtained by putting the programme to the Board in two parts. The first, which the Board approved in June 1995, described those measures to strengthen safeguards that could be taken without additional legal authority. The second part would set forth those measures that would require amplification of such authority and were to be incorporated in a protocol to be added to existing comprehensive safeguards agreements. The second part was submitted to the Board in December 1995, and in June 1996 the Board set up a special open ended committee to draft the protocol. After 55 meetings the Committee completed its work on 4 April 1997 and the Board approved the protocol on 15 May 1997.

During the negotiation of the protocol a number of European Union countries contended that some of the Secretariat's proposals would lead to a very intrusive system, entailing risks to proprietary information, that granting inspection access to buildings which did not contain nuclear material might cause them legal and even constitutional problems, that only more 'responsible' States would accept the new obligations, and that the changes would be discriminatory, putting an additional burden on non-nuclear-weapon States, while the nuclear weapon States would go free.

Some of these issues had arisen in 1970–1971 when the IAEA was negotiating the NPT system and, subsequently, the safeguards agreement with EURATOM. Part of the underlying problem was — and is — that the IAEA must have the same range of inspection authority in all States that have comprehensive safeguards agreements, and a right that may appear to be intrusive in one situation is essential in another. Another, perhaps even more fundamental, problem is that the NPT does discriminate between non-nuclear-weapon and nuclear weapon States. But that is a political reality that the parties to the Treaty have accepted, at least until the aims of Article VI of the Treaty have been achieved. In the meantime the conclusion of a fissile material cut-off treaty coupled with acceptance of 'Programme 93 + 2' by the nuclear weapon States, at least in respect of the nuclear plants they have volunteered to place under safeguards, would do much to eliminate this discrimination.

Growing demands on IAEA safeguards

The dissolution of the Soviet Union and progress towards a universal non-proliferation regime have required the IAEA to apply safeguards, for the first time, in Ukraine, Belarus, Kazakstan, Armenia, in other non-Russian

Republics of the Commonwealth of Independent States and in the Baltic States, and to apply additional safeguards in Argentina, Brazil and South Africa.[163] The dismantling of nuclear warheads is releasing large quantities of plutonium and high enriched uranium and, as noted, the USA has begun placing some of this material under IAEA safeguards. On 11 May 1995, the NPT Review and Extension Conference decided to extend the NPT indefinitely, in other words to make it permanent. By that action, all IAEA safeguards agreements with non-nuclear-weapon States party to the NPT also automatically became permanent.[164]

By the end of 1995, the amounts of material under IAEA safeguards included:[165]

— 45.1 tonnes of separated plutonium. 11.0 tonnes of this separated plutonium, or some 1300 'significant quantities' (SQs) (i.e. roughly the equivalent of some 1300 warheads), were in non-nuclear-weapon States and were safeguarded under comprehensive agreements.[166]
— 4408.5 tonnes of plutonium in irradiated fuel.
— 4 tonnes of recycled plutonium in fuel elements.
— 20.4 tonnes of high enriched uranium, amounting to 608 SQs. 10.0 tonnes of this uranium or, presumably, about 300 SQs, were in non-nuclear-weapon States and safeguarded under comprehensive agreements.
— 47 260 tonnes of low enriched uranium.
— 104 395 tonnes of source material (natural or depleted uranium and thorium).

Since only separated plutonium and high enriched uranium can be directly used in nuclear weapons, the more significant figures, if the possibility of diversion is assumed, were the 11.1 tonnes of separated plutonium and the 10.4 tonnes of high enriched uranium that are held by the non-nuclear-weapon States. Nonetheless, all the material referred to is under safeguards and must be inspected and accounted for.

As noted, the proposed fissile material cut-off convention would put an end to the production of fissile material for nuclear weapons. If the convention is concluded, the nuclear weapon States and the three remaining non-nuclear-weapon States that are operating unsafeguarded nuclear plants, India, Israel and Pakistan, may be required, if they join the convention, to place under IAEA safeguards all their reprocessing and enrichment plants, and all the plutonium and high enriched uranium produced by those plants that continue to operate, as well as any other plants using such material.

Laboratory support of the IAEA's safeguards

When the IAEA began to apply safeguards in the early 1960s, its laboratory had the task of analysing uranium and plutonium samples taken routinely at nuclear plants — essentially research reactors — to which safeguards are applied. After the entry into force of the NPT in 1970, nuclear material in many nuclear plants of all types came under IAEA safeguards and the number of samples to be analysed grew rapidly. This growth was particularly marked when all nuclear material in Canada came under safeguards in 1972 and towards the end of the 1970s when comprehensive safeguards agreements with EURATOM and its non-nuclear-weapon States and Japan came into operation.

In the early 1970s, the IAEA decided to build a special Safeguards Analytical Laboratory (SAL) as part of the Seibersdorf complex, and construction was completed in 1975.[167] However, it was not expected that SAL should analyse all the samples that the IAEA inspectors would take each year. The IAEA and the governments concerned planned to establish a Network of Analytical Laboratories (NWAL) in Member States of which SAL was to become a part. It was foreseen that regular intercomparisons between the laboratories in the network would ensure the high quality and uniformity of their analyses.

In 1972–1973, SAL and eight other laboratories in the network carried out a successful test of the system by analysing typical plutonium products supplied by a reprocessing plant and a fuel fabrication plant in Germany. In a second experiment in 1974–1975, 12 laboratories analysed input solutions supplied by the EUROCHEMIC reprocessing plant at Mol in Belgium.

NWAL came into operation in 1975, analysing about 480 samples that year, chiefly at SAL. In 1976, SAL began the regular analysis of uranium and spent fuel and, in 1979, of plutonium. During the 1980s, SAL itself analysed more than 1000 samples each year and by the mid-1990s the number had grown to about 1500 a year.[168] Much of this work was in support of the IAEA's operations in Iraq or in the development of 'Programme 93 + 2'.

In 1991, the IAEA began to use environmental monitoring in Iraq. To make the most effective use of this technique the Agency completed the building of a 'clean room' as part of SAL in 1995.[169]

Delays in concluding safeguards agreements

As already noted, the NPT requires each non-nuclear-weapon State to conclude a comprehensive safeguards agreement with the IAEA within 18 months of its accession to the Treaty. At the end of 1996, 63 non-nuclear-weapon States party to the NPT had not yet concluded their safeguards agreements. In over 50 of the cases more than 18 months had elapsed since the State had acceded and in several cases the agreements were 20 to 25 years overdue![170]

In practice this situation was less serious than these statistics might suggest. In many cases, such as Burundi or Cambodia, there were extenuating circumstances, and nearly all the States whose agreements were overdue were small developing countries in Africa or Central America having no significant nuclear activities. Only five of the States whose agreements were overdue had any nuclear material or plant that would require the application of safeguards; in three of them all nuclear material was already covered by other comprehensive safeguards agreements pursuant to the Tlatelolco Treaty or a special agreement (Argentina, Colombia, Ukraine). In one of the remaining two (Algeria) all nuclear activities were covered by safeguards based on the pre-NPT system (INFCIRC/66/Rev. 2) and in the other (Georgia) negotiation of a safeguards agreement was under way.

Nonetheless, the conclusion of the safeguards agreement is a requirement of the NPT. To say the least, it was unfortunate that a third of the parties to the treaty that underpins the international non-proliferation regime were formally in non-compliance with one of its quite important provisions. Such non-compliance also provides States that have 'safeguardable' nuclear plants and material with a precedent or pretext for delaying the conclusion of their safeguards agreements — as the DPRK did for almost five years.

Perhaps the fault lies in the NPT itself. It might have provided an alternative requirement — that States that have more than a predetermined amount of nuclear material or a 'safeguardable' nuclear plant must conclude its safeguards agreement with the IAEA within 18 months of acceding to the NPT, but that the State that has neither might, on accession, formally notify the IAEA accordingly, and undertake to conclude a safeguards agreement if and when it acquires plant or material that should be placed under safeguards. Perhaps it is not too late to apply such a procedure; it might be recommended as an interim measure by a future review conference.

The financing of safeguards

In the early years the budget for IAEA safeguards was an integral part of the Agency's regular budget. The argument advanced in favour of this approach was that safeguards, like several other IAEA activities, were of benefit to all members and all should pay according to the standard scale.

In 1971, following the entry into force of the NPT and in expectation that a probable sharp rise in safeguards costs would be resisted by most developing countries, the Board and General Conference approved special arrangements for financing safeguards. These arrangements substantially reduced the shares of the safeguards budget to be paid from 1972 onwards by Member States having relatively low per capita incomes which were henceforth known as 'shielded' countries or contributors. The shielded countries were those whose per capita national income was less than one third of the average per capita income of the ten largest contributors. In 1976, in a further attempt to make rising safeguards costs more acceptable to the G-77, the amounts of the 'shielded' contributions were frozen.

In 1978, the application of the 1971 arrangements brought the USSR into the category of low per capita income countries, but only for one year. In 1980, the ten Member States making the largest contributions to the budget were made ineligible for 'shielding' and the threshold for being shielded was lowered to include only those countries with per capita incomes of less that one third of the 15 (instead of 10) highest per capita income countries.

In 1989, the Board recommended and the General Conference approved a new system that took into account the effect of price increases on the safeguards budget. In effect this 'unfroze' the contributions of 'shielded' countries by permitting their contributions to be raised to take account of price increases. This system was extended in 1992 and applied to the IAEA's budgets for 1993, 1994 and 1995.

In response to the General Conference's request, the Board came forward in 1995 with a complex revision of the 1971 and 1979 systems. Under this revision, poorer Member States would, as a rule, eventually contribute half as much to the safeguards budget as they would have paid under the standard IAEA scale of assessment.[171] The Board would review the new arrangements in or before the year 2000.

Global production, use and stocks of plutonium

It will be recalled that in the wake of the International Nuclear Fuel Cycle Evaluation in the late 1970s and early 1980s, the IAEA Secretariat tried but was unable to obtain international agreement on a system that would implement Article XII.A.5 of the Statute which gives the IAEA the right to call for the "deposit with it" of any surplus civilian plutonium — in other words to establish an international plutonium storage scheme. In the early 1990s, the Secretariat returned to the issue, but it was clear that the political will to create such a storage facility was still lacking.

Nonetheless, the nuclear weapon States and the other main producers and consumers of separated plutonium were coming under pressure to provide more information about their production and stocks of fissile material — to be more 'transparent' as the saying goes. Accordingly, the nine States concerned (the five nuclear weapon States as well as Germany, Japan, Belgium and Switzerland) and the IAEA began meeting informally to agree on means of increasing transparency.

In the early 1990s, as the pace of nuclear disarmament picked up and as new reprocessing plants came into operation, there was growing interest and, in some quarters, concern about the large amounts of high enriched uranium, and in particular about the separated plutonium becoming available from dismantled nuclear weapons and from civilian reprocessing. The high enriched uranium, could be 'blended down', in other words mixed with natural or depleted uranium, and used as low enriched nuclear fuel in light water reactors (the most common power reactor). In low enriched form the uranium could not be used as a nuclear explosive. The plutonium, on the other hand, and particularly the plutonium recovered from dismantled nuclear warheads, would retain its potency as a nuclear explosive. (Plutonium recovered from the spent fuel of light water reactors, if it has been heavily irradiated in the reactor as it should be for most economical use, would contain plutonium isotopes that would make it unsuitable, though not entirely unusable, in a nuclear warhead.)[172]

Many ideas have emerged for dealing with surplus plutonium from dismantled nuclear warheads. It appeared that the two most promising were to mix plutonium oxide with uranium oxide and burn the resulting mixed oxide, or 'MOX', fuel in nuclear power plants, or to mix the plutonium with the highly radioactive fission products that are a by-product of reprocessing, vitrify the mixture and dispose of it deep underground. It has been contended that it would be very difficult and expensive to reverse the process and to try to recover weapon grade plutonium from the MOX fuel or the vitrified product.

In response to the interest and concern about growing stocks of separated plutonium the IAEA began in 1993 to create a database on the amounts of separated plutonium in civilian nuclear programmes and to identify additional confidence building measures relating to the safe handling, storage and disposal of plutonium.[173] The results, in the form of short reports on the production, use and stocks of plutonium, were published in the *IAEA Yearbook* for 1995 and 1996.[174]

The reports in the Yearbooks indicated that because of French, British and Japanese commitments to build new or expand existing reprocessing plants and the deferral of almost all plans to build fast breeder reactors, there was a mismatch between the supply of and demand for civilian plutonium that was likely to last until the year 2001. By then the use of plutonium in MOX fuel might start reducing the surplus stock, which was likely to peak at about 220 tonnes in or around the year 2001. These estimates were, however, sensitive to factors that might slow the growth of demand for MOX fuel or, conversely, delay the full use of civilian reprocessing plants. The matter was further complicated by uncertainties about the fate of more than 100 tonnes of plutonium that might be recovered from dismantled nuclear warheads and might become available as an additional source of MOX fuel.

Safeguards: The situation today

The end of the Cold War and other events since the late 1980s transformed the environment in which IAEA safeguards operated and the scope of their operations. We have noted the expansion of safeguards to the successor States of the former Soviet Union. But that was only one aspect of the transformed picture. Had the Cold War not ended it is at least questionable whether the Security Council would have reached agreement on measures for eliminating Iraq's nuclear weapon potential or on putting some pressure on the DPRK to comply with its safeguards agreement and to negotiate the "Agreed Framework". Or that the Council would have been able to agree unanimously on its January 1992 declaration regarding the threat to international peace and security posed by the proliferation of weapons of mass destruction.

In the case of South Africa, according to President F.W. de Klerk's statements, the changed international security situation made it counter-productive for South Africa to retain its nuclear armaments. South Africa's decision to scrap its nuclear warheads and join the NPT removed the main obstacle to an African nuclear weapon free zone and may have encouraged the negotiation of similar zones in other regions.

Even more fundamentally, the end of the Cold War opened the way to major nuclear disarmament by the Russian Federation and the USA. Without such disarmament there might have been little prospect in 1995 of making the NPT permanent and, with it, making permanent all safeguards agreements concluded pursuant to the Treaty.[175]

The IAEA and its safeguards have thus been major beneficiaries of the end of the Cold War. By providing a bridge between the superpowers from the early 1960s (and, in a sense, since 1955, when the Soviet Union joined the Washington talks) until the termination of the Cold War in the late 1980s, and by pioneering the use of institutionalized on-site inspections, they helped in a modest way to bring about that termination.

NOTES

1 The safeguards programme drawn up in the Initial Report of the Prepcom (document GC.I/1, GOV/1) was vague and general — it amounted to recommending that the IAEA should study ways of implementing the relevant articles of its Statute. In doing so it should keep pace with the development of the Agency's work. Safeguards procedures "should be adapted to the specific character of each individual project and the degree of potential risk of material diversion." There was no suggestion that the IAEA should draw up a detailed safeguards system. The programme did, however, provide for the creation of a Division of Safeguards with a Professional staff of eight and an Inspection Unit with a Professional staff of four, the latter "to plan for the implementation of safeguards and health and safety standards" (GC.I/1, GOV/1, paras 84–85, 141–143 and 124–125). Despite the General Conference's approval of these recommendations, the first Director General was to run into strong opposition in 1958 when he sought to appoint the first staff members of the safeguards Division.

2 Except for the reactors that the USA and United Kingdom temporarily placed under safeguards in the mid-1960s in order to help the IAEA test its system and

procedures and for proposals by certain eastern European States in 1966 (in the run-up to the NPT) for full-scope safeguards in central Europe.

[3] CONGRESS OF THE UNITED STATES, *Background Material for the Review of the International Atomic Policies and Programs of the United States*, Report to the Joint Committee on Atomic Energy, Vol. 3, US Govt. Printing Office, Washington, DC (1960) 808, 827–839.

[4] "Agreement for Cooperation between the Government of the United States of America and the European Atomic Energy Community (EURATOM) Concerning Peaceful Uses of Atomic Energy".

[5] CONGRESS OF THE UNITED STATES, *Review of the International Atomic Policies and Programs of the United States*, p. 837 (Article XII.A of the US–EURATOM Agreement).

[6] Ibid., p. 839.

[7] Ibid., p. 837 (Article XII.D of the US–EURATOM Agreement).

[8] HEWLETT, R.G., HOLL, J.M., *Atoms for Peace and War: 1963–1961, Eisenhower and the Atomic Energy Commission*, University of California Press, Berkeley, CA (1989) 442–443.

[9] HEWLETT, R.G., HOLL, J.M., ibid., p. 430.

[10] CONGRESS OF THE UNITED STATES, *Review of the International Atomic Policies and Programs of the United States*, p. 809.

[11] The IAEA/EURATOM/Five Nation agreement (INFCIRC/193) was approved by the Council of Ministers of the European Community in 1973, but it was not until 1977 that arrangements could be made to put it into operation in the plants of the EURATOM non-nuclear-weapon States. However, at the invitation of the United Kingdom, the IAEA had applied safeguards (chiefly for the purpose of familiarizing IAEA inspectors with the requirements for applying safeguards to MAGNOX-type plants) at the Bradwell power reactor until 1970 and, before and after that date, to small quantities of nuclear material subject to safeguards agreements concluded before the United Kingdom joined the Common Market.

[12] The only non-nuclear-weapon States in which the IAEA was able to apply safeguards during the 1950s and the 1960s were Japan, the European States that were not then members of the European Community or the Warsaw Pact, Australia and a number of developing countries. Of the plants under IAEA safeguards in 1970, substantially the largest number were in Japan. Other than Bradwell — see endnote 11 — the only European plants under IAEA safeguards on 30 June 1970 were two power reactors in Spain and research reactors in Austria, Denmark, Finland, Greece, Portugal, Spain, Turkey and Yugoslavia almost all supplied by the USA, and a fast critical assembly in the United Kingdom. (*Annual Report of the Board of*

Governors to the General Conference 1 July 1969–30 June 1970, GC(XIV)/430, IAEA, Vienna (1970) 40–42.)

[13] This was immediately clear to some delegations in Vienna. Hewlett and Holl write of the "...consternation of other Western nations, which...agreed that the Soviet bloc would never permit the establishment of effective international controls under the Agency if EURATOM were allowed to establish its own system" (HEWLETT, R.H., HOLL, J.M., *Atoms for Peace and War*, p. 442).

[14] Document GOV/OR.83, paras 35 and 60.

[15] STOESSINGER, J.G., "Atoms for Peace: The International Atomic Energy Agency", *Organizing for Peace in the Nuclear Age*, Report of the Commission to Study the Organization of Peace, New York University Press, New York (1959) 182.

[16] Canada set a peppercorn price of $1.00 for the three tons of uranium. See the article by Ambassador William Barton in *Personal Reflections*.

[17] McKNIGHT, A., *Atomic Safeguards: A Study in International Verification*, UNITAR, New York (1971) 46–47. The USSR, India, Indonesia and the United Arab Republic (Egypt) were amongst the critics of the agreement and its accompanying letter which specified the safeguards to be applied pending the approval of "general regulations". The critics claimed that the safeguards proposed were excessive and unnecessary. (Document GOV/OR.117.)

[18] SZASZ, P.C., *The Law and Practices of the International Atomic Energy Agency*, Legal Series No. 7, IAEA, Vienna (1970) 551.

[19] *IAEA Statute*, Article XII ("Agency safeguards").

[20] CONGRESS OF THE UNITED STATES, *Review of the International Atomic Policies and Programs of the United States*, p. 758.

[21] SZASZ, P.C., *The Law and Practices of the International Atomic Energy Agency*, p. 552.

[22] Ibid.

[23] Officially known as *The Agency's Safeguards System (1961)*, document INFCIRC/26.

[24] *The Inspectors' Document*, GC(V)/INF/39, Annex. See SZASZ, P.C., *The Law and Practices of the International Atomic Energy Agency*, pp. 560–561, 599, 607–615.

[25] CONGRESS OF THE UNITED STATES, *Review of the International Atomic Policies and Programs of the United States*, p. 743.

[26] *Annual Report of the Board of Governors to the General Conference 1 July 1960–30 June 1961*, GC(V)/154, IAEA, Vienna (1961), p. 37, paras 228–229.

[27] Ibid., and *Annual Report of the Board of Governors to the General Conference 1 July 1961–30 June 1962*, GC(VI)/195, IAEA, Vienna (1962), p. 21, paras 114, 115 and 118.

[28] McKNIGHT, A., *Atomic Safeguards*, pp. 53–55. Three members of the Board abstained from the decision, which also committed the Board to review the 1961 system. The

power reactors being sold to India were Tarapur-1 and 2 supplied by US General Electric (construction started in October 1964) and Rajasthan-1 supplied by Atomic Energy of Canada Limited (construction started in August 1965). Construction of Rajasthan-2 began in April 1968. The plant the United Kingdom sold to Japan was Tokai-1, the construction of which had already begun in March 1961. (*Nuclear Power Reactors in the World, April 1996 Edition*, Reference Data Series No. 2, IAEA, Vienna (1996) 27–28 and 30.)

29 GOLDSCHMIDT, B., *Le Complexe Atomique*, Fayard (1980) 404.

30 McKNIGHT, A., *Atomic Safeguards*, pp. 55–56. One explanation given for this was that the subject of safeguards was so contentious that once passage had been agreed no one dared to suggest even minor editorial changes, for fear of reopening the debate.

31 SZASZ, P.C., *The Law and Practices of the International Atomic Energy Agency*, pp. 553–554.

32 The abstainers were South Africa and Switzerland (document GOV/OR.357, para. 48).

33 McKNIGHT, A., *Atomic Safeguards*, p. 55.

34 SZASZ, P.C., *The Law and Practices of the International Atomic Energy Agency* pp. 554–555; and McKNIGHT, A., *Atomic Safeguards*, pp. 56–58.

35 The United Kingdom adopted the same policy and turned over to the IAEA responsibility for applying the safeguards prescribed in its bilateral agreements.

36 Paul Jolles told the author that the Swiss, too, preferred to have US inspection. Swiss relations with the USA were cordial and US inspectors were usually friendly and easy going, while IAEA inspectors were an unknown quantity.

37 Information provided by Myron Kratzer, leader of the US delegation at the Safeguards Committee (1970).

38 *Annual Report of the Board of Governors to the General Conference 1 July 1963–30 June 1964,*" GC(VIII)/270, IAEA, Vienna (1964), p. 28, paras 130 and 132. The text of the USA–IAEA agreement is given in document INFCIRC/47.

39 "Virtually all their nuclear material", since the NPT does permit non-nuclear-weapon States to withdraw nuclear material from safeguards if the material is to be used for non-explosive military purposes such as propulsion of submarines. This question is examined later in this chapter.

40 Published as document INFCIRC/153.

41 In such cases the prohibition against any military use of the supplied items remained in force.

42 That is, the closing date of the last IAEA Annual Report before the approval of INFCIRC/66. In 1975, the Board accepted Director General Eklund's proposal that

henceforth the IAEA should publish only a single annual report (thus eliminating the special annual reports to the General Assembly and ECOSOC) and that the report should cover the calendar year instead of, as previously, the period from 1 July of a given year to 30 June of the next.

43 *Annual Report of the Board of Governors to the General Conference 1 July 1969–30 June 1970*, pp. 35–36 and 38–42, paras 99, and 115 (Table 22).

44 GOLDSCHMIDT, B., *Le Complexe Atomique*, p. 176.

45 LEWIS, J.L., LITAI, X., *China Builds the Bomb*, Stanford University Press, Stanford, CA (1988) 60–61.

46 *Annual Report of the Board of Governors to the General Conference 1 July 1962–30 June 1963*, GC(VII)/228, IAEA, Vienna (1963), p. 18, para. 114; and *Annual Report of the Board of Governors to the General Conference 1 July 1963–30 June 1964*, p. 29, para. 133.

47 *Annual Report of the Board of Governors to the General Conference 1 July 1965–30 June 1966*, GC(X)/330, IAEA, Vienna (1966), p. 47, para. 208.

48 *Annual Report of the Board of Governors to the General Conference 1 July 1969–30 June 1970*, p. 38, para. 115.

49 *Annual Report of the Board of Governors to the General Conference 1 July 1967–30 June 1968*, GC(XII)/380, IAEA, Vienna (1968), pp. 30–31, paras 120–121 and 126.

50 *Annual Report of the Board of Governors to the General Conference 1 July 1968–30 June 1969*, GC(XIII)/404, IAEA, Vienna (1969), p. 34, para. 124.

51 GOLDSCHMIDT, B., *Les Rivalités Atomiques*, Fayard, Paris (1967) 289.

52 Finland was the second non-nuclear-weapon State to ratify the NPT — on 5 February 1969. (Ireland was the first.) Finland wished to be the first party to conclude a safeguards agreement with the IAEA, an ambition that it achieved on 9 February 1972.

53 A description of the work done in preparing for the application of safeguards under the NPT is given in ROMETSCH, R., "Development of the IAEA safeguards system for NPT", *Peaceful Uses of Nuclear Energy* (Proc. 4th Int. Conf. Geneva, 1971), Vol. 9, UN, Geneva (1971) 386–396.

54 *Annual Report of the Board of Governors to the General Conference 1 July 1969–30 June 1970*, p. 37, para. 109.

55 Namely, the difference between the amount of nuclear material in an MBA calculated on the basis of reports by the plant manager, and the amount of material actually found to be present when stock is taken.

56 *Annual Report of the Board of Governors to the General Conference 1 July 1969–30 June 1970*, p. 37, para. 109.

57 The issues addressed included studies of the problems of measuring the amounts of nuclear material ('inventories') in various parts of reprocessing plants when they are in continuous operation, the rapid measurement of quantities of plutonium and

uranium in the liquid wastes of such plants and on monitoring the movement of spent fuel (*Annual Report 1 July 1970–30 June 1971*, GC(XV)/455, IAEA, Vienna (1971), p. 7, para. 2, and p. 45, para. 117). The resolution of the Board of Governors (largely a British draft, co-sponsored by Italy and the USA) asked the committee to advise the Board "on the Agency's responsibilities in relation to safeguards in connection with the Treaty, and in particular on the content of the agreements which will be required in connection with the Treaty" (document GOV/INF/222). The leading Western members of the Board envisaged that the Committee would first draft the model to be followed in agreements with individual States and then prepare a model for the agreement to be concluded with groups of States — in practice this meant EURATOM. It soon became clear that it would be politically feasible to draft only a single model agreement and that this model (i.e. INFCIRC/153) would have to serve as the basis for negotiations with EURATOM as well as individual States.

Since the agreements to be concluded pursuant to Article III.1 of the NPT are to verify that the non-nuclear-weapon State is not diverting nuclear material *in that State or under that State's jurisdiction or control,* and since the NPT already contained an article calling for safeguards on nuclear exports (Article III.2), the Committee and the model agreement did not address the question of what safeguards should be applied to nuclear exports after they had left the non-nuclear-weapon State concerned. (INFCIRC/153 only requires that a non-nuclear-weapon State must notify the IAEA of all exports of nuclear material to other non-nuclear-weapon States. What safeguards are to be applied when nuclear material or equipment reaches the importing State are prescribed in general terms in Article III.2 of the NPT.) See FISCHER, D.A.V., *Towards 1995: The Prospects for Ending the Proliferation of Nuclear Weapons*, UNIDIR, Dartmouth Publishing, Aldershot (1993), Chapter 5, "Safeguards", and Chapter 6, "Export Conditions and Controls").

[58] NPT, Article III.4.

[59] Document SAF/112.

[60] Document GOV/COM.22/3.

[61] RAINER, R.H., SZASZ, P.C., *The Law and Practices of the International Atomic Energy Agency: 1970–1980, Supplement 1 to the 1970 Edition of Legal Series No. 7*, Legal Series No. 7-S1, IAEA, Vienna (1993) 289–291.

[62] The broad outline of the agreements to be concluded with non-nuclear-weapon States and the timetable for the negotiation of the agreements are set forth in Articles III.1 and III.4 of the NPT.

[63] On many issues the United Kingdom, then on the verge of joining the Common Market, tended to side with the non-nuclear-weapon States of EURATOM and may

have been the proponent of the limits on "inspection effort" that were incorporated in the Safeguards Committee's recommendations. However these limits are far above the effort actually deployed by the IAEA and thus had little practical significance. (Information provided by Myron Kratzer.)

64 In particular, the sixth paragraph of the Preamble and Article III.1 of the NPT.

65 In fact, most if not all nuclear plants and fuel in Japan were already subject to INFCIRC/66/Rev. 22 safeguards agreements.

66 The Committee agreed, however, that the obligation to accept safeguards (and hence to declare nuclear material) extended to all nuclear material *that was required to be safeguarded under the agreement*, i.e. all material in the State or under its jurisdiction or control anywhere — except material in a permitted military use. Failure to declare material would thus be a breach of the agreement.

67 For instance, if the information provided by the State was "not adequate for the Agency to fulfil its responsibilities under the agreement" (INFCIRC/153, para. 73). These responsibilities include that of ensuring "...that safeguards will be applied, in accordance with the terms of the [safeguards] Agreement on all source and special fissionable material..." in all the State's peaceful nuclear activities. The reference to "peaceful nuclear activities" reflects the fact that the NPT does not prohibit non-explosive military activities, such as the use of nuclear power to propel warships, and that such activities cannot be 'safeguarded' by the IAEA. INFCIRC/153 accordingly provides a procedure (para. 14) for withdrawing nuclear material from safeguards for such non-peaceful uses. These procedures have never been invoked.

68 Document INFCIRC/153, subparas 71(a), 71(b) and 76(a).

69 As noted, the Committee's remit was limited to the actions to be taken by non-nuclear-weapon States and by the IAEA in applying safeguards in those States. The absence of a national system of accounting for and control of nuclear material in the Russian Federation (which, as a nuclear weapon State, was not required to have such a system), and of such systems in the non-Russian members of the CIS when they gained independence partly accounts for current concerns about trafficking in nuclear material in those States.

70 By the time the Committee reached paragraph 81 of the 116 paragraphs of the model agreement it had become clear to the EURATOM countries that there would be no re-run to prepare recommendations concerning the content of agreements to be concluded with "groups of States".

Paragraph 81 of INFCIRC/153 lists the criteria that the IAEA should apply in determining the number, duration, intensity, etc., of the inspections it will carry out at a particular nuclear plant. Subparagraph 81(b) includes as one of the criteria "the effectiveness of the State's accounting and control system..." This omits one word from the corresponding formulation in paragraph 7 of the model agreement which requires that the IAEA "...in its verification, shall take due account of the *technical* effectiveness of the State's system" (emphasis added). During the negotiation of the IAEA–EURATOM agreement the EURATOM delegation maintained that the elimination of the word "technical" in subpara. 81(b) had been deliberate and that it required the IAEA to take account of the political as well as the technical effectiveness of the EURATOM system. The IAEA delegation did not accept this tortuous argument.

71 The definition of 'nuclear material' does not include ore (INFCIRC/153, para. 112).

72 In effect what had happened was that when the EURATOM parties abandoned their original plan that the safeguards committee should negotiate two basic documents, one for individual States and the second for groups of States, they had tacitly left it to the IAEA Secretariat to negotiate the second document directly with EURATOM. The original EURATOM mandate is still reflected in the German name for the agreement, "Das Verifikationsabkommen".

73 The IAEA negotiators took the position that there was no provision in INFCIRC/153 that would permit the IAEA to discriminate on political grounds between its arrangements with EURATOM and those with any other State's system of accounting for and control of nuclear material. Discrimination could only be justified on the grounds implicit in para. 81(b) of INFCIRC/153 that a particular State's system was technically more effective and functionally more independent than another State's system. Hence, if any other State established and maintained a SSAC comparable with that of EURATOM it would be entitled to comparably favourable treatment.

Only Japan decided to follow this path. Australia formally reserved its right to negotiate an agreement similar to that with Japan but it has not done so, perhaps because the very modest Australian nuclear programme (apart from uranium mining and export) has hardly changed since 1970.

74 Document GOV/OR.475, paras 33–38.

75 Document GOV/1823 of 3 February 1977.

76 *IAEA Statute*, Article II.

77 Spain acceded to the NPT on 5 November 1987 and to the IAEA–EURATOM–EURATOM non-nuclear-weapon States agreement on 5 April 1989.

78 Document GOV/OR.474, paras 60–62.

79 The agreement with France and the Republic of Korea (INFCIRC/233) entered into force on 22 September 1975, with France and Pakistan (INFCIRC/239) on

18 March 1976 and with the Federal Republic of Germany and Brazil (INFCIRC/237) on 26 February 1976.

80 In 1977, when President Carter announced that he intended to withdraw certain US troops from the Republic of Korea, the South Korean Government responded by threatening to "go nuclear" — to acquire nuclear weapons. REISS, M., *Without the Bomb: The Politics of Nuclear Nonproliferation*, Columbia University Press, New York (1988) 78–108.

81 Communication from Myron Kratzer.

82 *Nuclear Power Reactors in the World, April 1996 Edition*, p. 43. One nuclear power plant, Angra-1, completed by Westinghouse in 1984, is operating at the same site, Angra dos Reis.

According to *Nucleonics Week*, the Brazilian utility concerned, Furnas, estimated that by the time the Angra-2 plant was completed in 1999 it would have cost $7.2 billion. Furnas' holding company and state electricity monopoly, ELECTROBRAS, put the total cost at $10 billion, the same as the estimate made in 1994 by Brazil's federal audit court. Reportedly, the construction company had run into great depths of soft sand when it tried to lay the foundations of the plant; costs had also risen because of 'on-again, off-again' construction. ("Furnas says Angra-2 will be ready for June 1999 commercial operation", *Nucleonics Week* (23 January 1997) 10.)

83 The guidelines identified as 'sensitive' enrichment and reprocessing plants and plants for the production of heavy water.

84 The leader of the project was an outstanding nuclear engineer working in the IAEA Secretariat, Robert Skjöldebrand.

85 There are two other important multilateral nuclear ventures, Eurodif and Urenco. The first is a large gaseous diffusion enrichment plant built and operated by France, but in which other States (notably Italy and Iran) originally made substantial capital investments. Urenco is essentially an arrangement between Germany, the Netherlands and the United Kingdom for marketing the product of their gas centrifuge plants at Gronau, Almelo and Capenhurst.

86 *Annual Report of the Board of Governors to the General Conference 1 July 1965–30 June 1966*, p. 41, para. 201; *Annual Report of the Board of Governors to the General Conference 1 July 1966–30 June 1967*, GC(XI)/355, IAEA, Vienna (1967), p. 28, para. 100; and *Annual Report of the Board of Governors to the General Conference 1 July 1967–30 June 1968*, p. 29, para. 112.

87 Documents INFCIRC/207, INFCIRC/207/Add. 1 and INFCIRC/207/Add. 2 of 26 July 1974, March 1984 and December 1991. The texts of the notifications from the five nuclear weapon States are identical.

88 Document INFCIRC/153, para. 92.

89 NPT, Article III.2.

90 The adjective 'universal', which appears in the *Annual Report for 1991*, GC(XXXVI)/1004, IAEA, Vienna (1992) 143, was subsequently and rightly dropped.

91 *Annual Report of the Board of Governors to the General Conference 1 July 1966–30 June 1967*, p. 5, para. 3.

92 *The Annual Report for 1994*, GC(39)/3, IAEA, Vienna (1995), p. 187, footnote (e).

93 Brazil ratified the Treaty but refrained from waiving the four conditions set by the Treaty for its entry into force.

94 *Annual Report for 1995*, GC(40)/8, IAEA, Vienna (1996), p. 70, Table and p. 71, footnote (a).

95 On a number of occasions the IAEA has asked the nuclear weapon States to review these estimates, most recently, it is understood, in 1996.

96 Eklund described to the Board the 'diversion scenarios' that could theoretically be possible, and their flaws (Document GOV/OR.571, paras 20–26).

97 This statement and several of the following points are based on GRUEMM, H., "Safeguards and Tamuz, setting the record straight", *IAEA Bull*etin **23** 4 (December 1981) 10–14. At that time, Professor Gruemm was Deputy Director General in charge of the Department of Safeguards.

98 France's lack of confidence in Iraqi intentions was also implicit in an exchange of letters of 11 September 1976 between France and Iraq that the French Government brought to the IAEA's notice. The letters constitute an agreement that the two countries would conclude with the Agency a trilateral safeguards agreement (pursuant to INFCIRC/66, Rev. 2) if Iraq's NPT agreement were to lapse, as it would have done if the NPT itself had lapsed. Furthermore, the two countries agreed that if the trilateral agreement failed to come into force three months before the lapse of Iraq's NPT agreement, the safeguards provisions of the NPT agreement would continue to be applied *so as to ensure fulfilment of the agreement under which France had supplied the reactor to Iraq*. (RAINER, R.H., SZASZ, P.C., *The Law and Practices of the International Atomic Energy Agency: 1970–1980*, p. 341.)

99 Under the NPT safeguards system, as under previous IAEA systems, the Agency is required "to secure the consent of the State to the designation of Agency inspectors to that State" (INFCIRC/153, para. 9). This provision enables the State concerned, if it is acting in bad faith, to reject any inspector that might be too curious.

100 As later events were to show, Tuwaitha illustrated the vital importance to effective safeguards of having access to high definition satellite images.

101 *Annual Report for 1981*, GC(XXVI)/664, IAEA, Vienna (1982), p. 10, para. 22.

[102] For example, by comparing reports from Canada and Pakistan on shipments and receipts of the fuel.

[103] The Kanupp reactor was covered by an INFCIRC/66 agreement and hence subject to "access at all times" by IAEA inspectors. It is not clear why the IAEA Secretariat did not invoke this provision when Pakistan objected to the additional safeguards proposed by the IAEA.

[104] *Annual Report for 1982*, GC(XXVII)/684, IAEA, Vienna (1983), p. 15, footnote (3). In the Annual Reports for 1981 and 1982, the Secretariat noted, however, that in two cases (the Pakistani and Indian plants) it had not been able to conclude that all material under safeguards in 1981 and 1982 had "...remained in peaceful nuclear activities or was otherwise adequately accounted for," *Annual Report for 1982*, p. 15, para. 54. In other words, in these two cases the Secretariat was unable to provide the blanket assurance it had given in all previous Annual Reports about the non-diversion of safeguarded nuclear material.

[105] *Annual Report for 1982*, p. 15, para. 53. It will be recalled that the USA and the United Kingdom had offered to place all civilian nuclear plants, and France certain nuclear plants, under safeguards.

[106] *Annual Report for 1983*, GC(XXVIII)/713, IAEA, Vienna (1984), p. 13, para. 34; and *Annual Report for 1985*, GC(XXX)/775, IAEA, Vienna (1986), p. 12, para. 29.

[107] See document INFCIRC/153, para. 14. For instance, the State would have to inform the Agency of the activity in which it planned to use the nuclear material it was withdrawing from safeguards. The State would have to make it clear that such use was not in conflict with any undertaking the State might have given and in respect of which IAEA safeguards applied (e.g. if the material had been imported the State would have to make it clear that the material was not subject to a "peaceful use only" undertaking). The State would have to make an arrangement with the IAEA identifying as far as possible how long and under what circumstances safeguards would not apply. As soon as the material was reintroduced into a peaceful activity (such as reprocessing or re-enrichment), safeguards would again apply.

[108] *Nuclear Research Reactors in the World, July 1990 Edition*, Reference Data Series No. 3, IAEA, Vienna (1990) 39.

[109] The core of the reactor contained about 3.2 kg of 80% enriched uranium (ibid., p. 56). A further 29.7 kg were in storage as fresh or irradiated fuel. (FISCHER, D.A.V., *Towards 1995: The Prospects for Ending the Proliferation of Nuclear Weapons*, p. 48.)

[110] Iraq also had several hundred tons of uranium concentrates from Portugal and Niger. The NPT required Iraq to notify the IAEA of the import of the uranium concentrates, but such materials are not subject to other safeguards. In other words, the IAEA did not have the right to inspect them.

[111] The USA used electromagnetic isotope separators to produce high enriched uranium for the Hiroshima bomb. The machines were also known as 'calutrons', after the University of California where they had been devised by Professor Ernest Lawrence.

[112] Besides the Action Team's office at IAEA Headquarters, it was provided with accommodation in Baghdad at the Monitoring and Verification Centre established by UNSCOM. The team had a staff of 16, including 4 provided by Member States cost free to the IAEA. The team was established separately from the IAEA Department of Safeguards but drew upon it (and upon Member States) for expert help.

[113] None was detected in the first months of 1997.

[114] It consisted of 208 irradiated fuel assemblies from Iraqi research reactors.

[115] 1.8 tonnes of low enriched, 6 tonnes of depleted, and 540 tonnes of natural uranium.

[116] Paragraph 1 of INFCIRC/153, the model for the standard NPT safeguards agreement.

[117] An unofficial French estimate was that the programme employed about 20 000 workers at more than 30 sites and would have cost about $15 billion if carried out in an industrialized country (estimate made to the author by Georges Le Guelte, former Head of External Relations at the Commissariat à l'Energie Atomique).

[118] GC(XXXV)/OR.341, paras 76–78.

[119] *The United Nations and the Iraq–Kuwait Conflict, 1991–1996*, IAEA Director General's Eighth Report to the Security Council on the Implementation of the Agency's Plan for Future Ongoing Monitoring and Verification of Iraq's Compliance with Paragraph 12 of Resolution 687 (1991), S/1995/844, 6 October 1995, Document 213, Unnited Nations, New York (1966) 766–768.

[120] *BBC World Service*, 0400 GMT, 12 August 1991.

[121] *IAEA Press Release*, PR/91-24 of 18 July 1991.

[122] But, as noted, they did not detect the unreported production of a few grams of plutonium, in violation of the safeguards agreement.

[123] Some clandestine activities were carried out at the Tuwaitha centre, regularly visited by IAEA inspectors, but inspections were confined to 4 of the 85 structures within the perimeter of the centre, namely the two research reactors, an away-from-reactor fresh fuel store and a pilot fuel fabrication plant.

[124] Paragraph 77 of INFCIRC/153 provides that "...in circumstances which may lead to special inspections...the State and the Agency shall consult forthwith. As a result...the Agency may make inspections in addition to [its routine inspections]…, and may obtain access in agreement with the State to information or locations in addition to the access specified...for ad hoc and routine inspections… In case action

by the State is essential and urgent, paragraph 18 above shall apply." Before 1991, the IAEA had apparently carried out one or two special inspections (which it may do if the State submits a special report indicating that there may have been an unusual loss of nuclear material or if the containment of a plant had unexpectedly changed (INFCIRC/153/para. 68), but the IAEA had not carried out a special inspection at an additional location, i.e. at a location not declared by the State concerned.

[125] Document INFCIRC/153, para. 73.

[126] Document INFCIRC/153, para. 18.

[127] Document INFCIRC/153, para. 19.

[128] *IAEA Statute*, Articles III.B.4, XII.C, XVI.B.1.

[129] LEWIS, P., "UN bomb experts put back estimate of Iraq's progress", *International Herald Tribune*, 21 May 1992.

[130] But it has been said that if the large calutron plants had gone into full operation their presence would have become obvious to satellites by reason of the large 'heat sinks' and the electromagnetic disturbances that they would have created. It is difficult to believe that the operation of two vast complexes, each containing some three hundred buildings and other structures and each occupying several square kilometres, could have remained undetected indefinitely.

[131] *IAEA Safeguards Glossary — 1987 Edition*, IAEA/SG/INF/1 (Rev. 1), IAEA, Vienna (1997) 23. The 'significant quantity' is the approximate quantity of special fissionable (fissile) material required for a single nuclear explosive device. SAGSI's approximation takes into account "unavoidable losses of conversion and manufacturing processes."

[132] Comment by the IAEA Department of Safeguards.

[133] Under para. 80(a) of INFCIRC/153, the maximum amount of routine inspection of a reactor or sealed store with a content exceeding five effective kilograms is one sixth of a person-year, or 50 person-days. However, in determining the actual number of inspections, the Agency must take account of several factors, including the accessibility of the nuclear material, which decreases if the material has been irradiated since it would take longer to process it for use in a nuclear explosive device. While the IAEA should apply uniform verification standards in fully comparable situations, it has some latitude, if it wishes to use it, in determining the actual number of inspections it will carry out at a plant in this category during each year. It will be recalled that Professor Gruemm wrote that it was envisaged that the IAEA would increase the frequency of inspections at Tamuz 1 to twice a month as soon as the first full fuel load was in place.

[134] It is widely assumed, for instance, that the nuclear weapon States use only some 4 kg of plutonium in their nuclear warheads (and not the 8 kg that the IAEA defines as a 'significant quantity'). It is also theoretically possible to reduce much

further the amount required. But IAEA safeguards are designed to detect diversion in 'beginner' States and not in those States that have long and extensive experience in manufacturing nuclear weapons.

135 Document INFCIRC/153, para. 28. As noted above (endnote 97), it is understood that in 1996 the IAEA sent a letter to the nuclear weapon States asking for advice on changing the values set for 'significant quantities'.

136 Another question is suggested by the fact that national intelligence agencies apparently failed to detect the vast Iraqi programme. If this is correct, how much confidence can there be that national intelligence would detect smaller clandestine programmes in other countries? Future technical advances, such as the use of lasers to enrich uranium or to transform reactor grade into weapon grade plutonium, may make concealment even easier.

137 The concept is reflected in Articles 14, 16, 17 and 21 of the protocol to the IAEA–EURATOM agreement. Briefly, these provide that the IAEA will carry out routine inspections simultaneously with *certain* of EURATOM's inspections, that the two agencies will agree in advance in which EURATOM inspections the IAEA will take part, that EURATOM will notify the IAEA in advance of its detailed inspection plans so that the IAEA can decide at which inspections it will be present and that the IAEA will get working papers for those inspections at which the IAEA will be present and inspection reports for all other EURATOM inspections.

138 The new approach is described in GOV/INF/654 of 13 May 1992 and the Annex.

139 That is, that in certain types of plant the IAEA would *observe* the work of EURATOM inspectors; an ambiguous legacy of the original EURATOM concept that the IAEA would do no more than verify the efficacy of EURATOM's safeguards.

140 To the uninitiated observer this sounds very much like a 'joint team'!

141 Document GOV/INF/793, p. 7, para. 19.

142 Because MOX fuel is a mixture of low enriched uranium and plutonium oxides and because the plutonium can be directly used to make a nuclear device, plants producing MOX fuel and MOX fuelled reactors require more frequent inspection than plants that fabricate low enriched uranium fuel and reactors fuelled with low enriched uranium.

143 Reportedly four WWER-440 MW(e) nuclear power reactors.

144 Its political conditions had, in fact, been largely met. They were, for instance withdrawal of US tactical nuclear weapons from the Korean peninsula, halting the joint USA–Republic of Korea annual ('Team Spirit') military manoeuvres.

The DPRK was far from alone in missing the deadline for the conclusion of its NPT safeguards agreement with the IAEA.

145 Document INFCIRC/153, para. 62. The report should be sent within 30 days after the end of the month when the agreement entered into force. (It should also specify the location as well as the amounts and composition of the material.)

146 As noted elsewhere, the IAEA assumes that a nation embarking on a nuclear weapon programme will need 8 kg of plutonium for its first nuclear warhead. However, it is generally believed that with experience this quantity can be reduced to 4–5 kg, or even less.

147 The plutonium, the nuclear waste from which it was said to have been separated, and traces of radioactive material on the surfaces of the radiochemical laboratory, were analysed in the laboratories of the IAEA and the USA.

148 As noted above, this procedure is foreseen in paragraphs 73 and 77 of the standard IAEA safeguards agreement which permits the IAEA to send its inspectors to any location where it has reason to believe that undeclared nuclear material may exist.

149 For instance:

— In October 1993, after the IAEA's General Conference had adopted a resolution declaring that the DPRK "had widened the area of non-compliance by not accepting ad hoc and routine inspections," that country suspended all inspections.

— On 2 and 3 December 1993, Blix warned the Board that safeguards "cannot be said at present to provide any meaningful assurance of peaceful use" of the declared plants.

— After further discussions with the USA, the DPRK agreed, in effect, to freeze its programme and to unload the 5 MW(e) reactor only in the presence of IAEA inspectors. But — see below — in May 1994, the DPRK violated this agreement.

— Once again, on 21 March 1994, the Board of Governors formally declared that the IAEA was no longer able to verify that the DPRK had not diverted nuclear material and referred the matter to the Security Council. The Western members of the Council and Russia pressed for a resolution that would threaten the DPRK with sanctions, but China objected.

— In April 1994, the DPRK authorities asked the IAEA to remove the seals from the fuel assemblies of the 5 MW(e) reactor so that the fuel could be withdrawn for reprocessing, which, they maintained (probably correctly), was essential for safety reasons. The IAEA explained that it would be necessary not only to observe the withdrawal and subsequent treatment of the fuel, but also to take samples to determine whether, as the DPRK maintained, the core being withdrawn was the first core of the reactor. However, the DPRK refused to allow any sampling.

— In May 1994, ignoring fresh warnings by the IAEA and the USA that the 5 MW(e) reactor should not be unloaded except in the presence of IAEA inspectors, the DPRK operators broke the seals on the reactor and began to withdraw as quickly as possible its 8000 fuel rods. This breach of the safeguards agreement led to further IAEA reports to the Security Council on 19 and 27 May 1994.

— On 30 May, the President of the Council issued an agreed statement calling upon the DPRK forthwith to unload the 5 MW(e) reactor in a way that would permit the IAEA to do whatever it deemed necessary for effective verification. On 2 June, the DPRK rejected the Council's requests.

150 The substitution of light water reactors for graphite moderated reactors was justified on the grounds that light water reactors do not normally produce weapon grade plutonium.

151 If it did decide to do so it would have to reapply for membership and its application would have to be approved by the General Conference of the IAEA.

152 On one previous occasion the Board did report to the Council undeclared production of plutonium — by the Ceauçescu regime — but this was with the agreement of the new Romanian Government, which had brought the matter to the IAEA's notice. The more incisive stance of the IAEA forced the DPRK onto the defensive, complaining that IAEA inspectors had behaved like policemen searching the house of a suspect instead of like invited guests!

153 The distinctive physical properties of nuclear materials make it possible to detect even minute traces and to correlate specific physical 'signatures' with specific nuclear operations such as reprocessing, enrichment, fuel fabrication and reactor operation. Samples of air, water or even swabs wiped on the surfaces of nuclear plants or equipment are analysed for traces of radioactive material. The technique involves the analysis of very small amounts of nuclear material contained in single particles. By this method uranium or plutonium can be detected and isotopically characterized in amounts as small as 10^{-18} to 10^{-15} grams.

154 Document INFCIRC/153, paras 92–94.

155 Document INFCIRC/207 and Addenda.

156 By the end of 1996, more than 50 States had chosen to participate in the expanded reporting scheme.

157 The way in which this system operates has often been compared with that of an auditor: the IAEA audits the nuclear accounts of all NPT non-nuclear-weapon States. (See HOOPER, R., "Strengthening IAEA safeguards in an era of nuclear co-operation", *Arms Control Today* (November 1995) 15.) As already noted, however, there would be no limit on the IAEA's access rights in the case of a special inspection.

158 Until 1991, the IAEA had no information pointing to an undeclared facility or material in a State having a comprehensive safeguards agreement. It should be stressed that the 1971 system was designed to detect any diversion of nuclear material placed under safeguards (or required to be placed under safeguards). If the IAEA's verification disclosed that a significant quantity of material was unaccounted for, this might point to the existence of an undeclared plant, for instance an enrichment plant where the material was being processed into nuclear explosives, or a reprocessing plant that was separating plutonium from spent fuel. No such diversion has been detected, and it is most unlikely that any has occurred.

159 For a more detailed assessment of 'Programme 93 + 2', see PELLAUD, B., *Safeguards and the Nuclear Industry*, Core Issues No. 5, The Uranium Institute, London (1996) and HOOPER, R., "IAEA safeguards 'Programme 93 + 2'", prepared for the PPNN Seminar, 7–8 March 1997, Harriman, NY. Available from the Programme for Promoting Nuclear Non-Proliferation, Department of Politics, Mountbatten Centre, University of Southampton, Southampton, 507 1BJ, United Kingdom. Dr. Pellaud is currently Deputy Director General in charge of the Department of Safeguards at the IAEA and Hooper is Director of the Division of Concepts and Planning in that Department.

160 The Head of the South African Atomic Energy Corporation, Waldo Stumpf, told the author that when South Africa acceded to the NPT in July 1991, the Security Council had recently approved the very intrusive inspection measures designed to uncover the full extent of the Iraqi programme and to eliminate it. The South Africans feared that they would be faced with a spate of demands for special inspections, which they expected to be highly confrontational. To avoid this they had told the Agency that its inspectors could go to any place any time (within reason) in their country.

161 For instance, the IAEA might be required to give advance notice if its inspectors wished to enter such a structure. The occupants might have the right to cover sensitive equipment, provided that 'managed access' should not prevent the IAEA from meeting its safeguards objectives.

162 That is, non-nuclear-weapon States party to comprehensive safeguards agreements with the IAEA, concluded pursuant to INFCIRC/153.

163 On 31 December 1995, there were 181 parties to the NPT, 40 more than in 1990 (on 1 January 1991 there were 141 parties — *SIPRI Yearbook 1991*, Oxford University Press, Oxford (1991) 668). The new adherents included global powers and regional leaders: China, France, South Africa and Argentina. Brazil, like Argentina, has accepted comprehensive IAEA safeguards under the Tlatelolco Treaty and the

agreement between ABACC and the IAEA. (By June 1997, the number of parties had risen to 185.)

164 Brazil is a party to the Tlatelolco Treaty but not to the NPT. Since the Tlatelolco Treaty is permanent, the comprehensive safeguards agreement that Brazil has concluded with the IAEA, pursuant to that Treaty, is also permanent.

165 *Annual Report for 1995*, p. 77.

166 Separated plutonium and high enriched uranium are the materials that can most easily and quickly be used in warheads. However, 34 tonnes out of the 45.1 tonnes of separated plutonium were in nuclear weapon States, presumably most in the United Kingdom, which has placed a large quantity of separated plutonium under safeguards.

167 The descriptions of SAL, NWAL and their work is based on the IAEA pamphlet, *International Atomic Energy Agency's Laboratories: Seibersdorf*, GEN/PUB/15, IAEA, Vienna (1989) pp. 79–80.

168 *Annual Report for 1994*, p. 194.

169 *Annual Report for 1995*, p. 47. For the detection and analysis of samples of materials containing minute trace amounts of radionuclides, it is essential to have a laboratory area — a 'clean room' — that is as free as possible of any matter (dust, particles, vapour) that might contaminate the samples and distort the analysis. The Seibersdorf Clean Room became operational in 1996.

170 *Annual Report for 1995*, p. 45.

171 The new system was set forth in resolution GC(39)/RES/11, which the General Conference adopted on 22 September 1995. Its main elements were:

(1) The budget would include a non-safeguards and a safeguards component.
(2) Poorer Member States, i.e. those "having per capita net national product of less that one third" of the average of the 15 richest members, would constitute a shielded group. A Member State could voluntarily opt out of the shielded group.
(3) All Member States would contribute to the non-safeguards component according to a standard scale derived from the UN scale of assessment
(4) Members of the shielded group would pay only half as much to the safeguards component as they would have under the standard scale, but with the proviso that no member of this group would have to contribute to any increase in the safeguards budget above the rate of inflation (i.e. above "zero real growth").
(5) None of the ten countries making the largest contribution to the Agency's regular budget could be a member of the shielded group, even if it would have qualified under (4).

(6) There would be a five year transitional period during which each shielded member would gradually move up from its 1995 safeguards contribution to the amount it would pay under the new system (i.e. the amount it would have to pay under (4)).
(7) Member States not belonging to the shielded group would make up the deficit in the safeguards budget caused by the reduced contributions of the shielded group.

172 This is a very controversial issue. In the early 1960s, the USA successfully tested a nuclear device fuelled with 'reactor-grade plutonium' — plutonium recovered from spent fuel 'burned up' for a relatively lengthy period in a power reactor and therefore having more than a prescribed proportion of certain radioisotopes. Testimony given to the US Congress in the 1980s confirmed that reactor-grade plutonium could be used as a nuclear explosive, but that because the plutonium would contain very radioactive isotopes, nuclear warheads made from the material could lead to undesirable radiation exposure of the personnel making the warheads and the military personnel handling them. There would be some risk of premature fission and the fuel would continue to generate heat.

Some nuclear authorities in Germany contend that the device tested in 1960 in the USA used relatively low burnup plutonium and is therefore not comparable with the very high burnup plutonium recovered today from light water power reactors, and they imply that the latter is most unsuitable for weapon use. The Russian Ministry of Atomic Energy goes further, bluntly maintaining that plutonium that might be recovered from the WWER (high burnup light water) power reactors that it plans to sell to India cannot be used to make nuclear weapons.

As far as is publicly known, none of the 90 000 or more nuclear warheads manufactured since 1945 has used reactor grade plutonium; it is simpler, cheaper, easier and safer to produce weapon grade plutonium.

173 *Annual Report for 1993*, GC(XXXVIII)/2, IAEA, Vienna (1994) 3.

174 *IAEA Yearbook 1995*, IAEA, Vienna (1995) C68–C71; and *IAEA Yearbook 1996*, IAEA, Vienna (1996) C76–C78.

175 The parties have the right under Article X.1 to withdraw from the Treaty and thus terminate their NPT safeguards agreement with the IAEA. Only one State has sought to do so — the DPRK — but subsequently in effect reversed course. Now that the NPT is permanent it seems unlikely, though not impossible, that any nation will withdraw. To do so would be to invite suspicion that the nation concerned intended promptly to acquire nuclear weapons and thus challenge the norm that has been established against further proliferation.

Chapter 9

THE TRANSFER OF NUCLEAR TECHNOLOGY TO THE DEVELOPING WORLD

Technical co-operation

The technologies transferred

For the great majority of the IAEA's developing Member States the use of nuclear energy to generate electricity, or to heat or desalt water was and remains a distant prospect.[1] For these developing nations the chief beneficial uses of nuclear energy were and still are the myriad, relatively small scale, applications of nuclear techniques in agriculture, human health, industry, environment, hydrology and biological and physical research, as well as the use of research reactors as educational tools, and for the production of radioisotopes, especially for medical use.[2]

The chief beneficiaries

The scientific infrastructure that a developing country needs to make use of these techniques is far less demanding than what it would need to support a nuclear power programme. Nonetheless, many even of these smaller scale uses of nuclear energy were and still are out of the reach of the least technically advanced countries. At the end of 1996, the Member States of the IAEA included 20 countries considered in the category of least developed countries (LDCs) by UNDP.[3] Accordingly, the bulk of the IAEA's country programmes and support of research has tended to flow towards developing nations that have already made significant technical and scientific progress. Thus, in 1976 the IAEA noted that: "Of the 98 countries that have received technical assistance since 1958, only sixteen have received assistance of the value of more than one million dollars; each is a relatively populous developing country which is also relatively well advanced in the nuclear field. Thirty-six developing countries, on the other hand, have received less than $250 000 of technical assistance from all the resources available to the Agency."[4] This pattern continued in the following years; from 1986 to 1996, 20 developing countries each received more that $6 000 000 worth of technical co-operation and 31 countries received less than $1 000 000.

Figure 1 demonstrates how prominently 20 of the more technically advanced amongst the developing countries have figured as recipients of technical assistance during the ten years from 1986 to 1995.[5] The leading beneficiaries were seven countries operating nuclear power plants (Brazil, Bulgaria, China, Hungary, Pakistan, Mexico and Romania), three countries building or planning nuclear power plants (Cuba, Indonesia and Iran) and two countries that were planning to build nuclear power plants but had abandoned them after Chernobyl (Egypt and Poland). Only two countries characterized by UNDP as 'least developed' (Bangladesh and Tanzania) were amongst the 20.

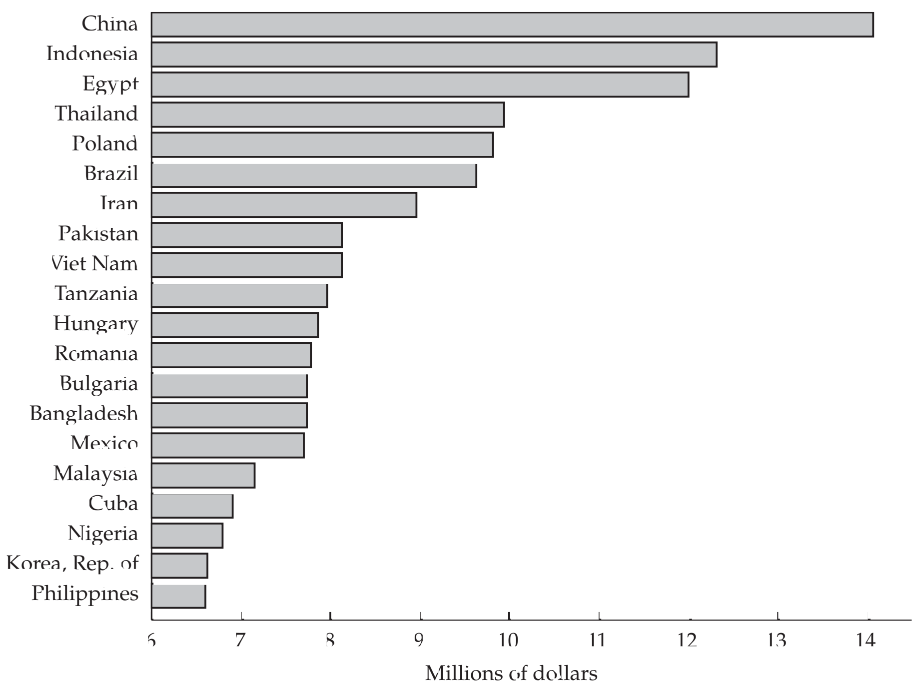

FIG. 1. The total IAEA technical co-operation programme, 1986–1996 (the 20 countries receiving the most assistance).

Eighteen of the 20 countries were operating or constructing one or more research reactors, the exceptions being Cuba, which has apparently suspended its earlier plans to build one, and Tanzania. Notable absentees from the 20 countries listed are Iraq and Yugoslavia, which were formerly significant recipients of technical aid, as well as Argentina and India, for reasons explained later.

But the IAEA has also made special efforts to serve the less advanced Member States by undertaking projects designed to improve their scientific infrastructures and by helping to train and educate their scientists and technicians. Moreover, regional programmes are often of benefit to all the countries in the region, including those that are not able to play an active role in carrying them out. For instance, the IAEA and its laboratories have used isotope hydrology techniques to trace and measure the underground water resources of countries in the Sahel (the arid southern marches of the Sahara), although some of the nations concerned were not yet able to participate scientifically in the programme. The IAEA has also used the sterile insect technique to eliminate insect pests such as the 'New World Screwworm', a grave threat to man and cattle, which invaded Libya in 1988.[6] All neighbouring countries and many further afield benefited from this programme (described more fully in Chapter 10) even if they took no active part in carrying it out.

Scientific support of IAEA technical co-operation

Since the late 1950s, three of the IAEA Secretariat's technical Divisions in the Department of Research and Isotopes have dealt chiefly with the applications of isotopes and radiation and encouraged their use in the developing countries.[7] The Divisions provide scientific and technical support for the IAEA's technical co-operation programme; they launch the IAEA's Co-ordinated Research Programmes, promote information exchange and provide laboratory services and training at the IAEA's laboratories. Since 1989–1990, two Divisions in the Department of Technical Co-operation have developed and administered the programme, one putting together the programme for each developing country in the regions concerned (Africa, East Asia and the Pacific, West Asia, Latin America and Europe (East and West)), and the other arranging the delivery of various services (experts, fellows, equipment and training courses).[8]

The IAEA's laboratories also assist the technical co-operation programme; the Seibersdorf laboratories, for instance, have trained numerous scientists, chiefly from developing Member States, and helped them to set up facilities for calibrating nuclear instruments, estimating radiation doses and analysing environmental samples. The IAEA's Marine Environment Laboratory at Monaco (MEL — the only such laboratory in the United Nations system) has also trained fellows from developing countries.

What is a 'developing country'?

In September 1984, delegations at the meeting of the Board of Governors and at the General Conference raised questions about the meaning that the Secretariat was giving to the term 'developing country', in the context of a recommendation by the General Conference that such countries should be more fully represented on the staff of the Agency.[9] Clearly the matter also has implications for the IAEA's technical co-operation programme which is primarily, but not exclusively, intended to benefit developing Member States. The Director General sought the views of the G-77 on the subject and summarized them in a statement to the Board on 11 June 1985.[10] Essentially the G-77 dealt with the matter by referring to certain lists of countries attached to resolutions adopted by the United Nations General Assembly.[11]

The Board's discussion illustrated the difficulty of finding a precise and exhaustive definition of the term. In practice, the absence of such a definition has rarely given rise to problems and the Board clearly thought that any attempt to reach agreement as to which were and which were not 'developing countries' would be an academic and unrewarding exercise.

As noted earlier, all Member States are, in principle, eligible for the IAEA's assistance, unless they have been explicitly debarred from receiving it by a decision of the General Conference or the Security Council.[12] In practice, however, members of the OECD and other richer nations do not normally seek help financed by the IAEA's Technical Co-operation Fund.

Why not have a single UN aid programme for all the UN agencies?

From time to time the question has arisen why the IAEA should have its own programme, financed directly by contributions to its own Technical Co-operation Fund. Would it not make sense for governments to channel all aid through UNDP instead of allotting some of the funds direct to the assistance programmes of various agencies? The beneficiary governments would then ask UNDP to provide them with the funds they needed for the development of each sector of their economy and society. In other words, recipient governments rather than donors would determine how the totality of available resources should be divided between competing sectors. If a recipient government accorded high priority to a nuclear project, and if the IAEA judged the project to be sound and affordable, it would ask UNDP to finance it — with the IAEA acting as the executing agency for UNDP — as is the case today when governments turn to UNDP for help in nuclear applications. But there would be no pressure on governments to draw up and put forward nuclear projects so as to be eligible for funds that donor governments had explicitly earmarked to the IAEA.[13]

This is a logical argument and the UN family might have taken this path. In the early days of the IAEA, when UNDP was a major source of funding for its technical assistance programme, the Agency appeared to be moving in this direction with some support from donor countries.[14] However, for a number of reasons the agencies of the United Nations family have tended to become more rather than less administratively and financially independent of the UN and of each other.[15] One reason is that centralized planning and administration have not clearly emerged as the most effective way of dealing with the very diverse needs of a heterogeneous group of more than 150 countries at almost all levels of development. The most economically successful developing countries have demonstrated the advantages of a flexible and entrepreneurial approach to development. For the IAEA, excessive centralization would also pose other problems. When governments and planning commissions consider what assistance they can obtain from UNDP, the bigger and more powerful national constituencies, dealing with the traditional branches of agriculture, health and education, tend to corner the lion's share of the funds available.

The IAEA illustrates the trend towards financial autonomy. Instead of moving towards greater dependence on UNDP, the IAEA's UNDP-funded programme now "consists of only a few large scale projects"[16] and, as indicated in Fig. 2, has shrunk in the last two decades from almost half to only a few percentage points of the total technical co-operation programme.[17] Figure 2 also shows a considerable increase in the nominal value of the programme until 1989. The sharp drop in 1992 was due to the devaluation of the currency of a major donor, the rouble.

Political calculations have also played a role in enhancing the importance of the IAEA's own funds as a resource for technical co-operation. To make the growth of the safeguards budget more acceptable to the G-77, the richer countries have been willing to support an annual increase in the target

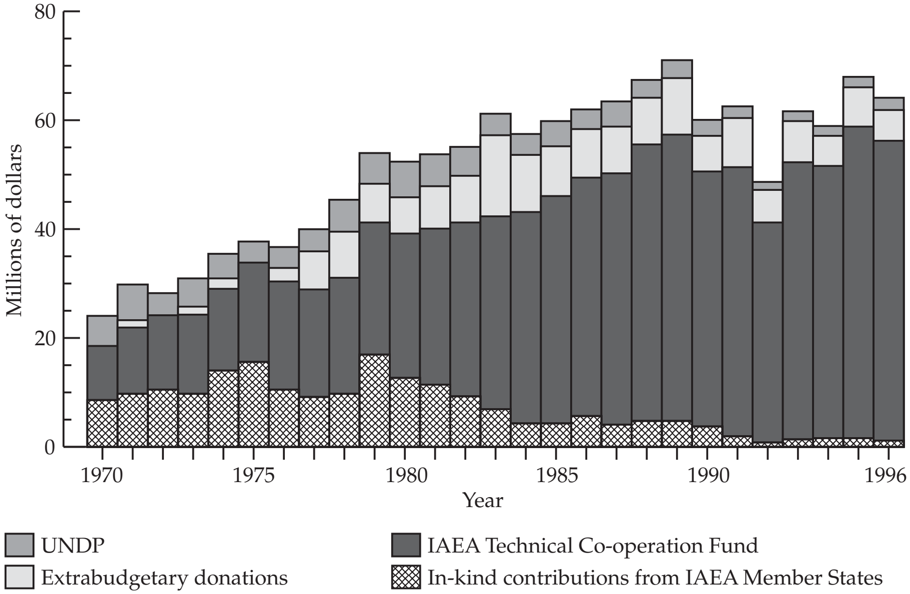

FIG. 2. Resources available for the IAEA technical co-operation programme, 1970–1996.

of the Technical Co-operation Fund as well as to separate the safeguards budget from the remainder of the regular budget and to freeze the contributions of poorer Member States to the cost of safeguards at the level that existed before the NPT entered into force in 1970.

Many governments have become dissatisfied with the way in which some agencies of the UN family spend their resources, with the amount of duplication, the proliferation of committees and floods of paper. The reluctance of the US Congress to settle the large US debt to the UN, US withdrawal from UNESCO in the 1980s, the more recent withdrawal of the USA from the United Nations Industrial Development Organization and the withdrawal threatened by the United Kingdom, Australia and possibly Germany, are symptoms of this discontent. The IAEA's reputation for sound management and the value that the leading donors attach to the IAEA's safeguards and nuclear safety missions seem likely to preserve it from the radical surgery that may be forced upon other agencies. The IAEA's technical co-operation programme may be immune because of its growing emphasis on nuclear safety, the role it is seen to play in making safeguards more palatable, the perception that it has brought concrete economic and social benefits, and the effective use it has made of the funds available to it.

The evolution of the technical assistance (technical co-operation) programme

Chapters 5, 6 and 8 underline that from the outset there was little demand for the nuclear material put at the IAEA's disposal, that the IAEA faced grave initial difficulties and delays in launching safeguards and that nuclear power also took off much more slowly that had been expected ten years earlier. As the IAEA programmes in these fields failed to gain momentum, technical assistance rapidly emerged as the IAEA's major programme and maintained its lead until the late 1960s. As noted, the programme consisted chiefly of helping developing countries to make use of radioisotope and radiation techniques.

The IAEA's first step was to draw attention to the benefits that developing Member States could derive from these techniques. In 1958, the IAEA began to send out multidisciplinary 'Preliminary Assistance Missions' (PAMs). The missions consisted of staff members who were expert in the use of these techniques in medicine, agriculture and hydrology, in nuclear power, in prospecting for and mining nuclear materials and in the use of research reactors. By the end of 1959, PAMs had surveyed the potential uses of nuclear science and nuclear energy in 40 developing Member States and by the time the missions came to an end more than 50 countries had been visited.[18]

The Prepcom had noted that the main factor limiting the use of nuclear techniques in many developing countries was the lack of trained personnel. Hence, from the early years until today the programme has given priority to the award of fellowships and the organizing of training courses. As noted, the first General Conference set a 1958 target of $250 000 for voluntary contributions to launch a fellowship programme. By the end of the year the programme had made a quick start with the award of 218 fellowships.[19] By the mid-1990s, the programme was awarding about 1000 fellowships every year and paying for the participation of approximately 1800 persons in its training courses.

Although the Statute enjoins the IAEA, in allocating its resources, to bear "in mind the special needs of the underdeveloped areas of the world," it is also "based on the principle of the sovereign equality of all its members..."[20] Accordingly, from its inception, the IAEA has taken the position that all Member States are eligible for technical assistance under the IAEA's own programme.[21] This was of much benefit to nuclear science in Eastern European countries since the citizens of the countries concerned were thus eligible for coveted IAEA fellowships. Given Cold War restrictions on travel, these fellowships were also highly prized by their hosts in the West who had lost touch with their Eastern colleagues for nearly twenty years.[22]

The USA took a parental interest in the Agency and did its best to help it through its teething troubles. To launch the assistance programme it offered the services of 20–30 consultants as well as the entire cost of the 1958 fellowship programme, a radioisotope laboratory, two mobile isotope laboratories and a small reactor (the last offer was not taken up).[23]

The first mobile laboratory arrived in Vienna in October 1958. The IAEA used it in Austria, Greece, Yugoslavia and Germany and then shipped it to East Asia. The second, handed over in December 1959, was used in Mexico and Argentina.[24] These novel vehicles attracted attention to the IAEA and its work and provided valuable training to local scientists.

The 1958 programme consisted solely of selecting and placing fellows. In 1959, it was broadened to include the provision of expert services, scientific equipment that the experts might need, arrangements for 'visiting professors' and training courses.[25]

After much debate, the first Board recommended and the 1958 General Conference agreed that the IAEA should seek participation in the UN Expanded Programme of Technical Assistance (EPTA). Some of the arguments advanced against participation were not without force. It was maintained that the established specialized agencies would continue to receive an unduly large share of EPTA's resources, that governments would only direct a small share of their requests to the very novel activities that the IAEA would wish to help and, more fancifully, that participation in EPTA would lead to the assimilation of the IAEA into the specialized agencies at some cost to its special status in the UN system.[26] In 1963, the Board decided that fellowships paid for out of IAEA funds should be reserved for students from Member States that were currently receiving assistance from EPTA's country programmes.[27]

In 1960, in order to regulate and harmonize the conditions for providing technical assistance, the Board approved the 'Guiding Principles and General

Operating Rules' to be applied in carrying out the programme. These Principles were subsequently embodied in a 'Supplementary Agreement' that each State receiving assistance was required to sign.

Until 1977 the technical assistance projects financed from the IAEA's own funds consisted of "a collection of relatively small projects involving at a maximum twelve man-months of expert services and some equipment."[28] Larger multi-year projects were funded by UNDP. In 1978, the IAEA, following the advice of a group of experts, introduced multi-year projects into its own programme. The expert group also recommended closer monitoring of the execution of technical assistance projects.[29]

In 1976 and 1977, the Board debated the extent to which safeguards should be applied to the technical assistance operation. As usual at that time Governors expressed sharply conflicting views on this and on any other issue involving the application of safeguards. In September 1977, the Board decided that safeguards would normally be applied to a technical assistance project if it made a "substantial contribution" to a "sensitive technological area" — in other words, an activity involving enrichment, reprocessing, production of heavy water, handling of plutonium or the manufacture of MOX fuel.[30] The imprints of the London Club and the NSG's Guidelines (see Chapter 8) were apparent in this decision and it was sharply criticized by the Governors from countries not party to the NPT. In practice, at least since 1977, the IAEA has given no technical assistance that would help a national nuclear programme in a 'sensitive technological area'.

In 1979, after four years of study in the Secretariat, the Board approved a revised version of the 'Guiding Principles and General Operating Rules' for the provision of technical assistance. This was preceded by an unusually heated debate and a roll-call vote on the new version. At the heart of the debate was the question of how the prohibition of diversion or misuse of the IAEA's technical assistance should be worded.[31] The 1960 version of the rules had required the receiving country to undertake not to use IAEA assistance in such a way as to "further any military purpose". This was essentially the proscription used in Articles II and XI of the IAEA Statute and in safeguards agreements concluded before 1975. After India had carried out what it termed a 'peaceful' nuclear explosion in 1974, the text of safeguards agreements was changed so as to prohibit the use of safeguarded items to make nuclear weapons *or other explosive devices* or for any other military purpose. This change reflected the formula used in the NPT, prohibiting non-nuclear-weapon States from manufacturing or otherwise acquiring nuclear weapons or other nuclear explosive devices.

The revised version of the Guiding Principles and General Operating Rules submitted by the Secretariat now contained a prohibition similar to that used by the NPT and in recent safeguards agreements.[32] A handful of Governors representing developing States that were not party to the NPT objected strenuously to this change, maintaining that it was neither required by nor in conformity with the IAEA Statute, and that NPT type commitments should not be forced upon States that had not joined the Treaty. But a substantial majority of the members of the Board was in favour of the revised version. The vote was 22 for, 3 against (Argentina, Brazil and India) and 4 abstaining (Guatemala, the Republic of Korea, Tanzania and Venezuela). The revised principles and rules were then incorporated in a 'Revised Supplementary Agreement'.

The Indian Governor announced that India was "no longer interested in receiving technical assistance from the Agency since it could not give its consent to an undertaking which contravened the Statute."[33] Argentina followed suit and withdrew from the technical co-operation programme. Brazil and Pakistan were prepared to accept the new conditions in the Revised Supplementary Agreement, but only on a case by case basis, and did not sign the Agreement until 1991 and 1994, respectively. Argentina returned to participate in the technical co-operation programme in 1991. India maintained its refusal to sign the Revised Supplementary Agreement and has not participated in the technical co-operation programme (except for some training courses) since 1979.

The issue that caused so much argument in the Board was one of principle rather than of any practical importance. It was difficult to imagine how IAEA technical assistance in, for instance, agriculture, medicine or hydrology could be used to develop a nuclear weapon or other explosive device, or indeed to further any military purpose. But it was conceivable that an engineer who received IAEA training in certain aspects of nuclear technology, for example in radiochemistry, might put his or her expertise to work in a nuclear weapon programme, or that uranium ore found or mined with the IAEA's help might, after processing and enrichment, wind up in a nuclear weapon.

In the same year (1979) many Governors welcomed the introduction of large scale multi-year projects into the technical assistance programme, but the Federal Republic of Germany still maintained that such projects should be financed by UNDP rather than by the IAEA.

In 1983, the Board undertook its first review of technical co-operation policies. It directed the Secretariat to help developing Member States in establishing priorities in drawing up requests for assistance.[34] In the same year the

Agency began to evaluate systematically what impact IAEA technical co-operation projects were having in the beneficiary countries. The Board approved the creation in the Department of Technical Co-operation of a special unit for this purpose. In 1987, evaluation of 63 projects concluded that the Secretariat had "responded effectively" to the challenge of a rapidly growing programme and that the projects were contributing to the transfer of technology. The evaluation also showed that the two most common problems faced by technical co-operation projects were those of arranging for adequate training of personnel selected to carry out the projects and shortages of national counterpart staff.[35]

In November 1986, the Technical Assistance and Co-operation Committee recommended to the Board an experimental change from a one to two year cycle for the entire programme. This experiment was successful, giving more time to prepare and technically appraise projects. In 1991, the Board confirmed that the two year cycle would henceforth be the norm.[36]

The conceptual evolution of the programme

For the dozen or so developing countries that were preparing to introduce nuclear power, the role of the IAEA was often indispensable. To those for whom nuclear power was a distant prospect, the IAEA transferred, as we have seen, nuclear techniques for use in industry, human health, agriculture, management of water resources, etc. The latter projects were usually small, involving a single instrument or technique, a training course and a fellowship or two, and a few months of the services of an expert. Nonetheless, their cumulative effect on the ability of the recipient country to undertake projects in nuclear science and technology was significant. The basic principle was that in the absence of technical foundations on which to build — manpower, skills and other resources — development cannot succeed. Another crucial role of technical co-operation was to help create the regulatory framework for the safe use of nuclear energy and radioactive materials, for the safe disposal of nuclear waste and for the provision of essential services such as radiation dosimetry.

In March 1995, the Board endorsed the Director General's proposal for a 'Standing Advisory Group on Technical Assistance and Co-operation' (SAGTAC), consisting of 12 members from developing and industrialized Member States to advise him on the IAEA's technical co-operation activities, particularly on policy and strategy matters, and to recommend measures for increasing the effectiveness of the programme.[37]

The achievement of many of the main original objectives of the technical co-operation programme, the impact of Chernobyl and the consequences of the breakup of the Soviet Union have led to a fundamental evolution in the programme's aims, direction, modus operandi and content. During the first 30 years, the principal objective of the IAEA's assistance was to help developing Member States to create the institutions and facilities that would enable them to introduce and enlarge the role of nuclear technology or apply nuclear techniques and to do so safely and effectively. An illustration of its achievements was that by the end of 1996 the IAEA had helped train more than 19 000 scientists, engineers and technicians under its fellowship programmes. From 1980 to 1996 it had held 1558 training courses.[38]

By the end of the 1980s, this phase of institution building was largely completed and the time was ripe to concentrate the programme on the development process itself — in other words to seek to ensure that the programme would have a cost efficient, direct and measurable impact on the high priority economic or social needs of the country being assisted, an impact well beyond the institute through which the activity was carried out. In this way the Agency and the beneficiary country would become partners in development, strengthening the ability of national institutions to define, organize and manage applications of nuclear technology. To give a concrete example, the programme should assist projects that would put new varieties of crops or better practices for dealing with pests in the hands of the farmer rather than lead to a new scientific publication by an institute of higher learning.

To achieve these goals the Secretariat identified three concepts. The first was the 'Model Project'; the criteria that a Model Project had to meet were that it had to respond to a well assessed need of the country, produce a significant economic or social achievement by the end-user (who, together with the recipient institute, must be involved from the start), use nuclear technology only if it had a distinct advantage over other technologies and was demonstrably sustainable because of a strong commitment by the government concerned. The IAEA would also closely monitor and evaluate progress in carrying out the Model Project. In 1993, the Board approved the first 12 such projects, followed by 11 more in 1994.[39]

The second concept was the 'Country Programme Framework'. The IAEA and the government should identify and agree upon a few priority areas for technical co-operation that can produce significant impacts. The process would, of course, have to take into account the technical capacity of the country concerned. The Country Programme Framework would point to opportunities for Model Projects.

The third concept was that of thematic or sectoral planning. The thematic plan should provide evidence that, when compared with non-nuclear alternatives, a particular nuclear technique would offer the most efficient way of reaching a development objective in a particular sector. It should indicate in which regions or countries the application of particular nuclear techniques would be most relevant and identify those countries that have the capacity to use the technique. It would be for the country concerned to decide whether to include in its Country Programme Framework the project or opportunity identified by thematic planning.

The primacy of safety

Since meeting basic safety standards is a precondition for all activities involving ionizing radiation, the first thematic plan to become operational was in radiation protection. Other priority themes would be waste management and the safety of nuclear power plants.

Chernobyl had already brought about a greater emphasis on nuclear safety and waste disposal in the technical co-operation programme. The end of the Cold War and the breakup of the Soviet Union also brought into the Agency several new Member States with pressing needs in nuclear safety. Except in Romania, all the nuclear power reactors operating or under construction in Eastern Europe and in the Soviet Union's successor States had been designed and operated according to Soviet safety standards which, in some respects, were inferior to or incompatible with international standards. A conspicuous example was the absence of the containment dome which is the most visible feature of power reactors built to international standards.[40]

Chapter 7, on nuclear safety and waste management, provides examples of the actions and projects that the IAEA undertook to help the countries concerned bring up their nuclear plants, in particular their WWER power reactors, to international safety standards.

Help to developing countries with dynamic nuclear power programmes

A limited number of developing countries are introducing nuclear power. In such cases the technical co-operation programme has helped the governments concerned to plan their programmes and to focus on nuclear plant safety. Thus, in the late 1970s and early 1980s, the programme helped the Republic of (South) Korea establish a framework for the dynamic nuclear power programme it was launching and, in particular, to establish the safety infrastructure of the programme. The IAEA had played a similar role in the early days of the Spanish programme.

In introducing nuclear power, China needed special help to bring its safety standards and practices up to international levels. The Chinese authorities simply took over the entire body of the Nuclear Safety Standards (NUSS), translated them into Chinese and adopted them by national legislation. OSARTs from the IAEA also helped to evaluate the safety of the Chinese designed Qinshan reactor, the first nuclear power reactor to be built on Chinese soil. An OSART mission concluded that the safety of the reactor fully met international standards. The IAEA also helped train large numbers of Chinese nuclear engineers and safety experts.[41]

The programme's resources

Since it began work in 1958, the IAEA has depended on the following funds/sources for the transfer of nuclear technology to developing countries:

— The Technical Co-operation Fund (TCF),[42] financed by the voluntary financial contributions of Member States. This has become by far the largest source of funds at the disposal of the IAEA for the transfer of nuclear technology.

— Extrabudgetary funds. These consist chiefly of two groups:

- Those available to all organizations of the UN family and administered by special United Nations bodies (such as UNDP — and its precursor, EPTA, which was subsequently complemented by the Special Fund).
- Numerous earmarked 'research contributions' by Member States, such as the Italian contribution to the Trieste Centre, and the so-called 'footnote a/' projects.[43]

— 'Contributions in kind', i.e. gifts of the services of experts and fellowships or other opportunities for training offered at no cost or limited cost to the IAEA, and equipment similarly provided by Member States.

— The regular budget, i.e. assessed contributions which Member States are required by the Statute to pay to the IAEA. In principle, under the Statute, regular budget funds are not available for assistance to individual Member States. In practice, however, the regular budget bears:

- The cost of administering all Agency activities, including those of the safeguards and technical co-operation programmes funded by the TCF and extrabudgetary donations from Member States.[44]
- The costs incurred by the Agency when members of the Secretariat serve as technical officers for individual projects and provide scientific and technical services.
- The IAEA's share of the cost of contracts awarded under Co-ordinated Research Programmes. As pointed out elsewhere, in principle these contracts are designed to procure scientific services that the IAEA itself requires in support of its programmes. In practice, the contracts are normally of direct benefit to the country in which they are carried out as well as to the IAEA's programmes.[45]

Over time the relative importance of each source has varied widely. In the early years the contributions of various United Nations funds and 'contributions in kind' were comparable in magnitude to the funds provided by the IAEA itself via what is now called the TCF. However, the TCF now dwarfs all other sources (see Fig. 2). The IAEA Secretariat suggests several reasons why the role of UNDP in funding the IAEA's programme has declined so sharply since the early years. The central planners in the governments of developing countries, who have a crucial role in submitting requests to UNDP, are often unaware of the contribution that nuclear techniques could make to their national development and may prefer to give help to more traditional activities. The influence of nuclear energy authorities in the governments concerned, never very strong, has been declining. Many of the larger UN agencies have their own country representatives who push their own projects; the IAEA relies on UNDP representatives who are often unfamiliar with nuclear techniques.

Funding the technical co-operation programme

The target for voluntary contributions to the technical assistance programme (since 1982, the technical co-operation programme) rose sharply from \$125 000 in 1958 to \$1 500 000 in 1959. But there were no further significant increases for several years; indeed, from 1962 until 1970 the target remained fixed at $2 000 000. One reason was that from 1959 onwards, the IAEA encountered a problem that continues to dog it today — a widening gap between the target set each year and the amount that States were willing to pledge and, less frequently in recent years, a further gap between the amounts pledged and actual payments. For example, in 1959 the amount pledged towards the $1 500 000 target was only $1 183 044[46] and the amount paid was $875 000.[47] Five years later, in 1963, the target had risen to $2 000 000 but by June 1964 the amount pledged was $1 437 394 and payments amounted to only $1 192 797.[48]

Recurrent shortfalls of this magnitude stimulated numerous proposals for placing the financing of technical assistance on a firmer basis. For instance, it has often been proposed that the Statute be amended so as to incorporate the funds for technical assistance in the regular budget which, as noted, is financed by assessed and not by voluntary contributions. The proponents of such an amendment saw this as the only practical way of ensuring a secure and predictable source of funds.

A further problem was that while contributions to the regular budget must be made in a convertible currency, voluntary contributions to the TCF may be made in whatever currency the donor chooses. The IAEA Secretariat ran into difficulty in disposing of stacks of non-convertible currencies, in persuading experts sent to certain countries to be paid in part in national currencies and in convincing scientists from the developing countries to accept some of the training opportunities offered by countries that were not particularly renowned for their expertise in nuclear science or technology.[49]

In 1961 and 1962, the General Conference appealed to each Member State to contribute an amount to the General Fund (i.e. for technical assistance) equal to or greater than its percentage of the regular budget.[50] Many States have met this appeal. However, as Fig. 3 shows, the problem of shortfalls remains critical — though the causes of the shortfall naturally vary with changes in the economic circumstances of the main donors and their policies towards UN family programmes. Figure 3 also shows that, since 1984, the main problem has been the widening gap between the annual target and the contributions pledged towards that target rather than the gap between pledges and payments.

Targets, pledges and payments to the TCF

In the 1970s, the IAEA's assistance programme began to forge ahead. As noted in Chapter 6, the funds and contributions from all sources increased eightfold in nominal value from 1960 to 1980 (from $2 526 000 to $20 947 000).[51] The growth of the TCF or its precursors was even more marked, from $1 008 000 in 1960 to approximately $13 301 000 in 1980.[52] Despite the inroads of inflation this was indeed a large increase. Member States also made pledges that came close to the targets set each year, in 1974 the total amount pledged actually exceeded the target by 2.8%[53] and the payments were even higher than the pledges (Fig. 3).

As the programme expanded the problem of making good use of contributions to the TCF in the form of non-convertible currencies grew steadily more difficult. Thus, in 1978, when the funds available for the TCF stood at approximately $10 million, there was a deficit of $2.1 million in the amount available for approved projects for which only convertible currencies could be used and a corresponding surplus of $2.1 million in non-convertible funds.

With the help of the main contributors of non-convertible currencies the situation improved in 1979,[54] and by 1980 the surplus of non-convertible currencies had declined to $542 000.[55]

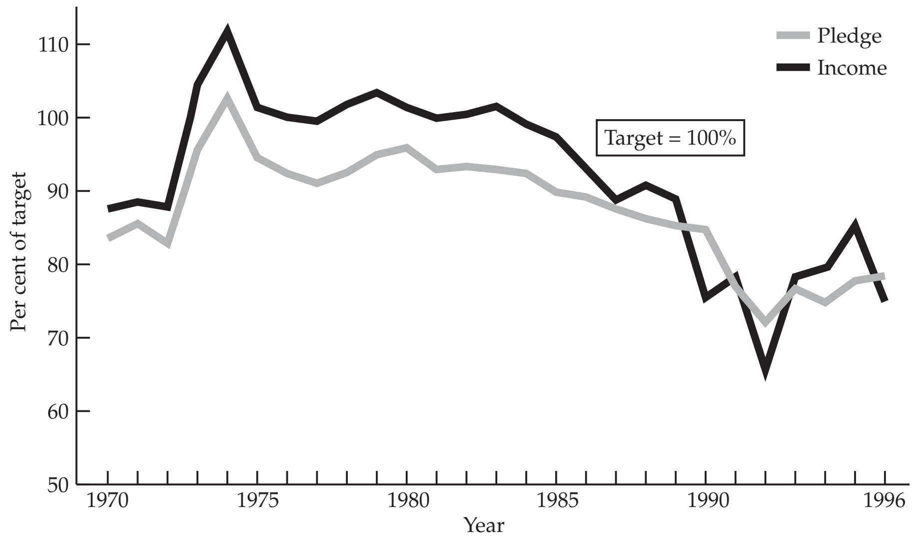

FIG. 3. Patterns of pledges and income for the IAEA's Technical Co-operation Fund.

As requests for assistance began greatly to exceed the financial resources available, the Secretariat began in 1976 to identify technically sound requests for assistance that could not be funded, so as to encourage potential donors to step in and provide the IAEA with the funds to carry out these projects[56] — what were called 'footnote a/' projects. In effect, this was a means whereby donor countries could, if they so wished, selectively help developing countries that had joined the NPT. (The IAEA could not discriminate in its own programmes between States that were or were not party to the NPT.)[57] The total value of projects financed this way has grown from about $400 000 in 1976 to $7 079 880 in 1996.[58]

In March 1980, Egypt, supported by India and several other developing countries, renewed the proposal to incorporate the financing of technical co-operation in the IAEA's regular (assessed) budget and pressed the Board to set up a committee to study the problem. The Board subsequently established an open-ended working group for this purpose. The Soviet Union as well as the USA, the Western Europeans, Australia and Japan strongly resisted the Egyptian proposal. The informal working group began its meetings at the end of April 1980 but was unable to reach agreement.[59] Several further attempts were made in the following years, but equally without success.

The target and the resources available for technical co-operation continued to rise until 1989 when the total amounted to about $50 088 000. The TCF accounted for $44 687 000 of this amount, more than three times the 1980 figure ($13 301 000). It was agreed that there would be an annual increase of $3.5 million in the target for the TCF but the inability of the USSR/Russia and other successor States to contribute significantly to the programme caused a decline in resources in 1990 and 1992 (particularly sharp in the latter year). Despite this discouraging drop, the IAEA was able to include "over 80% of the requests received" in the 1993–1994 biennial programme.[60] In 1993, as the 1995 NPT Review and Extension Conference approached, the upward trend resumed and in 1995 the total funds available for technical co-operation amounted to around $63 352 000, of which the TCF accounted for $60 300 000.

The wide fluctuations in the amount of money available for technical assistance could lead to uncertainty whether approved projects would in fact be carried out and thus reduce the cost effectiveness of the operation for beneficiary governments, as well as for the IAEA. This uncertainty would have been particularly disconcerting at a time when the planning of the programme was increasingly long term and it consisted of larger projects designed to have a significant social or economic impact. This was one of the concerns that led many developing countries to press for assured and predictable funding of the programme. The Secretariat avoided disruption of the programme by making very careful and precise estimates of expected income and by monthly monitoring of income and disbursements. Largely as a consequence of this cautious approach, the IAEA has never had to cancel or defer an approved technical co-operation project because of insufficient funds.

In 1990, the General Conference asked the Board to take steps to ensure that technical assistance was funded by "predictable and assured resources", and in 1992 the Board again established an informal working group on the financing of technical assistance.[61] The working group was unable to reach a consensus on any specific proposals, but in 1995 the Board encouraged the Secretariat to seek financial support for technical co-operation projects from national development agencies administrating 'bilateral funds' and from international financial bodies. Experience with the recently instituted Model Projects had shown that more funds could be obtained if the projects were of sufficiently high quality and if the beneficiary country was also prepared to seek bilateral funding.[62]

Changes in the distribution of resources among technical programmes

From the early days until the mid-1980s (i.e. until Chernobyl), an amount equal to 15–20% of the disbursements under the programme went to each of four groups of projects, namely those relating to the use of nuclear techniques in: food and agriculture; medicine; physical and chemical sciences[63]; and radiation protection and nuclear safety. Applications in industry and earth sciences (e.g. hydrology and geology) also accounted for more than 10%.

In the late 1960s and 1970s, the proportion of funds spent on projects directly related to nuclear power rose markedly, but fell again in the succeeding years. As noted in Chapter 7, in the 1980s, and particularly after Chernobyl, governments and the IAEA gave increasing attention to nuclear safety and safety related activities.

In 1994, 'nuclear safety' overtook all other components, accounting for 22.9% of the programme. Food and agriculture came second with 22.4%. Other significant components were physical and chemical sciences (17.3%), human health (13.1%), and industry and earth sciences including hydrology (12.1%).

Interest in receiving assistance for nuclear power programmes in countries engaged in or contemplating such programmes decreased dramatically after the 1979 Three Mile Island accident. A small recovery in 1984–1985 was followed by another and continuing decline after 1986 (Chernobyl).

Although the IAEA has helped to carry out numerous assessments of the pros and cons of introducing nuclear power and a number of surveys of particular nuclear power projects, has trained many nuclear engineers and has served as nominal supplier of nuclear power plants and their fuel in Mexico and Yugoslavia, the Agency's technical assistance programme has not been directly involved in the building of any nuclear power plant or other major fuel cycle plant.

Changes in the forms of technical help provided

Table I shows changes in the shares of the main components of the technical co-operation programme: services of experts, equipment, fellowships and training courses. It does not cover the 55 or so regional or interregional training courses that the IAEA has been holding in recent years, which account for about 10–15% of the cost of the technical co-operation programme.

In recent years the IAEA has been sending out about 2000 experts each year, dealing with the roughly 150 scientific subjects covered by the technical co-operation programme.

Since 1971, the cost of equipment provided has been kept at about 40% of the total programme, although for States that have difficulty in finding the means of buying imported equipment it may constitute the largest share of the value of assistance provided. This applies particularly to the least developed countries in Africa and Asia.

Of the three main components of technical assistance, fellowship training is often the most difficult to provide and takes the longest time to arrange. This is partly because the IAEA is required to arrange the acceptance and placing of fellows through governmental channels. Delays of 18 months in the processing of requests are not uncommon. Placing fellows of certain nationalities can be very difficult even if the training sought for them is in agricultural, medical or environmental applications of nuclear science where the techniques involved are remote from any conceivable military, let alone nuclear explosive, use.

TABLE I. CHANGES IN THE SHARES OF THE MAIN COMPONENTS OF THE IAEA's TECHNICAL CO-OPERATION PROGRAMME

Year	Total programme (million $)	Experts (%)	Equipment (%)	Fellowships and other training (%)	Others (%)
1970	4.6	27.5	25.0	47.5[a]	
1971–1980	NA	30.3	39.4	30.3	
1980	21.7	24.6	43.5	31.9	
1990	62.6	28.0	37.7	30.9[b]	3.4
1995	83.3	27.0	39.4	30.9[b]	2.7

[a] *Annual Report 1 July 1970–30 June 1971*, GC(XV)/455, IAEA, Vienna (1971), pp. 11–12, paras 24–25. The report does not give the percentage of the programme taken by fellowships but notes that experts and equipment accounted for 52% of the aid requested in this form and that the share of resources allocated to equipment in 1970 amounted to 25%.

[b] In 1990 and 1995, training courses were listed as a separate component. It is presumed that in 1980 and earlier years they were included in the fellowships component. In 1990, fellowships accounted for 15.5% of funds spent and training courses for 15.4%. The corresponding shares for 1995 were fellowships 18.5% and training courses 12.4%.

NA: Not available.

Servicing the programme

In the late 1950s, three specialized units in three different Departments were set up to manage the technical assistance programme: a Division dealing with fellowships, another servicing all forms of technical assistance except fellowships, and a co-ordinating Division. In the early 1960s, Sigvard Eklund put an end to this irrational arrangement by creating a Department to manage all technical assistance and by scrapping the co-ordination Division and eventually replacing it with a co-ordination Section in the office of the Head of the Department.

Nonetheless, the Department of Technical Assistance remained largely reactive, and its approach was fragmented. Delegations would come to the annual General Conference with a shopping list of often unrelated requests which the IAEA would evaluate for technical soundness and to which it would parcel out available funds. The fact that assistance came from so many different sources was conducive to such a fragmentation. As time went on the IAEA encouraged applicant States to draw up better integrated and longer term country programmes. As noted, in 1982 the Agency introduced a two year programming cycle and in 1992 introduced the concept of Model Projects that were designed to surmount significant technical barriers to development in the countries concerned rather than to build up infrastructures in particular research institutions.

Regional co-operation under the IAEA

One of the first essays that the IAEA made in the domain of technical assistance was a mission to Latin America in May 1958 in response to a proposal by Brazil to study the need for and the means of establishing one or more regional training centres.[64] Unfortunately, the countries concerned were unable to reach agreement on the project.

After a visit by an IAEA mission to eight African and Middle Eastern Member States to evaluate proposals for regional radioisotope training centres, the Board of Governors decided in 1960 to endorse the request of the United Arab Republic (Egypt) to establish the centre in Cairo for the Arab countries. The Board also endorsed the Secretariat's proposal that before the centre was established the Director General should arrange in Cairo as a 'test' a series of training courses and report to the Board on the results. After two such courses the centre was inaugurated on 18 March 1963.[65]

In 1972, the IAEA launched its first agreement for standing regional co-operation in the nuclear field, the Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology (RCA) — for Asia. The experiment was politically as well as technically successful. As a result, researchers from India and Pakistan — as well as from other nations in the region — began working together in fields as diverse as the optimum use of research reactors and the application of nuclear science techniques in breeding new varieties of food crops. By bringing together scientists from the region who are working in the same field, the RCA's periodic and specialized meetings provided a forum for exchanging information, comparing problems and results and avoiding unnecessary duplication.[66]

The RCA subsequently attracted the support of industrialized nations in the region, Japan, Australia and New Zealand, which have funded certain Co-ordinated Research Programmes as well as technical co-operation projects within the framework of the RCA. The agreement, which is reviewed every five years, has been extended several times.

In the light of this encouraging experience the Agency promoted similar agreements in Latin America (ARCAL — Regional Co-operative Arrangements for the Promotion of Nuclear Science and Technology in Latin America, which entered into force in 1982) and in Africa (AFRA — African Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology, which entered into force in 1990).[67] AFRA and RCA are intergovernmental undertakings and ARCAL is an arrangement between institutions.

The three regional agreements aim to promote:

- Technical co-operation between the developing countries themselves,
- Sharing of resources, including facilities, equipment and manpower,
- Pooling of knowledge and closer communication and collaboration between scientists in the region.

By the end of 1996, 17 nations were members of the RCA, 19 of ARCAL and 21 of AFRA.

EPTA, the Special Fund and UNDP

In 1958, the Economic and Social Council approved the IAEA's participation in the United Nations Expanded Programme of Technical Assistance (EPTA) and the UN Special Fund. The IAEA subsequently concluded an agreement with EPTA setting the terms under which any government eligible to participate in EPTA could make use of help given by the Agency whether or not it was an IAEA Member State. It will be seen from Table I in Annex 3 that EPTA soon began to finance a considerable share of the IAEA's technical assistance programme, its contribution rising from $304 000 in 1959, to $633 000 in 1960 and to $1 317 000 in 1965 more in fact than the contribution from the IAEA's own funds that year ($1 200 000). Throughout the 1960s, EPTA and the Special Fund remained a source of funds comparable to (and in 1965, outstripping slightly) the IAEA's own programme.

After that, however, the IAEA's share began to rise, reaching more than double the EPTA/UNDP contribution by the mid-1970s (for instance, in 1976 the share of the IAEA was $6 221 000 and that of UNDP was $3 002 000). By 1985, UNDP's share was less than one tenth of that of the IAEA (IAEA $30 681 000 and UNDP $2 654 000). By 1995, the IAEA's input had risen to $60 300 000 million and UNDP's had fallen to $1 355 000 million.[68]

Contributions in kind

Contributions in the form of fellowships, expert services and equipment were also an important source for technical assistance operations in the IAEA's early years. Assessment of the monetary value of such gifts is always somewhat arbitrary, but during most of the 1960s they were estimated to be comparable with those of contributions in cash. They fluctuated around much the same level until 1977, while the level of monetary contributions rose rapidly.[69] As a result, by 1980 the value of contributions in kind was only about one fifth of the IAEA TCF input ($2 628 000 compared with $13 301 000) and by 1995 only 3.5% ($1 877 000 compared with $60 300 000).[70]

Balance between 'promotional' and 'regulatory' activities

After the entry into force of the NPT in 1970, the target for voluntary contributions, after remaining relatively unchanged for several years, began to climb again. As already noted, it is likely that the major donor countries agreed to raise the target as a means of encouraging support for safeguards and the NPT. For the same reasons they agreed in 1971 to establish a separate scale of contributions to the budget for safeguards. Since then, these measures have put an effective brake on any significant increase in the contributions of the poorer countries to the safeguards budget (see Chapter 8).

The 1973 Arab–Israeli war and the 1973–1974 oil price rise led many developing countries to begin planning nuclear power programmes, and hence to seek help in training their engineers and to request other forms of assistance they would need in carrying out these programmes. This naturally led the developing countries to press for more resources for technical assistance, and they began to call for a balance between the budgets for the IAEA's 'regulatory' and 'promotional' activities. In other words, as the budgets for IAEA safeguards and for nuclear and radiation safety increased, so too should the target for contributions to the TCF.

The representative of Egypt succinctly put the case for such a balance in a statement to the Board on 5 March 1980: "...the IAEA could retain the confidence of all Member States only by maintaining a fair balance between technical assistance and its regulatory activities."[71] One of the issues that the concept of 'a balance' raises is discussed in the final chapter of this book. Suffice it to say here that since 1980, the unforeseen and indirect effect of seeking a balance between 'regulatory' and 'promotional' activities, coupled with zero growth in the IAEA's regular budget, has been to cap the safeguards budget in real terms, while the total contributions to the TCF have continued to rise, except in 1990 and 1992 when the precipitous devaluation of the rouble caused a sharp fall in the real value of the Russian contribution. The effects since 1980 of zero growth in the regular budget, coupled with increasing targets for the TCF, are shown in Table II. The tables in Annex 3 provide a more detailed statistical analysis of the growth of and fluctuations in the technical co-operation programme from 1957 to 1995.

TABLE II. COMPARISON OF THE GROWTH OF THE REGULAR BUDGET, THE TARGET FOR THE TCF AND THE BUDGET FOR SAFEGUARDS, 1965–1995 (AMOUNTS IN DOLLARS)

Year	1965	1970	1975	1980	1985	1990	1995
Regular budget for Agency programmes							
	7 938 00	12 250 000	32 175 000	78 935 000	91 611 000	158 348 000	205 517 000
Target for voluntary contributions to TCF or precursor							
	2 000 000	2 000 000	4 500 000	10 500 000	26 000 000	45 500 000	61 500 000
Budget for safeguards							
	354 000	1 272 000	4 802 000	19 396 000	32 574 000	54 486 000	72 745 000

Research support

In 1958, the IAEA began concluding research contracts with laboratories and other scientific institutes in Member States. This was a novel activity for any United Nations agency. The successful launching of the programme owed much to the efforts of Henry Seligman, formerly Director of the Isotope Laboratory at Harwell in the United Kingdom and from 1958 the first Head of the IAEA's Department of Research and Isotopes.[72]

In theory, at least, the contracts were designed to produce data or other results of direct value to the IAEA's own programmes, and they were presented as a means of procuring services needed by the IAEA and not as technical assistance given to the Member State that housed the institute carrying out the research.[73] In practice, the proposals for research contracts usually came from an interested institute and not from the IAEA, and in many cases the contracts were a disguised form of technical assistance to the institute and State concerned.

In recent years the IAEA has indicated which fields of research it wishes to promote; in other words, in which areas it would welcome research proposals. This did and does not, however, apply to research contracts awarded in support of the safeguards programme and certain other technical contracts where the IAEA itself took the initiative.

The isolated and frequently uncoordinated contracts of the early days have evolved into Co-ordinated Research Programmes, in which a group of laboratories or institutes in developing and selected industrialized countries focus their research on a topic of common interest. Annual or biennial meetings of the contract holders have provided an excellent opportunity for sharing experience. In many cases the successful results of a Co-ordinated Research Programme have led to a proposal for a technical co-operation project. By bringing together laboratories in developing and industrialized countries the IAEA also introduced a form of 'twinning', in which the scientists in the developing country benefit from the sophisticated techniques and extensive resources available to their colleagues in the 'advanced' laboratory. The United Nations has a 'Joint Inspection Unit' which monitors the performance of the various United Nations agencies. In 1991, an evaluation carried out by the Unit assessed the IAEA's Co-ordinated Research Programme as "perhaps the most important co-operative effort in the [United Nations] system."[74]

The total cost of research contracts awarded annually — other than those in support of safeguards — remained fairly constant at between $750 000 and $850 000 from 1961 until 1970. Because of the effects of inflation, this reflected a decline in the relative importance of the programme and a decline in real terms of the money spent on it. After 1975, however, the total cost of research contracts began rising quite substantially. Figure 4 shows its growth from 1970 to 1995.

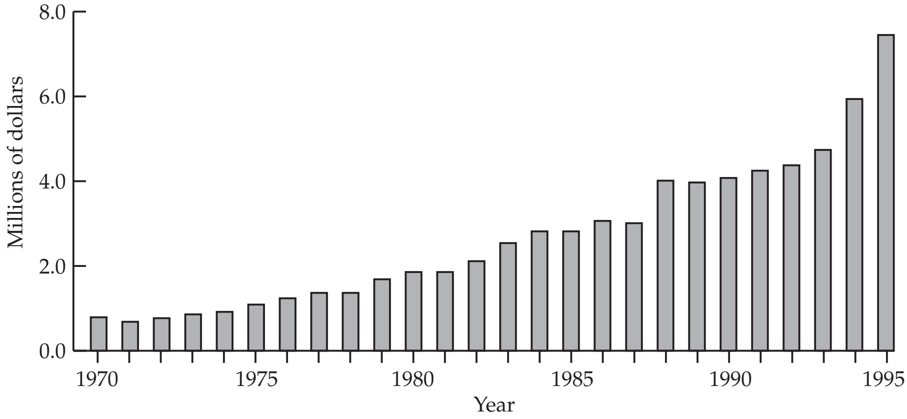

FIG. 4. Growth of the IAEA research contract programme, 1970–1995.

In the earlier years the dominant subjects of research were radiobiology, radiation protection and waste management. Subsequently, the use of nuclear techniques in agriculture and in medicine gradually emerged as the main topics, reflecting a trend towards subsidizing research on practical questions of more direct interest to the developing countries.

The supply of nuclear materials

Although the Agency failed to become a significant source of supplies of nuclear power plants and their fuel, it served quite frequently in the early years as a broker for the supply of small quantities of nuclear materials for laboratory research. In September 1968, the Board delegated authority to the Director General to approve transfers of amounts up to 1 kg of natural uranium or its equivalent in plutonium and enriched uranium, i.e. amounts that qualified for exemption from safeguards under the INFCIRC/66 system.[75] The USA originally made available up to $50 000 each year to cover such supplies. By 1970, the IAEA had arranged such supplies to some 30 Member States.[76] In the early 1980s, arrangements for such supply of small quantities became increasingly rare.

By 1970, the IAEA had also brokered the supply of subcritical assemblies or research reactors and/or their fuel or major components to Argentina, Chile, the Congo (Leopoldville, i.e. Zaire), Finland, Indonesia, Iran, Israel, Japan (the first), Mexico, Norway, Pakistan, Philippines, Spain, Uruguay, Viet Nam and Yugoslavia.[77] In the next decade the recipients of research reactors and/or their fuel included Greece, Malaysia, Romania, Turkey and Venezuela. During this period the IAEA also brokered for the first — and last — time the supply of power reactors and their fuel, namely to Mexico and Yugoslavia, and booster rods for a power reactor in Pakistan (Kanupp). More recently, the Agency assisted with the transfer of fuel for two miniature neutron source reactors of Chinese origin to Syria (1992) and Ghana (1994).

In the 17 years from 1981 to 1997, the list of new recipients of research reactors and/or their nuclear fuel under project agreements with the IAEA comprised Ghana, Jamaica, Morocco, Peru, Syria and Thailand.

It is clear from the record that while the developing Member States of the IAEA have very rarely turned to it as the supplier of nuclear power plants and their fuel, they have customarily asked it to arrange for the provision of a research reactor. One reason for this was probably that the nuclear authority of the developing country that would normally operate the research reactor had a relatively close relationship with the IAEA, but that this would not necessarily be true of the electric power utility or authority. Nonetheless, the number of requests for the IAEA's help in obtaining research reactors declined after the 1960s, probably because most developing countries that wished to obtain a research reactor had already done so by 1970.

The International Centre for Theoretical Physics in Trieste and the Agency's laboratories

The Trieste Centre

In 1963, thanks largely to the leadership and drive of the eminent Pakistani physicist and Nobel Prize winner Professor Abdus Salam,[78] the IAEA established a unique institution, the International Centre for Theoretical Physics (ICTP).

In the late 1950s, it was obvious that some of the IAEA's main programmes were off to a slow start. New ideas were needed, particularly ideas that would promote East/West co-operation. An international centre for theoretical physics was just such an idea. It need not be costly, it would not involve the investment in expensive equipment that would be essential for a centre for experimental physics like CERN in Geneva — all that the theoretical physicist would need was a pencil and paper, or chalk and a blackboard. Interested Member States proposed the creation of the ICTP at the fourth session of the General Conference in 1960, which adopted a resolution calling for a study of the proposal.[79] In June 1963, the Board, accepting an offer by the Government of Italy, approved the establishment of the Centre in Trieste.[80]

The ICTP began its work in October 1964 with a four week seminar on plasma physics. It has since provided to physicists from all over the world, and especially from the developing countries, a facility that enables them to maintain contact with their colleagues and to keep abreast of developments in many branches of pure and applied physics and related disciplines. It served as host to numerous conferences, seminars, workshops and training courses. By the 1990s, the ICTP was receiving some 4000 scientists from all regions of the world every year, and more than 40 Nobel Prize winners had taken part in its activities. Under Professor Salam's direction the Centre invented ingenious forms of association to enable scientists from the developing countries to maintain contact with their colleagues, for instance by becoming associate members and visiting the centre three times over a period of six years for stays of six weeks to three months. Another scheme enabled institutes federated with the ICTP to send young scientists to Trieste for 40–120 days a year. By 1995, there were some 300 Federation Agreements.

From the start the ICTP received generous support from the Italian Government and the city of Trieste. In 1970, UNESCO became a joint sponsor of the Centre.[81] Professor Salam remained the Director of the Centre until 1993, when he retired from that post, but was appointed President of the Centre. In June 1995, Professor Miguel Virasoro from Argentina succeeded Professor Salam.

In 1994, to celebrate the thirtieth anniversary of the ICTP, the International Foundation Trieste published a tribute to Abdus Salam. It included a message from Hans Blix in which he wrote that: "The extraordinary success of the ICTP as a place for co-operation and as a landmark for physicists and mathematicians from developing countries is due to the vision, competence and energy of its creator, Abdus Salam."[82]

Professor J. Niederle, of the Czech Academy of Sciences, described the ICTP as "a clearing house for new ideas", "a crossroad for physicists" and "a place for doing research" and wrote movingly about his first visit to the Centre in 1964 from Prague where "the cornerstones of the first Czechoslovak Republic...democracy, tolerance and humanity...were brutally oppressed by a totalitarian regime..."; his stay at the Centre "meant for me a penetration through the iron curtain...to think in global terms as a free people."[83]

The ICTP has served as a model for other institutions and triggered their development in the industrialized as well as developing countries, in the United Kingdom and the USA as well as in Colombia and the Republic of Korea. UNESCO coined the term 'Triestino' "to mean a scientific institution devoted to international co-operation in science and with modalities modelled on those of the International Centre for Theoretical Physics."[84]

Since the Centre's inception, the Italian Government has met by far the largest share of its operating costs, the IAEA has contributed a second, much smaller share and, since 1 January 1970, when it became joint sponsor of the centre, UNESCO has made the same annual contribution as the IAEA. Several governments (e.g. of Denmark, Germany, Japan, the Netherlands, Sweden and the USA), the European Union, OPEC, UNDP and numerous institutes have also helped to fund some of the Centre's activities.[85]

At the end of 1995, UNESCO took over administrative responsibility for the ICTP, but the IAEA decided to remain a partner in the operation of the Centre and to work with it in subjects directly related to the IAEA's programmes.[86]

The Headquarters and the Seibersdorf laboratories

In 1958, the IAEA set up a provisional laboratory in the basement of its headquarters building in the former Grand Hotel. The 'Headquarters laboratory' had small physics and chemistry sections. Its main work was:

— To analyse samples of air, milk and vegetation (supplied by UNSCEAR and Member States) in order to measure environmental contamination resulting from atmospheric tests of nuclear weapons;[87]

— To help set international standards by preparing and distributing controlled samples of radioisotopes to other laboratories in Europe and North America;
— To launch a worldwide programme for the measurement of the concentrations of tritium in the atmosphere, for which the atmospheric tests were chiefly responsible. This programme is more fully described in Chapter 10.[88]

As noted in Chapter 5, in April 1959 the Board approved plans for a permanent laboratory to be built adjacent to the Austrian Nuclear Research Centre at Seibersdorf, near Vienna. The Agency's Seibersdorf laboratory went into operation in October 1961. It was the first full-fledged laboratory of a truly international character.[89] The laboratory was designed "especially for certain types of work that call for comparison and co-ordination on the widest possible basis."[90] In August 1961, Sterling Cole invited all developing Member States to make known any requirements that might be met by the laboratory and to suggest activities or projects in which they had a particular interest.

The Seibersdorf laboratory was not intended to be a centre for independent nuclear research but rather a means of providing essential support to the Agency's technical and scientific programmes. Since 1961, the laboratory has underpinned the Agency's work relating to protection of the environment, medicine, agriculture, hydrology, nuclear safety and safeguards. The scientists working at the laboratories do, of course, engage in research, but such research is usually of direct utility to the programmes of the 'parent' Divisions and Departments at IAEA Headquarters.

After the creation of the FAO/IAEA Division of Food and Agriculture in 1964, the laboratory's work in support of research on agriculture and nutrition and on applications of radiation began to expand, and in 1965 the FAO and the IAEA established a plant breeding unit. In 1968, the two agencies set up an entomology unit and in 1986 they completed the construction of a new agriculture wing. In 1990, a new training facility, funded by the USA, Austria, Germany and the FAO, was also constructed. Construction of a new modern extension to the entomology unit, made possible by a donation from the USA, was completed in February 1997.

The work of the Seibersdorf laboratories in support of the IAEA's food and agriculture, human health and isotope hydrology programmes — chiefly for the benefit of developing countries — is described in Chapter 10. The main work of the laboratories that did not fall within these categories was in relation to nuclear fallout, preparation of standards and analytical quality control.

Measuring nuclear fallout, 1961–1963

From 1961 to 1963, the Seibersdorf laboratory measured radioactivity in samples of food, milk, etc., resulting from the fallout that was caused by the nuclear weapon tests that the USA, the USSR, the United Kingdom and France carried out in the atmosphere and at ground level. This was a continuation of the work begun at the Headquarters laboratory and it came to an end after the cessation of most atmospheric testing in 1963.[91]

Preparation of tritium and other standards used in hydrology

Since 1961, the hydrology section of the laboratory has supplied water standards to tritium laboratories in numerous countries in connection with the IAEA's programme for a worldwide survey of hydrogen and oxygen isotopes.[92] This too was a continuation of the work begun at the Headquarters laboratory and, as explained in the next chapter, it established one of the crucial bases of the IAEA's hydrology projects.

Analytical quality control services[93]

To give some examples of the usefulness of analytical quality control services, accurate and precise knowledge of the chemical contents of a given sample provides the essential data for deciding:

— Whether the material sampled is fit for human consumption,
— Whether or not the environment is being contaminated,
— Whether trace chemical elements essential for good health or responsible for diseases are present in the human body,
— Whether or not the materials or batch of goods from which the sample is taken meet certain agreed specifications for a commercial transaction.

Thus, accurate chemical analysis may be crucial for human life or human health, or in determining whether the conditions agreed to in an important commercial contract or other agreement have been fulfilled. It is also essential for determining the extent of chemical pollution of the environment by, for instance, the overuse of fertilizers or pesticides, or resulting from a major accident such as Chernobyl.

In the early 1960s, the Seibersdorf laboratory began providing a broad range of analytical quality controls. This started with the collection of data on low level radionuclide pollution resulting chiefly from the atmospheric tests of nuclear weapons referred to above. UNSCEAR, responsible for assessing the effects of the tests, noticed alarming discrepancies in the data supplied by national laboratories and asked the IAEA to assist it in ensuring the comparability of results. The IAEA arranged intercomparisons between co-operating laboratories and provided the reference materials against which the laboratories could test their own results.

The results of some preliminary intercomparisons in the mid-1960s were 'impressively bad': even some of the results received from old and well established laboratories showed wide deviations from the norm. The IAEA organized a succession of meetings to resolve these problems and arranged further intercomparisons. By 1974, the laboratory was able to offer a comprehensive analytical quality control service to Member States.

In the 1970s and 1980s, the IAEA also gradually extended the range of material that it analysed, and for which it provided reference materials, to include sea water, sediments and marine life (biota) — analysed by the IAEA's Monaco Laboratory for radionuclide, pesticide and trace element content — and hydrological materials to determine their isotopic composition (the ratios of hydrogen and oxygen isotopes).

Other sources of reference materials included the Commissariat à l'Energie Atomique in France, the European Union's Central Bureau of Nuclear Measurements in Geel, Belgium, and the New Brunswick Laboratory in the USA. At the same time, progress in electronics, chemical instrumentation, microprocessing and computing permitted the simultaneous or nearly simultaneous analysis of many different elements, and eventually of the detection and measurement of more and more minute traces. In this way the IAEA was able to provide reference materials for the analysis of a constantly growing range of trace elements.

A very wide and increasing range of customers has required reference materials to enable them to make accurate and precise analyses of samples containing minute quantities of elements and compounds. They have included research institutions and laboratories, almost every organization concerned with setting standards and ensuring safety such as regulatory and environmental authorities, and industrial corporations. By 1995, the IAEA was able to provide a catalogue of approximately 1600 reference materials.

After the Chernobyl accident, the analytical services of the Seibersdorf laboratories were used by several Member States and by the International Chernobyl Project to study the environmental impact of the accident.[94]

Training of scientists from developing countries

In 1963, the Seibersdorf laboratory held its first international training course. The subject was how to determine the radionuclide content of food. Since then the laboratory has conducted three to four international training courses each year. They have covered various agricultural disciplines, the use of isotopes in hydrology studies, the maintenance and repair of nuclear instrumentation and radiochemical analyses. The laboratory also plays host each year to many scientists from developing countries who receive hands-on training in the application of specific nuclear techniques to the solution of practical problems.

The Monaco Laboratory

In 1958, the United Nations Conference on the Law of the Sea adopted a resolution recommending that the IAEA should pursue whatever studies and take whatever action were necessary to assist States in controlling the discharge of radioactive materials into the sea.[95] An IAEA panel, meeting in 1958 and 1959, proposed limits on such disposals and in November 1959 the IAEA convened in Monaco the first international conference on the disposal of radioactive wastes at sea.[96]

In 1961, the IAEA, the Government of Monaco and the Musée Océanographique (directed by Jacques Cousteau) began a three year research programme on the effects of radioactivity in the sea. As noted in Chapter 5, this opened the way to the establishment of the IAEA's International Laboratory of Marine Radioactivity (ILMR). The Laboratory began work in the 1960s by analysing the distribution of radionuclides in the sea, the composition of marine organisms, the way in which these organisms incorporate radionuclides and the impact of radiation on marine life.[97]

The Laboratory also served as an 'umbrella' institute, providing samples of sea water, sediments and marine life containing measured quantities of radioisotopes to many national laboratories in order to help them standardize and calibrate their measurement techniques, and to ensure that the results of their analyses were comparable with each other. For instance, in 1975, 110 laboratories in 27 Member States of the IAEA took part in an intercalibration exercise.[98]

It is obvious that one of the main political rationales for the Laboratory was concern in the late 1950s about the dumping of low level waste at sea. Low level waste included slightly radioactive laboratory equipment overalls and waste from the radiology units of hospitals. The USA had terminated its earlier dumping activities, but several Western European nations were continuing to send a ship into the North Atlantic each year to dump barrels filled with concrete as well as waste thousands of feet down in ocean trenches. The practice aroused much criticism and strong objections by Cousteau, amongst others. As noted elsewhere, the Soviet Union was amongst the fiercest critics, but kept silent about the massive amounts of high level waste it was dumping in the Arctic seas and the Far Eastern seas.

The year 1974 marked a turning point for the Laboratory. One of the main projects of the recently established United Nations Environment Programme (UNEP) was to undertake an accurate assessment of the levels of pollution in the principal seas, beginning with the Mediterranean and the Persian Gulf and later extending to all the world's oceans. The rising level of non-radioactive pollution of these seas by industry, farming, shipping, drilling for oil and tourism was a far more pressing and formidable problem than that caused by the dumping of low level waste in the depths of the Atlantic. In 1974, the Laboratory's functions were accordingly broadened to cover non-nuclear contamination. It became, in effect, a service laboratory for much of the UNEP programme as well as the leading international centre for assessing the effects of radioactivity in the sea. It also provided training (about a dozen specialist training courses a year) and analytical quality assurance services.

Thus, in 1974, UNEP joined the IAEA and the Government of Monaco as the principal funders of the Laboratory. It also received funds, equipment and other forms of support from UNDP, the Intergovernmental Oceanographic Commission of UNESCO and from many governments and other intergovernmental or non-governmental bodies, including France, Germany, Japan, Sweden, the USA and the European Union.

In 1986, the IAEA created a Marine Environmental Studies Laboratory within ILMR to co-ordinate studies on non-radioactive marine pollution.[99]

To reflect more accurately the broader scope of the Laboratory's work on behalf of Member States and several UN agencies, the Laboratory's name was changed in 1991 to the IAEA Marine Environment Laboratory (IAEA-MEL).[100] As the only such laboratory in the United Nations system, it was now at the forefront of international efforts to understand, preserve and protect the marine environment.

Since 1974, the Laboratory has assessed and helped to mitigate many grave challenges to the marine environment. Its more recent work has included:

— A study of the impact of the 1991 Gulf War on the Persian Gulf; in other words, the extent and effects of the pollution caused by the release of oil into the Gulf and by the burning of some 67 million tonnes of oil when Iraqi troops set fire to the Kuwaiti oil wells (since 1980 the Laboratory had already been helping UNEP and the Gulf countries to set up a regional marine monitoring and research programme).[101]

— A Co-ordinated Research Programme on the condition of the Black Sea. The IAEA began this programme in 1992. Public concern about the consequences of Chernobyl and about releases from some nuclear plants in the region induced the countries concerned to give high priority to research on radioactive pollution of the Black Sea.[102]

— A major study of radioactive pollution of the Arctic and Far Eastern seas (see also the section on radioactive waste management in Chapter 7). In 1993, the IAEA began work on an 'International Arctic Seas Assessment Project'. The aim was to determine the potential hazards to humans and the marine environment resulting from the dumping of nuclear waste, spent nuclear fuel and nuclear propulsion reactors in the shallow waters of the Kara and Barents Seas, and to predict the dispersion of any radioactive material that may leak in the future.[103] The Laboratory took part in five expeditions to the region. Measurements made in two of the bays in which waste was dumped have shown that in 1994 there has been some contamination by the objects dumped "...but at radiologically insignificant levels."[104] "Sediment contamination is limited to the immediate vicinity of the [dumped] containers."[105] At the end of 1996, the IAEA presented a report on the results of the study to the parties to the London 'Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter'.[106]

— An analysis of samples of sea water and sediments taken by a joint Japan–Republic of Korea–Russian Federation expedition to the Far Eastern seas, which was also the scene of large scale dumping. Analysis of the samples "did not show any effects from the dump sites."[107] (See also Chapter 7.)

— An analysis of the consequences of weapon tests in the Pacific. Specifically, a study of the effects of France's nuclear tests on and above Mururoa Atoll in the South Pacific. In 1991, the analysis of the first samples showed that "radioactivity concentrations around Mururoa are extremely low, close to detection limits and generally at global fallout levels."[108]
— A study of the role of the oceans in mitigating global warming.
— Studies on the impacts on the marine ecosystem of industrial pollution and the runoff of fertilizers and other agricultural chemicals.
— A survey of nuclear and other industrial pollution of the Danube River basin. This study, which the Cousteau Foundation and the IAEA began in 1992, assessed the impact of fossil fuel power stations, phosphate and other industrial chemical plants as well as of nuclear sites in Hungary, Romania and Bulgaria.[109] The survey "showed that the Danube River and catchment are radiologically clean... The only man-made radioactivity consistently observed is from fallout from the Chernobyl accident and the levels are relatively low..."[110]
— A study of the contamination of the northern Adriatic Sea by, for instance, PCBs and mercury.[111] The European Union has funded the project, which was aimed at improving understanding of the causes of eutrophication of the sea. Isotopic methods have been used to help define the rates of the most relevant marine processes.

In 1995, the Laboratory began studies of the causes of the dramatically rising levels of the Caspian Sea. Isotopic techniques have been used to study the water table of the Caspian region and the IAEA's hydrology laboratory is taking part in the project.[112]

In support of its work the Monaco Laboratory has created a 'Global Marine Radioactivity Database' (GLOMARD) to provide governments with radioactivity baseline data on sea water, sediments and biota — in other words, data on the amounts of radioactivity in various locations of the seas, their sediments and marine life.

In 1994, the Principality of Monaco completed new and permanent premises for the Laboratory. It is expected that by 1998 new construction will more than double the floor space of the Laboratory.

A changed assessment of the usefulness of the laboratories

In the early 1960s, several members of the Board were sceptical about the value of and the need for the IAEA's laboratories and the ICTP at Trieste; many Governors, including those representing the USSR, France and the United Kingdom, argued that they would simply duplicate work that could be done better and more cheaply by national laboratories and institutes. Experience has shown that this scepticism was ill-founded. The laboratories and ICTP, as well as the Divisions with which the laboratories most closely work, have earned a fine reputation in the world of science and have provided valuable services to the IAEA's Member States. It is noteworthy that Russia and France, which in the early days were particularly dubious about the potential value of Trieste, Seibersdorf and Monaco, have found them most useful in determining the environmental impact of their own previous or recently discontinued military nuclear operations.

NOTES

1 The number of developing Member States seriously involved in nuclear power — operating, building or about to order nuclear power plants — has remained at about a dozen since the 1960s, after having peaked at 15 or more in the 1970s. The States that have abandoned incipient nuclear power programmes include Egypt, Israel, the Philippines and Yugoslavia.

2 The chief techniques are the uses of radioisotopes as tools in agricultural, medical, environmental and biological research, or in field studies (e.g. tracing the course of underground aquifers, measuring the rate of recharge of underground reservoirs), and the use of radiation in medicine and in various industries such as food preservation, sterilization of medical supplies and improving plastics.

3 Afghanistan, Bangladesh, Cambodia, Ethiopia, Haiti, Liberia, Madagascar, Mali, Myanmar, Namibia, Nicaragua, Niger, Senegal, Sierra Leone, Sudan, Uganda, Tanzania, Yemen, Zaire and Zambia.

4 *Annual Report for 1976*, GC(XXI)/580, IAEA, Vienna (1977) p. 18, para. 39.

5 The countries are: Bangladesh, Brazil, Bulgaria, China, Cuba, Egypt, Hungary, Indonesia, Iran, Malaysia, Mexico, Nigeria, Pakistan, Philippines, Poland, Romania, Tanzania, Thailand, Republic of Korea and Viet Nam. (Information provided by the IAEA's Department of Technical Co-operation.)

[6] LACHANCE, L.E., KLASSEN, W., "Applying the sterile insect technique to the control of insect pests", *IAEA Yearbook 1991*, IAEA, Vienna (1991) B23. At a special facility, e.g. at the IAEA's entomology laboratory at Seibersdorf, specialists breed large numbers of the target insect pests and sterilize them by radiation. These insects are released in an infected area, usually at a time when the wild population is naturally low or has been reduced by the use of chemicals. If the insect only mates once the entire population may be eliminated by infertile matings.

[7] The Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture and the Divisions of Human Health and of Physical and Chemical Sciences.

[8] *Annual Report for 1989*, GC(XXXIV)/915, IAEA, Vienna (1990) 136. The IAEA now has 15 technical Divisions, including the two responsible for the technical assistance programme. Six of the technical Divisions are in the Department of Safeguards.

[9] Resolution GC(XXV)/RES/386.

[10] See GOV/OR.635, paras 31–32, and GOV/OR.639, pp. 14–17, paras 49–67.

[11] The G-77 referred to "lists A and C" in an annex to United Nations General Assembly Resolution 1995 (XIX) and related resolutions subsequently adopted by the Assembly.

[12] "Moreover, there is no statutory limitation on the eligibility of Member States to receive technical assistance, and a number of them are both donors and recipients of such assistance" (GOV/INF/467 of 5 February 1985, para. 3).

[13] In fact, some tentative steps were taken to incorporate the *entire* budgets of FAO and UNESCO into the budget of the UN itself and, pending such incorporation, to have the FAO and UNESCO budgets reviewed by the General Assembly (GOODRICH, L.M., HAMBRO, E., SIMONS, A.P., *Charter of the United Nations, Commentary and Documents*, Columbia University Press, New York (1969) 424).

[14] One might have gone even further towards centralization. It would have been administratively logical to put the UN and all the agencies in one place where they could have shared a single administrative and financial infrastructure. In the relationship agreements with some specialized agencies, including those with FAO and ILO, there is "a qualified commitment to establish headquarters of the agency at United Nations headquarters, or at least to consult before a final decision is taken" [about the location of the headquarters of the two agencies]. (GOODRICH, L.M., et al., *Charter of the United Nations*, *Commentary and Documents*, p. 423.)

[15] And ECOSOC has been quite unable to play the programmatic co-ordinating role foreseen for it; for many observers it has become little more than a talking shop.

[16] *Annual Report for 1991*, GC(XXXVI)/1004, IAEA, Vienna (1992) 148.

[17] BARRETTO, P.M.C., "Activities of the International Atomic Energy Agency relevant to Article IV of the Treaty on the Non-Proliferation of Nuclear Weapons," NPT/CONF.1995/PC.IV/8 (1995).

[18] CONGRESS OF THE UNITED STATES, *Background Material for the Review of the International Atomic Policies and Programs of the United States*, Report to the Joint Committee on Atomic Energy, Vol. 3, US Govt Printing Office, Washington, DC (1960) 752; and *Annual Report of the Board of Governors to the General Conference 1 July 1959–30 June 1960*, GC(IV)/114, IAEA, Vienna (1960), p. 4, para. 15 (b); *Annual Report of the Board of Governors to the General Conference 1 July 1960–30 June 1961,* GC(V)/154, IAEA, Vienna (1961), p. 28, paras 185–186.

[19] *Annual Report of the Board of Governors to the General Conference Covering the Period from 1 July 1958 to 30 June 1959*, GC(III)/73, IAEA, Vienna (1959), p. 31, para. 131.

[20] *IAEA Statute*, Articles III.B.3 and IV.C.

[21] Document INFCIRC/267, part B, para. 2 ('The Revised Guiding Principles and General Operating Rules to Govern the Provision of Technical Assistance by the Agency', March 1979); and SZASZ, P.C., *The Law and Practices of the International Atomic Energy Agency*, Legal Series No. 7, IAEA, Vienna (1970) 455. INFCIRC/267, part B, para. 2, provides that "each Member State…shall be eligible for technical assistance provided from the Agency's own resources", but this is subject to the Guiding Principle that these resources "shall be allocated primarily to meet the needs of developing countries."

[22] Little did one know that four decades later even Russia itself might receive assistance from programmes designed chiefly for the 'developing countries' (*The Agency's Technical Co-operation Activities in 1994*, GC(39)/INF/8, IAEA, Vienna (1995), p. 35, para. 123). Russian experts were invited to take part in several regional technical co-operation activities and interregional training courses. Russian experts were also awarded fellowships. Recently, 'footnote a/' projects (described later in this chapter) in Russia have also been included in the technical co-operation programme.

[23] CONGRESS OF THE UNITED STATES, *Review of the International Atomic Policies and Programs of the United States*, p. 740-741; and *First Annual Report of the Board of Governors to the General Conference Covering the Period from 23 October 1957 to 30 June 1958*, GC(II)/39, IAEA, Vienna (1958), p. 30, para. 131.

[24] CONGRESS OF THE UNITED STATES, *Review of the International Atomic Policies and Programs of the United States*, p. 740; and *Annual Report of the Board of Governors to the General Conference 1 July 1959–30 June 1960*, p. 41, paras 257–258.

[25] The first training course was held jointly with FAO at Cornell University in the USA. Other training courses in 1960 and 1961 were held in Argentina (use of

radioisotopes in agriculture and medicine), India (radioisotopes in agricultural research, and on reactors), Netherlands (agricultural research) and Israel (radiobiology) (*Annual Report of the Board of Governors to the General Conference Covering the Period from 1 July 1958–30 June 1959*, p. 33, paras 144 and 145; *Annual Report of the Board of Governors to the General Conference 1 July 1959–30 June 1960*, p. 25, paras 133 and 135).

[26] SZASZ, P.C., *The Law and Practices of the International Atomic Energy Agency*, p. 459.

[27] SZASZ, P.C., ibid, p. 479.

[28] *Annual Report for 1976*, p. 18, para. 40.

[29] *Annual Report for 1978*, GC(XXIII)/610, IAEA, Vienna (1977), p. 15, para. 42.

[30] RAINER, R.H., SZASZ, P.C., *The Law and Practices of the International Atomic Energy Agency: 1970–1980, Supplement 1 to the 1970 Edition of Legal Series No. 7*, Legal Series No. 7-S1, IAEA, Vienna (1993) 218–219.

[31] RAINER, R.H. SZASZ, P.C., ibid., pp. 220–221.

[32] The formula used in the revised document (INFCIRC/267, para 1.(I)) was that "Technical assistance shall be provided only for peaceful uses of atomic energy. For the purposes of the technical assistance programme, peaceful uses of atomic energy shall exclude nuclear weapons manufacture, the furtherance of any military purpose and uses which could contribute to the proliferation of nuclear weapons, such as research on, development of, testing of, or manufacture of a nuclear explosive device."

[33] Document GOV/OR.529, paras 14 and 17.

[34] *Annual Report for 1983*, GC(XXVIII)/713, IAEA, Vienna (1984), pp. 20–21, paras 61–66.

[35] *Annual Report for 1987*, GC(XXXII)/835, IAEA, Vienna (1988), p. 17, paras 46–47.

[36] *Annual Report for 1991*, p. 1.

[37] *Annual Report for 1995*, GC(40)/8, IAEA, Vienna (1996) 6.

[38] The statistics for IAEA training courses before 1980 are not readily available.

[39] In 1996, the Board approved a further 35 Model Projects.

[40] Finland has been successfully operating Soviet plants of the WWER type for nearly 20 years. It addressed this deficiency by building containment domes around the reactors and by installing more advanced Western reactor control instruments.

[41] The information in this paragraph was provided by Jihui Qian, Deputy Director General in charge of the IAEA's Department of Technical Co-operation. Before joining the IAEA, Mr. Qian was closely associated with the Chinese nuclear power programme.

[42] This is, in effect, an offspring of what the IAEA Statute refers to as the "General Fund". In the *Annual Report for 1995*, p. 54, it is referred to as the "Technical Co-operation Fund".

[43] Projects that the Secretariat has found to be technically sound but for which the Agency does not have enough funds in the TCF to carry out. In the document that the Secretariat submits to the Technical Co-operation Committee of the Board, these are identified by a footnote a/. Donor States select those that they are prepared to finance.

[44] In the case of projects funded by UNDP or by other development funding organizations, the funding body makes a contribution to the IAEA to enable it to meet overhead costs.

[45] For a discussion of this issue, see SZASZ, P.C., *The Law and Practices of the International Atomic Energy Agency*, pp. 501–502.

[46] *Annual Report of the Board of Governors to the General Conference 1 July 1959–30 June 1960*, p. 20, paras 98–99.

[47] See Table I, Annex 3.

[48] *Annual Report of the Board of Governors to the General Conference 1 July 1963–30 June 1964*, GC(VIII)/270, IAEA, Vienna (1964), p. 35, para. 166.

[49] In 1962, the representative of the United Kingdom, Michael Michaels, formally proposed amending the Statute to incorporate technical assistance funding into the regular (assessed) budget. Normally, Western countries (and the Soviet Union) insisted that all contributions to the technical assistance funds must be voluntary. The United Kingdom's departure from this position was to some extent a reaction to the fact that the contributions of the Soviet Union and other Eastern European countries were invariably in the form of non-convertible currencies, or in kind. In the Board the Soviet Union (Vassily Emelyanov) and its allies strongly objected to the proposal, and it was also opposed by Canada and, somewhat surprisingly, by India. Equally surprising was the support it received from the US Governor (Henry Smythe). It was also supported by the Federal Republic of Germany and by most of the other Governors from developing countries who took part in the debate (see GOV/OR.300 and 301).

The Board referred the issue to the General Conference, which asked the Board for a further report on the matter. When the Board's discussions were resumed in 1963, the USA put forward a somewhat different package, which included financing technical assistance out of the regular budget but set upper limits to the value of any equipment component of any technical assistance project. The Board was divided on much the same lines as in 1962, and the US proposal was approved by a vote of 12 to 5 and transmitted to the General Conference (GOV/OR.323). The General Conference decided not to act on the Board's recommendation and asked it to continue its examination of the issue, but by then it was obvious that no consensus could be reached, and the discussion came to an inconclusive end.

50 General Conference resolutions GC(V)RES/100 and GC(VI)RES/126.

51 Table I, Annex 3.

52 Ibid.

53 *Annual Report 1 July 1974–30 June 1975*, GC(XIX)/544, IAEA, Vienna (1976), p. 23, Table III.

54 *Annual Report for 1979*, GC(XXIV)/627, IAEA, Vienna (1980), p. 11, para. 46.

55 *Annual Report for 1980*, GC(XXV)/641, IAEA, Vienna (1981), p. 11, para. 56.

56 *Annual Report for 1976*, p. 11, para. 23.

57 For instance, such discrimination is incompatible with Article IV.C of the IAEA's Statute.

58 *Technical Co-operation Report for 1996*, GC(41)/INF/4, IAEA, Vienna (1997), p. 42, para. 143. The total assessed cost of footnote a/ projects amounted to $17.9 million, of which 39.5%, or $7.1 million, was made operational by donor countries or by funds that became available from the TCF.

59 For Soviet, Western and other opposition and for Indian and other developing country support of an amendment of the Statute, see GOV/OR.543 and GOV/OR.544 of May 1980.

60 *Annual Report for 1992*, GC(XXXVII)/1060, IAEA, Vienna (1993) 176.

61 Ibid., p. 1

62 *Annual Report for 1995*, p. 52.

63 The heading 'physical and chemical sciences' covers, for instance, projects relating to the operation of research reactors, the production of radioisotopes and the maintenance of nuclear instruments.

64 *First Annual Report of the Board of Governors to the General Conference Covering the Period from 23 October 1957 to 30 June 1958*, p. 31, paras 133–135; and *Annual Report of the Board of Governors to the General Conference Covering the Period from 1 July 1958 to 30 June 1959*, p. 32, para. 139.

65 *Annual Report of the Board of Governors to the General Conference 1 July 1959–30 June 1960*, pp. 24–25, para. 132; and *Annual Report of the Board of Governors to the General Conference 1 July 1962–30 June 1963*, GC(VII)/228, IAEA, Vienna (1963), p. 1, para. 5. It is understood that the centre is still operating and has asked the FAO to fund a number of training lectures (Information provided by James D. Dargie, Director of the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture.)

66 The RCA's meetings have been particularly useful for those responsible for planning the use of research reactors in various countries in the region. These reactors, supplied chiefly by the USA and former USSR, represent relatively large and costly investments of foreign exchange and scarce scientific manpower. In at least one

case (in Venezuela in the 1970s), lack of available scientists forced the closing of the reactor for several years.

[67] *Annual Report for 1990*, GC(XXXV)/953, IAEA, Vienna (1991) 142.

[68] See Table I, Annex 3.

[69] *Annual Report for 1980*, p. 9, Table I.

[70] See Table I, Annex 3.

[71] Document GOV/OR. 543.

[72] The first two contracts were awarded to institutes in Vienna for research on the effects of radiation and on factors determining the distribution of fission products in the biosphere.

[73] If the research contracts had been regarded as a form of technical assistance to the institute, it would have been legally necessary under Article XIV.B.2 of the Statute to charge them against the scarce and coveted funds available for technical assistance (technical co-operation) and not against the regular budget. To maintain the fiction that the contracts were designed to secure services or information needed by the Agency, they were concluded directly between the Secretariat and the laboratory or institute, and not through official Agency-to-State channels. Initially, the only contracts charged against the regular budget were those relating to explicit statutory functions such as health and safety and safeguards. In 1967, the Board decided to charge all research contracts against the regular budget. Previously more economy-minded Governors had sought to maintain a distinction between those contracts that should be financed by the regular budget and those that should be regarded as a form of technical assistance, but this distinction vanished with the 1967 decision (SZASZ, P.C., *The Law and Practices of the International Atomic Energy Agency*, pp. 502–503).

[74] *Annual Report for 1991*, p. 2.

[75] RAINER, R.H., SZASZ P.C., *The Law and Practices of the International Atomic Energy Agency: 1970–1980*, p. 198.

[76] The recipients included Algeria, Argentina, Austria, Brazil, Bulgaria, Burma (Myanmar), Ceylon (Sri Lanka), Chile, Congo (Zaire), Finland, Greece, Hungary, India, Iran, Indonesia, Mexico, Pakistan, Philippines, Poland, Romania, Singapore, Spain, Turkey, United Arab Republic (Egypt), Uruguay, Viet Nam, Yugoslavia and the IAEA itself. After the NPT came into force in 1970 the States that requested such supplies were required to undertake not to use them for any purpose prohibited by the Treaty.

[77] SZASZ, P.C., *The Law and Practices of the International Atomic Energy Agency*, pp. 422–431.

[78] Salam was awarded the Nobel Prize for Physics in October 1979 (GOV/OR.540).

[79] Resolution GC(IV)/RES 76. *Annual Report of the Board of Governors to the General Conference 1 July 1960–30 June 1961*, p. 34, para. 214.

[80] *Annual Report of the Board of Governors to the General Conference 1 July 1962–30 June 1963*, p. 8, para. 52.

[81] The agreement between the IAEA and UNESCO for the joint operation of the Centre came into force on 1 January 1970 (*Annual Report of the Board of Governors to the General Conference 1 July 1969–30 June 1970*, GC(XIV)/430, IAEA, Vienna (1970), p. 46, para. 120).

[82] HAMENDE, A.M. (Ed.), *From a Vision to a System*: *The International Centre for Theoretical Physics of Trieste (1964–1994),* International Foundation Trieste for the Progress and the Freedom of Sciences, Trieste (1996) 10.

[83] NIEDERLE, J., "The ICTP in a thirty year perspective", ibid., p. 237.

[84] BERTOCCHI, L., "The ICTP: Historical developments and present status", ibid., p. 57.

[85] See, for instance, the *Annual Report for 1981*, GC(XXVI)/664, IAEA, Vienna (1982), p. 56, para. 226.

[86] *Annual Report for 1995*, p. 7.

[87] There was still much fear of the effects of fallout, especially of the bone-seeking radioisotope strontium-90 in milk as a potential cause of childhood leukaemia. An incident in 1954 vividly demonstrated how dangerous fallout could be when fall-out from a hydrogen bomb test at Bikini Atoll killed two members of the crew of a Japanese fishing boat, the *Lucky Dragon*, and seriously injured the others. (GOLDSCHMIDT, B., *Le Complexe Atomique*, Fayard, Paris (1980) 125.) Public concern helped to induce the three nuclear weapon States of the time to put an end in 1963 to testing in the atmosphere and under the sea. It will be recalled that the same concern was the chief reason why the United Nations established UNSCEAR in 1956.

[88] *Annual Report of the Board of Governors to the General Conference 1 July 1959–30 June 1960*, p. 40, para. 254; *Annual Report of the Board of Governors to the General Conference 1 July 1960–30 June 1961*, p. 20, para. 128.

[89] "Das neue Laboratoriengebäude der Internationalen Atombehörde", *Neues Österreich* (21 October 1961). EURATOM was already operating a number of large specialized regional laboratories.

[90] "An International Atomic Energy Laboratory", *Nature* (London) No. 4814 (1962) 427–428.

[91] France and China were not parties to the Limited Test Ban Treaty of 1963 and for a few years after 1963 they continued atmospheric testing (China carried out its first test in 1964).

[92] As noted, the hydrogen isotopes deuterium and tritium also resulted chiefly from tests in the atmosphere of hydrogen bombs (i.e. thermonuclear explosions).

[93] This section is largely based on SUSCHNY, O., DANESI, P.R., "Controlling the accuracy of chemical analysis", *IAEA Yearbook 1991*, pp. B35–B52.

[94] In 1996, the IAEA laboratories' radioanalytical expertise was used in support of an international study funded by France to analyse the consequences of the French nuclear weapon tests on Mururoa and Fangataufa Atolls.

[95] *First Annual Report of the Board of Governors to the General Conference Covering the Period from 23 October 1957 to 30 June 1958*, p. 35, para. 158.

[96] *Annual Report of the Board of Governors to the General Conference Covering the Period from 1 July 1958 to 30 June 1959*, p. 39, paras 181 and 183. The panel was chaired by Harry Brynielsson of Sweden, Managing Director of the Swedish Atomic Energy Company (Aktiebolaget Atomenergi) and mentioned previously as the favoured candidate for the post of IAEA Director General until the US Government decided to propose Sterling Cole. The Monaco conference was co-sponsored by UNESCO.

[97] *IAEA Laboratory Activities*, Technical Reports Series No. 41, IAEA, Vienna (1965) 73.

[98] *Annual Report for 1976*, p. 37, para. 148(b).

[99] *Annual Report for 1986*, GC(XXXI)/800, IAEA, Vienna (1987), p. 40, para. 367.

[100] *Annual Report for 1991*, p. 32.

[101] FOWLER, S.W., "Pollution in the Gulf: Monitoring the marine environment", *IAEA Bulletin* **35** (June 1993).

[102] *Annual Report for 1992*, p. 42.

[103] In May 1993, Russia officially confirmed that it had dumped seven submarine or ice breaker reactors still containing fuel and ten reactors without fuel (but highly radioactive), as well as large quantities of liquid and solid wastes, in the shallow bays and troughs of Novaya Zemlya and in the open sea. Waste had also been dumped in the northwest Pacific, chiefly in the Sea of Japan (*IAEA Yearbook 1993*, IAEA, Vienna (1993) C87–C88).

[104] *Annual Report for 1994*, GC(39)/3, IAEA, Vienna (1995) 54.

[105] *Annual Report for 1995*, p. 17.

[106] Ibid., p. 16; *Annual Report for 1993*, GC(XXXVIII)/2, IAEA, Vienna (1994) 40–41; and *Annual Report for 1996*, GC(41)/8, IAEA, Vienna (1997) 14.

[107] *Annual Report for 1994*, p. 54; and *Annual Report for 1995*, p. 17.

[108] *Annual Report for 1991*, p. 33; and *Annual Report for 1995*, p. 17. After the end of France's series of tests in 1995–1996, the French Government invited the IAEA to take part in a thorough analysis of the consequences of several decades of nuclear weapon testing on the Mururoa and Fangataufa Atolls.

[109] *Annual Report for 1991*, p. 34.

110 *Annual Report for 1992*, p. 42.

111 *Annual Report for 1995*, p. 17. “The findings were instrumental in establishing the pollution histories of important environmental contaminants, such as PCBs and mercury.”

112 *Annual Report for 1995*, p. 31.

Chapter 10

THE IAEA AND THE APPLICATIONS OF NUCLEAR TECHNIQUES (RADIOISOTOPES AND RADIATION)

In Chapter 9 it was emphasized that the IAEA's programmes of the greatest benefit to the developing countries have been those relating to the use of isotopes and radiation. The industrialized countries have also profited from these uses, but they have done so without much involvement of the IAEA except in the international exchange of information.

This chapter focuses on the work that has been done by the IAEA and jointly by the FAO and the IAEA to promote the use of these techniques in the developing countries. It has been carried out mainly by the Departments of Research and Isotopes and Technical Co-operation and by the relevant units of the Agency's Laboratories at Seibersdorf. The IAEA has relied on Co-ordinated Research Programmes to develop and test isotope and radiation techniques and has made increasing use of laboratories in the developing countries themselves as well as of its own laboratories. The IAEA has used its technical co-operation programme as the chief means for transferring these techniques.

Many of the IAEA's programmes described have been of value to the IAEA's membership as a whole and to the general advancement of science as well as to their principal target, the developing countries. A good example is the programme now known as GNIP, or the 'Global Network for Isotopes in Precipitation', which is described later in this chapter under the Agency's programmes in the earth sciences.

The GNIP programme is clearly of interest to science and to all countries, but it provides data that are also used to determine how quickly water can be safely extracted from a particular underground reservoir. Information about the rate at which rainfall recharges underground reservoirs is especially valuable to the many developing countries in arid regions and to cities suffering from shortages of clean water.

FAO/IAEA programmes

By the time the IAEA began its work FAO had already established an Atomic Energy Branch. In 1959, the IAEA set up a unit of agriculture in the Division of Life Sciences to promote the use of nuclear techniques in research on food and agriculture. In September 1961, the IAEA opened its laboratory at Seibersdorf, which was soon providing services to the agricultural unit.

With two international organizations working independently but pursuing similar objectives, overlapping and jurisdictional disputes were inevitable. As noted in Chapters 5 and 12, the Directors General of the two agencies therefore decided to pool their resources in a joint division. The essay by Björn Sigurbjörnsson in the companion volume, *Personal Reflections*, vividly describes the turbulent early years that eventually led to the very successful work of what has become the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture.

After more than 30 years of collaboration between FAO and the IAEA, the following programmes dealing with the use of isotopes and radiation are well established. Their goal is:

— Improving the production of milk and meat and other products of animal husbandry;
— Eradicating or controlling insect pests;
— Reducing losses of food by extending shelf life and suppressing sprouting, and improving food safety by reducing contamination by microorganisms;
— Optimizing the use of fertilizers and water and maximizing fixation by crops of biological nitrogen;
— Inducing mutations in plants so as to obtain the desired varieties of agricultural crops;
— Studying the pathway of pesticides and agricultural chemicals in the environment and in the food chain and determining contaminants in food.

Animal production and health

In recent years the FAO/IAEA programme relating to 'animal production and health' has chiefly aimed at:

— Testing the results of vaccination campaigns;
— Developing new sources of protein for livestock, such as leguminous trees, poultry manure and urea–molasses blocks;
— Testing the results of programmes to eliminate insect pests.

An example of the work that the IAEA and FAO have done to improve animal production and health is their contribution to the campaign to eliminate rinderpest, chiefly by testing the results of vaccination campaigns. Rinderpest is a deadly viral disease in cattle related to measles in humans. When it reached Africa a century ago it killed more than 90% of the continent's cattle. The rinderpest virus cannot survive if 85% or more of the cattle are effectively vaccinated. The Organization of African Unity recognized that vaccination on this scale would require substantial strengthening of veterinary services in Africa and it embarked on what has been described as the largest ever programme for the eradication of an animal disease, the Pan-African Rinderpest Campaign.

The programme is funded chiefly by the European Union, but a consortium of other international and bilateral organizations and 34 countries have participated in the campaign. Today rinderpest, previously widespread, is under control in all but two African countries. Its eradication will not only help to avoid the disastrous cattle losses of the past in Africa, but will also promote trade in livestock and livestock products.

Rinderpest is not confined to Africa. Eleven countries in the Middle East are taking part in a Model Project to provide national laboratories with the equipment, training and expertise needed to ensure effective surveillance.[1]

Since 1986, the IAEA and FAO have worked together to help African nations control and eradicate the disease,[2] chiefly by promoting the use of a simple, cheap and reliable kit that enables laboratories to monitor progress in their vaccination campaigns and by helping to establish a regional laboratory network to monitor the disease.

The work of the two agencies included the equipping and training of laboratory staff, applied research to validate the test and, ultimately, the routine use of the test in national vaccination programmes and assessment of the results. The campaign has resulted in such a high level of immunity from rinderpest that it is now possible to stop mass vaccination, thus saving several hundred million dollars each year. It is expected that a formal international declaration will be made that herds in most countries in Africa and Asia are free from this disease, but national veterinary laboratories will have to continue surveillance and stamp out remaining pockets where the virus has survived. The project has therefore concentrated on removing the remaining pockets of infection, and on surveillance using technologies that rapidly identify the existence of the disease or confirm its elimination.

Insect and pest control

The principal technique used by FAO and the IAEA in the control and elimination of insect pests is the sterile insect technique (SIT). Essentially, SIT is a novel form of insect birth control. It is specific to the target species, exploiting the behaviour of the insect when it seeks its mate. Insects are mass reared in 'factories' and sterilized by gamma rays emitted by a cobalt-60 source. The sterile insects are then released in a controlled manner into nature. Matings between the released, sterile insects and native or 'wild' insects are infertile. If enough matings take place the pest population falls and it may eventually be controlled and in some cases eradicated.[3]

The main limitations to the technique are that the requirements for its success are extremely demanding and that the mass rearing of certain insect pests, such as moths and certain varieties of butterfly, is very difficult.[4]

In the 1960s, the Seibersdorf Laboratory began to test techniques for the small scale rearing of sterilized insect pests. Since 1983, the FAO/IAEA entomology unit of the Agency's Laboratories has developed means for the mass rearing of pests that cause vast losses, especially in developing countries. They include the Mediterranean fruit fly (medfly), which attacks more than 200 varieties of fruit and vegetables, and the tsetse fly (the vector of sleeping sickness in animals and people).

The entomology unit has also made studies of the processes of radiation sterilization and the computer modelling of insect populations, and provides sterile insects for use in the field and by other institutions. Chemical pesticides or other technique are often used to bring down the insect population before the sterile insects are released. SIT accomplishes what conventional techniques cannot, namely the total eradication of the insect pest in the region where SIT is applied.

In 1988, the 'New World Screwworm', until then a stranger to Africa, made its appearance in Libya. The insect lays its eggs under the skin of livestock where they hatch, breed and cause festering sores that lead to infection, debility (a disease known as myiasis) and eventually death. Unchecked, the pest would have threatened to spread throughout Africa and perhaps the Middle East and further afield.[5]

Under a project launched by FAO in 1989 and financed by a consortium of donors, UNDP, the IAEA and FAO, millions of sterile flies were brought by air from the rearing facility in Mexico and released in Libya to swamp and eliminate the invader. The cost of the project had been estimated at $80–90 million.

On 22 June 1992, the Libyan Government declared that the New World Screwworm had been eradicated.[6] In the same year the IAEA and FAO reported that the pest had been eradicated at less than half the expected cost (less than $40 million) a year ahead of schedule.[7]

The Mediterranean fruit fly was first introduced into Chile in 1963.[8] Consumer countries placed restrictions on the import of fruit from Chile where the medfly was still present in its northern provinces. The restrictions caused substantial losses to Chile's multi-billion dollar fresh fruit export industry. After ten years of unsuccessful attempts to eradicate the fly by the use of insecticides, Chile decided to try SIT. With the help of FAO and the IAEA, which provided training to professional staff, the services of experts and specialized equipment as well as the design of a medfly mass rearing plant, a facility with a production capacity of about 60 million sterile flies a week was completed in 1993, when sterile insects were first released. No wild medflies have been detected in Chile since early 1995. The eradication of the pest from the country was corroborated by plant protection inspectors from Japan and the USA, thus concluding a 32-year campaign against the insect. This was officially announced in December 1995. The 'fly-free' status has given the country's fruit industry access to previously closed export markets. The benefits to the Chilean economy have been estimated at $500 million a year.[9]

A Model Project was approved at the end of 1993 for the use of SIT in Argentina to eradicate the medfly from large areas of the country. By the end of 1995, the medfly had been brought under control in 250 000 hectares of Mendoza province.

The FAO/IAEA laboratories have developed a strain of the medfly that permits the separation of the sexes by the colour of their pupae. This development, which is being put to use in Argentina, will greatly increase the efficacy of the technique.[10] The laboratories have also recently developed a female strain of the medfly which makes it lethally sensitive to changes in temperature; this is expected to reduce the cost of rearing and releasing the insect by about 40% and to make the technique much more effective.

The tsetse fly is the vector of sleeping sickness (trypanosomiasis) in man and nagana in cattle. Its hosts are the antelope and other game and it makes large regions of Africa unusable for most breeds of cattle.[11] Recently, the IAEA, with support from the USA, the United Kingdom, Belgium and other donors, began an SIT campaign to eliminate the tsetse fly from the island of Zanzibar. The largest colony of sterile tsetse flies in the world has been established in insectaries at Tanga (on the mainland of Tanzania, opposite Zanzibar) with almost one million breeding flies. It was reported that "the last wild fly [in Zanzibar] was captured in September (1996) with no detections since then" and that "trypanosomiasis declined rapidly reaching the lowest levels over recorded…" In the meantime the Government is encouraging farmers to establish livestock on tsetse-free land by offering low interest loans.[12]

Not all attempts to use nuclear methods to control insect pests have been successful. The first major project had to be aborted because of public fears and lack of understanding about the use of radiation. In June 1965, the governing body of the UN Special Fund approved a proposal drawn up by the IAEA and the Turkish Government for a pilot plant using a cobalt-60 source to kill insect pests in stored grain.[13] Rumours about the purpose of the plant began to circulate and the local Turkish press launched a campaign against the project, which a newspaper described as a plot to sterilize the local population with radioactive food. Eventually public feeling was so aroused that the project had to be abandoned — an early example of a successful anti-nuclear campaign! The IAEA had already procured the cobalt source but was later able to divert it to be used by Argentina in another technical co-operation project.[14]

A second undertaking in the early days ran into a more technical problem. The object was to eliminate the olive fly from an area in Greece by the use of what was then called the sterile male technique. The project was eventually abandoned because of difficulties in finding acceptable food on which to rear the insect artificially.

An unfortunate fate was also in store for an SIT project to eliminate the medfly in Egypt. In October 1982, the IAEA and Egypt, supported by Austria and Italy, launched a four-year project at an estimated cost of $19.3 million to eliminate this pest from the Nile Valley using the technique that had been successfully employed in Mexico.[15] In 1986, the Government of Egypt decided to postpone the implementation of the project[16] and it was subsequently terminated by mutual agreement between Egypt, the IAEA and Italy (the major potential donor country) without ever becoming operational. Apparently there were intractable differences between the Agency and the authorities who would have been responsible for carrying out Egypt's tasks under the project.

Food irradiation

The use of ionizing radiation to preserve food has had to overcome formidable obstacles from the first years of the Agency's involvement in the process. Many such obstacles still exist today, for instance widespread fear that irradiation causes harmful changes in the treated food,[17] and the consequent reluctance of the food industry to invest in the process, despite the fact that it knows that irradiation causes no such deleterious effects. Largely because of concern about public reactions, governments still limit the use of the process to a few food items. Irradiation also faces competition from other methods of preserving food which may be cheaper when large stocks of food are processed.

So far, the commercial use of irradiation has been largely confined to expensive or perishable foods, especially spices, onions and fresh fruit, but it has also been used to preserve poultry, seafood and even wine. It is interesting to note that two countries that are world renowned for their cuisines, France and China, are amongst those that make use of food irradiation, as does the food conscious USA, while the United Kingdom is not yet amongst the 39 countries that permit large scale irradiation of food products.

Despite these obstacles, food irradiation has been making progress in the last decade. Chemical fumigants are demonstrably carcinogenic and their use is increasingly prohibited. The most widely used refrigerants, chlorofluorocarbons or CFCs, are also increasingly proscribed because of the damage they do to the ozone layer (although other harmless chemical refrigerants are being substituted for CFCs). The number of cases of salmonella poisoning has grown significantly as a result of the consumption of infected chickens that have been mass reared, slaughtered and dressed by automated techniques. The irradiation of poultry could greatly reduce or eliminate the risk of salmonella infection.

The quantity of irradiated spices provides an example of the growing use of the technique: about 6000–7000 tonnes in 1987; nearly 20 000 tonnes in 1991 and more than 45 000 tonnes in 1995.[18]

One of the main aims of the FAO/IAEA programme has been to investigate whether foodstuffs that had been irradiated underwent any physical or chemical changes that could reduce their wholesomeness. In January 1965, the IAEA, FAO, ENEA in Italy and the Austrian Atomic Energy Society jointly started work on a project for the irradiation of fruit and fruit juice at the Austrian Nuclear Research Centre at Seibersdorf. The project lasted three years and confirmed the safety of the process, but Austria has still not approved the use of radiation for preserving any foodstuff.[19]

On 1 January 1971, the IAEA, FAO and WHO launched the first large international test of the wholesomeness of irradiated food at Karlsruhe in Germany. A committee of the three agencies had given a provisional five-year clearance to irradiated potatoes, wheat and wheat products. The clearance would only be confirmed, however, if the foodstuffs could pass a large scale, five-year test to ascertain whether irradiation induced any unwanted somatic or genetic effects and whether it affected the palatability of the food.[20] The test required the feeding on irradiated food of a large number of various species of laboratory animals during the five years of the test, and the eventual post-mortem examination of the animals. More than 23 countries took part in the project, which was subsequently extended until 1978. Another committee of the three agencies reviewed the results of the test. It showed that there had been no harmful effects.

The three agencies also drew up a standard for irradiated foods which was subsequently accepted by the WHO/FAO commission responsible for the international Codex Alimentarius.[21] An expert committee also reported to the commission that the irradiation of any food up to an average dose of 10 kilogray presented no toxicological hazard, required no further testing and introduced no special nutritional or microbiological problems. The agencies also published a code of practice for operating food irradiation plants.

In 1984, the three agencies established an international consultative group on food irradiation to advise them on subjects such as ensuring the safety of food irradiation, appropriate legislation to permit the marketing of irradiated food, the economic feasibility of the process and the international trade in irradiated food. In 1988, an international conference entitled 'Acceptance, Control of and Trade in Irradiated Food' adopted a guide on principles for the acceptance of irradiated food. By 1994, 44 countries had joined the group and its mandate was extended until 1999.[22]

Summing up, over the last 40 years more than adequate scientific data have become available to show that food irradiation is safe and effective in preserving a growing range of foodstuffs with no significant side effects. The main obstacles to the wider use of the technique is its cost and public acceptance problems, but this is offset in the case of higher value foods by the savings that can be made by reducing spoilage. Because of the prohibition of certain other hitherto widely used methods of food preservation, irradiation offers an increasingly attractive alternative.

Soil fertility, irrigation and crop production

The soil, irrigation and crop programme aims chiefly to help farmers make more economical and efficient use of water and fertilizers, make greater use of natural plant nutrients and cultivate poor soils and improve crop yields with less damage to the environment. Some examples of the crops being developed are drought resistant varieties of wheat, maize, cotton and acacia trees, chiefly in Africa and Asia, and crops that can tolerate salt affected soils. A recent project aims to increase the natural ability of plants to take nitrogen from the atmosphere (reducing the need for chemical fertilizers) by encouraging the growth of rhizobium nodules on the roots of plants.

Nuclear techniques have also shown how nitrogen fertilizers can be used more efficiently by placing the fertilizer in bands instead of broadcasting it.

Plant breeding and genetics

Projects in the plant breeding and genetics programme use radiation to induce mutants that are better in various ways than the parent plant. For instance, FAO/IAEA programmes have promoted the use of radiation to breed rapidly growing and ripening cereals in regions that have short summers or short ripening seasons (e.g. barley in the altiplano of Peru), higher yield rice (e.g. in provinces adjoining the Yangtze River in China), and drought and disease resistant sorghum, rice and cassava (in Central Africa). The agricultural economies of many other countries have also benefited from mutant varieties: for instance, cotton in Pakistan and China, rice in Viet Nam and the USA as well as in China, barley in most of Europe and durum wheat in Italy.

By 1995, nearly 1800 new (mutant) varieties of more than 150 species of crops had been officially released for planting in 52 countries (most of these varieties had, of course, been developed by national or other laboratories and not by the FAO/IAEA laboratories at Seibersdorf). New molecular and in vitro techniques have accelerated the process and each year the number of officially released mutants has increased.

Control of pesticides and other agrochemicals

The pesticides and agrochemicals programme has been designed to monitor and control the effects of using or releasing pesticides and other potentially contaminating chemical or physical substances. Rape seed oil is used for making lubricants. A recent project has demonstrated that this oil, free of the caesium-137 released by the Chernobyl accident, can now be produced on contaminated land in Belarus. Another recent project has shown that certain commonly used chemical insecticides have no serious effects on the environment (e.g. they do not harm the natural enemies of insect pests) when used in hot, moist tropical conditions.

Human health

When the IAEA's Division of Life Sciences began work in 1958 it dealt with the applications of radiation in medicine, dosimetry, the environment and radiobiology. In 1993, the programme was broadened and renamed 'Human Health'. Since 1990, the programme has increasingly focused on solving those health problems of developing countries that can best be tackled by the use of nuclear techniques, such as the early diagnosis and treatment of cancer, the assessment of nutritional deficiencies in women and children, the timely detection of infectious and communicable diseases and the accurate measurement of radiation doses given to patients.

Treatment of cancer

Radiotherapy is perhaps the most publicized medical application of radiation. The IAEA's initial programmes concentrated on research in radiation biology such as chromosome aberrations caused by exposure to radiation and basic research to determine the lethal doses that must be administered for bacteriological sterilization. However, in response to the demands of Member States, the Agency's programmes relating to cancer have since focused more on the design and provision of clinical radiation facilities. By 1997, more than 40 long term projects dealing with the radiation treatment of cancer were under way in Africa, Asia, Europe and Latin America.

The IAEA has also helped developing countries to design national strategies for cancer diagnosis and therapy. For instance, the IAEA succeeded in helping the countries of Latin America to replace the use of radium in the treatment of uterine cancer by the safer and more reliable radioisotope caesium-137.

Developing countries have often needed the help of the IAEA to design the facilities, select and procure the equipment and train the staff needed to begin the diagnosis and treatment of cancer, and to arrange visits by experts to help them begin clinical work. They have also needed IAEA help to improve existing therapy or introduce new techniques and to provide training in radiography and specialized nursing as well as in radiology and radiotherapy.

International assistance in the dosimetry of radiotherapy[23]

The success or failure of radiation treatment depends on the dose delivered to the tumour, which should not vary by more than a few per cent from the dose prescribed. If the dose is too small, it will not be effective and will increase the resistance of the tumour to radiation. If it is too large, it may cause severe complications and even death. Precise measurement of the dose (dosimetry) delivered by radiotherapy machines is therefore essential.

In the 1960s, it became clear that patients at many clinics throughout the world were being irradiated without adequate control of the radiation dose they were receiving. These observations alarmed the IAEA and WHO and they agreed to undertake an extensive training programme and enlarge the existing pilot system for the verification of doses administered in radiotherapy so as to cover all the main regions of the world.

Since 1962, the Agency has been giving assistance to laboratories, hospitals and clinics in Member States to calibrate the equipment they used for measuring radiation doses. In 1963, the Agency acquired the world's first portable system for measuring the absorbed radiation dose from high energy X rays, cobalt-60 and betatron electron beams. From 1963 to 1970, the IAEA sent it to radiotherapy centres and research laboratories in Belgium, Czechoslovakia, Germany, Hungary, Switzerland, the USSR and the United Kingdom. In 1968, the IAEA began providing a service for the accurate measurement of radiation emitted by cobalt-60 therapy units and medical accelerators used in cancer treatment.

In 1966, thermoluminescent dosimeters became available for measuring the radiation dose delivered to patients at radiotherapy centres. The IAEA began an international postal distribution service and sent out about 300 sets of dosimeters per year. In 1968, WHO joined this project. The two agencies agreed to a division of labour under which the Agency's dosimetry laboratory would prepare and evaluate the thermoluminescent dosimeters and the WHO would distribute them by post to hospitals and other institutes in developing countries.[24] By the end of 1996, the services provided by the IAEA had verified 3000 radiotherapy beams. The IAEA provided a similar service for measuring the cobalt-60 radiation used in plants for radiation processing (food irradiation, sterilization of medical supplies, etc.).

Following a December 1974 WHO/IAEA meeting in Rio de Janeiro, the two agencies took an important decision, namely to help member nations set up a world network of specialized laboratories for dosimetry calibration. The laboratories became known as Secondary Standard Dosimetry Laboratories (SSDLs).[25] The purpose of the network was to ensure that the doses of radiation that patients receive are measured according to international standards. The IAEA distributed the equipment and instruments — ionization chambers and dosimeters — needed for the precise measurement and calibration of therapy beams. A 'Working Arrangement' of 1976 between the IAEA and WHO ensured that there would be an effective link between the bodies maintaining primary standards, such as the International Bureau of Weights and Measures, and the SSDLs responsible for calibrating dosimeters in participating countries. Since 1976, the IAEA has served as the central point in the network, establishing the link to the international measurement system and, under its technical co-operation programme, has helped several developing countries to build SSDLs and to train their staff. In 1979, the IAEA built its own dosimetry laboratory in Seibersdorf which has served as a model of a medium sized SSDL in developing countries. The IAEA has provided help to SSDLs to calibrate standards for measuring radiation used in radiotherapy diagnosis, in radiation protection and for the measurement of environmental radiation.

By the end of 1995, 69 laboratories and 6 SSDL national organizations in 57 countries were taking part in the network.[26] The network also included 16 affiliated members such as Primary Standard Dosimetry Laboratories, the International Bureau of Weights and Measures and the International Commission on Radiation Units and Measurements.

Nuclear medicine

Nuclear medicine is perhaps the most common application of radiation in developing as well as industrialized countries. It is based on the use of minute amounts of radioactive molecules of known biological behaviour to trace specific biochemical processes and functions. These tracers, or 'radiopharmaceuticals', can be thought of as guided molecular probes. If they are administered to the patient in vivo or added to a sample of tissue in a test tube — in vitro — as they are in radioimmunoassay, these probes search through the body or the sample until they find 'recognition sites' in the targeted cells where their solubility, charge and shape lead them to be selectively bonded to a cell component.

If labelled with a gamma radiation emitter (emitting very small quantities of radioactivity), the guided molecular probes can be detected by external detectors and their emitted radiation can be measured, thus providing functional and biochemical quantitative data of value in diagnosis. This information is given by a gamma camera in the form of two-dimensional images showing the spatial distribution of the radiotracer in the body and thus reflecting the quality and regional distribution of a given biochemical or functional process.

Nuclear medicine also applies physiological concentrations of beta ray emitting radionuclides that emit enough radioactivity to destroy the targeted tissue. In this case the molecular probe becomes an actual molecular 'guided missile' of great accuracy. If the binding site — the target — of the radioactive molecular missile is a cancerous tumour, the aim of the treatment is the specific and total destruction of malignant tissue with a highly radioactive dose, but with nearly no effects on the surrounding normal cells.

The IAEA has also played a significant role in introducing and promoting the progress of nuclear medicine in developing countries. By 1995, more than 95% of the Agency's developing Member States had established nuclear medicine services. An IAEA survey showed that 2172 gamma cameras were installed in 78 developing countries in 1995.

Following the development of the radioimmunoassay technique[27] in the late 1960s in the USA and the United Kingdom, the IAEA supported projects in Singapore (1972) and in Sri Lanka and Kuwait (1974). In 1986, the IAEA began the first regional project, on the radioimmunoassay of thyroid related hormones. It involved 123 laboratories in 13 countries in the Asia and Pacific region. From 1986 to 1995, the Agency supported 51 technical co-operation projects on radioimmunoassay in 34 Member States as well as 7 regional projects involving, all in all, over 300 laboratories.

As laboratories in developing countries became more expert, some of the primary reagents needed were produced locally and after proper testing began to replace the costly imported articles. Finally, the IAEA helped to introduce into the developing regions of Asia, Latin America and Africa external quality assessment schemes as a final arbiter of the reliability of assays. The assays covered thyroid related hormones.

Between 1986 and 1995, 568 scientists in Latin America, 161 in Asia and the Pacific and 90 in Africa were trained in various aspects of radioimmunoassay and related topics. The results were to reduce the costs of radioimmunoassays, increase the number of such assays that individual medical personnel could carry out, improve the reliability of assay results and increase the availability of reagents at the local or regional level. From figures supplied to the Agency it was clear that two thirds of the laboratories participating in the regional projects had reduced the costs of processing a sample for a common hormone to less than 30% of the cost of using an imported commercial kit. In the case of laboratories able to produce more sophisticated reagents, the cost of a single test came down by 90% or more and clinical workloads increased by a factor of two to five. Although by 1995 Agency assistance had largely ceased, sustainable screening programmes had been established in Thailand, where 80% of the one million live births each year are now being screened for hypothyroidism and there are realistic prospects of full coverage by the year 2000.

In the 1990s, the IAEA extended its programme to cover therapeutic as well as diagnostic and other uses of open sources of radiation. An IAEA Co-ordinated Research Programme enabled hospitals in developing countries to use strontium-89, phosphorus-32 and samarium-153 to treat patients suffering from intractable bone pain as a result of cancer metastases. Iodine-131, traditionally used as a means of treating hyperthyroidism (goitre), was also employed to enhance the response of such patients to the treatment.

Nuclear medicine includes the use of radioactive DNA probes or genetic markers to identify specific bits of DNA present in the genetic material of cells. These bits can be amplified or multiplied by the 'polymerase chain reaction' (PCR), which produces the amount of material needed from a test sample containing the minute bit of DNA of a single cell. In the early 1990s, the IAEA promoted this technique as a means of detecting Chagas' disease in Latin America, and malaria in Africa, and also to detect other communicable diseases prevalent in developing countries such as meningeal tuberculosis, lepra, schistosomiasis and leishmaniasis. In the 1990s, the IAEA introduced the use of this technique to detect genetic or hereditary diseases such as cystic fibrosis, thalassemia and haemophilia.

The Agency's human health programmes have recently included a growing amount of work on human nutrition. Isotopic techniques — mainly those involving stable isotopes — have been used to help identify persons at risk of malnutrition in micronutrients (in other words, at risk because their diets contain too little of certain vitamins and trace elements) and help scientists to monitor and enhance the effectiveness of programmes designed to improve their diets. The IAEA's programmes have focused on iron, vitamin A and iodine because deficiencies of these micronutrients are known to occur commonly in developing countries; it is also known how they should be treated and the effectiveness of treatment can be measured unambiguously.

Too little iron in the diet causes anaemia, a condition which afflicts about 50% of small children (under four years old) and 60% of women of childbearing age in developing countries. One of the reasons for this high incidence is that the diet of most people in these countries is largely vegetarian, while easily absorbed iron is present only in meat and other animal tissues. Nuclear techniques cannot of course substitute for this deficiency, but stable or, where appropriate, radioactive isotopes provide a means for measuring iron bioavailability (how much iron the body absorbs and uses from a measured amount of a particular food). This helps to show what change of diet is most likely to reduce the incidence of anaemia. Isotopic techniques are also used to measure iron status (the amount of iron in the body) so as to determine, for instance, the impact of a particular change in or enrichment of diet.

Severe vitamin A deficiency afflicts about three million of the world's children and a milder deficiency threatens the health of some 230 million. The deficiency can lead to blindness, greater vulnerability to infectious diseases such as measles, diarrhoea, bronchitis and other respiratory diseases, and may possibly increase the risk that a mother suffering from AIDS will pass the disease on to her infant children. The chief cause of the deficiency is lack of the right foods such as butter, liver, eggs and leafy green and yellow vegetables, but many factors affect the bioavailability of vitamin A and of other food components that are converted in the body to vitamin A. The IAEA's programmes that support the use of isotopes to measure the bioavailability and status of vitamin A and its precursors are similar to those relating to iron deficiency.

Isotope techniques have a number of other practical applications in studies of human nutrition. These include:

— Determining the requirements of undernourished children for protein and amino acids, and relationships with stunted growth;
— Monitoring breast feeding (i.e. breast milk intakes by infants, and the resulting energy requirements of their mothers);
— Monitoring improvements in nutritional status resulting from 'dietary intervention programmes' (i.e. school breakfasts);
— Exploring some of the causes of osteoporosis (the loss of bone tissue, leading to the weakening of bone).

The IAEA has supported work of this kind through a number of Co-ordinated Research Programmes, as well as by technical co-operation projects.

Other medical uses of radiation

Ionizing radiation is also of great value in the bacteriological sterilization of medical appliances (surgical dressings, sutures, catheters and syringes) and tissue for graft implants in humans (bone, nerve, fascia, dura, chorion dressings for burns and cardiac valves). These items incorporate heat sensitive materials and cannot be sterilized by steam or dry heat. Sterilization by ethylene oxide gas or other chemicals leaves undesirable residues that are hazardous to health. The IAEA has played a key role in establishing radiation sterilization facilities in several developing Member States in Asia, Latin America, Africa and Europe.

Health related environmental monitoring and research

Environmental pollution, for instance of the air and of food and water for human consumption, is a problem of growing concern in almost every country of the world, including many developing countries. The most important pollutants affecting human health have nothing to do with isotopes or nuclear industries. However, nuclear analytical techniques provide useful and sensitive tools for research on these pollutants and for monitoring their levels in the environment.

For many years the Agency has been helping nuclear centres in developing countries to use their laboratories for research on non-radioactive pollutants such as toxic heavy metals (for instance, mercury and lead) and pesticide residues. Recent Agency supported programmes have focused on urban air pollution. A particular risk is posed by very small airborne particles in the size range below 10 microns (thousandths of a millimetre) which can penetrate deep into the lungs of people breathing them. This kind of air pollution is thought to cause the premature deaths of tens of thousands of people each year in many large cities of the world. The Agency has helped to establish a unique network of centres in more than 30 countries (mainly developing) all over the world for collecting and analysing such airborne particles. The aims of the Agency's programme in this field have been to support the use of nuclear and nuclear related techniques for research on and monitoring of air pollution, to identify major sources of air pollution in each of the countries taking part in the programme and to obtain comparative data on pollution levels in areas of high pollution (e.g. a city centre or a populated area downwind of large pollution sources) and of low pollution (e.g. rural areas).

Isotope hydrology and the development of uranium resources

Since 1958, isotope hydrology and the development of uranium resources have been the main subjects of the IAEA's work in the 'earth' sciences.

However, the importance of the latter has receded since the late 1980s, when stocks of uranium reached high levels, its price fell and prospecting and production declined.

Isotope hydrology

The practical applications of isotopes in assessing, monitoring, developing and managing resources of fresh water are especially interesting to the developing world, which contains most of the earth's arid regions and where available fresh water is falling far short of the needs of rapidly growing populations.

The practical uses of isotope techniques include:

- Measuring the flow of river water and of water in lakes and reservoirs,
- Measuring the rate and direction of groundwater flow,
- Investigating the sources and pathways of underground water,
- Determining the areas of recharge of groundwater,
- Estimating the rate at which bodies of groundwater are recharged (this enables the hydrologist to estimate the age of the water and the rate at which it can be safely extracted and used without running the risk of overuse),
- Detecting leakages and locating excessive losses due to seepage from lakes and reservoirs,
- Measuring the transport of sediments.

In the late 1950s, France, the Federal Republic of Germany, Israel, Japan, the USA and the United Kingdom began using radioactive tracers in studies relating to water resources. This encouraged the IAEA to enter the field, which it did in 1958, its first year of operation. Most of the IAEA's early work involved the injection of artificially produced radioisotopes to be used as tracers to monitor the movement of surface water and groundwater. However, as analytical techniques improved, naturally occurring isotopes, including stable isotopes of the elements of water, largely replaced radioisotopes in hydrological applications.

In 1961, the Agency took an important step when, together with the World Meteorological Organization (WMO), it launched a project for the worldwide measurement of tritium (the heaviest isotope of hydrogen), oxygen-18 and deuterium. To carry out their global tritium measurement programme it was necessary for the IAEA and WMO, working with a number of other international bodies, to establish a global network for the collection of isotopic data so as "to decipher this ongoing tracer experiment in the laboratory of nature."[28]

The number of meteorological stations taking part in the global survey rose from 100, when the survey was launched, to 220 in 1962–1963. In 1963, most nuclear tests in the atmosphere came to an end with the conclusion of the Limited Test Ban Treaty.[29] The amount of tritium in the atmosphere then began to decline and so did the number of network stations. Tritium is produced both naturally and by explosions of hydrogen bombs in the atmosphere. Atmospheric tritium combined with oxygen to form water vapour and came down to earth in the form of slightly radioactive rain or other forms of precipitation.

By monitoring the concentration and movement of tritium and other isotopes in water molecules, hydrologists were able to determine the rate at which water moves through the hydrological cycle: from cloud to earth; to river, underground reservoir, aquifer or glacier; to the ocean; and back again to cloud. In this way hydrologists could determine the origin of water and its age, the rate of precipitation and evaporation or infiltration into the ground. If a body of underground water contained no tritium it must have accumulated before the hydrogen bomb tests of the 1950s and early 1960s.

However, in the 1980s concern about global warming and its impact on the world's climate began to mount. One product of this concern was growing interest in establishing accurate models of the circulation in the atmosphere of water, water vapour and other greenhouse gases and in ancient climates (palaeoclimatology) as a potential key to future changes. As a result, several countries established new national networks.[30]

By serving as a sort of greenhouse, various gases, in particular water vapour, carbon dioxide and methane, let most of the sun's rays penetrate the atmosphere, but block the loss of heat from the earth into outer space. By determining the proportions of carbon isotopes in atmospheric carbon dioxide it is possible to identify better some of the sources of these greenhouse gases some of and consequently to understand better the global atmospheric 'budget': a prerequisite for the prediction of climate change.

Water vapour is the chief 'greenhouse gas'; it does more than any other to help maintain the global atmosphere at its present temperature and thus makes possible life on earth. Hence, accurate information about the manner and the speed with which water moves through or resides in the global water cycle has been valuable in the study of global changes in the earth's climate.

In 1963, the IAEA began holding international symposia on isotope hydrology, usually at four-year intervals (the ninth symposium was held in March 1995).[31] It also trained scientists from developing countries to make use of isotope hydrology techniques; the fifth isotope hydrology course was held in 1995.[32] Since the mid-1980s, the IAEA has supported about 160 projects and trained more than 500 scientists to help governments make use of isotope hydrology techniques.[33]

For the foreseeable future the fundamental priority in the development and use of water resources will be to overcome scarcities and to deliver sufficient clean water to all people to meet their needs and to provide basic sanitation.

In its first field project, in 1960–1961, the IAEA made a hydrological study of a region in Greece in support of an irrigation project that the FAO was carrying out in that country.[34] In the following years the IAEA carried out numerous hydrology studies in all continents, often as a subcontractor to FAO or another UN agency and in the framework of UNDP projects. It also gave extensive support to research on isotope hydrology, at first awarding individual research contracts and later arranging Co-ordinated Research Programmes. In recent years these were extended to cover topics such as identifying the sources of groundwater pollution, the suitability of particular locations for the disposal of nuclear waste (where the movement of water towards the earth's surface and into the food chain is a critical factor), variations in the concentration of carbon dioxide in the atmosphere (to help determine the circulation of this critical greenhouse gas and the extent to which it is absorbed in carbon 'sinks' in the oceans).[35]

Recent work has included a regional study of groundwater in which Egypt, Ethiopia, Morocco and Senegal are taking part. The first results in Morocco have shown that the local groundwater contains much ancient water (palaeowater), thus disproving an assumption that the groundwater was recently replenished. The implication is that if consumers continue to use groundwater at present rates they will exhaust remaining reserves and cause the water table to sink rapidly.

Another study in the Philippines has shown that the source of the water that is feeding some of the wells supplying Manila is not seepage from a local lake (Laguna Lake) — as was assumed — and that it will be necessary to drill additional wells at new sites going to deeper and more productive underground levels.

The IAEA has been helping the five countries on the shores of the Caspian Sea to use isotope techniques in order to determine why the level of the sea is rising and threatening to inundate cities and farmland. The IAEA has also used isotope techniques to determine the rate at which the groundwater level in Bangkok is sinking and thereby endangering ancient buildings.

As noted, better knowledge about the changes in climate that have taken place in the past will enable climatologists to make more accurate predictions about future climates. By measuring the proportions of various isotopes in groundwater and lakes, the hydrologist can determine the dates and magnitudes of previous changes. For instance, recent studies have shown a fall in temperature in tropical areas of about 5°C between the Holocene age and the last maximum glaciation. This challenges the accuracy of previous reconstructions of temperature changes in tropical and subtropical regions. Other studies have pointed to large changes in the intensity of Indian monsoons and rainfall during the Holocene period, confirming the vulnerability of the climate of South East Asia to relatively small changes in the atmosphere.

Recent hydrological projects

The IAEA has helped El Salvador to use stable isotopes to monitor its geothermal resources and to understand better the hydrological systems of two local geothermal reservoirs. This will permit better use of the wells producing geothermally heated water and those in which wastewater containing unwanted chemicals is re-injected underground. In the context of this project the IAEA also helped to build a laboratory that enables El Salvador and other countries in the region to analyse stable isotopes (oxygen-18 and deuterium), develop and manage water resources and monitor hydrological problems of surface water and groundwater. Eventually the laboratory will be able to provide analytical services for geothermal studies in other Central American countries that are planning to make greater use of this source of energy — for instance Costa Rica, which expects to increase production to 170 MW(e), and Guatemala, which plans to install 94 MW(e) of geothermal power.

Elsewhere in South America, Caracas, the capital of Venezuela, has been running short of fresh water at the rate of about 25 million litres per day. The quality of the water available has also deteriorated. A large proportion of the water was drawn from wells tapping groundwater reservoirs. Isotopes were used to help identify regions favourable for drilling new wells to overcome the water deficit. IAEA and Venezuelan experts using a variety of techniques, including isotopes, were also able to define the mechanism of recharge of water in different sectors of the city, the changes in the quality of groundwater at various depths (i.e. along 'vertical profiles'), and the zones of the city that are most vulnerable to pollution, where protective measures were needed. As a result, 50 new wells were drilled in the Caracas Valley and the water company was able to monitor the quality of the water it supplies to the city.

The IAEA, together with Brazil, Chile, Costa Rica, Cuba, Mexico and Venezuela, recently completed a regional project designed to overcome problems of water management. Teams of hydrologists and other experts investigated apparent leakages in a number of reservoirs in the region, three used for the supply of drinking water, three for irrigation and two for electricity generation. Stable and artificial isotopes were used to identify the origin of the water flowing downstream from the dams and to check whether there was a hidden interconnection between any of the reservoirs. In most cases it was found that the apparent leakage had its source in groundwater and that there was little or no contribution from the reservoirs. In a few cases where the leakage originated in the reservoir, the experts suggested corrective measures to the national authorities. In no case did the leakage endanger the structure of a dam. Planned engineering work costing $6 million was shown to be unnecessary.

IAEA assistance in developing uranium resources

Uranium is present in the earth's crust in an average concentration of only two to four grams per tonne of rock, i.e. two to four parts in a million. Higher concentrations occur in certain geological strata. Uranium can also be recovered as a by-product of gold mining (e.g. in South Africa) and copper mining (e.g. in Chile) and from the production of phosphoric acid (e.g. in the USA).

In the 1950s, the demand for uranium slackened and its price fell in free market countries as the Western nuclear weapon States, in particular the USA, completed building up sufficient stocks for their military programmes. When the Agency began working in 1958, demand was beginning to rise again in anticipation of increasing industrial needs.

After 1959, when the IAEA launched its first uranium development project, it broadened its technical assistance to cover geological studies, surface and aerial radiometric surveys of large areas, identification of promising deposits, mining of ore, production of concentrates (yellow cake) and processing of concentrates for the production of uranium oxide to be used in fuel elements.

In the 1970s, when many countries began to see nuclear energy as their main source of electric power, the world's uranium reserves appeared to be very limited. Accordingly, countries with large nuclear programmes sought to ensure adequate future supplies, while many developing countries such as Gabon[36] and Niger joined the main producers, Canada, the USA, South Africa (together with Namibia) and Australia. Similar efforts in Eastern Europe and the USSR led to discoveries in Czechoslovakia, the German Democratic Republic, Poland, Kazakstan, Kyrgyzstan and Mongolia. Between 1970 and 1980, over $600 million were invested each year in geological/geophysical surveys and drilling and development of mines, an expenditure that was second only to the nuclear industry's investment in nuclear power plants. To help Member States, and especially developing countries, prospect for and develop uranium resources, the Agency published a growing amount of reference material.[37]

In the 1960s, the IAEA and the OECD's NEA established a joint specialist group whose work resulted in: the acceptance by governments of common standards for reporting uranium reserves; a publication on uranium exploration techniques; and a joint publication (the 'Red Book') which periodically assessed uranium resources in free market countries. The Red Book was recently expanded to include data from the former Socialist countries.

After 1980, interest in finding new resources declined as a consequence of the Three Mile Island and Chernobyl accidents, the discovery of substantial reserves at Athabasca Lake in Canada and in Australia and the accumulation of large reserve stocks at nuclear power plants.

The IAEA has recently supported a number of fresh analyses of information and samples collected during the 1970s and early 1980s.[38] The resulting radiometric data have helped to assess the mineral resources of Iran, Malaysia, Portugal and Zambia and a number of other countries, and to provide baseline information for environmental monitoring and related studies.

Industrial uses of isotopes and radiation

When the IAEA began work in 1958, many industries in the technically advanced countries were already applying radiation techniques in numerous branches of industry, and the first Geneva Conference in 1955 devoted much of its time to this subject. As noted in Chapter 5, the subject of the first large IAEA conference, held in Warsaw in September 1959, was 'The Application of Large Radiation Sources in Industry and Especially Chemical Processes'. The

IAEA held a second conference on this subject, in co-operation with UNESCO, in Copenhagen in September 1960.[39] Most industrial uses were already available commercially. This left little scope for IAEA activities other than promoting the exchange of information at, for instance, the Warsaw and Copenhagen conferences, and by publishing systematic surveys of the existing industrial applications. These described procedures for obtaining isotopes and radiation sources, provided information on important physical data, and listed suppliers and prices.[40]

By 1969–1970, the growing interest in developing countries led to several proposals for projects to be financed by the UN Special Fund, for instance a demonstration project for three Far Eastern States on the use of radiation techniques in the manufacture of wood plastic composites. In 1969, the IAEA held two meetings on industrial uses. An IAEA symposium in Munich showed that the use of radiation to process polymers, plastics and textiles ('non-iron' fabrics) was becoming routine.[41]

In 1979, the IAEA launched a large UNDP project under the auspices of the Asian Regional Co-operative Agreement (RCA)[42] to demonstrate the use of radioisotopes and radiation in the rubber, plastics, paper, steel making, tin mining and wood processing industries in the countries of the region. The project included several training and demonstration courses, the construction of a cobalt-60 irradiation facility and a vulcanization plant.[43]

By 1990, the scope of the programme had broadened to cover research on the radiation treatment of sewage sludge, radiation processing of flue gases in fossil fuelled power stations, nuclear techniques for assessing the pollutants in coal and coke, as well as traditional uses of nuclear techniques in mining. The flue gas project has demonstrated that electron beams, generated by accelerators in the chimney stacks of coal burning power plants, can eliminate sulphur and nitrogen emissions (the chief causes of acid rain). If ammonia is added, the potentially polluting flue gases are turned into fertilizers.[44] In 1990, the IAEA held seminars on the subject in China, Mexico and the Philippines and supported a large scale demonstration plant in Poland.[45] In 1995, the basic irradiation equipment was selected for a full scale electron beam plant in that country, which is expected to be in operation in 1998.

In a world that depends more and more on telecommunications there is a growing demand for light and durable polymer covers for cables, amongst other products, and irradiation of polymers produces precisely such covers. In another RCA project, the IAEA has helped to make this technique available to the growing telecommunications industry of South East Asia.[46]

Non-destructive testing

Radiography was one of the first uses of radiation in industry, offering a unique means for the non-destructive testing of industrial products and processes. As relatively cheap radiation sources became available from recently acquired research reactors, the number of the IAEA's non-destructive testing projects began to grow, firstly in Latin America and later in other developing regions. From 1985 until 1995, more than 30 000 specialists took part in such IAEA projects, chiefly in civil aviation and other areas of transport, in the power and other industries (for instance, to monitor the impact of ageing on components of power plants) and in inspecting and monitoring the condition of civil engineering structures.

In 1972, the IAEA helped Argentina establish a National Centre for Non-Destructive Testing, partly funded by UNDP.[47] This provided inspection services to the national atomic energy commission and to industry in general. It developed national non-destructive testing standards and prescribed the qualifications needed by workers carrying out non-destructive tests. By 1979, the Centre had trained some 1300 individuals and its success encouraged the Latin American region to convene a conference on non-destructive testing in Buenos Aires in the same year. This in turn led to an IAEA non-destructive testing regional project in which, by 1985, 18 Latin American countries were taking part. As a result, by the 1990s tens of thousands of persons were using non-destructive testing techniques in Latin America. A total of 1680 persons had taken part in the 85 training courses which the IAEA had organized, while more than 22 000 had been trained in national programmes that used the project's guidelines. The project helped Latin America to draft an International Organization for Standardization (ISO) standard — specification — for the qualification of personnel for non-destructive testing. The IAEA also drew up a programme for training in the main non-destructive testing techniques which was recommended as a guideline by the ISO. In 1988, the national non-destructive testing organizations of the region established a federation to ensure continuity of non-destructive testing activities.

This project ranks amongst the most effective of those yet undertaken by the IAEA technical co-operation programme and has helped to make industry throughout the Latin American region aware of the importance of non-destructive testing.

NOTES

1 *Annual Report for 1995*, GC(40)/8, IAEA, Vienna (1996), p. 23; and *Technical Co-operation Report for 1995*, GC(40)/INF/3, IAEA, Vienna (1996), p. 21, para. 82.

2 JEGGO, M.H., GEIGER, R., DARGIE, J.D., "Animal health: Supporting Africa's campaign against rinderpest," *IAEA Bulletin* **3** (1994).

3 LACHANCE, L.E., KLASSEN, W., "Applying the sterile insect technique to the control of insect pests", *IAEA Yearbook 1991*, IAEA, Vienna (1991) B23.

4 LACHANCE, L.E., KLASSEN, W., ibid., pp. B29–B33.

5 The SIT had been used to eliminate the pest from Curaçao, the continental USA and Mexico and it is planned to eliminate it from all of Central America in the next few years.

6 LINDQUIST, D.A., ABUSOWA, M., KLASSEN, W., "Eradication of the New World Screwworm in the Libyan Arab Jamahariya," *IAEA Yearbook 1992*, IAEA, Vienna (1992) B8–B17.

7 *Annual Report for 1991*, GC(XXXVI)/1004, IAEA, Vienna (1992) 2.

8 Ibid., pp. 22–23.

9 *Annual Report for 1995*, p. 23.

10 *The Agency's Technical Co-operation Activities in 1993*, GC(XXXVIII)/INF/3, IAEA, Vienna (1994), pp. 17–18, para. 76; and *Technical Co-operation Report for 1995*, p. 12, paras 48–49.

11 LACHANCE, L.E., KLASSEN, W., "Applying the sterile insect technique to the control of insect pests", *IAEA Yearbook 1991*, pp. B25–B27.

12 *Annual Report for 1996*, GC(41)/8, IAEA, Vienna (1997) 21.

13 *Annual Report of the Board of Governors to the General Conference 1 July 1964 to 30 June 1965*, GC(IX)/299, IAEA, Vienna (1965), pp. 28–29, para. 114.

14 Information provided by M. Mutru of the 1996 Finnish delegation to the IAEA, who was then a staff member of the IAEA.

15 *Annual Report for 1982*, GC(XXVII)/684, IAEA, Vienna (1983), p. 47, para. 202.

16 *Annual Report for 1986*, GC(XXXI)/800, IAEA, Vienna (1987), p. 31, para. 240.

17 No treatment of food has "attracted so much political debate, media attention or protest", LOAHARANU, P., LADOMERY, L., AHMED, M., "Food irradiation: Issues affecting its acceptance by governments, the food industry and consumers", *IAEA Yearbook 1990*, IAEA, Vienna (1990) B11.

18 MOLINS, R., "New developments in food irradiation," *IAEA Yearbook 1996*, IAEA, Vienna (1996) B12.

19 *Annual Report of the Board of Governors to the General Conference 1 July 1964–30 June 1965*, p. 28, para. 113; and *Annual Report of the Board of Governors to the General*

Conference 1 July 1966–30 June 1967, GC(XI)/355, IAEA, Vienna (1967), p. 20, para. 51.

[20] *Annual Report 1 July 1970–30 June 1971*, GC(XV)/455, IAEA, Vienna (1971), p. 20, para. 41.

[21] *Annual Report for 1979*, GC(XXIV)/627, IAEA, Vienna (1980), p. 27, para. 112.

[22] *Annual Report for 1984*, GC(XXIX)/748, IAEA, Vienna (1985), p. 41, para. 221; *Annual Report for 1989*, GC(XXXIV)/915, p. 47; and *Annual Report for 1994*, GC(39)/3, IAEA, Vienna (1995) 84.

[23] The following is based chiefly on EISENLOHR, H.H., "Standardizing radiation doses in medicine and industry", *IAEA Yearbook 1989*, IAEA, Vienna (1989) A19–A33.

[24] *Annual Report of the Board of Governors to the General Conference 1 July 1966–30 June 1967*, p. 20, para. 61; and *Annual Report 1 July 1971– 30 June 1972*, GC(XVI)/480, IAEA, Vienna (1972), p. 20, para. 49.

[25] *Annual Report 1 July 1974–30 June 1975*, GC(XIX)/544, IAEA, Vienna (1975), p. 27, para. 78.

[26] *SSDL Newsletter* No. 34 (1995) 36–37.

[27] Radioimmunoassay is a microanalytical technique that permits the detection and measurement of minute amounts of any immunogenic substance (i.e. a substance producing an immune reaction) in biological fluids, most commonly serum or plasma. For instance, hormones, enzymes, proteins, and medical and hard drugs, as well as substances specifically produced and secreted by certain tumours, the so-called 'tumour markers'. An ordinary medical laboratory with very simple instruments can carry out radioimmunoassays, simultaneously processing hundreds of samples in a few hours.

[28] SCHOTTERER, U., OLDFIELD, F., FROEHLICH, K., *Global Network for Isotopes in Precipitation (GNIP)*, IAEA/PAGES pamphlet (1996) 13.

[29] The Treaty, which had been negotiated by three of the four nuclear weapon States of the time (the USSR, the USA and the United Kingdom), prohibited nuclear tests in the atmosphere, the oceans and outer space.

[30] SCHOTTERER, U., OLDFIELD, F., FROEHLICH, K., *Global Network for Isotopes in Precipitation*, pp. 16–17.

[31] *Annual Report for 1995*, p. 31.

[32] Ibid.

[33] BLIX, H., "The good uses of nuclear energy", 252nd Memorial Lecture at the Faculty of Medicine and Surgery, University of Santo Tomas, Manila, 13 December 1996.

[34] *Annual Report of the Board of Governors to the General Conference 1 July 1960–30 June 1961*, GC(V)/154, IAEA, Vienna (1961), p. 20, para. 128.

[35] *Annual Report for 1994*, pp. 108–109.

[36] This extensive exploration led to a significant scientific discovery, namely the first natural chain reaction found on this planet. About two billion years ago a natural 'reactor' had been in operation for thousands of years near Oklo, in Gabon. As the nuclear reaction started and stopped by itself without any artificial containment, the 'Oklo Phenomenon' provided a valuable laboratory to study the migration of radionuclides in a natural environment, a migration that had been very small indeed.

[37] IAEA publications included *Radiological and Health and Safety in Uranium Mining and Milling* (1964), *The Recovery of Uranium* (1971), *Formation of Uranium Ore Deposits* (1974), *The Oklo Phenomenon* (1975), *Exploration for Uranium Ore Deposits* (1976), *Uranium in the Pine Creek Geosyncline* (1980) and *Uranium Evaluation and Mining Techniques* (1980).

[38] See TAUCHID, M., "Nuclear raw materials: Developing resources through technical co-operation," *IAEA Bulletin* **3** (1993).

[39] *Annual Report of the Board of Governors to the General Conference 1 July 1960–30 June 1961*, p. 16, paras 119–121.

[40] *Annual Report of the Board of Governors to the General Conference 1 July 1959–30 June 1960*, GC(IV)/114, IAEA, Vienna (1960), p. 34, para. 202; and *Annual Report of the Board of Governors to the General Conference 1 July 1961–30 June 1962*, GC(VI)/195, IAEA, Vienna (1962), p. 11, para. 68.

[41] *Annual Report of the Board of Governors to the General Conference 1 July 1969–30 June 1970*, GC(XIV)/430, IAEA, Vienna (1970), pp. 22–23, paras 48–50.

[42] *Annual Report for 1979*, p. 30, para. 130. The full title of RCA is the Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology.

[43] *Annual Report for 1983*, GC(XXVIII)/713, IAEA, Vienna (1984), p. 49, paras 241 and 245.

[44] BLIX, H., "The good uses of nuclear energy".

[45] *Annual Report for 1990*, GC(XXV)/953, IAEA, Vienna (1991) 66.

[46] BLIX, H., "The good uses of nuclear energy".

[47] BESWICK, K., "Regional non-destructive testing project for Latin America: Final report," *Non-destructive Testing in Quality Control Programmes*, Vols 1 and 2, Project RLA/8017, IAEA, Vienna (1994).

Chapter 11

THE EXCHANGE OF NUCLEAR INFORMATION

The first Geneva Conference demonstrated vividly the extent to which progress in nuclear science depended on a full and free exchange of information. Scientists and technologists from 73 countries took part in the meeting. Led by the USA, they cast off the shackles imposed on the exchange of nuclear information in the war years out of fear of helping the enemy, agreed to by President Truman and Prime Ministers Attlee and MacKenzie King in the 'Three Nation Agreed [Washington] Declaration on Atomic Energy' of 1945, proposed by the Baruch Plan until a global nuclear authority could be established, and confirmed in 1946 by the McMahon Act. The Three Nation Declaration had stipulated that "reciprocal and enforceable safeguards acceptable to all nations" must be in place before proceeding "with the exchange of fundamental scientific literature for peaceful ends." Nevertheless, in 1955 the world proceeded with a massive exchange of such information, particularly on the design and construction of nuclear reactors, long before "reciprocal and enforceable safeguards acceptable to all nations" were in place. No doubt the scientists present at Geneva enjoyed the return to the free exchange of information that had been the rule before the war. But competitive declassification was not just a spontaneous outbreak of *glasnost*. At least to some extent it was a carefully planned exercise to impress other participants in the Conference with the achievements of one's own nuclear manufacturing industry.[1] The USA, the United Kingdom and the Soviet Union believed that the commercial use of nuclear power was around the corner and Geneva offered an opportunity to show that one's own power reactors were the best on the market. The impressive exhibitions of nuclear plant and equipment that accompanied the Conference made the point that the meeting was also, in some ways, a trade fair.[2]

For better or worse, and probably inevitably, the curtain that had surrounded nuclear science and technology since 1939 had now been torn aside. But there was an inherent tension between the risk that spreading nuclear information might help the bomb designer and the objective, embodied later in the IAEA's Statute, of promoting the peaceful uses of nuclear energy. This tension would eventually affect the policies of the nuclear suppliers, the training and education in nuclear technology that they were prepared to offer, the countries whose scientists and engineers they were prepared to accept, and even essentially innocuous IAEA activities such as its technical co-operation programme.

The 'Initial Programme' of the Preparatory Commission (Prepcom) stressed the importance of the Agency's role in promoting the exchange of scientific and technical information. It noted that arranging for such an exchange was a service to its Member States that the IAEA could provide without delay. The Agency lost little time in doing so.[3] In March 1959, Director General Sterling Cole convened a panel of experts to advise the IAEA on how it could best carry out its functions under Article VIII.C of the Statute.[4] This required the IAEA to ensure access to information on the peaceful uses of nuclear energy that Member States had furnished to it, and to encourage the exchange of such information.

The IAEA's initial efforts consisted of building up a technical library (helped by generous gifts from the US Atomic Energy Commission) and by inviting leading scientists in Member States to write reviews on various nuclear topics, publishing these reviews, holding scientific meetings and publishing their proceedings, and publishing manuals on safety and other topics.[5] In October 1960, the IAEA began the publication of its first scientific periodical — the quarterly *Nuclear Fusion* journal.

Scientific meetings

The IAEA's first scientific conference ('The Application of Large Radiation Sources in Industry and Especially Chemical Processes') was held in Warsaw in September 1959.[6] By 1961, the number of larger meetings (classified as 'conferences, seminars and symposia') had risen to about 10–12 a year and during the 1970s their number remained roughly at that level. Scientific information was also exchanged at smaller meetings, for instance, at those held to co-ordinate work among the participants in Co-ordinated Research Programmes and at other meetings or panels of specialists.

The topics of the larger meetings ranged very broadly covering, for instance:

— Small and medium power reactors,
— Plasma physics and controlled thermonuclear fusion (the first international conference on this subject being held in Salzburg in 1961),

— Use of nuclear techniques in tropical medicine,
— Development of nuclear law,
— Use of nuclear techniques in entomology,
— Use of nuclear techniques in the study of tropical diseases.

Until 1988, when the terms of its members were not renewed, the IAEA's Scientific Advisory Committee selected the topics to be covered each year.

As noted elsewhere, at the request of the United Nations the IAEA assumed responsibility for the scientific and technical aspects of the third Geneva Conference in 1964 and co-sponsored with the United Nations the fourth conference in 1968. In 1977, the IAEA convened a conference in Salzburg as a follow-up to the four Geneva Conferences.

These very large broad coverage 'Geneva-type' meetings were not repeated after 1977. The number of more specialized conferences and symposia declined to about six to eight a year in the 1980s as other, more rapid and more regular means of exchanging information came into operation. But meetings of specialists in the same branch of science or technology still provided a valuable forum for intensive discussions or for a broad based assessment of the current state of a particular technology. An example of the latter was the IAEA's conference in September 1994 entitled 'The Nuclear Power Option'.

Publications

In 1959, the IAEA became a scientific publisher. By the middle of that year it had issued nine publications, including the first manual in the IAEA's Safety Series (*Safe Handling of Radioisotopes*) and the first volume of a ten volume *Directory of Nuclear Reactors*, as well as the first volume of a two volume *International Directory of Radioisotopes and Labelled Compounds.*

By 1961, the IAEA was publishing the papers and proceedings of the dozen larger meetings, as well as the reports of numerous panels of experts, recommendations in the Safety Series, reviews of special topics, technical reports (on, for instance, the prospects for nuclear power in a particular Member State), the *Nuclear Fusion* journal and the *IAEA Bulletin*, a semi-technical periodical.[7] As the scope of the IAEA's activities expanded, it became the leading international publisher of material relating to virtually every aspect of nuclear energy. By 1995, the number of IAEA scientific publications had risen to nearly 150 per year.

The library

By the end of the 1960s, the IAEA's library had become a valuable resource, acquiring and distributing information needed in support of various programmes of the IAEA and its Member States. In 1970, its holdings included more than 30 000 books and nearly 120 000 technical reports.[8] In 1979, the IAEA library was merged with that of the United Nations Industrial Development Organization and other UN organizations based in Vienna to form the Vienna International Centre Library. At the end of 1995, the Library had a combined collection of more than 115 000 books, about 1 200 000 documents, 250 000 technical reports and subscriptions to about 4000 journals, of which more than half specifically supported the work of the IAEA. The Library stores and distributes information in electronic as well as conventional form by subscribing to a number of data files on compact disk and by providing access to external information files.[9]

Nuclear data

In 1963, the IAEA established a specialized unit for the collection and diffusion of basic nuclear data. The IAEA unit has focused on nuclear cross-sections and other data of fundamental importance to the understanding of nuclear fission and fission reactors.[10] One of its main aims has been to provide nuclear data to countries and regions such as India and Latin America not served by existing centres. The unit has collaborated with other major nuclear data compilation centres in the USA, the USSR (later the Russian Federation) and the centre operated by the (E)NEA for OECD countries. In this way the four centres achieved a worldwide exchange of nuclear data.

The International Nuclear Information System

In the second half of the 1960s, the IAEA launched the International Nuclear Information System (INIS), a major project to promote the exchange of information on all aspects of the peaceful uses of nuclear energy. The birth of the project was not easy. Western members of the Board of Governors had access to a wide range of nuclear science and technology information in, for instance, the *Nuclear Science Abstracts* published by the US Atomic Energy

Commission,[11] and in the services provided by the NEA such as its nuclear data centre. There was, at first, a Cold War reluctance to proceed to a comprehensive exchange of nuclear information with the Soviet Union and its allies. One Governor went so far as to suggest that pieces of information should be exchanged initially on a one-for-one basis with the USSR! Much of the credit for overcoming these obstacles must go to the Canadian Director of the Division of Scientific and Technical Information and his US successor.[12]

As early as 1962, a panel of experts had recommended that the IAEA should help UNESCO's efforts to encourage R&D on "mechanizing [the] storage and retrieval of information, and the broader study of science abstracting...at the international level."[13] In 1965, Soviet and US experts outlined a scheme for an international information system to cover the expanding flow of literature on the peaceful uses of nuclear energy and to meet the information needs of countries at different levels of development and different backgrounds and traditions in the techniques of information handling.[14]

The IAEA convened a number of panels of experts to review the consultants' proposals and to elaborate a detailed design for the system. In 1968, an international team of experts made a detailed study of the system and drew up a report to the Board.[15]

The system was designed to provide machine processed data on the particular nuclear topic that a user selected. It is decentralized in the sense that each participating State is responsible for preparing and arranging the input of all literature relating to the peaceful uses of nuclear energy that is published or becomes available in that State.[16] The IAEA arranges for the input of material that it and other international organizations produce. Each participating State designates a central point to handle all input. A national INIS Liaison Officer is in charge of the operation. The centre is responsible for limited processing of the input such as the recording on computer tape of bibliographical descriptions and key words.[17] The IAEA processes incoming material, stores it and distributes it to participating States and individual users. The products of INIS consist of magnetic tapes or a printed bulletin (*INIS Atomindex*) containing bibliographic descriptions and key words, as well as cumulative indexes and microfiches with abstracts or complete texts.

In February 1969, the Board gave the green light for the establishment of INIS but imposed restrictions that would enable it to control the growth and cost of the system. INIS began its output in April/May 1970, distributing *INIS Atomindex*, computer tapes and microfiches covering the literature already reported to it.

In 1972, the Board decided that the scope of INIS should henceforth cover all nuclear science information. By the mid-1970s, 35 countries had agreed to take part in INIS, thus ensuring that the system would be able to cover at least 90% of the sources of the world's nuclear publications.[18] In 1974–1976, INIS reached a steady level of operation, processing 60 000–70 000 citations per year. With the demise of the US *Nuclear Science Abstracts* in July 1976, INIS became the world's only abstracting service on nuclear energy and the only system with worldwide coverage of nuclear literature. In the late 1970s and 1980s, INIS began providing a completely computerized information service, offering direct on-line access to many Member States and organizations. In the early 1990s, the INIS database began to be available on CD-ROM as well as on-line and in print.

INIS served as a model for other information systems such as UNISIST, a worldwide science information system developed by UNESCO, and for AGRIS, a similar system covering food and agriculture, operated by FAO in co-operation with the IAEA.

By 1995, when INIS celebrated its 25th birthday, 94 States and 17 international organizations were participating in the system and the INIS database had grown to over 1.8 million references to nuclear literature, and was expanding at the rate of about 80 000 references each year. The 'INIS Clearinghouse' had microfilmed the full texts of more than 345 000 documents of 'non-conventional' literature such as reports, proceedings of conferences, doctoral dissertations and laws.[19] INIS also began the electronic storage of the full texts of non-conventional literature on CD-ROM.[20]

NOTES

1 HEWLETT, R.G., HOLL, J.M., *Atoms for Peace and War: 1953–1961, Eisenhower and the Atomic Energy Commission*, University of California Press, Berkeley, CA (1989) 233–235 and 250–251.

2 This point was also stressed by the hospitality lavished on participants by the companies hoping to sell nuclear power plants. This included night cruises on Lake Geneva, as well as countless dinners and cocktail parties, which came as a surprise to many scientists accustomed to a more austere way of spending the evening.

3 Referring to the IAEA's role in collecting and disseminating scientific and technical information, the Prepcom observed that "This function is moreover one which the IAEA can begin to discharge effectively from the first year." (Document GOV/1, GC/1, p. 16, para. 59).

[4] "The Agency shall assemble and make available in an accessible form the information made available to it [by its Member States]. It shall take positive steps to encourage the exchange among its members of information relating to the nature and peaceful uses of atomic energy and shall serve as an intermediary among its members for this purpose."

[5] *Annual Report of the Board of Governors to the General Conference 1 July 1959–30 June 1960*, GC(IV)/114, IAEA, Vienna (1960) 26–28.

[6] Ibid., p. 34, para. 203.

[7] Currently, the *IAEA Bulletin* has a circulation of 20 000.

[8] *Annual Report of the Board of Governors to the General Conference 1 July 1969–30 June 1970*, GC(XIV)/430, IAEA, Vienna (1970), p. 34, para. 98.

[9] Information provided by the VIC Library.

[10] *Annual Report of the Board of Governors to the General Conference 1 July 1963–30 June 1964*, GC(VIII)/270, IAEA, Vienna (1964), p. 11, paras 65–66; and *Annual Report of the Board of Governors to the General Conference 1 July 1964–30 June 1965*, GC(IX)/299, IAEA, Vienna (1964), p. 33, para. 140.

[11] The USAEC's *Nuclear Science Abstracts* and the IAEA 'successor' (the *International Nuclear Science Abstracts* of INIS) provided an extremely useful service to the world nuclear community, especially between the 1950s and 1970s.

[12] John Woolston (Director, Division of Scientific and Technical Information, 1967–1970) and Ed Brunenkant (Director, 1972–1978).

[13] *Development of INIS: Highlights*, pamphlet, IAEA, Vienna (1996).

[14] *Presenting INIS*, pamphlet, IAEA, Vienna (1995).

[15] Report of the INIS Study Team, PL-308 (1968).

[16] RAINER, R.H., SZASZ, P.C., *The Law and Practices of the International Atomic Energy Agency: 1970–1980, Supplement 1 to the 1970 Edition of Legal Series No. 7*, Legal Series No. 7-S1, IAEA, Vienna (1993) 263–268.

[17] The system made use of a thesaurus of key words provided by EURATOM and CERN. UNESCO and the ICSU also helped the IAEA Secretariat to develop the system.

[18] *Annual Report of the Board of Governors to the General Conference 1 July 1969–30 June 1970*, p. 32, para. 88.

[19] Data provided in December 1996 by the Head of INIS, Claudio Todeschini.

[20] *Annual Report for 1995*, GC(40)/8, IAEA, Vienna (1996) 53.

PART III

ISSUES AND CONCLUSIONS

Chapter 12

ISSUES

The changing perceptions of the developing Member States

It was natural that the developing countries should give preference to IAEA programmes that could bring them practical benefits, and their interest in technical co-operation became obvious as soon as two of their number, Brazil and India, joined the 1956 twelve-nation working level meetings on the Statute and was even more apparent at the October 1956 Conference on the Statute.[1] On the other hand, in the early years most developing countries showed little interest in or, in a few cases, were openly hostile to safeguards, while the problems of ensuring the safety of nuclear plants were as yet seldom of immediate concern to them.

It was noted in Chapter 5 that after 1973, when the membership of the Board of Governors rose from 25 to 34, the influence of the G-77 on the Agency's policies grew stronger and that this became evident at the General Conference in Rio de Janeiro in 1976 when the first decisive steps were taken to exclude South Africa from the Board and eventually the General Conference, and to recognize the PLO. In other words, the G-77 was beginning to shape the policies of an organization which, in the 1950s and the 1960s, had been largely, though by no means entirely, in the hands of the industrialized countries (although the latter were deeply divided in the IAEA by the Cold War until 1963).

When, in 1963, the USA and the USSR and their allies began to see eye-to-eye on the importance of IAEA safeguards, they both sought to ensure that safeguards would be adequately funded, and for this the safeguards budget would have to rise quite rapidly, as it did from $1 272 000 in 1970 to $4 802 000 in 1975. A growing safeguards budget would require the acquiescence of the developing countries in the General Conference, where they had a commanding majority of votes.[2]

But many developing countries still had little interest in safeguards, and a few of the most influential amongst them continued to decry them as a form of neocolonialism.[3] The G-77 would only accept a growing safeguards budget if there were corresponding increases in the funds available for technical co-operation (see Chapter 9). The 'North' had no option but to accept the concept of what was now called a balance between the IAEA's 'regulatory' and 'promotional' activities — a concept more fully discussed in the next section. To make it easier for the G-77 to accept the growing safeguards budget, the industrialized countries accepted its request to separate that budget from all other expenditures and to freeze the developing countries' contribution.[4] Some interpreted this as recognition by the North that safeguards were, indeed, of little interest to the 'South', but others viewed it as a logical consequence of privileged treatment of the nuclear weapon States by the NPT; as they saw it, privilege had its price.

Yet in the late 1960s and 1970s, the views of many countries within the G-77 were beginning to evolve on the value of safeguards in their own regions and on the tactics to be followed to bring under IAEA safeguards the programmes of countries that they feared or distrusted. The first major step was the acceptance of safeguards by the countries (all developing) of Latin America, under the leadership of Mexico, as required by Article 13 of the 1967 Tlatelolco Treaty. The Arab States certainly desired to see the entire Israeli nuclear programme placed under safeguards and the Africans sought the same constraints on the South African programme. In some cases they sought to achieve this by joining the NPT, as most Arab States did; in other cases (the 'front line' States in southern Africa) they tried to bring Western pressure to bear on South Africa by refusing to join the Treaty — how could the West expect them to ratify the NPT while it allowed South Africa to continue its suspect programmes? In practice, neither the Arab nor the African tactic worked. There would have to be a radical transformation within South Africa and in its relations with the rest of Africa before it changed its nuclear policy. Such a change has still to come in relations between the States of the Middle East.

In more recent years the cohesion which was such a marked feature of the G-77 in the later 1970s and 1980s has declined, as the world ceased to be bipolar, non-alignment lost most of its meaning, economic competitiveness became more important and the economies of some developing countries surged ahead. The 1994 ABACC agreement between Argentina and Brazil, the reversal of South Africa's nuclear weapon programme and the emergence of several regional nuclear weapon free zones also reflected growing developing country support of non-proliferation and of effective safeguards. All the regional treaties require the permanent application of IAEA safeguards and, with two exceptions, all their members are developing countries.[5]

Between 1990 and 1995, nearly 40 States joined the NPT, the great majority being members of the G-77, and at the end of the period only a handful of countries still remained outside the Treaty. The few but prominent States in Latin America that had previously been sceptical of safeguards now fully accepted them, as did most of the States that emerged from the breakup of the Soviet Union. Iraq and the DPRK demonstrated how seriously nuclear proliferation could undermine the stability of a developing region. Israeli, Indian and Pakistani retention of their nuclear arsenals, or of the means of making nuclear weapons at short notice, had become continuing causes of tension in the Middle East and South Asia.[6]

The divisions between members of the G-77 in their approach to the NPT was particularly noticeable at the 1995 NPT Review and Extension Conference. Latin America, with Argentina in the lead, was in the end, and without exception, in favour of the indefinite extension of the Treaty.[7] So too were the majority of African States; amongst them South Africa played a major role in securing the extension. The Arab States were at first only prepared to accept extension if Israel placed its programme under safeguards, and South East Asia was divided on this issue. In the end indefinite extension was accepted by all without a vote. But the extension was linked to a set of principles and objectives that prescribed a more rigorous and systematic process for reviewing the way in which the parties were implementing all articles of the Treaty and which set a number of aims and targets for assessing the progress made in such implementation.[8]

The loss of G-77 cohesion, so obvious at the NPT Review and Extension Conference, was much less marked in the Governing Bodies of the IAEA. Nonetheless, the influence of the G-77 on the policies of the IAEA remained weaker than in most UN agencies. Many factors contributed to this. The poorest members of the IAEA still had only a limited interest in three of the main programmes of the Agency (safeguards, nuclear power and hence, too, nuclear safety) and relatively few developing countries had a domestic nuclear constituency strong enough to influence their own government's policy towards the IAEA. Even the nuclear science applications (the use of radiation and radioisotopes) that provide the substance of most of the technical co-operation programmes were, in 1995, still out of the reach of some of the least developed countries. And, though these applications of nuclear science were often of much economic or humanitarian significance, they were chiefly managed by limited or specialist groups in the technically more advanced amongst the developing countries.[9]

Moreover, by 1995 many in the developing countries felt that the benefits of the major applications of nuclear energy were more limited than they had believed before the Three Mile Island and Chernobyl accidents, and before large overruns in the cost of the power reactors that some developing countries had incurred, chiefly because construction times were much longer than expected.[10] Chernobyl had also shown that the consequences of a major nuclear accident were not confined to the industrialized world and that nuclear safety was of concern to all countries. This point was later underlined in the reaction of many developing as well as industrialized countries to the transport by sea of plutonium and nuclear waste from Western Europe to Japan. It was also reflected by the large number of countries that, in the aftermath of Chernobyl, joined the 'Convention on Early Notification of a Nuclear Accident' and 'Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency'.

Changes in the position of the industrialized States

It must also be borne in mind that there had been major political realignments in the industrialized world, especially since the dissolution of the Soviet Union.

In the 1960s and 1970s, the industrialized States by and large shared the view of most developing countries that the principal task of the IAEA was to promote nuclear power and associated nuclear technologies. By 1995, however, many industrialized countries had become less interested in directly 'promotional' nuclear programmes; in fact several of them, including the IAEA's host government, had come out publicly against nuclear power.

From the late 1940s until the 1980s, most of Western Europe as well as Australia and Japan were determined to retain and, if possible, to strengthen what they regarded as 'stable nuclear deterrence' by the NATO/US nuclear umbrella, for instance by introducing Pershing and cruise missiles into the European theatre. The end of the Cold War had led many in the West to question the continuing need for nuclear arsenals, including several of the generals and admirals who were once in charge of those arsenals. By 1995, the nuclear weapon States themselves had come fully to support the chief objective of four previous NPT review conferences, namely to put a stop to the further improvement of nuclear arsenals by concluding a comprehensive nuclear test ban treaty, a treaty for which, as recently as 1990, at least two of the nuclear weapon States had shown little enthusiasm. Indeed, US policy, as explicitly stated by President Clinton, is the ultimate elimination of all nuclear weapons, although the USA and the other nuclear weapon States are not prepared to set a date or timetable for the achievement of this aim.

In the early days, a number of the industrialized countries, including France, the Federal Republic of Germany, the Soviet Union, Italy, Japan, Belgium (and even, on occasion, Australia) were, for a variety of reasons, also mistrustful of non-proliferation initiatives and of IAEA safeguards. In 1995, all pressed for the indefinite extension of the NPT and, in varying degrees, all supported the strengthening of IAEA safeguards (although it must be conceded that subsequent divisions on how far the Agency should go in strengthening safeguards were chiefly between the industrialized countries, in other words between the North and North).

By 1997, it was becoming clear that at least in the context of nuclear arms control, disarmament and the application of safeguards, the lines were increasingly being drawn between the nuclear and the non-nuclear-weapon States rather than between alliances or between States at different levels of economic development.[11]

In short, seeing the IAEA chiefly in terms of a North/South divide was always an oversimplified view, and by 1995 it had become all but obsolete. The foci of interest of both groups had changed over the years, particularly since Chernobyl and the erosion of Cold War tensions and alliances. Differences had emerged within both the 'Northern' and 'Southern' groups of countries, and between nuclear and non-nuclear-weapon States, perceptions and allegiances were changing and many roles had been reversed.

The IAEA's 'promotional' and 'regulatory' roles

In 1958, the US political scientist J.G. Stoessinger, writing about the recently created IAEA, noted that "From the day of the Agency's conception its founding fathers were haunted by a formidable dilemma: how was the optimum balance to be struck between the Agency's developmental function as a 'contributor' to peace, health and prosperity throughout the world, on the one hand, and its restrictive role, as deterrent against atoms-for-war, on the other?"[12] Stoessinger also noted that one of the IAEA's first tasks was to deflate the excessive optimism about nuclear power engendered by Eisenhower's speech and his statement that atomic energy was "here, now, today", and that in doing so the IAEA's programme was "a bitter disappointment to the underdeveloped countries."[13] This was an early reflection of the apparent tension between the Agency's 'promotional' and 'regulatory' roles. It calls for several comments.

In the first place the distinction between 'promotional' and 'regulatory' activities is somewhat artificial. Enhancing nuclear safety is crucial for the promotion of nuclear power, and today there can be no transfer of nuclear power plants to a developing or an industrialized non-nuclear-weapon State without effective safeguards. Moreover, as we have seen, what is commonly referred to as the 'promotional' work of the IAEA has been to promote the transfer of radioisotope and radiation techniques to the developing countries rather than to promote the use of nuclear power. There is no conflict of principle or interest between helping to eradicate rinderpest and trying to stop the spread of nuclear weapons.

The fundamentally false dichotomy of promotion versus regulation also flowed in part from a misconception. The modest programme of the IAEA's Division of Nuclear Power had never been comparable in objective or in scope to the vast investments that the nuclear energy authorities of the industrialized countries or of developing countries such as India, the Republic of Korea and Brazil have made in promoting nuclear power technology and in subsidizing nuclear power programmes. In the boom years of nuclear power the Division advised several developing countries, at their request, on the merits or demerits of launching a nuclear power programme. From the start its advice was cautious; it could usually be summed up as 'assess your needs, compare the options for meeting them, train the needed staff, prepare the legal and safety infrastructure, but wait before you invest'.[14] In 1996, the IAEA's work relating to nuclear power (as reflected in the actual expenditure under this heading)[15] accounted for less than 2.6% of its total expenditures under its 'regular' budget. It consisted largely of helping Member States to assess their needs for more electric power using IAEA computer programs for this purpose, to compare the economic, technical and environmental advantages and drawbacks of various energy options, to draw up plans for meeting their needs, to ensure efficient and safe operation of nuclear plants,[16] as well as of promoting the exchange of information between all interested Member States on the status of and progress made in advanced nuclear systems. Nuclear safety was an increasingly significant component of the nuclear power programme. All these were manifestly worthwhile activities.[17]

The apparent conflict of interest between the promotional and regulatory roles of the IAEA led in the past to several proposals for changing the way in which the UN system deals with nuclear and energy issues. Such proposals are now less frequently heard than they were in the immediate aftermath of the Iraqi disclosures. In the case of the DPRK, the Agency reacted promptly and vigorously when it was denied access to the locations it needed to visit in order to verify that the DPRK's Initial Report was complete, so vigorously that the authorities in the DPRK complained, as we have noted, that IAEA inspectors behaved like policemen searching the house of a suspect instead of like invited guests.[18]

It should be stressed that proposals for restructuring international responsibility for nuclear energy have never been made by the government of any Member State. On the contrary, judging by the proceedings of the NPT Review and Extension Conference and of the IAEA's General Conference and the UN General Assembly, Member States are broadly satisfied with the present allocation of responsibilities and would resist any attempt to change it. The proponents of radical surgery have chiefly been individual academics or non-governmental bodies, or occasionally columnists writing in the North American and Western European media.[19] And the Secretariat's proposals for strengthening safeguards ('Programme 93 + 2') have been criticized by some Western governments, not because they were too gentle with the operators of nuclear plants, but for being unnecessarily intrusive, ignoring constitutional rights of privacy and the sanctity of private property, and discriminating in favour of the nuclear weapon States — in a sense a repetition of the debates (and misperceptions) of the Safeguards Committee (1970).

Some may still ask whether the IAEA should continue to raise doubts in some quarters about its impartiality as a regulatory body by appearing to promote nuclear power. Those who know the IAEA well also know that these doubts are misplaced. The staff of the IAEA have not tempered their approach to safety or safeguards because of concern for the interests of the nuclear industry or because they feared that rigorous safeguards or safety measures would push up the cost of nuclear power. On the contrary, in the nuclear industry safe operation is profitable operation and safety is a condition for the survival of the industry. The constraints on the IAEA's 'regulatory' work were (and continue to be) imposed on a Secretariat that is ready and able to operate as a much more rigorous and intrusive regulator. The constraints were and are imposed by governments seeking to keep the IAEA (and other UN agencies) on a tight financial and operational leash, and not eager to have an unduly intensive international inspection of their own nuclear activities. Shuffling the pack of international responsibilities will not change this.

Should the IAEA narrow its scope?

For 40 years the IAEA has spanned, sometimes uneasily, four different nuclear technologies or categories of work, one of which has little in common today with the other three. The four (with the 1996 regular budget and technical co-operation expenditures in parentheses[20]) are:

— Nuclear power and comparative assessment of nuclear power and other energy sources ($6 209 599 plus $2 059 654). Technical co-operation in nuclear power ($2 338 000).
— Smaller scale applications of nuclear science, i.e. the uses of radioisotopes as tracers or sources of radiation and of research reactors as sources of tracers and radiation and for training purposes ($31 497 710). Technical co-operation ($38 185 000[21]).
— Nuclear and radiation safety including the management of nuclear waste: nuclear safety ($13 573 104) and nuclear waste management ($7 505 404). Technical co-operation ($11 895 000).
— Nuclear safeguards ($86 166 813).

The growing importance of regulatory activities

The entry into force of the NPT, the Three Mile Island and Chernobyl accidents and the breaches of IAEA safeguards agreements by Iraq and the DPRK increased the importance of the IAEA's 'regulatory' activities, particularly in the eyes of the industrialized countries.

Recent developments have tended to accentuate this trend. The focus of international politics has moved from containing the threat of nuclear war to promoting nuclear disarmament and non-proliferation, two separate but related subjects, both tending to give increasing weight to IAEA verification and safeguards. The decision to make the NPT permanent also made comprehensive NPT safeguards permanent in the non-nuclear-weapon States party to the NPT. The new nuclear weapon free zones require IAEA safeguards. The IAEA has begun to verify that surplus military stocks are not returned to military use. The prospects for a 'cut-off' convention are still distant, but if it comes about it is expected to bring more nuclear material in the nuclear weapon and threshold States under safeguards.

Several industrialized Member States have also lost much of their former interest in the 'promotion' of nuclear energy, at least as a source of electricity.[22] Concern about environmentally safer energy is likely to grow if the greenhouse effect becomes more marked, in turn underlining the importance of enhancing the safety of nuclear energy as the main alternative to fossil fuel. The safe decommissioning of older reactors, and disposal of their components, is also an area of growing interest.

Nuclear science applications

Nuclear science techniques are usually (but not always) one of several alternative means of achieving a particular technical goal — preserving food, controlling insect pests, breeding improved varieties of plant, treating cancer, tracing biological processes, etc.

When the IAEA's Statute took shape scientists were, of course, aware of the value of these techniques, but most nuclear authorities cherished much greater expectations for the future of nuclear power or for the IAEA's role as a depository and supplier of nuclear fuel than as a channel for transferring isotope techniques. There are plenty of references in the IAEA's Statute to "special fissionable materials" (enriched uranium and plutonium) and to "source materials" (natural uranium and thorium), but there is no mention of radiation or radioisotopes.[23] However, when the IAEA began work in 1958 the only serious promotional option open to it was that of encouraging the use and transfer of these applications of nuclear science. They dominated the IAEA's programmes for many years, to the annoyance of specialized agencies that had already set up units to deal with those aspects that directly concerned them. FAO, for instance, had a unit dealing with atomic energy in agriculture and WHO a unit covering nuclear medicine. The resulting jurisdictional disputes were generally solved in favour of the IAEA, partly because sophisticated nuclear science applications were of relatively low priority for the developing countries whose interests largely determined the programmes of the agencies concerned, and partly because the new and glamorous IAEA had stronger political sponsorship.

Nuclear science techniques were state of the art in the mid-1950s. How significant are they today?

Nuclear medicine is an established discipline and although non-radioactive techniques have supplanted or complemented some of the earlier nuclear techniques, medical research, diagnosis and treatment would be unthinkable without the use of ionizing radiation. The use of these techniques in the industrialized countries is hardly dependent upon support from the IAEA.[24] The same is not true, however, of the developing countries.

The IAEA and FAO have successfully used nuclear techniques in hydrology and in certain areas of agricultural and food related *research*. It must be conceded, however, that after more than 40 years of vigorous promotion, the *industrial* use of radiation to preserve or disinfect food is still very limited, often because of the relatively high cost of the process or misplaced public concern about irradiated food.[25]

Summing up, the range of applications of radioisotopes has not changed fundamentally since 1957, some new techniques have been developed to the point of being in normal commercial use, and others have been replaced by techniques that do not involve the use of ionizing radiation. Many uses of radiation and radioisotopes are still beyond the means or technical expertise of the least developed countries. The large scale industrial use of radiation has not materialized to the extent that was foreseen in the 1950s. Some other applications have made a valuable, and in one or two cases a vital, contribution. The amount spent on transferring these techniques is very modest and unlikely to grow significantly.[26]

Should the IAEA now encourage the (re)transfer of responsibility for the application of nuclear techniques to the agencies concerned?[27] The question can be put in another way. As the 21st century approaches should not the IAEA focus its role more narrowly and effectively to meet the main challenge facing nuclear energy — at least in the eyes of the industrialized countries — by helping to verify that no new nuclear arsenals come into being and that existing nuclear arsenals are irreversibly reduced, and by helping to provide a safe and environmentally benign source of energy?

There are a number of other arguments in favour of narrowing the IAEA's focus. The agencies now in gestation for prohibiting chemical weapons and nuclear testing have no other roles.[28] If the IAEA had been established in the mid-1990s instead of the mid-1950s, it is conceivable that its role would be limited to that of safeguarding nuclear energy and possibly regulating its safety aspects.

One may also ask the more specific question — why should the IAEA be involved in promoting the use of radioisotopes in non-nuclear fields?

There are several answers. In the case of food and agriculture, the merging of FAO's activities and those of the IAEA, where FAO often carries overall responsibility for a project and the IAEA provides the nuclear tools, is a sensible and practical arrangement. So too are the co-operative arrangements in isotope hydrology, where national nuclear establishments and the IAEA pioneered many of the techniques used, where there are at present no effective alternatives to the nuclear technique and where there is close co-operation with the World Meteorological Organization on global monitoring of atmospheric radionuclides and with FAO on the use of water resources. But when we turn to medicine one is almost bound to ask why an international nuclear agency should be involved in the detection of anaemia — or the improvement of breast milk. Just because an isotopic or radiation technique is used may seem a rather weak hook on which to hang a programme of a nuclear organization.

This was precisely the type of question that WHO sometimes asked in the early days. Perhaps the best answer is that reportedly given by Dr. Marcolino Gomez Candau, the Brazilian Director General of WHO at that time. He is said to have told Sigvard Eklund that WHO had higher priorities in the developing countries than the introduction of nuclear medicine — it must seek to meet the pressing needs to improve sanitation, provide clean water, combat infectious disease, etc. If the IAEA had access to funds for introducing sophisticated techniques he would not stand in its way. So, on that pragmatic note the IAEA became a doctor of medicine! Another practical consideration was that WHO's programmes were largely carried out by its regional bodies such as the regional office for Africa or the Pan American Health Organization, that had little interest or specialist knowledge of nuclear medicine. Moreover, the IAEA and WHO work closely together in radiation dosimetry and in some other aspects of nuclear medicine. WHO co-sponsors the IAEA's Basic Safety Standards and other regulatory documents. Finally, as Hans Blix puts it, what is wrong with the IAEA offering worthwhile programmes to all its Member States, including those whose only significant use for nuclear energy today is in its applications to human health.

There are other arguments for maintaining the IAEA's role as a source of aid for the transfer of radioisotope and radiation techniques. In the past 40 years a great deal of intellectual as well as financial and physical capital has been invested to enable the IAEA and FAO to provide the very wide range of services now available from the two agencies. The variegated and dedicated work of the scientific Divisions concerned and the Seibersdorf and Monaco laboratories, and the results they have achieved, show how difficult it would be to excise them out of the IAEA without gross and perhaps irreparable disruption.

There is another, more political argument for maintaining the status quo. While the developing countries appear to have no strong objections to the safeguards foreseen in the Chemical Weapons Convention (CWC) or the Comprehensive Test Ban Treaty (CTBT), it is clear that many of them look at the safeguards required by the NPT in a different light. The reason is obvious. The CWC and CTBT safeguards will apply to *all* States that join those treaties, but as long as the nuclear weapon States are legally permitted to retain their nuclear arsenals, even if those arsenals go on shrinking, nuclear safeguards will continue to discriminate between the nuclear weapon States and the non-nuclear-weapon States party to the NPT. Concern about such discrimination is not, of course, confined to the developing countries; leading industrialized nations feel at least equally strongly about the way in which, as they perceive it, the nuclear safeguards regime favours the nuclear weapon States.

In other words, if the IAEA's only role were to administer safeguards it would be regarded chiefly as an instrument that the nuclear weapon States use to deny other States the possession of nuclear weapons while they keep their own. Many developing countries would concede that maintaining this nuclear status quo is also in their interest, or at least that they were prepared to tolerate it; otherwise the vast majority of them would not have agreed as they did in 1995 to making the NPT permanent, though the implicit condition they set for supporting a permanent NPT was the eventual elimination of all nuclear weapons. That is many years away; in the meantime the assistance that the IAEA has given to the developing world has softened the image of a guardian who was strict with the weak but had no concern with the behaviour of the powerful.

Whether it was sensible 40 years ago to make the IAEA the main source of radiation and radioisotope assistance would now be largely immaterial were it not for a by-product of that decision. As noted, the transfer of nuclear science applications accounts for the bulk of the IAEA's technical co-operation programme and many countries have successfully pressed for a balance between the size of the budget for technical co-operation (financed by voluntary contributions) and the budget for the IAEA's regulatory activities. In practice, since 1980, the net effect of this 'balance' has been a substantial increase in the target for voluntary contributions (to which the zero growth rule does not apply), while the size of the IAEA's regular budget for nuclear safeguards has been frozen in real terms.[29] This has made the operation of safeguards increasingly dependent on earmarked 'extrabudgetary' grants by interested donor countries and on 'cost-free' experts seconded to the Agency. Both tend to detract from the international and independent character of the IAEA's safeguards work and staff.

There is no logical connection between the size of the Agency's budgets for technical co-operation and for nuclear safety and safeguards; their growth or stability are or should be determined by quite different processes and needs. The balance between them is driven solely by political considerations. However, the IAEA's fortunes are determined by politics and it could not ignore the fact that such a balance is the wish of a large majority of its Member States.

Finally, why should *any international organization* spend public funds on radiation and radioisotope projects in the developing countries? Could they not be left to private enterprise or national governments? In the early years of the IAEA, Governors would occasionally ask these questions. One reason for channelling such assistance through the IAEA is that this agency, acting alone or jointly with other international organizations, has pioneered some of the most successful applications of isotopes and radiation. For instance, after taking over some work by British scientists (and recruiting the chief scientist concerned),[30] the IAEA pioneered the worldwide use of nuclear techniques in hydrology. It also promoted novel approaches to uranium exploration and production. Similarly, by taking over work done by US scientists and recruiting some of these scientists themselves, the IAEA, jointly with FAO, has pioneered the use of the sterile insect technique in many developing countries.

This points to the second main justification for internationally sponsored activities. Private industry has generally shown limited interest in scientific work that may be of great benefit to small farmers in the developing world, but the results of which are inherently uncertain, and may offer little prospect of early profits. Moreover, scientists from developing countries can greatly benefit from contacts with their colleagues in other developing countries. International agencies are usually more able than national governments to arrange such contacts and co-ordinate geographically scattered research programmes, thus promoting the objective of technical co-operation amongst developing countries. But the international agencies should be ready to move out of such work when private industry shows that it is ready and able to move in.

The IAEA's changing constituencies

It has been noted that when Sigvard Eklund was Director General the Board became somewhat more technical in its composition and more businesslike in its methods of work as heads of national nuclear energy establishments — having little time to spare — replaced some of the diplomats who had initially represented their countries on the Board of Governors. Of course, nuclear energy is never far from politics and the expulsion of South Africa and the resolution condemning the Israeli attack on Tamuz 1 were both in Eklund's time. But in the 1960s and 1970s, it was the increasingly powerful nuclear energy authority rather than the foreign ministry that framed nuclear policy in many leading countries, and it was then of prime importance that national nuclear establishments should have confidence in the Director General and in the Board.[31]

Towards the end of Eklund's tenure, the composition of the Board of Governors gradually began to change again and the process continued in the 1980s. By the time that the 1995–1996 Board took office, only 10 of the 35 Governors came from national atomic energy authorities, 5 came from other technical offices such as the ministry of energy or the department of trade and the remaining 20 were ambassadors.[32] And if the Governor represented a technical institution, the alternate was now, in most cases, the country's ambassador in Vienna who sat in for the Governor at IAEA meetings that he or she could not or did not attend.[33]

There were several reasons for this. In many countries the influence of the national atomic energy authority declined as responsibility for nuclear power was moved to ministries of energy or industry. At the same time the influence of national nuclear regulatory authorities had grown.[34] After the NPT came into force, the political significance of the IAEA's work began to overtake that of most of its technical activities. This trend was accentuated as nuclear power lost much of its attraction in North America and in most of Europe and nuclear programmes stagnated or shrank. In many countries responsibility for national policies towards the IAEA began to move to the officials concerned with arms control in ministries of foreign affairs or to be shared by them and other national bodies. As more international organizations came to Vienna, the governments of smaller countries found that it made good financial sense to accredit one person, their ambassador to Austria or a specially appointed ambassador, as resident representative to all the organizations (the Governors from the leading nuclear States were and are normally based in their nations' capitals where they could have greater influence in shaping nuclear policies).

One consequence was that the IAEA no longer had a single clear-cut and relatively powerful constituency in its Member States to further the Agency's interests or to shape its programmes.[35] The generation of ambitious and dynamic chiefs of nuclear energy commissions, having the ear of the head of State or government, that bestrode the stage in the 1950s and 1960s and that often made policy on the spot, was succeeded — with a few exceptions — by less colourful officials, concerned about safety or non-proliferation or about keeping the IAEA's budget in check rather than about nuclear power, and almost always acting on instructions from their ministries.[36]

This evolution may have been inevitable and in some ways it was for the better. Some nuclear energy authorities in the industrialized countries showed less concern in the 1950s and 1960s about the spread of nuclear weapons and more about selling nuclear technology, including sensitive plants, to any nation that could afford them or, at least, pay for them.

There is little prospect that the current situation will change. Indeed, if as seems likely, the IAEA's safeguards operation becomes relatively more important and if nuclear power continues to stagnate in North America and most of Europe, while the problems of decommissioning old reactors and of dealing with nuclear waste loom ever larger, those departments in ministries of foreign affairs concerned with arms control and the national nuclear regulatory and environmental authorities will acquire an even stronger say in the IAEA's affairs.[37]

The role of the Board of Governors as an executive body

Since the Statute entrusts the Board with the authority "to carry out the functions of the Agency...subject to its responsibilities to the General Conference,"[38] it is obvious that the effectiveness of the IAEA as an instrument for carrying out the policies of its members depends critically on the collective wisdom, cohesion, incisiveness and authority of the Board.

The consensus rule

For a brief period in 1957 and early 1958, the Board continued to maintain the tradition of seeking decisions by consensus that had been established at the Washington working level meetings, the Conference on the Statute and the Prepcom. Very soon, however, as we have seen, the Board was riven by the dissensions of the Cold War. It had difficulty in reaching agreement on any important matter of policy. At the same time, partly because several Governors mistrusted Sterling Cole's judgement, the Board attempted to micromanage the Agency, for instance by requiring Cole to make a report to it every two months on the activities of the IAEA,[39] by rejecting or postponing action on many of his proposals and by holding 84 meetings between October 1957 and July 1958 at which it would discuss at length such minutiae as the promotion of a particular junior officer or the grant of consultative status to a particular non-governmental organization.

The third Chairman of the Board, Ambassador Donald Sole of South Africa, had some success in re-establishing the rule that decisions should be taken by consensus on all but the most politically disruptive questions. And Eklund helped to transform the Board into an effective executive body that did its work quickly and, as a rule, harmoniously. He stressed the technical aspects of the IAEA's work and downplayed the political, and he insisted that the Secretariat should put proposals before the Board only after wide ranging consultations to ensure that they would be acceptable. Eklund's success in reducing the number of meetings of the Board and eliminating most polemics from its discussions was not only a personal achievement but was due to a great extent to the relatively cordial relationship between the USA and the USSR that followed the 1962 Cuban missile crisis, as well as to the fact that the two leading powers were now in full agreement that the chief task of the IAEA was to apply effective safeguards. Moreover, the States that did not subscribe to this view were not able effectively to challenge the two 'superpowers' of the time.

But although the Board now seldom abandoned the consensus rule, there were some issues on which differences ran so deep that a vote could not be avoided. They included, until the mid- and late 1970s, the representation of China and the former German Democratic Republic, the incorporation of an NPT type undertaking in the rules governing technical co-operation, the designation of South Africa as a member of the Board in 1977, the acceptance of the credentials of its delegation to the General Conference in 1979 and the Israeli attack on the Tamuz reactor in 1981.

After that attack, the legally dubious rejection in 1982 of Israel's credentials to the General Conference and the subsequent withdrawal of the USA from most IAEA activities, the consensus rule was once again in jeopardy.

With skill and patience the Chairman of the Board in 1982–1983, Ambassador Keblúšek of Czechoslovakia, succeeded in restoring it. He also established the practice of holding informal negotiations between Governors on controversial issues so as to ensure that they were aware of the positions that their colleagues would take in the Board and so that they could, if possible, reach informal agreement on the matter at issue before the Board discussed it.

Despite the growth in the size and diversity of the Board, the North/South differences of opinion about the capping of the IAEA's regular budget, concern about the Israeli nuclear programme and the occasional intrusion of other political questions, the tradition of seeking consensus had become so deep rooted that it continued to guide the Board's proceedings in the latter part of the 1980s and remained the usual practice when this book was written. By putting an end to many long-standing East/West controversies, the end of the Cold War helped to sustain the tradition. However, when the Board was faced with a highly divisive issue such as whether Iraq and the DPRK had breached their safeguards agreements, a vote could again not be avoided.[40]

The frequency of the Board's meetings

One measure of the effectiveness of an executive body is the time it takes to reach a policy decision and, hence, the number and length of the meetings it holds during a given year. By the later years of Eklund's tenure, the number of Board meetings had declined from the 98 held by the first Board in 1957–1958 to about 10 to 12 a year (four morning and afternoon meetings or two days in February/March each year, another four to six meetings in June and a morning or afternoon meeting immediately before and after the General Conference).[41] Since then the number of Board meetings has again increased, although not to the levels of 1958 and 1959. In the 1980s, the Board decided to hold an additional series of meetings in December so as to be able to evaluate and approve as early as possible the technical co-operation programme for the subsequent year. This was a laudable innovation but gradually — and inevitably — the agenda of this series of meetings grew longer as the Secretariat found it convenient to add other items for the Board's consideration. In time the length of the February/March and June series doubled or trebled, and in 1995 the Board held 29 meetings — three times as many as in the mid-1970s. This was partly due to the increase in the Board's size in recent decades and to its decisions to give the floor to members of the Agency not currently serving on the Board, but it also reflected the IAEA's growing responsibilities for non-proliferation and nuclear safety.

The size and composition of the Board

Within limits, the smaller an executive body, the more effective it is, and a group of about 8–15 members is regarded by some as the optimum size. If it is too small it is unlikely to be representative, if it becomes too large the more powerful members are likely to establish a smaller core group.[42] On the other hand, it can be argued in the IAEA context that the decisions of a Board representing a large proportion of the Agency's membership carry more authority and legitimacy than those of a smaller, more 'elitist' Board.

The 1954–1955 draft of the IAEA Statute proposed a Board of 16 members, but by the time the draft went to the Statute Conference in 1956, the various bargains struck amongst the twelve-nation negotiating group had pushed the number up to 23. In 1963, the addition of two seats for Africa raised the membership to 25.[43] In 1973, the 'Italian' amendment to the Statute raised it to 34.[44] Finally, in 1989 the amendment to provide a seat to China raised it to 35.[45]

After the substantial expansion of the Board in 1973, the Governors from Africa and from the Middle East/South Asia frequently complained that their regions were still under-represented. They quoted figures to show that the numbers of Member States in their regions having Board seats were proportionately much lower that those of other regions. The matter figured annually on the agendas of the Board and General Conference. In 1977, the Governors concerned proposed that their seats be increased by three (Africa) and two (Middle East/South Asia), but no agreement could be reached.[46] At the end of the 1970s, it appeared that a compromise was in sight under which one extra elective seat would be awarded to each region, but at the last moment the negotiations fell through. Other developing regions seemed relatively content with their representation on the Board, but Latin American Governors made it clear, on occasion, that if extra seats were given to Africa and to the Middle East/South Asia, they too would press for more seats.

The General Conference and Board repeatedly discussed the matter throughout the 1980s but could not reach agreement. Broadly, there seemed to be three schools of thought: those that wanted chiefly to increase the number of elective seats, those that sought a general revision of the structure and composition of the Board, and those, chiefly the Governors from Western and Socialist States, that were opposed to any change.[47]

In the 1960s and 1970s, it was unusual for a Member State not currently serving on the Board of Governors to address the Board unless it had a special reason to do so, for instance as representative of the host State on a matter concerning the headquarters building. In 1988, the Board took several practical steps to make it easier for non-members to take part in its discussions and those of its subsidiary bodies. In September 1990, the Board affirmed that all Member States should have "every opportunity to participate fully" in the meetings of the Board's Technical Assistance and Co-operation and the Administrative and Budgetary Committees, that their views should be reflected in the reports of those Committees and that the Committees should strive to reach consensus recommendations, a procedure which also virtually eliminated the distinction between voting and non-voting participants. Non-members thus came to enjoy much the same rights in the Board's main committees as Governors themselves.[48] In addition, the Board established a growing number of informal working groups in which all Member States had the right to be represented and which also, as a rule, made recommendations by consensus.

After the breakup of the Soviet Union most of its successor States joined the IAEA and its membership grew from 110 in 1990 to 125 in mid-1997.[49] Many of the newcomers had nuclear energy programmes, and a few included nuclear power plants. The Ukrainian programme was quite substantial and might be seen as justifying a seat on the Board.[50] Another new factor was the rapidly growing nuclear power programme of the Republic of Korea.[51]

Following a 1994 request by the General Conference, the Board re-established the 'open-ended consultative group' in December of that year. The group received two formal proposals and some informal suggestions for expansion of the Board and one for the retention of the present structure and size.[52] Interestingly, the proposals for expansion retained the procedure, unusual in United Nations organizations, of having a significant proportion — about one third — of the incoming Board designated by the outgoing Board, and also retained advancement in nuclear energy as the criterion for designation. The chair concluded, however, that "none of the specific proposals enjoyed sufficiently wide support to enable the Group to make a recommendation...to the General Conference..."[53]

After 1973, several Western governments consistently opposed any enlargement of the Board (except to provide a place for China), arguing that such a step would be likely to lengthen the Board's meetings and reduce its effectiveness as an executive body and that if additional seats were given to the two dissatisfied regions it would be difficult to resist requests from other regions. But there have been signs that Western resistance to a modest increase is diminishing. In April 1997, Ambassador Peter Walker, the Canadian Chairman of the Board, submitted a proposal for adding six seats to the Board, four in the designated category and two elected.[54]

The increase in the number of *effective* members of the Board has been even larger than that implicit in the formal amendments of the Statute. In the 1960s and 1970s, many of the developing Member States of the IAEA still had no diplomatic or other official representatives in Vienna. When the General Conference elected them to serve on the Board they often left their seat empty. After the United Nations Industrial Development Organization and other UN bodies had established their headquarters in Vienna, almost all members or potential members of the Board found it necessary to have diplomatic missions in the city, and all those elected to serve on the Board were able, with a few exceptions, to attend all its meetings.

The net effect of increases in the size and number of meetings of the Board, the changes in the affiliations of Governors and the arrival of other United Nations bodies in Vienna was to make the IAEA more like the larger specialized agencies of the United Nations instead of the lean and laconic body into which it had evolved in the 1970s. Normally this would have meant that the IAEA, like those agencies, would become chiefly an instrument for advancing the economic and social interests of the developing countries. Several factors have curbed such an evolution in the IAEA. For instance, there is the growing importance of the IAEA's political role in non-proliferation and its work in nuclear safety and the facts that nuclear power is still confined to less than a dozen developing countries (and less than a score of industrialized countries) and that some of the least developed countries still have little interest in the applications of nuclear science.

Despite the growth that has taken place in the size of the Board of Governors and the number of its meetings, both the Board and the General Conference are regarded as being amongst the most effective governing organs of the United Nations and its agencies. The meetings of both organs are still much shorter than those of most other agencies; they produce less paper and are still largely, though not entirely, free of the windy oratory that has given many UN bodies a bad name.

The IAEA's relations with other organizations

The United Nations and the IAEA

As noted in Chapter 3 there were, from the start, widely differing views about the proper relationship between the IAEA and the United Nations. The USSR wished to see the Agency subordinate to the Security Council, and therefore subject to a Soviet veto, but also wanted it to be closely linked to the United Nations as the organization responsible for international peace and security. The developing countries and the UN Secretariat, and especially Secretary General Dag Hammarskjöld, believed that the peaceful uses of nuclear energy were too important to leave in the hands of an autonomous agency, even if that agency was a member of the UN family. They also distrusted the small group of countries, distinctly right of centre, that was drafting the Statute of the IAEA in Washington and they sought a very close relationship with the UN and particularly with the General Assembly. Most Western powers, on the other hand, feared the political impact of the General Assembly on the IAEA's policies and wanted to maximize the distance between the two bodies.

In the end, the IAEA was established as a fully autonomous body, its policies, programmes and budgets being determined by its Board of Governors and General Conference. Its relationship with the General Assembly consisted essentially of a reporting link and a commitment to consider any resolution adopted by the General Assembly or any other UN Council and, if so requested, to report on any action it had taken in response to the resolution.[55]

Although Member States had different views about the closeness of the relationship between the IAEA and the United Nations, all were agreed that the IAEA should administratively be part of the 'Common [UN] System', applying the same salary scales and administrative and financial rules, its Secretariat having rights to the same pensions as the staff of the UN and most specialized agencies, and the Agency itself being required, at least in principle, to co-ordinate its activities with those of other UN agencies through the UN Administrative Committee on Co-ordination (ACC) and the UN Economic and Social Council (ECOSOC). Parenthetically, it may be noted that the IAEA has found that direct bilateral negotiations with other agencies have been more effective in co-ordinating related or overlapping technical programmes than discussions in multilateral bodies like ECOSOC and the ACC.

Relations with the General Assembly

At first the General Assembly had little impact on the IAEA, but after the entry into force of the NPT in 1970 the IAEA's relations with the Assembly began to change. Until the late 1960s, the IAEA's *Annual Report* to the General Assembly had been discussed only by the Assembly itself in a brief plenary session which then took note of the report in a tersely worded resolution. As the IAEA's safeguards operation expanded, the General Assembly began to adopt less laconic resolutions which, however, did little more than commend the IAEA's various programmes. As time went on the role of the Agency in applying safeguards, in underpinning non-proliferation and in verifying nuclear weapon free zones attracted increasing attention.

In the mid-1970s, the Assembly began to influence the way in which the Agency would deal with certain political issues. In the *Annual Report* the Secretariat invariably drew attention to the General Assembly's resolutions concerning South Africa and Israel. At its 1976 session, the General Conference called upon the Board to reconsider the designation of South Africa.[56] The Board's decision in 1977 to cease designating South Africa was in part justified by the proponents of the decision by the position taken by the General Assembly. So too was the pressure that the General Conference vainly brought to bear on Israel to place all its nuclear activities under IAEA safeguards.[57] Equally, the General Conference resolution of 1994, in effect calling upon the Board to renew the designation of South Africa, referred to recent resolutions of the General Assembly (and the Security Council).[58]

Relations with the Security Council

As noted in Chapter 5, the Board sent a report to the Security Council after the Israeli bombing of the OSIRAQ reactor in 1981. However, it was the Gulf War ten years later that brought the IAEA for the first time into direct consultation with the Council, which adopted resolutions calling upon the Agency to destroy, remove or render harmless Iraq's military and most of its civilian nuclear potential.[59] Since 1991, the Director General has regularly reported to the Council on the implementation of those resolutions.

The IAEA has also become the technical instrument for implementing the Security Council's resolutions and recommendations relating to the DPRK's nuclear activities. Thus, since the beginning of the 1990s the IAEA's relations with the Security Council have become of prime importance.

These developments have brought to the fore the role of the Security Council as the organ for ensuring compliance with IAEA safeguards, which is implicit in the statement on this issue that the President of the Council made on 31 January 1992 that "the proliferation of all weapons of mass destruction constitutes a threat to international peace and security" and that its members "will take appropriate measures in the case of any violations notified to them by the Agency." As noted in Chapter 8, the Council also emphasized "the integral role in the implementation of [the NPT]...of fully effective International Atomic Energy Agency safeguards..."

The question thus arises whether the IAEA should formalize the practice of reporting regularly to the Security Council on the main developments in its safeguards work. In practice, since 1991 the Director General has done so, twice a year in the case of Iraq. He has also reported regularly to the Council about the application of safeguards in the DPRK, has kept the Council informed about progress in 'Programme 93 + 2' and on the steps taken by the IAEA to help combat nuclear trafficking.

Relations with ECOSOC

Since the Agency is required by its Statute to deal with issues of security of direct concern to the General Assembly and the Security Council, it was not constituted as one of the specialized agencies of the United Nations whose work is almost entirely in economic and social fields and whose main link with the United Nations is to ECOSOC, to which body the other agencies are required to report each year.[60] Nonetheless, until the late 1960s, when safeguards became an important part of the IAEA's activities, there was little to differentiate the IAEA from most of the specialized agencies. The fact that most of the IAEA's early programmes were designed to contribute (in a modest way) to the economic and social progress of the developing countries, and the decision of the General Conference in 1958 that the IAEA should submit a special annual report to ECOSOC as well as to the General Assembly, enhanced the similarity between the IAEA and the specialized agencies. Like the heads of other agencies Sterling Cole and subsequently Sigvard Eklund made an annual speech to ECOSOC at its summer session in Geneva on the work of the IAEA (other than the application of safeguards).

In time Eklund became unwilling to deliver the IAEA's report and delegated the task to a senior member of the staff. Later it was decided to forego entirely the Director General's prerogative to address ECOSOC — and none of the national delegations to ECOSOC or the UN Secretariat seemed to notice its disappearance! Finally, no one from IAEA Headquarters was sent from Vienna to take part in the session, and the IAEA delegation shrank to the Head of the Geneva office, part of the time, and her able secretary for the remainder.

The Board's decision in 1975 that there should henceforth be a single annual report also implied that the IAEA's relationship with ECOSOC was receiving less attention. The Board would approve the single report in June and it would be issued too late for ECOSOC's July session when other agencies presented their reports. It would thus be slightly more than a year old when it reached ECOSOC at the latter's subsequent summer session. By the 1990s, the IAEA's relations with ECOSOC had thus become of little importance to either body, except very occasionally when ECOSOC dealt with general issues of co-ordination such as the activities of all UN agencies relating to energy, science and technology, or the protection of the environment.

The Joint FAO/IAEA Division and WHO

The creation of the Joint FAO/IAEA Division in 1964 eventually brought an end to lengthy arguments between the Secretariats of the two agencies about the role of nuclear energy in food and agriculture and to jurisdictional disputes between the atomic energy unit that the FAO had set up before the creation of the IAEA and an agriculture section in the IAEA Secretariat. It was agreed that the Head of the Joint Division would be an FAO official (to this end an IAEA official was transferred to the staff of FAO), that the deputy would be an IAEA official (an unhappy and unwilling FAO official was transferred to the staff of the IAEA) and that the Division should be located at IAEA Headquarters. Although it took several years before the effects of previous disputes wore off (see Bjorn Sigurbjörnsson's article in *Personal Reflections*), the practical and common sense concept reflected in the Joint Division proved to be a great success. It set an example that the IAEA and UNESCO followed in the late 1960s when the International Centre for Theoretical Physics at Trieste became (and remained until recently) a joint venture.

The work of the IAEA and WHO in radiation protection and in the medical uses of radioisotopes and radiation could also lead to duplication or conflicting recommendations and some thought was given in the early 1960s to establishing arrangements similar to those between the IAEA and FAO. However, the IAEA has explicit statutory responsibilities for establishing or adopting and applying nuclear safety standards while, as noted, WHO assigned higher priority to the major health problems of the developing world than to the medical use of nuclear techniques. Accordingly, the solution to the jurisdictional problems between the two agencies was sought in the joint preparation and sponsorship of standards and other activities (in which other interested UN and regional agencies took part), as well as in co-operation on problems such as those of internationally standardized radiation doses. Numerous examples of such co-operation have been given in Chapters 7 and 9 (see also the comment below on the conference 'One Decade After Chernobyl').

To ensure close working relationships and to resolve any jurisdictional problems that might arise, WHO assigned a senior member of its medical staff as liaison officer to the IAEA until the late 1970s, when the arrangement was no longer felt to be necessary.[61] The IAEA's Geneva office played and continues to play a similar co-ordinating role.

Relations with regional organizations

The initiative for concluding most of the formal co-operation agreements mentioned in Chapter 4 was taken by the other organizations or regional bodies concerned rather than by the IAEA. This was not of course the case with the co-operative regional arrangements such as RCA, ARCAL and AFRA that the IAEA itself launched and that were designed to promote technical co-operation between working scientists on common problems of developing countries, with as little administrative overhead as possible.

In the nuclear field the justification for establishing an autonomous regional organization has usually been political. The aim of the Tlatelolco Treaty was to keep Latin America free of nuclear weapons and prevent a repetition of the Cuban missile crisis. The original stimuli for the Pelindaba and Rarotonga Treaties were French nuclear tests in Algeria and later in the South Pacific, and concern about South Africa's nuclear activities. In the Middle East, IAEA NPT-type safeguards would hardly be regarded by the States concerned as adequate unless they were supplemented by a regional system of safeguards and inspections.

In the case of EURATOM the need for co-operation in introducing nuclear energy was perceived in the 1950s as the motor that would drive Western Europe to unite. This perception rested on the economic promise that atomic power was seen to offer and also on the novelty of this means of generating electricity. EURATOM safeguards would enable Western Europe to obtain US nuclear supplies. Moreover, atomic energy was unlike coal or steel, the other two fields of regional European co-operation, which were the preserve of old and firmly established national entities that would be loath to accept multinational direction. EURATOM safeguards were also a means whereby the other Western Europeans, especially France, could keep in touch with developments in the nuclear activities of the Federal Republic of Germany. At the same time EURATOM, like other European Community organizations, was a means of binding a peaceful and democratic Germany into the fabric of Western Europe.

EURATOM has since lost most of its significance as a promoter of nuclear energy in Western Europe but it still maintains its safeguards function. The 13 European Union non-nuclear-weapon States therefore pay twice for the verification of their nuclear activities.

The OECD's Nuclear Energy Agency (NEA) also used a political argument as one of its raisons d'être. In private discussions senior NEA officials maintained that because the organization's membership was relatively homogeneous and its members had similar political systems it was easier for the NEA than for the IAEA to launch new nuclear activities or to exchange information that its parties regarded as semi-confidential. There was some force in this while East and West were divided and when the NEA was chiefly a Western European body, but with the end of the Cold War and the growth in the NEA's membership to include several nations from other continents little is left of the argument today.

As more OECD countries joined EURATOM, some of the justification for independent NEA nuclear programmes tended to erode but the organization compensated for this, at least in part, by expanding its membership to include the USA, Canada, Japan, Australia, the Republic of Korea and, in 1994, Mexico. In 1996, the first countries from the former Warsaw Pact, the Czech Republic and Hungary, were approved for NEA membership. With their accession the membership of NEA has risen to 27 countries, of which 20 are in Europe.[62]

Two of the NEA's three joint undertakings (the Mol reprocessing plant in Belgium and the Dragon high temperature gas cooled reactor in the United Kingdom) were subject to EURATOM safeguards. With the advent of the NPT the remaining joint undertaking, the Halden reactor in Norway, came under IAEA safeguards, while the Mol and Dragon plants were decommissioned in the 1970s. In the late 1970s, NEA decided in effect to wind up its own safeguards operation.

There was a tacit understanding between the IAEA and the NEA that the latter would leave to the IAEA the principal responsibility for setting global nuclear safety norms and standards. The NEA would help the IAEA by addressing detailed technical issues and by promoting individual R&D projects in its members, for instance in nuclear waste management. It would also refrain from establishing direct links with IAEA Member States that were not members of NEA. If, for instance, the NEA wished to secure the participation of the Soviet Union in a particular meeting it would ask the IAEA to arrange this, usually by co-sponsoring the meeting. In recent years, however, the NEA has embarked on a policy of reaching out to non-Member States and established direct links with all States of Central Europe (one or two of which have joined the organization) and also with Russia.

The NEA and IAEA have continued to work closely with each other by co-sponsoring scientific meetings, in preparing the 'Red Book' (the periodic worldwide survey of uranium reserves, production and demand) and, particularly, in regard to nuclear safety and waste management, the two topics on which the NEA has increasingly focused its work.[63] Moreover, beyond the frontiers of the former Soviet Union, most of the fallout from Chernobyl came down on OECD countries. They were also the nations outside the frontiers of the former Soviet Bloc that were most concerned about the possible consequences of defects in older model Soviet reactors and the dumping of high level nuclear waste in the Kara Sea and Sea of Japan.[64]

For similar reasons, the IAEA and the European Union (through the European Commission) have worked more closely with each other in nuclear safety and nuclear waste management than they did in earlier years, particularly to enhance the safety of older Soviet reactors and to deal with the consequences of Chernobyl.

The Agency's co-operation with EURATOM in the application of safeguards is discussed in Chapter 8. After the conclusion in the 1970s of the safeguards agreement between the two organizations and the European Union non-nuclear-weapon States, one might have expected the latter to pare down EURATOM's safeguards operation to the minimum compatible with the Rome Treaty. The opposite happened: EURATOM safeguards grew while those of the IAEA in the EURATOM non-nuclear-weapon States eventually shrank after the 'new partnership approach' was negotiated.

Why were the Western European nations intent on maintaining and even expanding EURATOM safeguards? It is conceivable that in the 1970s and 1980s at least one of the EURATOM nuclear weapon States wished to keep EURATOM's safeguards in reserve in case the NPT expired, or in case the Federal Republic of Germany showed interest in the military applications of nuclear energy. These considerations have lost whatever force they may have had, the NPT is now permanent and Germany has become the most reluctant to be involved in warlike activities amongst the major States of Western Europe!

Relations with the nuclear industry

The IAEA took its first steps towards formalizing its relations with the nuclear industry when the Board of Governors granted consultative status to non-governmental organizations established by national or regional nuclear energy associations. When the procedure of granting consultative status was discontinued in the early 1960s, the IAEA maintained or established contact in several other ways, for instance, by involving the associations in the IAEA's technical and scientific meetings, by taking part in their meetings, by regularly exchanging information with them and by inviting them to be represented at the IAEA's General Conference. Among those with whom regular contact was maintained were the European Atomic Energy Forum, the US Nuclear Energy Institute, the International Union of Producers and Distributors of Electrical Energy, the Uranium Institute (which is taking a growing interest in the Agency's activities) and the World Association of Nuclear Operators.

The impact of other organizations on the work of the IAEA

Other bodies external to the IAEA that have had a powerful, though sometimes indirect, influence on its work include:

— The Conference on Disarmament (CD), as, for instance, the progenitor of the NPT and the CTBT and, potentially, of the fissile material cut-off convention. When the CD drew up the Chemical Weapons Convention the IAEA provided it with material and advice. The scope of the IAEA's safeguards activities has been profoundly affected by the CD's decisions on the NPT and on the CTBT.

— The quinquennial Review Conferences of the NPT which have acclaimed the IAEA's operations, particularly in safeguards. The IAEA has been the chief international source of background material for the NPT Review Conferences and the chief international organization to which it has addressed its recommendations.

Issues resolved and issues emerging

In the 1950s and early 1960s, the IAEA's work relating to the applications of radioisotopes and radiation in agriculture, hydrology, industry and medicine and its concern with protection against radiation brought it into contact, and sometimes into competition, with other UN agencies. However, by the mid-1960s most of the issues between the Agency and the specialized agencies concerned had been settled by a variety of arrangements and understandings. The conference 'One Decade After Chernobyl', sponsored jointly by WHO, the European Commission and the IAEA, and in co-operation with the UN, UNESCO, UNEP, UNSCEAR, FAO and the NEA, was a striking example of the degree of co-operation that has been established between the UN and regional organizations in the crucial issues of radiation protection and nuclear safety. A regional approach to nuclear waste storage and disposal, instead of a proliferation of national sites, would make eminently good sense but has so far been little explored.

The IAEA's work on nuclear power brought it into contact with the World Bank, which has a long record of helping its members to meet their energy needs. But the Bank considered itself 'a lender of the last resort' and during the years of rapid growth of nuclear power it concluded that several other sources of cheaper capital were available to prospective borrowers. Since the 1950s, when it helped to finance Italy's first nuclear power plant, the Bank has not invested directly in nuclear power.

As its safeguards programme expanded, the issue of the IAEA's relations with multinational/regional organizations, and in particular EURATOM, came into the limelight and was kept there by the establishment of ABACC, and the new partnership approach. The Board's approval of 'Programme 93 + 2' has raised the question of the respective roles of the IAEA and EURATOM in applying 'Programme 93 + 2' measures in the non-nuclear-weapon States — and the nuclear weapon States — of the European Union.

One issue suggested by these developments and by the constraints on the Agency's budget is whether, and if so how far, responsibility for the routine application of safeguards to materials and in facilities of little military significance should devolve upon regional and even national systems of accounting and control.

NOTES

1 In retrospect, it is surprising that the developing countries, who constituted a large majority of the 81 States represented at the Conference on the Statute, did not use their voting strength to insert a specific reference to technical assistance in the draft document before them.

2 The rules of procedure of both the Board and General Conference require that the decisions on the following matters shall require the votes of a two thirds majority of those present and voting: "any financial question" (General Conference, rule 69(a)); "the amount of the Agency's budget" (Board of Governors, rule 36(a)).

If they had so wished a group of Member States amounting to one third of the members of the Board or General Conference (or even less if some abstained or were absent) could thus have blocked the decision on the amount of the budget allocated to safeguards or to any other programme. As far as the author can recall, this manoeuvre was never resorted to. Instead the amount and breakdown of the IAEA's budget was agreed to in a series of compromises. In fact, voting on programmatic or financial issues has been extremely rare; the issues decided by vote have been chiefly political.

3 The impression that nuclear safeguards were directed against the developing world, though incorrect, might have been strengthened by an unforeseen evolution. In the 1960s, the chief targets of safeguards were the Federal Republic of Germany (together with the other non-nuclear-weapon States of the European Union) and Japan. After these States joined the NPT and the Cold War ended — and several developing countries acquired the technical ability to make nuclear weapons (and some did so) — the focus of concern shifted towards certain States in developing regions where political tensions were often acute.

4 Ambassador Domingo Siazon of the Philippines was largely instrumental in securing this concession. See 'Financing of safeguards' in Chapter 8.

5 The existing regional treaties creating nuclear weapon free zones are the Antarctic Treaty, the Tlatelolco Treaty covering Latin America and the Caribbean, the Pelindaba Treaty covering Africa, the Rarotonga Treaty covering the South Pacific and the Bangkok Treaty covering South East Asia. Except for the special case of the Antarctic Treaty, the only industrialized nations party to these Treaties are Australia and New Zealand. In all cases except the Rarotonga and Antarctic Treaties, the initiative for the creation of the Treaty was taken by one or more developing countries.

The dozen or so parties to the NPT that wished to make its extension conditional on further progress in nuclear disarmament are all strong supporters of and parties or potential parties to the Pelindaba and Bangkok Treaties. This suggests that their objection to an unconditional extension of the NPT did not stem from reluctance to accept permanent IAEA safeguards. It was directed against the discriminatory character of the NPT — in other words, against the privileged position under the NPT of the nuclear weapon States and their reluctance to accept a binding timetable for nuclear disarmament.

6 India and South Africa provide striking examples of changing attitudes in nuclear policies. India was once not only the leader of the developing nations, but also the world's most outspoken opponent of nuclear weapons. Today, powerful interests in that country proclaim the need to maintain India's nuclear option and even, by carrying out another nuclear test, to demonstrate that India is a nuclear weapon State — unless the nuclear weapon States agree to nuclear disarmament "within a time bound framework". South Africa pursued a semi-clandestine nuclear weapon programme — with no significant internal opposition — until 1991, when former President F.W. de Klerk decided that maintaining a nuclear arsenal was against the national interest or, at least, against the interests of the government of the day and the arsenal was dismantled.

7 The delegate of Venezuela originally favoured a 25 year renewable extension, but his government subsequently backed an indefinite extension. The delegate of Mexico, Ambassador Marin Bosch, had argued in 1990 in favour of setting conditions in return for an indefinite or lengthy extension of the NPT, such as a commitment to the early conclusion of a comprehensive test ban treaty, but in the end in 1995 he went along with the Conference's consensus decision. The only parties favouring a conditional extension were a few African States (led by Egypt) and South East Asian States (led by Malaysia). The Arab States were reluctant permanently to renounce nuclear arms as long as Israel remained free to retain its nuclear arsenal. In the end all delegations accepted a consensus declaration proposed by the President, Ambassador Jayantha Dhanapala of Sri Lanka, that the majority of the parties to the NPT favoured an indefinite extension of the Treaty.

8 These included the conclusion of a comprehensive test ban treaty before the end of 1996, the early conclusion of a fissile material cut-off treaty, the "determined pursuit by the nuclear-weapon states of...efforts to reduce nuclear weapons globally with the ultimate aim of eliminating those weapons" and of "general and complete disarmament under strict and effective control," as well as progress on other specified aspects of nuclear arms control and disarmament.

9 It is thus difficult to persuade central government planners to give high priority to the applications of radioisotopes and radiation. The IAEA Secretariat suggests that this is one of the factors that account for the declining role of UNDP in funding IAEA technical co-operation projects. (See also Chapter 9.)

[10] At a PPNN (Programme for Promoting Nuclear Non-Proliferation) meeting in Caracas in 1994, a participant from Brazil maintained that the second nuclear power plant at Angra dos Reis was costing his country as much as the Channel Tunnel!

[11] This emerged during the discussions of 'Programme 93 + 2' and at the first (April 1997) Preparatory Commission Meeting for the 2000 NPT Review Conference (see JOHNSON, R., "Reviewing the NPT: The 1997 Prepcom", *Disarmament Diplomacy* (April 1997) 10).

[12] STOESSINGER, J.G., "Atoms for Peace: The International Atomic Energy Agency", *Organizing for Peace in the Nuclear Age*, Report of the Commission to Study the Organization of Peace, New York University Press, New York (1959) 136.

[13] STOESSINGER, J.G., ibid., pp. 136-137 and 175.

[14] Somewhat ironically, in one of the rare cases in which the IAEA concluded that the country was ready for an investment in nuclear power, the Philippines, the Government concerned went ahead and constructed a nuclear power plant, but its successor decided not to bring the plant into operation.

[15] *Annual Report for 1996*, GC(41)/8, IAEA, Vienna (1997), Annex, p. 56, column (3). The regular budget expenditure on nuclear power in 1996 was $6 209 599 out of a total regular budget of $243 166 304, or 2.55%.

[16] The IAEA's nuclear power programme is described as promoting and supporting "efforts to improve the reliability, economics *and safety* of current and future nuclear power plants" (emphasis added). (*The Agency's Programme and Budget for 1995 and 1996*, GC(XXXVIII)/5, IAEA, Vienna (1996), p. 15, para. A/1.)

[17] Since 1996, a further change in the internal structure of the IAEA has also helped to make it clear that there is no significant conflict of interest. Within the Secretariat a new Department of Nuclear Safety has been established, separate from and independent of the Department of Nuclear Energy. The latter now contains two Divisions, one of them being a relatively small Division of 'Nuclear Power and the Fuel Cycle' with a Professional staff of 23 (*The Agency's Programme and Budget for 1995 and 1996*, p. 247). As noted elsewhere, on the initiative of some of its developing Member States, the IAEA is resuming its 30 year old assessments of the prospects for nuclear desalination and of small nuclear power reactors.

[18] DEMBINSKI, M., *Test Case North Korea*, Paper SWP-IP 2865, Stiftung Wissenschaft und Politik, Ebenhausen, Germany (September 1994).

[19] For example, in August 1995 the House of Delegates of the American Bar Association approved recommendations made by a section of the Association which strongly supported the IAEA's safeguards activities, but which maintained that " ...it also seems likely that the Agency's functions as a promoter of nuclear power tended to interfere with impulses to take safety really seriously when advising states about the design

of existing or future facilities. Safety (unlike) safeguards can be very expensive, and may affect the competitiveness of nuclear power in particular situations." The report went on to recommend the creation of an International Energy Agency "into which the IAEA's nuclear power functions would be folded", an International Arms Control Agency to take over safeguards (and the controls of the CWC and the CTBTO) and an International Nuclear Safety Agency. No facts were given to support the claim that the Agency's "...functions as a promoter of nuclear power tended to interfere with impulses to take safety really seriously when advising states about the design of existing or future facilities" and this claim has, indeed, no foundation in fact. Except in the broad context of the IAEA's safety standards, etc. (which the same report notes are "of great utility"), the IAEA does not advise States on the design of nuclear power plants and has rarely, if ever, done so in the past. Nuclear power plant design is a matter almost entirely in the hands of transnational corporations like Westinghouse, Framatome, Siemens, Atomic Energy of Canada Ltd and their Russian and Chinese counterparts, most of whom are conscious of the impact that another major nuclear reactor accident would have on their own economic health. As for operating safety, the statement is hardly consistent with the broad range of activities the IAEA has undertaken since 1980 to maintain and enhance safety, including most recently the promotion of a nuclear safety convention and preparation of a similar convention on the management of nuclear waste, or with the major effort the IAEA made — together with WHO and the European Union as well as several other UN and regional agencies — to ascertain and publish the causes and consequences of the Chernobyl accident, or with the IAEA's recommendations to shut down one of the Bulgarian power reactors at Kozloduy, or its recommendations for the upgrading of RBMK and WWER reactors.

The Bar Association's recommendations for restructuring the international organization of nuclear energy, safety and safeguards are, at best, unrealistic. They would require the creation of at least one new international organization as well as root and branch amendment of the Statutes of the IAEA, of the Organization for the Prohibition of Chemical Weapons (OPCW) and the CTBTO as well as the amendment of numerous other conventions and agreements and the NPT itself.

[20] The regular budget figures are taken from the *Annual Report for 1996*, Annex, p. 56, column (3). The total expenditure under the regular budget for 1996 was $243 166 304.

[21] Expenditures on the various applications of these techniques supported by the technical co-operation programme were:

— Food and agriculture: $13 247 000,
— Human health: $9 036 000,

— Industry and earth sciences: $8 352 000,
— Physical and chemical sciences: $7 550 000 (ibid., p. 57).

[22] Thereby also deepening the difference — in their perceptions of the role of the IAEA — between the nations that reject nuclear power, all of which are in the 'North', and the 'promoters', which are both in the 'North' and 'South'. An extreme example of this difference would be in the perceptions of the Governments of Denmark and India. Denmark has long since decided not to go in for nuclear power, but is greatly concerned about nuclear safety and a strong supporter of IAEA safeguards and non-proliferation. The Indian Government plans a continued expansion of its nuclear power programme, is unenthusiastic, to say the least, about IAEA safeguards, and dismisses the NPT as a licence to the nuclear weapon States to retain their nuclear weapons.

[23] The definition of source and special fissionable materials in Article XX contains the only statutory reference to isotopes, namely to the isotopes of uranium. But the applications of radiation and radioisotopes could be broadly subsumed under "the contribution of atomic energy to peace, health and prosperity" that, according to Article II of its Statute, the IAEA must seek "to accelerate and enlarge".

[24] Much the same is true of most industrial applications of radiation.

[25] As noted in Chapter 7, the banning of chemical fumigants and chlorofluorocarbons, and concern about salmonella, may be improving the prospects for food irradiation.

[26] In a world that relies increasingly on market forces, the prospects are poor for any significant growth in the funds that governments are willing to provide in order to subsidize such international R&D. If additional resources do become available to the IAEA, it is more likely that they will be directed to curbing proliferation, preventing trafficking in nuclear materials, eliminating the danger of nuclear terrorism (in the author's view, exaggerated by the media) and enhancing nuclear safety.

[27] The IAEA has transferred operational responsibility for the International Centre for Theoretical Physics in Trieste to UNESCO, but the example is hardly relevant. The Centre has operated as an independent unit, engaging in many activities that have little to do with the practical applications of nuclear energy, and linked only financially and administratively to the IAEA. The IAEA will remain one of the two main sponsors of the Centre.

[28] Thus, the OPCW has no responsibility for promoting the chemical industry (or for that matter, regulating its safety). And far from promoting 'PNEs', the organization for verifying compliance with the CTBT will also verify that nuclear explosives are not used for any civilian as well as any military purpose!

[29] The target for voluntary contributions increased in monetary terms from $10 500 000 in 1980 to $61 500 000 in 1995, or about six times, while the safeguards budget rose from $19 396 000 to $72 745 000, or less than three and a half times during the same period. However, a quite different picture emerges if one goes further back and takes 1970, the year of entry into force of the NPT, as the basis for comparison.

[30] Brian Payne, who worked in the United Kingdom Atomic Energy Agency at Harwell before joining the IAEA in the late 1950s.

[31] For example, in April 1975, of the 33 Governors (one State had not yet appointed its Governor), only seven were not heads or senior officials of the authority responsible for nuclear energy in the country concerned. The seven were Canada, India, the Republic of Korea, Thailand, Turkey and Venezuela. (*Board of Governors and Permanent Missions of Member States*, No. 35, IAEA, Vienna (April 1975).)

The IAEA's Scientific Advisory Committee (SAC) consisted almost entirely of the heads of the most powerful atomic energy authorities who, in several cases, doubled as their country's Governors on the Board. If SAC agreed on a specific recommendation to the Board, it was almost sure to be approved. This led Henry Seligman, the Secretary of SAC and Head of the Department of Research and Isotopes, to suggest — tongue in cheek — that the Committee should be renamed the PAC — Political Advisory Committee!

[32] *Board of Governors and Permanent Missions of Member States*, No. 115, IAEA, Vienna (June 1996).

[33] In a reversal of the arrangement that was often made in earlier days, some countries appointed their ambassador as Governor and the head of, or a senior official from, the nuclear authority as his or her deputy.

[34] In at least one important case — the USA — the nuclear energy authority had been disbanded. In others (e.g. France and the United Kingdom), responsibility for the national nuclear power programme had been taken over by the national electricity authority. Russia was an exception — the Ministry for Nuclear Energy remains very powerful.

[35] In a sense, the IAEA began to have multiple constituencies using different channels between it and the national entities concerned. The IAEA Department dealing with technical co-operation looked increasingly to national and multinational aid and development agencies, its Divisions dealing with nuclear safety looked to regulatory agencies, its safeguards staff to ministries of foreign affairs and national arms control organizations, and its staff dealing with nuclear technology to atomic energy commissions.

36 As early as the late 1960s and the 1970s, several heads of nuclear energy commissions in the developing countries lost or gave up their jobs and joined the staff of the IAEA. But there has also been a significant reverse flow. Both Munir Khan, for many years Chairman of the Pakistan Atomic Energy Commission and Jaldi Ahimsa who, until 1997, headed the Indonesian nuclear energy authority, had previously served in the IAEA Secretariat.

37 Even if orders for nuclear power plants remain infrequent, much of the international 'nuclear park' is likely to remain in operation for several decades. As it grows older, there will be growing concern about its safety. Moreover, the problems of dismantling obsolete plants and disposing of their radioactive components, as well as other nuclear waste, seem likely to enhance the influence of nuclear regulatory authorities, nationally as well as internationally.

38 *IAEA Statute,* Article VI.F.

39 *Rules of Procedure of the Board*, GOV/INF/5, IAEA, Vienna (1958), Rule 8(a). The US political scientist J.G. Stoessinger remarks that "The office of Director-General — in comparison with the chief executive posts of other agencies in the United Nations family — is probably the weakest in its relationship to the governing body." (STOESSINGER, J.G., "Atoms for Peace", p. 164.)

40 In both cases the Board decided by an overwhelming majority that the agreements had been violated.

41 In 1974, the Board held 12 half-day meetings, in 1975 it held 10 (4 in March, 4 in June and 2 in September) and in 1976, 9. Ten years earlier, in 1965, the Board held 14 half-day meetings.

42 The Conference on Disarmament, the NPT Review Conferences and the 1995 Review and Extension Conference provide examples of the formation of core groups. In several cases, in order to make progress in drafting important documents or reaching policy decisions, the President of the conference has established a group of 'friends of the President'. The members of the group represent various regions or blocs of States and take responsibility for persuading other members of their group to accept compromises put forward by the President. In other cases, the President of the conference, its Vice Presidents and the Chairmen of the conference's committees, have constituted an advisory 'bureau'. These are often time consuming procedures, and so far the Board has not made much use of them.

43 Entry into force on 31 January 1963.

44 Entry into force on 1 June 1973.

45 Entry into force on 28 December 1989.

46 Document GOV/OR.633, p. 24, para. 115. (The Governor from Argentina speaking on behalf of the Group of 77.)

[47] Ibid., p. 23, para. 112.

[48] Document GOV/OR.736, paras 9, 10 and 78; and GOV/OR. 738, paras 2–8.

[49] Ukraine and Belarus were founding and nominally independent Member States of the IAEA, just as they were in the United Nations itself. In the context of the NPT, they were regarded as non-nuclear-weapon States. This meant that, if Ukraine and Belarus ratified the NPT, they would be required by Article II of the NPT to renounce nuclear weapons and, by Article III, to accept IAEA safeguards on all their nuclear activities. These were requirements that Moscow would not have accepted as long as the two States were, in reality, provinces of the Soviet Union and played a role in the latter's nuclear military complex. Moreover, the USSR could not provide Ukraine and Belarus — as non-nuclear-weapon States — with *unsafeguarded* nuclear material without being in breach of Article III.2 of the NPT. The USSR — and the rest of the world — dealt with this problem by ignoring it. Belarus became a party to the NPT in 1993 and Ukraine in 1994.

[50] Ukraine had 16 nuclear power plants (including three at Chernobyl) in operation at the end of 1995 — total installed nuclear capacity was 13 629 MW(e). It was building four more — total additional capacity reaching 4750 MW(e).

[51] The Republic of Korea had 11 nuclear power plants in operation at the end of 1995 with a total installed nuclear capacity of 9120 MW(e). It was building five more with a total additional capacity of 3870 MW(e).

The sizes of both the Ukrainian and South Korean 'nuclear parks' are already comparable with those of States currently designated as being amongst the ten "...most advanced in the technology of atomic energy " in the world, such as Germany (22 017 MW(e)), Canada (14 907 MW(e)) and India (1 695 MW(e)) and well ahead of any other non-nuclear-weapon State in Europe or elsewhere. Of course, nuclear electrical capacity is not the only criterion to be used in assessing how advanced a nation is in nuclear technology, but it has the advantage of being easily measured. Incidentally, the IAEA Statute requires the designation of States "most advanced in the technology of atomic energy" and omits any qualification that only peaceful nuclear activities are to be taken into account. This omission was almost certainly deliberate.

To reach a consensus, if the Board is to be expanded it would be essential to find a solution that did not deprive any of the existing "most advanced States" of its seat on the Board.

[52] One proposal was that the membership of the Agency should be apportioned to five regions instead of eight, namely 'Western Europe and Other Countries' (with

13 seats on the Board), Latin America (7 seats), Eastern Europe (6 seats), Africa (8 seats) and Asia (11 seats). The outgoing Board would designate 25 States and 20 would be elected by the General Conference. The Board would thus have a total of 45 seats. A proposal by Morocco (formalized after the Chair of the consultative group had submitted her report) also foresaw a 45 member Board, 18 designated by the outgoing Board and 27 elected. If the proposals for expansion were adopted, about one third or more of the total membership of the IAEA would have seats on its executive body.

53 The Chair's report is contained in an attachment to GOV/2814. Her report also included, without comment, a set of proposed criteria for 'Determining Countries Advanced in Atomic Energy Technology' prepared by the Philippine Nuclear Research Institute, and an earlier assessment of the weight that should be given to various factors in considering the criteria for designation.

54 Ambassador Walker's proposal would abolish the category of globally most advanced States, distribute their seats among the eight statutory areas, and add a designated seat each for Latin America, Eastern Europe, the Middle East and South Asia, and the Far East. The additional two elected seats would be shared by Africa, Eastern Europe, the Middle East and South Asia, Western Europe and South East Asia/the Pacific. The proposal would make elected members eligible for re-election and would prescribe criteria for assessing the degree of advancement of a Member State. It would also define the region to which each Member State belonged and assign Israel to the Middle East and South Asia.

55 *IAEA Statute*, Article XVI.B.

56 *Annual Report for 1976*, GC(XXI)/580, IAEA, Vienna (1977), p. 6, para. 18 and General Conference resolution GC(XX)/RES/336 of 28 September 1976.

57 The support that the General Assembly gave to the creation of nuclear weapon free zones in Latin America, the South Pacific, Africa and South East Asia also helped indirectly to secure the expansion of IAEA safeguards in those regions.

58 General Conference resolution GC(XXXVIII)/RES/18 of September 1994.

59 In its Resolution 687, the Security Council asked the Director General of the IAEA to draw up a plan "for the destruction, removal or rendering harmless of all nuclear weapons or nuclear weapon usable material or any subsystems or components or any research, development support or manufacturing facilities" related to nuclear weapons, etc.

60 Under Articles 57 and 63 of the United Nations Charter, the specialized agencies are intergovernmental organizations "having wide international responsibilities...in economic, social, cultural, educational, health and related fields" that are brought into relationship with the United Nations by agreements concluded with ECOSOC.

The IAEA, however, was brought into relationship with the United Nations by means of an agreement approved by the General Assembly and its main links are with that body, to which it reports annually, and with the Security Council, to which it reports on issues within the Council's competence (essentially issues dealing with compliance or non-compliance with safeguards agreements).

In practice, the IAEA was more closely tied to the United Nations than the 'financial' or Bretton Woods specialized agencies located in Washington, the World Bank and the International Monetary Fund. Neither the Bank nor the Fund is a full member of the United Nations 'Common System' and they fiercely guard the operational autonomy they enjoy under their constitutions.

[61] The senior staff member was Dr. Georges Meilland. However, in 1995, the Director General of WHO appointed a Special Representative to the UN system organizations in Vienna.

In 1965 and 1966, a senior IAEA radiation medicine consultant, Dr. Godofredo Gómez Crespo, served as IAEA technical liaison officer at WHO. Dr. Gómez Crespo had previously carried out a novel task for the IAEA, travelling the world with a plastic dummy named 'Françoise', to be used for calibrating and standardizing radioactive doses administered to patients. The standards were packed in a bomb-like cylinder and this and the fact that Françoise was slightly radioactive caused numerous difficulties with suspicious customs officers and aircrews; difficulties that Françoise's magnificent torso helped to resolve!

[62] NEA communiques of 26 May 1994 and NEA/COM (96)12 of 27 June 1996. All members of the NEA except Mexico and Turkey could be classified as affluent, but the OECD and NEA reject the appellation of 'rich man's club'.

[63] In the 1960s, the NEA had standing committees of governmental representatives on radiation and public health and the safety of nuclear installations. In time the NEA added committees on, for instance, nuclear regulatory activities and radioactive waste management, as well as on technical and economic studies on nuclear energy development. These committees reflect the NEA's increasing focus on nuclear safety.

[64] In other fields there has probably been less need for close co-ordination between the IAEA and NEA in recent years, partly because the number of large nuclear symposia has declined, partly because of the IAEA's increasing concern with safeguards, and partly because the development of nuclear power is of less interest to most NEA members than it was in the 1960s and 1970s.

Chapter 13

CONCLUSIONS

How far has the IAEA fulfilled its mandate?

A bank to 'siphon off' and supply nuclear materials

Few organizations do precisely what their founding fathers expect of them, and as we have seen the IAEA is no exception. Even as the Prepcom began its work it was already clear, for example, that the principal concept that Eisenhower put forward in his 1953 address and that was reflected so extensively in the Statute of the IAEA[1] was a non-starter — namely, that the Agency should serve as a bank or pool for the receipt and storage of fissile materials, and thus as a means of drawing down the fissile material stocks of the nuclear weapon States.

On a very modest scale, however, we have seen that the nuclear weapon States are now beginning to use the IAEA to verify that surplus military material is permanently removed from their arsenals. There is no suggestion that the IAEA should take physical possession of the material. This is still a far cry from Eisenhower's concept. But if formal nuclear disarmament and if the proposals for a cut-off treaty regain the momentum they seem to have lost, the IAEA may, at last, have an increasingly useful role to play as the international monitor of surplus fissile material.

The Statute envisaged that, as a consequence of the IAEA's role as a pool or bank for nuclear material, it would become a major supplier of such materials and of nuclear plants and that its members would turn to it with proposals for 'Agency projects' through which they would acquire materials and plants under safeguards and be subject to IAEA safety regulations. As we have seen, this too failed to materialize to any meaningful extent. In the 1960s and 1970s, both suppliers and customers preferred simpler bilateral channels. By the early 1990s, all international transfers of nuclear plants had shrunk to a handful of bilateral sales to countries in the Far East and South Asia in which the IAEA's role was mostly limited to that of applying safeguards.

Use of radiation and radioisotopes

The IAEA has helped its members, and particularly the developing Member States, to make use of nuclear techniques — applications of radiation and radioisotopes — to a far greater extent than was foreseen in the Statute, which, as we have seen, does not explicitly mention these applications of nuclear energy. The IAEA and FAO have pioneered the international use of isotope hydrology and of certain applications of nuclear science in agriculture and food processing. The IAEA's Co-ordinated Research Programmes, described in Chapter 9, offer a novel way for developing countries to co-operate with each other and to 'twin' with leading laboratories in the industrialized nations in undertaking research on problems of special interest to the developing countries. As the only international facility of its kind, the IAEA's Marine Environment Laboratory in Monaco has moved beyond its original aim of studying the effects of radioactivity in the oceans to helping in the study of serious marine pollution problems that were unknown or little known in 1953, such as the effects of scuttling nuclear submarines and dumping nuclear waste in the Arctic and the rising level of the Caspian Sea.

Nuclear safety

The Statute foresaw that the IAEA would have a standard setting role in nuclear safety, in consultation or collaboration with the United Nations and the relevant specialized agencies.[2] The standards would be obligatory in the IAEA's own operations and in all cases where the IAEA was directly involved as a supplier, supervisor or controller. If Agency projects had become the main vehicle for obtaining nuclear supplies, as the negotiators of the Statute had expected, such projects would have led to the application of mandatory IAEA safety standards to most of the world's peaceful nuclear activities outside a few supplier States. This did not happen and IAEA safety standards remained mandatory only in the relatively few Agency projects approved by the Board of Governors and in a larger number of technical co-operation projects. As noted in Chapter 7, in 1976 the IAEA dropped entirely the concept of IAEA verification — by health and safety inspections — of compliance with these standards.

In another direction, however, the IAEA has gone a good deal further in promoting nuclear safety than the Statute foresaw, for instance in negotiating binding conventions on:

— Early warning in the event of a nuclear accident,
— Availability of emergency assistance,
— Safety of land based nuclear power plants,
— Safe disposal of nuclear waste,
— Protecting nuclear material against criminal acts, and providing for liability for nuclear damage.

Chapter 7 enumerates the wide range of advisory services that the IAEA has offered, particularly since Chernobyl, to help its Member States raise the level of nuclear safety and ensure the safe management of nuclear wastes. These services, too, go beyond the standard setting function which is prescribed in the IAEA Statute.

Nuclear safeguards

The Statute foresaw that the IAEA would have a unique international role in establishing and administering nuclear safeguards.[3] Inspection of one's own country by foreigners was not of course unknown before the middle of the twentieth century, but it had usually been imposed by victorious powers on the territory of defeated enemies in the wake of war. There had been no truly international inspections, no inspections by developing countries of the activities of industrialized countries, and vice versa. Until the nuclear weapon States accepted IAEA safeguards, there had been no foreign inspectors in the USA or the Soviet Union, in the United Kingdom, France or China. Now, for the first time, nation States were voluntarily agreeing, in binding accords, to accept inspection of what was at the time their most technically advanced and potentially sensitive research and industrial centres.

Perhaps the IAEA's chief claim to a place in history will be as the body that pioneered the practice of international on-site inspection — in the nuclear weapon as well as the non-nuclear-weapon States. It thus helped to prepare the way for major advances in disarmament, chemical and conventional as well as nuclear. It was also this form of international co-operation (and for the most part it has been a co-operative effort) that helped to maintain US–Soviet links through the rigours of the Cold War.

In this way too the IAEA has served an indirect promotional role, contributing to the safe use of nuclear energy in the broadest sense, helping to ensure the safety of nuclear material and plants and their wastes, assisting in preventing the diversion of nuclear plant and material to nuclear weapons and weapon related activities, and eventually helping to verify the permanent withdrawal of nuclear material from military stocks.

Has the IAEA contributed to the spread of nuclear weapons?

A nagging question in the minds of some is whether the Agency's programmes have inadvertently contributed to nuclear proliferation. Obviously neither the Governing Bodies of the IAEA nor the Director General and his staff have ever taken a deliberate decision to help any Member State along that road. On the contrary, all the IAEA's relevant programmes have become increasingly directed to preventing proliferation. It is conceivable that some scientists may have received training under IAEA auspices that later helped them to launch programmes for the manufacture of nuclear explosives, but no such case has been unambiguously identified; in fact, it would be very difficult to do so. It is also very difficult to draw the line; almost any training in nuclear science and technology can, in theory, bring knowledge that might be useful in designing a nuclear explosive, but we cannot close down the physics and chemistry departments of universities in States that we suspect of harbouring nuclear weapon aspirations, nor can we ban their youth from studying nuclear science.

As far as the IAEA is concerned, the most obvious doors have been closed for many years. No training has ever been available from the IAEA in the technology of enriching uranium, nor, at least for many years, in the technology of reprocessing spent fuel, but there may have been borderline cases where technical assistance or training in the management of nuclear waste could indirectly have helped a nascent reprocessing programme.

IAEA technical assistance in prospecting for and mining uranium may also in one or two cases have indirectly helped to provide the raw materials for a nuclear explosive programme. Such cases are of marginal interest. Almost any country with a moderate industrial infrastructure can find and process uranium ore; the technically difficult steps towards nuclear weapons come much later. Reprocessing itself has been in the public domain since 1955, and as Iraq and the DPRK have shown, every nation with an industrial chemical industry can separate small amounts of plutonium if it has a nuclear reactor.

As long ago as 1980, Professor Joseph Nye of Harvard University and Deputy Undersecretary of State for Security Assistance in the Carter

Administration, noted that in the three and a half decades since 1945, "nuclear technology has spread to more than two score nations" yet "only a small fraction have chosen to develop nuclear weaponry."[4] Today the number that possess or could speedily acquire the necessary technology is probably closer to 50. The technical constraints on nuclear proliferation have eroded and are likely to continue to erode. The challenge is to maintain an effective non-proliferation regime enjoying the widest possible political support and to reduce the political incentive to acquire the bomb. This raises issues beyond the scope of this book.

Lessons from the IAEA's experience

Safeguards

We have noted that the Statute imposes no obligation on Member States to accept or require IAEA safeguards. Could the negotiators of the Statute in 1954–1956 have taken a different course? For instance, could they have required that countries joining the IAEA accept comprehensive IAEA safeguards — or any IAEA safeguards — on their own programmes? Obviously not; the three nuclear weapon States, the USA, USSR and the United Kingdom, and the two aspirant nuclear weapon States, France and China, would have rejected any such idea out of hand. Mandatory comprehensive safeguards had to wait until the late 1960s, and then only in non-nuclear-weapon States as a consequence of adhering to another treaty.

But could not the Statute at least have required that all parties should ensure that safeguards were applied to their nuclear exports? This too would have been unacceptable, at least to some of the nuclear weapon States. The nuclear weapon programme of the United Kingdom was totally dependent, France and the USA were initially heavily dependent and the USSR somewhat dependent on imported uranium. They would not have wanted their suppliers, Belgium, Canada, South Africa, Australia, Gabon, Niger, the German Democratic Republic, Poland and Czechoslovakia, to make IAEA safeguards a condition of supply.

One lesson in international verification that can be learned from the IAEA's experience is the desirability of spelling out in as much detail as possible the rights and procedures of the verifying agency in that agency's constitution. In the IAEA's case this could be done only to a limited extent because of the novelty of international safeguards in 1955–1956 and the concerns and mistrust they provoked. It was difficult enough for those in favour of effective safeguards to persuade the twelve-nation negotiating group and the Conference on the Statute to accept the existing statutory provisions. But partly as a result of the lack of specifics of the relevant clauses of the IAEA's Statute, its safeguards suffered from some progressive weakening and dilution.

The prime example lay in the erosion of the rights of access and freedom of action of the Agency's inspectors. We have noted that under the 1956 Statute, IAEA inspectors "shall have access at all times to all places and data and to any person who by reason of his occupation deals with…[safeguarded] materials, equipment or facilities, as necessary to account for [nuclear] materials supplied and fissionable products…"[5] But the Statute is not a self-enforcing document. The precise procedures that the IAEA would be required to follow and the directives it would be required to observe would have to be articulated in detailed safeguards documents and in agreements with the States concerned.[6]

Thus, the 1961 Inspectors' Document required that the State concerned would normally be given at least one week's notice of each routine inspection (hardly "access at all times"), and that the inspector would be required to enter and leave the State at points and to follow routes and use modes of travel designated by the State (hardly "access...to all places").[7] Moreover, the IAEA soon ran into delays — sometimes inordinately long — in applying even previously agreed safeguards because of difficulties in obtaining acceptance of, or visas for, inspectors, especially those of 'unpopular' nationalities.

Under the 1971 NPT safeguards system (INFCIRC/153) and its standard subsidiary arrangements, the notice to be given in advance of each routine inspection was reduced to "at least 24 hours" for larger plants and stores containing plutonium or 5% or more high enriched uranium, and one week in other cases.[8] But the routine access of inspectors was further restricted. Except in the case of a special inspection, the inspector's access was confined to a limited number of strategic points in the nuclear plant, explicitly agreed to by the State, the operator and the IAEA, and listed in the 'facility attachment' to be drawn up for each plant.

Finally, in negotiating these facility attachments, the IAEA was eventually required to specify how much time, measured in person-days, the inspector would normally spend each year at the plant — in other words, the IAEA was required to specify its 'Actual Routine Inspection Effort', or ARIE, at the plant. Again, hardly "access at all times".

Paul Szasz has pointed to another example of a restrictive interpretation by the Board of Governors of the IAEA's statutory rights. Article XII.A.6 of the Statute authorizes the IAEA to designate inspectors "...after consultation with the State or States concerned..." In the Inspectors' Document this was taken to mean that the IAEA must ascertain whether the State 'accepts' the designation, and the State had the right to withdraw its acceptance at any time. In either case, if the State objected to the proposed designation, the Director General "shall propose an alternative designation..." In the 1971 system (INFCIRC/153), this requirement is subtly altered; the Agency must "...secure the consent of the State to the designation of Agency inspectors to that State."[9] In other words, the statutory term "after consultation with..." has come to mean "with the consent of..."

In practice, it would of course be difficult to secure the entry into a State of an inspector to whose designation the State had objected. Nonetheless, the relevant safeguards documents could have provided that if the State did not object within a specified period to an inspector whose appointment has been approved by the Board, its consent would be presumed. This is precisely the procedure that 'Programme 93 + 2' now seeks to secure.[10]

The Inspectors' Document and INFCIRC/153 thus (somewhat vicariously) accord to States the right to reject any individual inspector proposed by the Director General. In practice the problem turned out to be different, and considerably more serious. States adopted the practice of rejecting not simply an individual inspector but of making it clear in advance that they would not accept entire categories of inspectors if, for instance, the States of which they were nationals did not themselves accept IAEA safeguards, or were not a party to the NPT, or even if the inspectors were not fluent in Spanish. Often the reasons given for rejection (if any were given) cloaked an unstated political objection, such as the unwillingness of certain NATO States to accept inspectors from 'Socialist' countries, or the unwillingness of the rejecting State to accept inspectors from a country with which it had poor diplomatic relations.

In recent years the problem has become somewhat more manageable. With the expansion of the European Union and the end of the Cold War, many States no longer require visas for citizens of a broadening range of nationalities, or they grant visas without as much ado as in the past. Many governments have responded to Director General Blix's appeals to accept the designation of any staff member whose appointment as an inspector has been approved by the Board, and to waive visa requirements or to grant multiple entry visas. Nonetheless, the accreditation of inspectors and obtaining entry for them still present problems in several cases.

In 'Programme 93 + 2' the Secretariat has attempted to recover some of the ground lost during the negotiation of earlier safeguards systems, but it seems more difficult to restore eroded rights than to establish them unambiguously when the statute of a new verifying agency is being negotiated.

The negotiators of the Chemical Weapons Convention have taken account of the IAEA's more negative experiences. The Convention spells out in great detail the procedures that must be followed in verifying compliance with its provisions. In one important aspect it takes an approach quite different from that of the IAEA. States party to the Convention will have the right to require a 'challenge inspection' at any facility in another State party unless the executive council of the Organization for the Prohibition of Chemical Weapons (OPCW) rules by a majority of three quarters of its members that the request for the inspection is frivolous, abusive or outside the scope of the Convention.[11] The 'challenge' procedure, if ever used, is likely to be even more confrontational than that of the IAEA's 'special inspection', which would normally be initiated by the Director General rather than by a political entity.

Enforcement of compliance

Deliberate breaches of arms control treaties are rare, but in the case of the NPT two have occurred and more cannot be entirely ruled out. Ultimately the assurance provided by an international verification treaty like the NPT must depend on whether an effective mechanism exists for enforcing verification and for penalizing or reversing non-compliance. The IAEA itself has no mechanism for enforcing compliance with its agreements and only very limited ability to penalize non-compliance.[12] But the Board is required to report any non-compliance to all IAEA Member States and to the Security Council and General Assembly of the United Nations. The Council is the only organ in the United Nations system that has the authority to apply economic, political or military sanctions; hence it is in the Board's report to the Council and the consequent action that the Council takes that one must look for effective enforcement and possible sanctions.

As noted in Chapter 8, during the first 34 years of the Agency there were two instances when the IAEA was briefly unable to certify that no diversion had taken place. These resulted from Pakistani and Indian reluctance in

1981 to accept certain specified additional safeguards measures at CANDU type reactors. These additional safeguards were not specified in the original safeguards agreement, and neither the Board nor the Director General treated these cases as breaches of a safeguards agreement; hence the question of enforcing compliance did not arise and in both cases the problem was soon resolved.

The IAEA's first formal determination of non-compliance with a safeguards agreement was made in 1991 when the Board found and reported to the Security Council that Iraq had breached its NPT safeguards agreement. But the case was unique. Iraq was already the target of stringent sanctions because of its invasion of Kuwait, and the rigorous measures that the Council asked the IAEA to take to eliminate Iraq's nuclear potential were quite exceptional.

We have noted that on 31 January 1992, the President of the Security Council, which was then meeting at the level of heads of State or government, declared on behalf of the Council's members that "the proliferation of all weapons of mass destruction constitutes a threat to international peace and security" and that they would take "appropriate measures in the case of any violations notified to them by the Agency." In a sense this commitment was put to the test on 1 April 1993, when the Board told the Security Council that the DPRK was in breach of its safeguards agreement. The Council did put some pressure on the DPRK, but it stopped short of attempting to apply sanctions, probably expecting that China would veto such a step and perhaps fearing a violent reaction from the DPRK.[13] In the end, as we have seen, the issue was laid to rest, at least for the time being, by the conclusion of the 1994 "Agreed Framework" between the USA and the DPRK.[14] Nonetheless, the DPRK is still in violation of its safeguards agreement and will remain so until the IAEA is able to verify the completeness of the DPRK's Initial Report.

What lessons can be learned from the Iraqi and DPRK cases?

We discuss elsewhere the lessons for IAEA safeguards of Iraq's ability to carry out a clandestine nuclear weapon programme without being detected and what the IAEA has done to apply those lessons, for instance, in 'Programme 93 + 2'. One of the chief political lessons of the Iraqi case was that the risk of nuclear proliferation did not lie any longer in the large and complex nuclear programmes of the industrialized States (the focus of safeguards until the late 1970s), but in relatively small, clandestine or unsafeguarded programmes of nations located in regions of political tension. The chief technical lesson was that safeguards based only on accounting for nuclear materials in declared plants, and inspection access limited to previously agreed 'key measurement points', were unlikely to detect a clandestine programme and that it was crucial in such cases for the IAEA to have access to the results of national intelligence operations.

The IAEA's inspections, and the difficulties it encountered in carrying out those inspections, remain crucial in assessing whether Iraq and the DPRK are in compliance with their nuclear commitments (in the case of Iraq, under the Security Council's resolutions; in the case of the DPRK, its safeguards agreement with the IAEA and the "Agreed Framework"). Both cases also confirmed the inability of the IAEA, *acting on its own,* to apply any significant pressure on a non-compliant State — it would have been unrealistic to expect otherwise. The IAEA cut off technical assistance to Iraq at the behest of the Security Council; when it withheld technical assistance from the DPRK, the latter simply withdrew from membership in the Agency.[15] In both cases the sanctions prescribed in the IAEA's Statute were largely irrelevant and both cases confirmed, as the negotiators of the Statute had foreseen, that the IAEA would have to turn to the Security Council if it was not able to apply effective safeguards. All international verification agencies (currently the IAEA, the OPCW and the Comprehensive Test Ban Treaty Organization), as well as the regional bodies so far established to oversee nuclear weapon free zones, will also ultimately depend on the Council for effective enforcement of their rights.

The case of the DPRK suggests that it might be desirable for the members of the Council to state more authoritatively than they did on 31 January 1992, perhaps in a formal resolution of the Council, what action the latter would take in the event of a breach of a safeguards or verification agreement and, possibly, to negotiate a legally binding international agreement on this matter. But the prospects for such an agreement are poor. States are reluctant to specify in advance what they will do in a hypothetical future crisis. This is an inherent deficiency of any security system created by nation States whose actions reflect changing perceptions of where their interests lie.

Nuclear safety

There is no obvious reason why the Statute did not require members to accept IAEA safety standards once they had been established. There was relatively little discussion of the matter in Washington or at the Conference on the Statute.[16] As noted in Chapter 7, it was tacitly assumed that the conclusion of Agency project agreements would lead to the widespread application of mandatory IAEA safety standards. The Prepcom foresaw the recruitment of safety inspectors and the first health and safety measures, including 'Safety Standards' approved by the Board on 31 March 1960, authorized the Agency to carry out no more than two inspections a year of certain categories of 'assisted operations'.[17]

In the early 1960s, the nations operating major nuclear programmes took a different tack, insisting that nuclear safety was primarily a national responsibility, and often resisting any extension of the IAEA's role.[18] That governments are responsible for the safety of their citizens in the nuclear as in other fields is indisputable. However, the contrast between national attitudes to international regulation of the safety of air or sea transport and of nuclear safety is striking. In the instruments establishing the International Civil Aviation Organization and the International Maritime Organization, it was agreed that these organizations should have responsibility for making binding regulations and drawing up conventions.

There have also been numerous demonstrations — besides Chernobyl — of the international repercussions on safety and the environment of national nuclear policies and decisions. From time to time it has been suggested that nuclear safety would benefit, and public confidence would be enhanced, if the IAEA were to supervise the application of nuclear safety and waste management standards, for instance if governments were required to report to the IAEA periodically on how they are applying the IAEA's standards. Some proposals have gone further — for instance, it has been suggested that IAEA safety inspectors might verify such reports and monitor the performance of national regulatory authorities.

The 'Convention on Nuclear Safety', which came into effect on 24 October 1996, takes the international verification of adequate nuclear safety an important step forward by requiring the parties to hold periodic review meetings to which each party must submit "a report on the measures it has taken to implement each of the obligations of this convention," and by requiring the parties to attend these meetings. Although the negotiators of the Convention rejected proposals to give the IAEA a role in verifying its application, they did appoint the IAEA as Secretariat of its meetings. This should enable the IAEA to see how effectively the Convention is working and may provide the possibility of proposing ways of achieving its objectives.

Technical co-operation

As noted, technical assistance or co-operation has evolved over the years from a programme designed chiefly to support the then nascent nuclear energy establishments of the developing countries to one that has been able to provide direct and tangible benefits to major sectors of the national economy. It has moved from a programme of unrelated projects drawn up chiefly by the recipient government to one that focuses on a more limited number of projects, often backed up by the IAEA's support of research and by the work of the IAEA's laboratories.

One problem that remains unresolved after 40 years is that of ensuring that the programme has a more stable and predictable source of finance than the traditional haggling over the size of the annual target for contributions and the often unheeded appeal to States to meet the target set. In the current climate it seems unlikely that the target will continue indefinitely to increase. The problem may become one of stability in real terms rather than growth.

The Secretariat, the Board of Governors and the General Conference

The major decisions of the Board and the General Conference on political issues, including the appointment of the Director General, are shaped by forces and events over which the Secretariat has little or no influence. But by continuing to build up a tradition of professionalism, dependability and impartiality the Secretariat can influence the decisions of the IAEA's Governing Bodies, in particular the extent to which the IAEA is entrusted with responsibilities relating to safeguards, nuclear arms control and disarmament. The confidence that the States concerned had gained in the work of the IAEA's staff was one of the main reasons why they entrusted it with the task of verifying compliance with crucial obligations that States accept under the NPT.

As the saying goes, each Governing Body is master of its own proceedings. But the Secretariat can give (and has given) the lead in helping to streamline the procedures of the Governing Body, for instance in reducing the length of its meetings — in the case of the General Conference to five working days — and in eliminating unnecessary paper (for instance, scrapping the provisional records of debates).[19] It may be heresy to suggest that further progress could be made towards using English as the sole working language, at least of the committees of both bodies, as it is of the informal working groups. Budgetary constraints and the increasing demand by Member States for savings are leading in that direction. Thus, fewer information documents are now being translated. The main barrier is concern about prestige. The vast majority of delegations to both bodies have to use a language — almost always English — that is not their own, and they do so very effectively, be they from Pakistan, India, Sweden, Germany, Brazil, Egypt, Zimbabwe or Japan. The painful example of the European Union, where documents have to be translated into a dozen languages, might serve as an encouragement to proceed in the opposite direction and thereby set an example to other international and regional bodies.

The IAEA's role in the verification of arms control agreements

During the Washington talks in 1954–1956, interested US agencies debated the scope of the IAEA's future activities and proposals were made to assign it various roles in direct support of nuclear disarmament. Little came of those proposals at the time. However, the Statute did incorporate a requirement that the IAEA, in carrying out its functions, should "conduct its activities...in conformity with policies of the United Nations furthering the establishment of safeguarded worldwide disarmament and in conformity with any international agreements entered into pursuant to such policies."[20] The only universal agreement directly affecting the IAEA that has so far been concluded is the NPT itself which, in Article VI, calls for the negotiation 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 international control." If an international agreement on further nuclear disarmament is concluded and if it were to assign a verificatory role to the IAEA, it appears that the above-quoted provision of the Statute would authorize, and may even require, the IAEA to discharge that role.

The introduction to this book refers to the change that has taken place in the position of the nuclear weapon States regarding the IAEA's involvement in certain aspects of the military uses of nuclear energy. For many years the Western nuclear weapon States vigorously opposed any such involvement, for instance in the monitoring of fallout or in assessing the effects of nuclear weapon tests on human health, responsibility for which, as noted in Chapter 3, was given to UNSCEAR. The Western position was to some extent a reflection of Cold War controversies. The Soviet Union was often prepared to raise issues relating to the nuclear arms race and nuclear testing in the IAEA's Governing Bodies, particularly the General Conference, while Western Governments insisted that the place to discuss such issues was New York or Geneva.

In recent years the IAEA's involvement in assessing the health hazards of previous military activities, verifying the cessation of military nuclear programmes and overseeing nuclear material of military origin has become quite uncontroversial. For instance, at the request of the Government of the Marshall Islands, the IAEA ascertained whether it would be safe for the people of Bikini Atoll to return home.[21] As mentioned elsewhere, assessments of radiological contamination have been made at the Semipalatinsk nuclear test site in Kazakstan, of the Kara Sea and of the Mururoa and Fangataufa Atolls in the South Pacific. IAEA inspectors verified that the South African nuclear weapon programme had been terminated.[22]

Neither the IAEA nor any other international body has played or plays any role in the negotiation or verification of the major treaties between what were termed the 'superpowers', and that place a cap on their nuclear arsenals or require their reduction.[23] The view of the nuclear weapon States appears to be that the IAEA's role in promoting international security is to verify that there is no further spread of nuclear weapons. More recently, they have endorsed another role for the IAEA, namely to verify (as it has been doing since 1991 in South Africa, and since 1996 in the USA, and will be doing in Russia) that nuclear material withdrawn from military use is permanently removed from any military activity. When it comes to the dismantling of nuclear arsenals, however, verification of the actual process is a task that, until now, has been undertaken jointly by the nuclear weapon States themselves, in accordance with bilateral arrangements such as the Intermediate-Range Nuclear Forces Treaty and Strategic Arms Reduction Talks.[24] Issues of national survival were involved, and the stakes for the parties were too high to entrust the Board of Governors of the IAEA, or the Security Council, or the executive organ of any other international organization — which at any time can be distracted by other unrelated issues — to bear the responsibility for verifying that the parties are not clandestinely violating the treaty.

This is an issue that will have to be faced on a regional level if it becomes possible to create a nuclear weapon free zone, or a zone free of weapons of mass destruction in the Middle East and South Asia. A combination of regional and multilateral verification may have to be devised.

Even if the IAEA cannot be directly involved in the dismantling of nuclear weapons, it is well within its capacity to verify the peaceful storage and use (or closure or disposal) of the plants and material that would become subject to verification as a result of a fissile material cut-off convention.[25]

The fundamental dichotomy

From the start the main problem that the IAEA has had to face has not resulted from the East/West or the North/South divide, nor the IAEA's inability to develop its supply function, nor the decline since the mid-1970s in the prospects for nuclear power. It has been the inherent difficulty of serving the interests of both nuclear and non-nuclear-weapon States in a world in which the former have usually taken the lead.

The Agency had to accommodate this reality. But it meant at first that the IAEA would become the instrument for applying safeguards to nuclear plants and material supplied chiefly by nuclear weapon States to non-nuclear-weapon States. The NPT formalized the discrimination between the two groups. The sense of discrimination felt by the developing countries may have increased as the focus of concern about proliferation ceased to be Germany and Japan and moved to the developing regions. As a consequence, many of the IAEA's promotional programmes were seen by both donors and recipients as a means of making IAEA safeguards more palatable — in other words, as a means of sugaring the pill, and this impression was strengthened by the decisions of the mid-1970s to cap (and later to 'shield') the financial contributions of poorer countries to the safeguards budget.[26]

However, as time passed more of the non-nuclear-weapon States in both the industrialized world and amongst the G-77 have perceived that stopping the further spread of nuclear weapons was in their own interest and have acceded to the NPT, despite its discriminatory character. G-77 nations have also established, perhaps with more enthusiasm, nuclear weapon free zones, in other words zones in which no State was permitted to possess or test nuclear weapons. The 1995 decision to make the NPT permanent reflected a near consensus that all nations benefit from stopping proliferation, but one may doubt whether this decision would have been taken — or would have been taken without a dissenting vote — if the Cold War had not ended and if the nuclear weapon States had not made major reductions in their nuclear arsenals, promised more, and committed themselves to stop nuclear testing.[27]

Today the risk that nuclear weapons would come into the hands of additional nations seems smaller than at any time since 1945. The grim warnings of President Kennedy, H.G. Wells, C.P. Snow, Albert Wohlstetter and many others about the prospects of runaway proliferation have not been fulfilled. One US political scientist went so far as to write in 1980 that "…any suggestion that further proliferation can be stopped borders on the absurd."[28] Since 1985, the number of nuclear weapon States and nations regarded as 'threshold States' has decreased from 11 to 8,[29] since Argentina, Brazil and South Africa renounced the bomb. The entire southern hemisphere is on the point of becoming a nuclear weapon free zone. During the last ten years the number of effective zones of this kind has grown from one (the Antarctic) to five (the Tlatelolco, Rarotonga, Pelindaba, Bangkok and Antarctic Treaties).[30] The risk of proliferation in North East Asia (the DPRK) and the Middle East (Iraq) and in the former USSR has been contained, probably for the indefinite future in the case of the non-nuclear-weapon States that were formerly parts of the USSR. The NPT is now permanent and nearly all nations have joined it — more than 40 since 1990 (though the prospects of bringing in India, Israel and Pakistan still seem small). The nuclear suppliers' regime, though unpopular with many, is more effective than before 1989 and much more effective than before 1970. IAEA safeguards have proved to be effective in plants that contain declared nuclear material and are being strengthened to detect undeclared plants, material and nuclear activities.

In the 1950s and 1960s it could be said that as soon as a nation could make the bomb, it did so.[31] The remarkable progress made since then in halting and even reversing proliferation has been achieved at a time when nuclear technology was spreading around the world and when the purely technical constraints on nuclear proliferation were steadily eroding. For the most part, the progress was due to changes in political perceptions and to events on which the IAEA had little direct influence. Nonetheless, IAEA safeguards provided the means whereby States that had renounced nuclear weapons could demonstrate their renunciation and the IAEA's work has contributed substantially to the international security and confidence that are indispensable for stopping nuclear proliferation and for nuclear arms control.

In the long term, however, the viability of the regime of which the IAEA is the chief operational arm will depend not only on the efficacy of measures of non-proliferation. Its viability will also depend to a far greater extent on reducing and eventually eliminating the gap between the nuclear 'haves' and the 'have-nots'; in other words, on proceeding "with all deliberate speed" down the path of nuclear disarmament. This, above all, was the message of the 1995 NPT Review and Extension Conference.

NOTES

1 For example, Articles III.A.7, III.B.2, IX, X.C, XI.F and XIV.B.2 of the *IAEA Statute*.

2 *IAEA Statute*, Article III.A.6.

3 *IAEA Statute*, Articles III.A.5 and XII.

4 NYE, J., "Maintaining a non-proliferation regime", in QUESTER, G. (Ed.), *Nuclear Proliferation: Breaking the Chain*, University of Wisconsin Press, Madison, WI (1981) 36.

5 *IAEA Statute*, Article XII.A.6.

6 *IAEA Statute*, Article XI.F.4 relating to Agency projects provides that "the relevant safeguards [be]...specified in the [project] agreement."

7 Document GC(V)INF/39, Annex, paras II.4 and II.5.

8 Document INFCIRC/153, para. 83(c).

9 SZASZ, P.C., "IAEA Safeguards for NPT", *RECFIEL* **5** 3 (September 1996) 241. See also "The Agency's Inspectors", Annex to GC(V)/INF/39, paras I.1. and I.2, and INFCIRC/153, para. 9.

10 Document GOV/2914, Article 11.

11 Under the Comprehensive Test Ban Treaty (CTBT), on-site inspections are likely to be extremely infrequent, and they would only take place if a State had convincing reasons to believe that another party had carried out a nuclear test. They would thus be of a quite different character from the routine inspections of the IAEA and of the OPCW, which are designed to verify that a prohibited activity is not taking place rather than to check a suspicious event, and the procedures for triggering such inspections are complicated. If CTBT inspections do take place they will normally be at the request of a State party, and hence — as in the case of Chemical Weapons Convention challenge inspections and the IAEA's special inspections — will be highly confrontational. In a sense the inspections foreseen in the CTBT mark a retrograde step; in the case of the IAEA, inspections are not only frequent and routine, but are initiated by the Secretariat (which decides, within previously agreed limits, when and where routine inspections will take place) and not by the Board of Governors or by a Member State.

12 The Board may stop all assistance to the non-compliant State, call for the return of any material or equipment supplied to that State and suspend it from exercising the

privileges and rights of membership. These somewhat nominal sanctions are unlikely to deter a nation that believes its security will be eroded *unless* it breaches the Treaty.

13 There is little doubt that, behind the scenes, a good deal of pressure was applied, by Japan as well as China, to persuade the DPRK to freeze and eventually abandon its suspect programme.

14 Some have argued that the "Agreed Framework" rewards rather than penalizes the DPRK for being in breach of IAEA safeguards — see Chapter 8.

15 In the case of Iraq the IAEA cut off technical assistance at the request of the Security Council rather than as a sanction under Article XII.A.5 of the Statute.

16 The negotiators could have attached to such a requirement whatever conditions were needed to protect their own interests, for instance, the Statute could have required the establishment within the IAEA of an intergovernmental nuclear safety committee for setting such standards, on which the States operating significant nuclear programmes automatically would have been represented.

17 Document INFCIRC/18, p. 7, para. 31.

18 In this case the situation is not comparable with nuclear safeguards where *the IAEA* has international responsibility for applying effective safeguards, and would be held accountable if there was a significant diversion of safeguarded material.

19 Until recently, the summary records of discussions in the Board and General Conference were first issued in provisional form and later, after delegations had been given an opportunity to correct them (or to 'improve' them), re-issued in final form. This lengthy and somewhat wasteful procedure has been replaced by a single final issue of each summary record; any corrections that delegations may make are circulated separately.

20 *IAEA Statute*, Article III.B.1.

21 The IAEA panel set up for this purpose, which included experts from France, Russia, the United Kingdom and the USA, as well as Australia, Japan and New Zealand and a delegation from Bikini Atoll, concluded that if precautions were taken to reduce radioactivity in local crops, returning to Bikini would be safe. (*Annual Report for 1995*, GC(40)/8, IAEA, Vienna (1996), p. 3, Box 2.)

22 The IAEA inspectors visited the plants where the weapons had been made as well as the (unused) test site itself. The IAEA has also advised the Estonian Government on measures for the safe dismantling of a land based naval reactor formerly used by the USSR for training.

23 In the case of the NPT, the IAEA was simply assigned a verification role without being consulted beforehand (and only after the US/Soviet differences about the safeguards role of EURATOM had been settled).

[24] Although, in the very different circumstances of South Africa, the nuclear arsenal was dismantled in secrecy by the State itself and the Agency was later invited to examine what was left behind by an abandoned nuclear weapon programme.

[25] An agreement that the verification of a nuclear weapon free zone in the Middle East should be undertaken jointly by a regional safeguards authority and by the IAEA would also set a precedent for monitoring other significant regional or even global nuclear disarmament agreements.

[26] The matter is to be reviewed before the year 2000.

[27] A commitment more honoured in the breach than in the observance in 1995, but now, apparently, accepted as binding by the nuclear weapon States.

[28] WELTMAN, J.J., "Nuclear revolution and world order", *World Politics* **XXXII** (January 1980) 192, quoted in QUESTER, G.H., *Nuclear Proliferation: Breaking the Chain*, p. 15, footnote 1.

[29] The five 'official' nuclear weapon States, and India, Israel and Pakistan.

[30] The Treaties of Rarotonga and Tlatelolco were in force, or partially in force, in 1985, but without much real effect since the Western nuclear weapon States refused to sign the protocols under which they would undertake to respect the nuclear weapon free status of the South Pacific and to refrain from testing in the region (in fact, France continued to test), while Argentina, Brazil and Chile were not prepared to bring the Tlatelolco Treaty into force in their countries. As noted elsewhere, the situation is now completely different.

[31] With the striking exception of Canada.

Annex 1

STATUTE OF THE INTERNATIONAL ATOMIC ENERGY AGENCY

The Statute was approved on 23 October 1956 by the Conference on the Statute of the International Atomic Energy Agency, which was held at the Headquarters of the United Nations. It came into force on 29 July 1957, upon the fulfilment of the relevant provisions of paragraph E of Article XXI.

The Statute has been amended three times, by application of the procedure laid down in paragraphs A and C of Article XVIII. On 31 January 1963 some amendments to the first sentence of the then paragraph A.3 of Article VI came into force; the Statute as thus amended was further amended on 1 June 1973 by the coming into force of a number of amendments to paragraphs A to D of the same Article (involving a renumbering of sub-paragraphs in paragraph A); and on 28 December 1989 an amendment in the introductory part of paragraph A.1 came into force. All these amendments have been incorporated into the present text.

STATUTE

ARTICLE I *Establishment of the Agency*

The Parties hereto establish an International Atomic Energy Agency (hereinafter referred to as "the Agency") upon the terms and conditions hereinafter set forth.

ARTICLE II *Objectives*

The Agency shall seek to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world. It shall ensure, so far as it is able, that assistance provided by it or at its request or under its supervision or control is not used in such a way as to further any military purpose.

ARTICLE III *Functions*

A. The Agency is authorized:

1. To encourage and assist research on, and development and practical application of, atomic energy for peaceful uses throughout the world; and, if requested to do so, to act as an intermediary for the purposes of securing the performance of services or the supplying of materials, equipment, or facilities by one member of the Agency for another; and to perform any operation or service useful in research on, or development or practical application of, atomic energy for peaceful purposes;

2. To make provision, in accordance with this Statute, for materials, services, equipment, and facilities to meet the needs of research on, and development and practical application of, atomic energy for peaceful purposes, including the production of electric power, with due consideration for the needs of the under-developed areas of the world;

3. To foster the exchange of scientific and technical information on peaceful uses of atomic energy;

4. To encourage the exchange and training of scientists and experts in the field of peaceful uses of atomic energy;

5. To establish and administer safeguards designed to ensure that special fissionable and other materials, services, equipment, facilities, and information made available by the Agency or at its request or under its supervision or control are not used in such a way as to further any military purpose; and to apply safeguards, at the request of the parties, to any bilateral or multilateral arrangement, or at the request of a State, to any of that State's activities in the field of atomic energy;

6. To establish or adopt, in consultation and, where appropriate, in collaboration with the competent organs of the United Nations and with the specialized agencies concerned, standards of safety for protection of health and minimization of danger to life and property (including such standards for labour conditions), and to provide for the application of these standards to its own operations as well as to the operations making use of materials, services, equipment, facilities, and information made available by the Agency or at its request or under its control or supervision; and to provide for the application of these standards, at the request of the parties, to operations under any bilateral or multilateral arrangements, or, at the request of a State, to any of that State's activities in the field of atomic energy;

7. To acquire or establish any facilities, plant and equipment useful in carrying out its authorized functions, whenever the facilities, plant, and equipment otherwise available to it in the area concerned are inadequate or available only on terms it deems unsatisfactory.

B. In carrying out its functions, the Agency shall:

1. Conduct its activities in accordance with the purposes and principles of the United Nations to promote peace and international co-operation, and in conformity with policies of the United Nations furthering the establishment of safeguarded worldwide disarmament and in conformity with any international agreements entered into pursuant to such policies;

2. Establish control over the use of special fissionable materials received by the Agency, in order to ensure that these materials are used only for peaceful purposes;

3. Allocate its resources in such a manner as to secure efficient utilization and the greatest possible general benefit in all areas of the world, bearing in mind the special needs of the under-developed areas of the world;

4. Submit reports on its activities annually to the General Assembly of the United Nations and, when appropriate, to the Security Council: if in connexion with the activities of the Agency there should arise questions that are within the competence of the Security Council, the Agency shall notify the Security Council, as the organ bearing the main responsibility for the maintenance of international peace and security, and may also take the measures open to it under this Statute, including those provided in paragraph C of article XII;

5. Submit reports to the Economic and Social Council and other organs of the United Nations on matters within the competence of these organs.

C. In carrying out its functions, the Agency shall not make assistance to members subject to any political, economic, military, or other conditions incompatible with the provisions of this Statute.

D. Subject to the provisions of this Statute and to the terms of agreements concluded between a State or a group of States and the Agency which shall be in accordance with the provisions of the Statute, the activities of the Agency shall be carried out with due observance of the sovereign rights of States.

ARTICLE IV *Membership*

A. The initial members of the Agency shall be those States Members of the United Nations or of any of the specialized agencies which shall have signed this Statute within ninety days after it is opened for signature and shall have deposited an instrument of ratification.

B. Other members of the Agency shall be those States, whether or not Members of the United Nations or of any of the specialized agencies, which deposit an instrument of acceptance of this Statute after their membership has been approved by the General Conference upon the recommendation of the Board of Governors. In recommending and approving a State for membership, the Board of Governors and the General Conference shall determine that the State is able and willing to carry out the obligations of membership in the Agency, giving due consideration to its ability and willingness to act in accordance with the purposes and principles of the Charter of the United Nations.

C. The Agency is based on the principle of the sovereign equality of all its members, and all members, in order to ensure to all of them the rights and benefits resulting from membership, shall fulfil in good faith the obligation assumed by them in accordance with this Statute.

ARTICLE V *General Conference*

A. A General Conference consisting of representatives of all members shall meet in regular annual session and in such special sessions as shall be convened by the Director General at the request of the Board of Governors or of a majority of members. The sessions shall take place at the headquarters of the Agency unless otherwise determined by the General Conference.

B. At such sessions, each member shall be represented by one delegate who may be accompanied by alternates and by advisers. The cost of attendance of any delegation shall be borne by the member concerned.

C. The General Conference shall elect a President and such other officers as may be required at the beginning of each session. They shall hold office for the duration of the session. The General Conference, subject to the provisions of this Statute, shall adopt its own rules of procedure. Each member shall have one vote. Decisions pursuant to paragraph H of article XIV, paragraph C of article XVIII and paragraph B of article XIX shall be made by a two-thirds majority of the members present and voting. Decisions on other questions, including the determination of additional questions or categories of questions to be decided by a two-thirds majority, shall be made by a majority of the members present and voting. A majority of members shall constitute a quorum.

D. The General Conference may discuss any questions or any matters within the scope of this Statute or relating to the powers and functions of any organs provided for in this Statute, and may make recommendations to the membership of the Agency or to the Board of Governors or to both on any such questions or matters.

E. The General Conference shall:

1. Elect members of the Board of Governors in accordance with article VI;
2. Approve States for membership in accordance with article IV;
3. Suspend a member from the privileges and rights of membership in accordance with article XIX;
4. Consider the annual report of the Board;
5. In accordance with article XIV, approve the budget of the Agency recommended by the Board or return it with recommendations as to its entirety or parts to the Board, for resubmission to the General Conference;
6. Approve reports to be submitted to the United Nations as required by the relationship agreement between the Agency and the United Nations, except reports referred to in paragraph C of article XII, or return them to the Board with its recommendations;
7. Approve any agreement or agreements between the Agency and the United Nations and other organizations as provided in article XVI or return such agreements with its recommendations to the Board, for resubmission to the General Conference;
8. Approve rules and limitations regarding the exercise of borrowing powers by the Board, in accordance with paragraph G of article XIV; approve rules regarding the acceptance of voluntary contributions to the Agency; and approve, in accordance with paragraph F of article XIV, the manner in which the general fund referred to in that paragraph may be used;
9. Approve amendments to this Statute in accordance with paragraph C of article XVIII;

10. Approve the appointment of the Director General in accordance with paragraph A of article VII.

F. The General Conference shall have the authority:

1. To take decisions on any matter specifically referred to the General Conference for this purpose by the Board;

2. To propose matters for consideration by the Board and request from the Board reports on any matter relating to the functions of the Agency.

ARTICLE VI *Board of Governors*

A. The Board of Governors shall be composed as follows:

1. The outgoing Board of Governors shall designate for membership on the Board the ten members most advanced in the technology of atomic energy including the production of source materials, and the member most advanced in the technology of atomic energy including the production of source materials in each of the following areas in which none of the aforesaid ten is located:

(1) North America
(2) Latin America
(3) Western Europe
(4) Eastern Europe
(5) Africa
(6) Middle East and South Asia
(7) South East Asia and the Pacific
(8) Far East.

2. The General Conference shall elect to membership of the Board of Governors:

(a) Twenty members, with due regard to equitable representation on the Board as a whole of the members in the areas listed in sub-paragraph A.1 of this article, so that the Board shall at all times include in this category five representatives of the area of Latin America, four representatives of the area of Western Europe, three representatives of the area of Eastern Europe, four representatives of the area of Africa, two representatives of the area of the Middle East and South

Asia, one representative of the area of South East Asia and the Pacific, and one representative of the area of the Far East. No member in this category in any one term of office will be eligible for re-election in the same category for the following term of office; and

(b) One further member from among the members in the following areas:
Middle East and South Asia,
South East Asia and the Pacific,
Far East;

(c) One further member from among the members in the following areas:
Africa,
Middle East and South Asia,
South East Asia and the Pacific.

B. The designations provided for in sub-paragraph A-l of this article shall take place not less than sixty days before each regular annual session of the General Conference. The elections provided for in sub-paragraph A-2 of this article shall take place at regular annual sessions of the General Conference.

C. Members represented on the Board of Governors in accordance with sub-paragraph A-l of this article shall hold office from the end of the next regular annual session of the General Conference after their designation until the end of the following regular annual session of the General Conference.

D. Members represented on the Board of Governors in accordance with sub-paragraph A-2 of this article shall hold office from the end of the regular annual session of the General Conference at which they are elected until the end of the second regular annual session of the General Conference thereafter.

E. Each member of the Board of Governors shall have one vote. Decisions on the amount of the Agency's budget shall be made by a two-thirds majority of those present and voting, as provided in paragraph H of article XIV. Decisions on other questions, including the determination of additional questions or categories of questions to be decided by a two-thirds majority, shall be made by a majority of those present and voting. Two-thirds of all members of the Board shall constitute a quorum.

F. The Board of Governors shall have authority to carry out the functions of the Agency in accordance with this Statute, subject to its responsibilities to the General Conference as provided in this Statute.

G. The Board of Governors shall meet at such times as it may determine. The meetings shall take place at the headquarters of the Agency unless otherwise determined by the Board.

H. The Board of Governors shall elect a Chairman and other officers from among its members and, subject to the provisions of this Statute, shall adopt its own rules of procedure.

I. The Board of Governors may establish such committees as it deems advisable. The Board may appoint persons to represent it in its relations with other organizations.

J. The Board of Governors shall prepare an annual report to the General Conference concerning the affairs of the Agency and any projects approved by the Agency. The Board shall also prepare for submission to the General Conference such reports as the Agency is or may be required to make to the United Nations or to any other organization the work of which is related to that of the Agency. These reports, along with the annual reports, shall be submitted to members of the Agency at least one month before the regular annual session of the General Conference.

ARTICLE VII *Staff*

A. The staff of the Agency shall be headed by a Director General. The Director General shall be appointed by the Board of Governors with the approval of the General Conference for a term of four years. He shall be the chief administrative officer of the Agency.

B. The Director General shall be responsible for the appointment, organization, and functioning of the staff and shall be under the authority of and subject to the control of the Board of Governors. He shall perform his duties in accordance with regulations adopted by the Board.

C. The staff shall include such qualified scientific and technical and other personnel as may be required to fulfil the objectives and functions of the Agency. The Agency shall be guided by the principle that its permanent staff shall be kept to a minimum.

D. The paramount consideration in the recruitment and employment of the staff and in the determination of the conditions of service shall be to secure employees of the highest standards of efficiency, technical competence, and integrity. Subject to this consideration, due regard shall be paid to the contributions of members to the Agency and to the importance of recruiting the staff on as wide a geographical basis as possible.

E. The terms and conditions on which the staff shall be appointed, remunerated, and dismissed shall be in accordance with regulations made by the Board of Governors, subject to the provisions of this Statute and to general rules approved by the General Conference on the recommendation of the Board.

F. In the performance of their duties, the Director General and the staff shall not seek or receive instructions from any source external to the Agency. They shall refrain from any action which might reflect on their position as officials of the Agency; subject to their responsibilities to the Agency, they shall not disclose any industrial secret or other confidential information coming to their knowledge by reason of their official duties for the Agency. Each member undertakes to respect the international character of the responsibilities of the Director General and the staff and shall not seek to influence them in the discharge of their duties.

G. In this article the term "staff" includes guards.

ARTICLE VIII *Exchange of information*

A. Each member should make available such information as would, in the judgement of the member, be helpful to the Agency .

B. Each member shall make available to the Agency all scientific information developed as a result of assistance extended by the Agency pursuant to article XI.

C. The Agency shall assemble and make available in an accessible form the information made available to it under paragraphs A and B of this article. It shall take positive steps to encourage the exchange among its members of information relating to the nature and peaceful uses of atomic energy and shall serve as an intermediary among its members for this purpose.

ARTICLE IX *Supplying of materials*

A. Members may make available to the Agency such quantities of special fissionable materials as they deem advisable and on such terms as shall be agreed with the

Agency. The materials made available to the Agency may, at the discretion of the member making them available, be stored either by the member concerned or, with the agreement of the Agency, in the Agency's depots.

B. Members may also make available to the Agency source materials as defined in article XX and other materials. The Board of Governors shall determine the quantities of such materials which the Agency will accept under agreements provided for in article XIII.

C. Each member shall notify the Agency of the quantities, form, and composition of special fissionable materials, source materials, and other materials which that member is prepared, in conformity with its laws, to make available immediately or during a period specified by the Board of Governors.

D. On request of the Agency a member shall, from the materials which it has made available, without delay deliver to another member or group of members such quantities of such materials as the Agency may specify, and shall without delay deliver to the Agency itself such quantities of such materials as are really necessary for operations and scientific research in the facilities of the Agency.

E. The quantities, form and composition of materials made available by any member may be changed at any time by the member with the approval of the Board of Governors.

F. An initial notification in accordance with paragraph C of this article shall be made within three months of the entry into force of this Statute with respect to the member concerned. In the absence of a contrary decision of the Board of Governors, the materials initially made available shall be for the period of the calendar year succeeding the year when this Statute takes effect with respect to the member concerned. Subsequent notifications shall likewise, in the absence of a contrary action by the Board, relate to the period of the calendar year following the notification and shall be made no later than the first day of November of each year.

G. The Agency shall specify the place and method of delivery and, where appropriate, the form and composition, of materials which it has requested a member to deliver from the amounts which that member has notified the Agency it is prepared to make available. The Agency shall also verify the quantities of materials delivered and shall report those quantities periodically to the members.

H. The Agency shall be responsible for storing and protecting materials in its possession. The Agency shall ensure that these materials shall be safeguarded against (1) hazards of the weather, (2) unauthorized removal or diversion, (3) damage or destruction, including sabotage, and (4) forcible seizure. In storing special fissionable materials in its possession, the Agency shall ensure the geographical distribution of these materials in such a way as not to allow concentration of large amounts of such materials in any one country or region of the world.

I. The Agency shall as soon as practicable establish or acquire such of the following as may be necessary:

1. Plant, equipment, and facilities for the receipt, storage, and issue of materials;
2. Physical safeguards;
3. Adequate health and safety measures;
4. Control laboratories for the analysis and verification of materials received;
5. Housing and administrative facilities for any staff required for the foregoing.

J. The materials made available pursuant to this article shall be used as determined by the Board of Governors in accordance with the provisions of this Statute. No member shall have the right to require that the materials it makes available to the Agency be kept separately by the Agency or to designate the specific project in which they must be used.

ARTICLE X *Services, equipment, and facilities*

Members may make available to the Agency services, equipment, and facilities which may be of assistance in fulfilling the Agency's objectives and functions.

ARTICLE XI *Agency projects*

A. Any member or group of members of the Agency desiring to set up any project for research on, or development or practical application of, atomic energy for peaceful purposes may request the assistance of the Agency in securing special fissionable and other materials, services, equipment, and facilities necessary for this purpose. Any such request shall be accompanied by an explanation of the purpose and extent of the project and shall be considered by the Board of Governors.

B. Upon request, the Agency may also assist any member or group of members to make arrangements to secure necessary financing from outside sources to carry out such projects. In extending this assistance, the Agency will not be required to provide any guarantees or to assume any financial responsibility for the project.

C. The Agency may arrange for the supplying of any materials, services, equipment, and facilities necessary for the project by one or more members or may itself undertake to provide any or all of these directly, taking into consideration the wishes of the member or members making the request.

D. For the purpose of considering the request, the Agency may send into the territory of the member or group of members making the request a person or persons qualified to examine the project. For this purpose the Agency may, with the approval of the member or group of members making the request, use members of its own staff or employ suitably qualified nationals of any member.

E. Before approving a project under this article, the Board of Governors shall give due consideration to:

1. The usefulness of the project, including its scientific and technical feasibility;

2. The adequacy of plans, funds, and technical personnel to assure the effective execution of the project;

3. The adequacy of proposed health and safety standards for handling and storing materials and for operating facilities;

4. The inability of the member or group of members making the request to secure the necessary finances, materials, facilities, equipment, and services;

5. The equitable distribution of materials and other resources available to the Agency;

6. The special needs of the under-developed areas of the world; and

7. Such other matters as may be relevant.

F. Upon approving a project, the Agency shall enter into an agreement with the member or group of members submitting the project, which agreement shall:

1. Provide for allocation to the project of any required special fissionable or other materials;

2. Provide for transfer of special fissionable materials from their then place of custody, whether the materials be in the custody of the Agency or of the member making them available for use in Agency projects, to the member or group of members submitting the project, under conditions which ensure the safety of any shipment required and meet applicable health and safety standards;

3. Set forth the terms and conditions, including charges, on which any materials, services, equipment, and facilities are to be provided by the Agency itself, and, if any such materials, services, equipment, and facilities are to be provided by a member, the terms and conditions as arranged for by the member or group of members submitting the project and the supplying member;

4. Include undertakings by the member or group of members submitting the project: (a) that the assistance provided shall not be used in such a way as to further any military purpose; and (b) that the project shall be subject to the safeguards provided for in article XII, the relevant safeguards being specified in the agreement;

5. Make appropriate provision regarding the rights and interests of the Agency and the member or members concerned in any inventions or discoveries, or any patents therein, arising from the project;

6. Make appropriate provision regarding settlement of disputes;

7. Include such other provisions as may be appropriate.

G. The provisions of this article shall also apply where appropriate to a request for materials, services, facilities, or equipment in connexion with an existing project.

ARTICLE XII *Agency safeguards*

A. With respect to any Agency project, or other arrangement where the Agency is requested by the parties concerned to apply safeguards, the Agency shall have the following rights and responsibilities to the extent relevant to the project or arrangement:

1. To examine the design of specialized equipment and facilities, including nuclear reactors, and to approve it only from the view-point of assuring that it will not further any military purpose, that it complies with applicable health and safety standards, and that it will permit effective application of the safeguards provided for in this article;

2. To require the observance of any health and safety measures prescribed by the Agency;

3. To require the maintenance and production of operating records to assist in ensuring accountability for source and special fissionable materials used or produced in the project or arrangement;

4. To call for and receive progress reports;

5. To approve the means to be used for the chemical processing of irradiated materials solely to ensure that this chemical processing will not lend itself to diversion of materials for military purposes and will comply with applicable health and safety standards; to require that special fissionable materials recovered or produced as a by-product be used for peaceful purposes under continuing Agency safeguards for research or in reactors, existing or under construction, specified by the member or members concerned; and to require deposit with the Agency of any excess of any special fissionable materials recovered or produced as a by-product over what is needed for the above-stated uses in order to prevent stockpiling of these materials, provided that thereafter at the request of the member or members concerned special fissionable materials so deposited with the Agency shall be returned promptly to the member or members concerned for use under the same provisions as stated above .

6. To send into the territory of the recipient State or States inspectors, designated by the Agency after consultation with the State or States concerned, who shall have access at all times to all places and data and to any person who by reason of his occupation deals with materials, equipment, or facilities which are required by this Statute to be safeguarded, as necessary to account for source and special fissionable materials supplied and fissionable products and to determine whether there is compliance with the undertaking against use in furtherance of any military purpose referred to in sub-paragraph F-4 of article XI, with the health and safety measures referred to in sub-paragraph A-2 of this article, and with any other conditions prescribed in the agreement between the Agency and the State or States concerned. Inspectors designated by the Agency shall be accompanied by representatives of the authorities of the State concerned, if that State so requests, provided that the inspectors shall not thereby be delayed or otherwise impeded in the exercise of their functions;

7. In the event of non-compliance and failure by the recipient State or States to take requested corrective steps within a reasonable time, to suspend or terminate assistance and withdraw any materials and equipment made available by the Agency or a member in furtherance of the project.

B. The Agency shall, as necessary, establish a staff of inspectors. The Staff of inspectors shall have the responsibility of examining all operations conducted by the Agency itself to determine whether the Agency is complying with the health and safety measures prescribed by it for application to projects subject to its approval, supervision or control, and whether the Agency is taking adequate measures to prevent the source and special fissionable materials in its custody or used or produced in its own operations from being used in furtherance of any military purpose. The Agency shall take remedial action forthwith to correct any non-compliance or failure to take adequate measures.

C. The staff of inspectors shall also have the responsibility of obtaining and verifying the accounting referred to in sub paragraph A-6 of this article and of determining whether there is compliance with the undertaking referred to in sub-paragraph F-4 of article XI, with the measures referred to in sub-paragraph A-2 of this article, and with all other conditions of the project prescribed in the agreement between the Agency and the State or States concerned. The inspectors shall report any non-compliance to the Director General who shall thereupon transmit the report to the Board of Governors. The Board shall call upon the recipient State or States to remedy forthwith any non-compliance which it finds to have occurred. The Board shall report the non-compliance to all members and to the Security Council and General Assembly of the United Nations. In the event of failure of the recipient State or States to take fully corrective action within a reasonable time, the Board may take one or both of the following measures: direct curtailment or suspension of assistance being provided by the Agency or by a member, and call for the return of materials and equipment made available to the recipient member or group of members. The Agency may also, in accordance with article XIX, suspend any non-complying member from the exercise of the privileges and rights of membership.

ARTICLE XIII *Reimbursement of members*

Unless otherwise agreed upon between the Board of Governors and the member furnishing to the Agency materials, services, equipment, or facilities, the Board shall enter into an agreement with such member providing for reimbursement for the items furnished.

ARTICLE XIV *Finance*

A. The Board of Governors shall submit to the General Conference the annual budget estimates for the expenses of the Agency. To facilitate the work of the Board in this regard, the Director General shall initially prepare the budget estimates. If the General Conference does not approve the estimates, it shall return them together with its recommendations to the Board. The Board shall then submit further estimates to the General Conference for its approval.

B. Expenditures of the Agency shall be classified under the following categories:

1. Administrative expenses: these shall include:

(a) Costs of the staff of the Agency other than the staff employed in connexion with materials, services, equipment, and facilities referred to in sub-paragraph B-2 below; costs of meetings; and expenditures required for the preparation of Agency projects and for the distribution of information;

(b) Costs of implementing the safeguards referred to in article XII in relation to Agency projects or, under sub-paragraph A-5 of article III, in relation to any bilateral or multilateral arrangement, together with the costs of handling and storage of special fissionable material by the Agency other than the storage and handling charges referred to in paragraph E below.

2. Expenses, other than those included in sub-paragraph 1 of this paragraph, in connexion with any materials, facilities, plant, and equipment acquired or established by the Agency in carrying out its authorized functions, and the costs of materials, services, equipment, and facilities provided by it under agreements with one or more members.

C. In fixing the expenditures under sub-paragraph B-l (b) above, the Board of Governors shall deduct such amounts as are recoverable under agreements regarding the application of safeguards between the Agency and parties to bilateral or multilateral arrangements.

D. The Board of Governors shall apportion the expenses referred to in sub-paragraph B-1 above, among members in accordance with a scale to be fixed by the General Conference. In fixing the scale the General Conference shall be guided by the principles adopted by the United Nations in assessing contributions of Member States to the regular budget of the United Nations.

E. The Board of Governors shall establish periodically a scale of charges, including reasonable uniform storage and handling charges, for materials, services, equipment, and facilities furnished to members by the Agency. The scale shall be designed to produce revenues for the Agency adequate to meet the expenses and costs referred to in sub-paragraph B-2 above, less any voluntary contributions which the Board of Governors may, in accordance with paragraph F, apply for this purpose. The proceeds of such charges shall be placed in a separate fund which shall be used to pay members for any materials, services, equipment, or facilities furnished by them and to meet other expenses referred to in sub-paragraph B-2 above which may be incurred by the Agency itself.

F. Any excess of revenues referred to in paragraph E over the expenses and costs there referred to, and any voluntary contributions to the Agency, shall be placed in a general fund which may be used as the Board of Governors, with the approval of the General Conference, may determine.

G. Subject to rules and limitations approved by the General Conference, the Board of Governors shall have the authority to exercise borrowing powers on behalf of the Agency without, however, imposing on members of the Agency any liability in respect of loans entered into pursuant to this authority, and to accept voluntary contributions made to the Agency.

H. Decisions of the General Conference on financial questions and of the Board of Governors on the amount of the Agency's budget shall require a two-thirds majority of those present and voting.

ARTICLE XV *Privileges and immunities*

A. The Agency shall enjoy in the territory of each member such legal capacity and such privileges and immunities as are necessary for the exercise of its functions.

B. Delegates of members together with their alternates and advisers, Governors appointed to the Board together with their alternates and advisers, and the Director General and the staff of the Agency, shall enjoy such privileges and immunities as are necessary in the independent exercise of their functions in connexion with the Agency.

C. The legal capacity, privileges, and immunities referred to in this article shall be defined in a separate agreement or agreements between the Agency, represented for this purpose by the Director General acting under instructions of the Board of Governors and the members.

ARTICLE XVI *Relationship with other organizations*

A. The Board of Governors, with the approval of the General Conference, is authorized to enter into an agreement or agreements establishing an appropriate relationship between the Agency and the United Nations and any other organizations the work of which is related to that of the Agency.

B. The agreement or agreements establishing the relationship of the Agency and the United Nations shall provide for:

1. Submission by the Agency of reports as provided for in sub-paragraphs B-4 and B-5 of article III;

2. Consideration by the Agency of resolutions relating to it adopted by the General Assembly or any of the Councils of the United Nations and the submission of reports, when requested, to the appropriate organ of the United Nations on the action taken by the Agency or by its members in accordance with this Statute as a result of such consideration.

ARTICLE XVII *Settlement of disputes*

A. Any question or dispute concerning the interpretation or application of this Statute which is not settled by negotiation shall be referred to the International Court of Justice in conformity with the Statute of the Court, unless the parties concerned agree on another mode of settlement.

B. The General Conference and the Board of Governors are separately empowered, subject to authorization from the General Assembly of the United Nations, to request the International Court of Justice to give an advisory opinion on any legal question arising within the scope of the Agency's activities.

ARTICLE XVIII *Amendments and withdrawals*

A. Amendments to this Statute may be proposed by any member. Certified copies of the text of any amendment proposed shall be prepared by the Director General and communicated by him to all members at least ninety days in advance of its consideration by the General Conference.

B. At the fifth annual session of the General Conference following the coming into force of this Statute, the question of a general review of the provisions of this Statute shall be placed on the agenda of that session. On approval by a majority of the members present and voting, the review will take place at the following General Conference. Thereafter, proposals on the question of a general review of this Statute may be submitted for decision by the General Conference under the same procedure.

C. Amendments shall come into force for all members when:

(i) Approved by the General Conference by a two-thirds majority of those present and voting after consideration of observations submitted by the Board of Governors on each proposed amendment, and

(ii) Accepted by two-thirds of all the members in accordance with their respective constitutional processes. Acceptance by a member shall be effected by the deposit of an instrument of acceptance with the depositary Government referred to in paragraph C of article XXI.

D. At any time after five years from the date when this Statute shall take effect in accordance with paragraph E of article XXI or whenever a member is unwilling to accept an amendment to this Statute, it may withdraw from the Agency by notice in writing to that effect given to the depositary Government referred to in paragraph C of article XXI, which shall promptly inform the Board of Governors and all members.

E. Withdrawal by a member from the Agency shall not affect its contractual obligations entered into pursuant to article XI or its budgetary obligations for the year in which it withdraws.

ARTICLE XIX *Suspension of privileges*

A. A member of the Agency which is in arrears in the payment of its financial contributions to the Agency shall have no vote in the Agency if the amount of its arrears equals or exceeds the amount of the contributions due from it for the preceding two years. The General Conference may, nevertheless, permit such a member to vote if it is satisfied that the failure to pay is due to conditions beyond the control of the member.

B. A member which has persistently violated the provisions of this Statute or of any agreement entered into by it pursuant to this Statute may be suspended from the exercise of the privileges and rights of membership by the General Conference acting by a two-thirds majority of the members present and voting upon recommendation by the Board of Governors.

ARTICLE XX *Definitions*

As used in this Statute:

1. The term "special fissionable material" means plutonium-239; uranium-233; uranium enriched in the isotopes 235 or 233; any material containing one or more of the foregoing; and such other fissionable material as the Board of Governors shall from time to time determine; but the term "special fissionable material" does not include source material.

2. The term "uranium enriched in the isotopes 235 or 233" means uranium containing the isotopes 235 or 233 or both in an amount such that the abundance ratio of the sum of these isotopes to the isotope 238 is greater than the ratio of the isotope 235 to the isotope 238 occurring in nature.

3. The term "source material" means uranium containing the mixture of isotopes occurring in nature; uranium depleted in the isotope 235; thorium; any of the foregoing in the form of metal, alloy, chemical compound, or concentrate; any other material containing one or more of the foregoing in such concentration as the Board of Governors shall from time to time determine; and such other material as the Board of Governors shall from time to time determine.

ARTICLE XXI *Signature, acceptance, and entry into force*

A. This Statute shall be open for signature on 26 October 1956 by all States Members of the United Nations or of any of the specialized agencies and shall remain open for signature by those States for a period of ninety days.

B. The signatory States shall become parties to this Statute by deposit of an instrument of ratification.

C. Instruments of ratification by signatory States and instruments of acceptance by States whose membership has been approved under paragraph B of article IV of this Statute shall be deposited with the Government of the United States of America, hereby designated as depositary Government.

D. Ratification or acceptance of this Statute shall be effected by States in accordance with their respective constitutional processes.

E. This Statute, apart from the Annex, shall come into force when eighteen States have deposited instruments of ratification in accordance with paragraph B of this article, provided that such eighteen States shall include at least three of the following States: Canada, France, the Union of Soviet Socialist Republics, the United Kingdom of Great Britain and Northern Ireland, and the United States of America. Instruments of ratification and instruments of acceptance deposited thereafter shall take effect on the date of their receipt.

F. The depositary Government shall promptly inform all States signatory to this Statute of the date of each deposit of ratification and the date of entry into force of the Statute. The depositary Government shall promptly inform all signatories and members of the dates on which States subsequently become parties thereto.

G. The Annex to this Statute shall come into force on the first day this Statute is open for signature.

ARTICLE XXII *Registration with the United Nations*

A. This Statute shall be registered by the depositary Government pursuant to Article 102 of the Charter of the United Nations.

B. Agreements between the Agency and any member or members, agreements between the Agency and any other organization or organizations, and agreements between members subject to approval of the Agency, shall be registered with the Agency. Such agreements shall be registered by the Agency with the United Nations if registration is required under Article 102 of the Charter of the United Nations.

ARTICLE XXIII *Authentic texts and certified copies*

This Statute, done in the Chinese, English, French, Russian and Spanish languages, each being equally authentic, shall be deposited in the archives of the depositary Government. Duly certified copies of this Statute shall be transmitted by the depositary Government to the Governments of the other signatory States and to the Governments of States admitted to membership under paragraph B of article IV.

In witness whereof the undersigned, duly authorized, have signed this Statute.

DONE at the Headquarters of the United Nations, this twenty-sixth day of October, one thousand nine hundred and fifty-six.

Annex 2

ATOMS FOR PEACE

Extract from an Address by Mr. Dwight D. Eisenhower,
President of the United States of America,
to the 470th Plenary Meeting of the United Nations General Assembly
Tuesday, 8 December 1953

"Madam President and Members of the General Assembly;

....

But the dread secret and the fearful engines of atomic might are not ours alone.

In the first place, the secret is possessed by our friends and allies, the United Kingdom and Canada, whose scientific genius made a tremendous contribution to our original discoveries and the designs of atomic bombs.

The secret is also known by the Soviet Union. The Soviet Union has informed us that, over recent years, it has devoted extensive resources to atomic weapons. During this period the Soviet Union has exploded a series of atomic devices, including at least one involving thermo-nuclear reactions.

If at one time the United States possessed what might have been called a monopoly of atomic power; that monopoly ceased to exist several years ago. Therefore, although our earlier start has permitted us to accumulate what is today a great quantitative advantage, the atomic realities of today comprehend two facts of even greater significance. First, the knowledge now possessed by several nations will eventually be shared by others, possibly all others.

Second, even a vast superiority in numbers of weapons, and a consequent capability of devastating retaliation, is no preventive, of itself, against the fearful material damage and toll of human lives that would be inflicted by surprise aggression.

....

There is at least one new avenue of peace which has not been well explored — an avenue now laid out by the General Assembly of the United Nations.

In its resolution of 28 November 1953 (resolution 715 (VIII)) this General Assembly suggested: "that the Disarmament Commission study the desirability of establishing a sub-committee consisting of representatives of the Powers principally involved, which should seek in private an acceptable solution and report...on such a solution to the General Assembly and to the Security Council not later than 1 September 1954.

The United States, heeding the suggestion of the General Assembly of the United Nations, is instantly prepared to meet privately with such other countries as may be "principally involved", to seek "an acceptable solution" to the atomic armaments race which overshadows not only the peace, but the very life, of the world.

We shall carry into these private or diplomatic talks a new conception. The United States would seek more than the mere reduction or elimination of atomic materials for military purposes. It is not enough to take this weapon out of the hands of the soldiers. It must be put into the hands of those who will know how to strip its military casing and adapt it to the arts of peace.

The United States knows that if the fearful trend of atomic military build-up can be reversed, this greatest of destructive forces can be developed into a great boon, for the benefit of all mankind. The United States knows that peaceful power from atomic energy is no dream of the future. The capability, already proved, is here today. Who can doubt that, if the entire body of the world's scientists and engineers had adequate amounts of fissionable material with which to test and develop their ideas, this capability would rapidly be transformed into universal, efficient and economic usage?

To hasten the day when fear of the atom will begin to disappear from the minds of the people and the governments of the East and West, there are certain steps that can be taken now.

I therefore make the following proposal.

The governments principally involved, to the extent permitted by elementary prudence, should begin now and continue to make joint contributions from their stockpiles of normal uranium and fissionable materials to an international atomic energy agency. We would expect that such an agency would be set up under the aegis of the United Nations. The ratios of contributions, the procedures and other details would properly be within the scope of the "private conversations" I referred to earlier.

The United States is prepared to undertake these explorations in good faith. Any partner of the United States acting in the same good faith will find the United States a not unreasonable or ungenerous associate.

Undoubtedly, initial and early contributions to this plan would be small in quantity. However, the proposal has the great virtue that it can be undertaken without the irritations and mutual suspicions incident to any attempt to set up a completely acceptable system of world-wide inspection and control.

The atomic energy agency could be made responsible for the impounding, storage and protection of the contributed fissionable and other materials. The ingenuity of our scientists will provide special safe conditions under which such a bank of fissionable material can be made essentially immune to surprise seizure.

The more important responsibility of this atomic energy agency would be to devise methods whereby this fissionable material would be allocated to serve the peaceful pursuits of mankind. Experts would be mobilized to apply atomic energy to the needs of agriculture, medicine and other peaceful activities. A special purpose would be to provide abundant electrical energy in the power-starved areas of the world.

Thus the contributing Powers would be dedicating some of their strength to serve the needs rather than the fears of mankind.

The United States would be more than willing — it would be proud to take up with others "principally involved" the development of plans whereby such peaceful use of atomic energy would be expedited.

Of those "principally involved" the Soviet Union must, of course, be one.

I would be prepared to submit to the Congress of the United States, and with every expectation of approval, any such plan that would, first, encourage world-wide investigation into the most effective peacetime uses of fissionable material, and with the certainty that the investigators had all the material needed for the conducting of all experiments that were appropriate; second, begin to diminish the potential destructive power of the world's atomic stockpiles; third, allow all peoples of all nations to see that, in this enlightened age, the great Powers of the earth, both of the East and of the West, are interested in human aspirations first rather than in building up the armaments of war; fourth, open up a new channel for peaceful discussion and initiative at least a new approach to the many difficult problems that must be solved in both private and public conversations if the world is to shake off the inertia imposed by fear and is to make positive progress towards peace.

Against the dark background of the atomic bomb, the United States does not wish merely to present strength, but also the desire and the hope for peace. The coming months will be fraught with fateful decisions. In this Assembly, in the capitals and military headquarters of the world, in the hearts of men everywhere, be they governed or governors, may they be the decisions which will lead this world out of fear and into peace.

To the making of these fateful decisions, the United States pledges before you, and therefore before the world, its determination to help solve the fearful atomic dilemma — to devote its entire heart and mind to finding the way by which the miraculous inventiveness of man shall not be dedicated to his death, but consecrated to his life.

........"

Annex 3

SELECTED STATISTICAL DATA, 1958–1995

TABLE I. THE IAEA'S RESOURCES, MEMBERSHIP AND STAFF, 1958–1995
(monetary amounts in dollars)

Year	Regular budget	Voluntary contri-butions[a] [1]	EPTA and Special Fund (UNDP)	Estimated value of resources in kind	Total IAEA technical assistance	Number of Member States	Size of staff[b]
1958	3 465 000	124 000		390 000	414 000	66	
1959	5 225 000	875 000	304 000	531 000	1 710 000	70	424
1960	5 834 000	1 008 000	633 000	885 000	2 526 000	71	465
1965	7 938 000	1 200 000	1 317 000	497 000	3 014 000	91	648
1970	12 250 000	1 810 000	1 469 000	894 000	4 173 000	101	1 081
1971	13 778 000	2 443 000	1 839 000	922 000	5 204 000	101	1 116
1972	16 561 000	2 678 000	2 072 000	779 000	5 529 000	102	1 127
1973	18 127 000	3 376 000	1 964 000	1 039 000	6 379 000	103	1 129
1974	24 264 000	3 717 000	3 082 000	1 078 000	7 877 000	104	1 170
1975	32 175 000	4 645 000	3 942 000	942 000	9 529 000	104	1 280
1976	37 002 000	6 221 000	3 002 000	1 021 000	10 244 000	107	1 407
1977	46 341 000	8 109 000	2 836 000	1 284 000	12 229 000	108	1 585
1978	53 079 000	9 973 000	3 205 000	1 987 000	15 165 000	108	1 563
1979	66 377 000	11 437 000	6 066 000	2 015 000	19 518 000	108	1 531
1980	78 935 000	13 301 000	5 018 000	2 628 000	20 947 000	108	1 597
1981	85 614 000	16 475 000	5 186 000	2 788 000	24 449 000	108	1 624
1982	82 659 000	20 416 000	4 631 000	2 493 000	27 540 000	108	1 718
1983	88 071 000	27 342 000	3 706 000	2 172 000	33 220 000	109	1 756
1984	91 611 000	28 196 000	2 541 000	2 066 000	32 803 000	110	1 861
1985	95 025 000	30 681 000[2]	2 654 000	2 765 000	36 100 000	110	1 942
1986	114 298 000	33 562 000	3 480 000	2 282 000	39 324 000	110	1 994
1987	141 019 000	35 853 000	2 568 000	3 066 000	41 487 000	111	2 026
1988	150 816 000	40 220 000	3 051 000	2 322 000	45 593 000	111	2 079
1989	147 475 000	44 687 000	3 106 000	2 295 000	50 088 000	111	2 171
1990	173 720 000	39 480 000	2 856 000	2 214 000	44 550 000[c]	111	2 175
1991	181 160 000	45 900 000	1 513 000	1 702 000	49 115 000	111	2 193

TABLE I. (cont.)

Year	Regular budget	Voluntary contri-butions[a 1]	EPTA and Special Fund (UNDP)	Estimated value of resources in kind	Total IAEA technical assistance	Number of Member States	Size of staff[b]
1992	201 196 000	38 386 000	620 000	1 302 000	40 308 000[c]	113	2 135
1993	201 503 000[3]	50 204 000	1 059 000	1 642 000	52 905 000	118	2 188
1994	219 536 000	49 637 000	1 367 000	1 752 000	52 756 000	123	2 248
1995	251 159 000	60 300 000	1 355 000	1 877 000	63 532 000	123	2 295

[a] From 1965 onwards the figures given under 'Voluntary contributions' include miscellaneous income, the publications revolving fund, contributions by host States to the costs of meetings and 'extrabudgetary contributions'.

[b] Professional and General Service (GS) staff and, from 1966, also Maintenance and Operative (M&O) staff.

[c] Massive devaluation of the rouble.

EPTA: UN Expanded Programme of Technical Assistance.

See the end of this Annex for an explanation of the numbered footnotes.

TABLE II. THE IAEA'S TECHNICAL ASSISTANCE AND CO-OPERATION, 1958–1995 *(monetary amounts in dollars)*

Year	Estimated total value of resources available (See Table I)	Fellows in the field	No. of training courses or, from 1965, number of participants in courses	No. of experts provided	Value of equip-ment provided	Visiting professors
1958	514 000	161	Nil	Nil	Nil	Nil
1959	1 710 000	296	2[4]	8	74 023	7[5]
1960	2 526 000	385	2	40[6]	360 562	17[7]
1961	2 286 000	344	7[8]	95[9]	182 790	19[10]
1965	3 014 000	271	184	155	500 600	14
1970	4 173 000	370	249	252	1 055 600	15
1975	9 529 000	439	288	363	3 387 700	38
1980	20 947 000	682	547	457	8 163 600	69
1985	36 100 000	615	926	1 846	16 038 800	188
1989	50 088 000	760	1 331	1 621	19 000 000	360
1990	44 550 000	851	1 399	1 764	23 900 000	423
1991	49 115 000	771	1 473	1 881	19 459 800	329
1992	40 308 000	781	1 251	1 871	21 942 000	301
1995	63 532 000	1 041	1 806	3 327	25 716 800	314

TABLE III. TARGETS, PLEDGES AND PAYMENTS TO THE TECHNICAL CO-OPERATION FUND (TCF) *(in dollars)*

Programme year	Target for voluntary contributions to the TCF	Amount pledged	Per cent of target	Amount paid
1975	4 500 000	4 220 000	93.7	NA
1980	10 500 000	9 976 000	95.0	9 826 148
1985	26 000 000	23 314 101	89.7	15 696 128
1986	30 000 000	26 732 785	89.1	18 769 181
1987	34 000 000	29 772 162	87.6	29 137 993
1988	38 000 000	32 710 534	86.1	31 833 899
1989	42 000 000	35 732 734	85.1	33 810 873
1990	45 500 000	38 503 592	84.6	36 855 225
1991	49 000 000	37 816 993	77.2	36 703 915
1992	52 500 000	37 452 844	71.3	36 230 629
1993	55 500 000	42 466 893	76.5	41 588 181
1994	58 500 000	42 418 928	72.5	38 251 600
1995	61 500 000	47 680 389	77.5	46 390 600

NA: not available.

NOTES TO TABLES I AND II

1 Figures in this column include 'extrabudgetary' funds, including contributions by various Member States to specified projects or programmes. (These became significant after 1977 with the introduction of the 'footnote a/' system.)

2 The figures for 1985–1994 in this and in the next three columns are taken from or based on *The Agency's Technical Co-operation Activities in 1994*, GC(39)/INF/8, IAEA, Vienna (1995), p. 66, Table I.

3 Subsequently reduced by 12% from 201 503 000 because of an expected shortfall in receipts.

4 *Annual Report of the Board of Governors to the General Conference 1 July 1959–30 June 1960,* GC(IV)/114, IAEA, Vienna (1960), p. 24, paras 131 and 133.

5 Ibid.

6 *Annual Report of the Board of Governors to the General Conference 1 July 1960–30 June 1961,* GC(V)/154, IAEA, Vienna (1962), pp. 29–32, para. 200.

[7] Ibid.

[8] *Annual Report of the Board of Governors to the General Conference 1 July 1961–30 June 1962,* GC(VI)/195, IAEA, Vienna (1963), p. 17, para. 103.

[9] *Annual Report of the Board of Governors to the General Conference 1 July 1960–30 June 1961*, p. 31, para. 200.

[10] *Annual Report of the Board of Governors to the General Conference 1 July 1961–30 June 1962*, p. 17, para. 102.

GLOSSARY

ABACC. Brazilian–Argentine Agency for Accounting and Control of Nuclear Materials.

ARIE. Actual routine inspection effort — an estimate by the IAEA of the number of person-days that the IAEA's inspectors will spend at a particular nuclear plant or store during one year.

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 BHFs 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. Canada deuterium–uranium (reactor) — the most common heavy water reactor (HWR), 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.

Chain reaction. The continuing process of nuclear fission in which the neutrons released by one fission cause at least one other fission. In a nuclear weapon an extremely rapid, multiplying chain reaction causes the explosive release of energy. In a reactor the pace of the chain reaction is controlled so as to produce heat or power or neutrons for research purposes.

Containment and surveillance (C/S). 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.

Core (reactor core). The central portion of a reactor containing the fuel elements and usually the moderator.

Depleted uranium. Uranium in which the proportion of the fissile isotope uranium-235 is lower than the 0.71% normally found in nature. The products of the enrichment process are enriched and depleted uranium (c.f. cream and skimmed milk!).

Enriched uranium. Natural uranium contains 0.71% of the fissile isotope uranium-235 (^{235}U). The remainder is the fertile (convertible into plutonium) isotope uranium-238 (^{238}U). By various means such as pumping uranium in the gaseous form of uranium hexafluoride through the membranes of a gaseous diffusion plant or by rapidly rotating it in gas centrifuges ('ultra-centrifuges'), the proportion of ^{235}U to ^{238}U can be increased. The proportion of ^{235}U is raised to between 2% and 4% to produce fuel for use in the most common nuclear power plant — the light water reactor — as well as in the advanced gas cooled reactor and the Soviet designed RBMK. When the proportion of ^{235}U rises to 20% the material is classified by the IAEA as 'high enriched uranium'. In practice, however, the proportion of ^{235}U used in a nuclear explosive device or in a nuclear warhead is usually of the order of 90% or more. High enriched uranium was the explosive charge of the bomb dropped on Hiroshima. The bomb dropped on Nagasaki was charged with plutonium. High enriched uranium is also used as the fuel for certain research reactors and as the fuel for the propulsion units of most nuclear propelled warships (submarines, aircraft carriers, etc.).

EURATOM. The European Atomic Energy Community established by the Treaty of Rome in 1957 as the nuclear branch of the European Union. All members of the European Union are automatically members of EURATOM. In 1971–1972, the IAEA and EURATOM and its non-nuclear-weapon States concluded an agreement for co-ordinating the safeguards of the two agencies (document INFCIRC/153).

EURODIF. European Gaseous Diffusion Uranium Enrichment Consortium — a gaseous diffusion enrichment enterprise launched by France which began operating in 1979. Besides France, capital was provided by Belgium, Italy and Spain (and, originally, Iran) to help meet their needs for enriched fuel.

Facility attachment (FA). The detailed plan for safeguarding a particular plant. The facility attachment defines the material balance areas (MBAs — see below) within the plant (the entire plant may constitute a single MBA) and indicates the strategic points (key measurement points) to which the IAEA's inspector may have access during routine inspections and at which safeguards instruments may be installed. The FA specifies the measures to be used for accounting for the nuclear material at the plant, including the plant's records and reports system, the arrangements for containment and surveillance, and the mode and scope of the IAEA's routine inspections of the plant. The FA usually includes an estimate of the annual routine inspection effort to be carried out at the plant by the IAEA.

(Fast) breeder reactor (FBR). A nuclear reactor that produces more reactor nuclear material than it consumes. It normally does this by converting part of a 'blanket' of fertile ^{238}U into fissile plutonium. In the process it 'burns up' less of its plutonium fuel than the plutonium it 'breeds' in the blanket.

Fertile material. Material composed of atoms that easily absorb (capture) neutrons and, in doing so, turns into fissile material. ^{238}U and ^{232}Th (thorium-232) are the two naturally occurring fertile materials. By capturing a neutron, ^{238}U transmutes into ^{239}Pu (plutonium-239) and ^{232}Th transmutes into ^{233}U (uranium-233).

Fissile (fissionable) material. Material composed of atoms that readily fission, such as ^{235}U and ^{239}Pu, when struck by a thermal (slow) neutron.

Fission reaction (nuclear fission). The process in which a neutron strikes the nucleus of an atom and splits it into fragments. As a result of the collision several neutrons are emitted at high speed and heat and radiation are released.

Gas centrifuge. In the nuclear context this means a rapidly rotating vessel used to enrich uranium. The heavier isotopes of the gas uranium hexafluoride concentrate at the walls of the rotating centrifuge and are drawn off. A gas centrifuge enrichment plant may be used to produce weapon grade ^{235}U as well as low enriched uranium for light water reactors (i.e. the most common nuclear power station).

Gaseous diffusion. As used in the nuclear energy context, this is 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 very large and require much electricity. Like a gas centrifuge plant, a gaseous diffusion plant can be used to produce weapon grade ^{235}U as well as low enriched uranium fuel for light water reactors.

Gigawatt. A thousand megawatts (see below). 1 GW(e) = 1000 MW(e). Multiples of the unit GW(e) are often used to denote the total electrical generating capacity of a State or the total capacity of all plants of a certain type — e.g. all nuclear or all fossil fuelled plants.

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 oxygen and of a heavy isotope of hydrogen (^{2}H) (or deuterium) which has two neutrons in its nucleus (ordinary hydrogen has only one).

Heavy water reactor. A reactor that uses heavy water as a moderator (other moderators being ordinary (light) water and graphite) and, in some cases, also as a coolant. The moderator slows down the neutrons emitted by ^{235}U, plutonium or the nuclei of other fissioning atoms. This permits the fertile ^{238}U to 'capture' the neutrons and thus turn 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 in natural uranium. With light water it is necessary to use enriched uranium to produce a chain reaction.

High temperature gas cooled reactor (HTGR). An advanced type of reactor which uses enriched uranium for fuel, graphite as a moderator and helium as a coolant.

Hot cell. A shielded room with remote handling equipment for analysing and experimenting with highly radioactive materials such as spent reactor fuel. A hot cell can be used to reprocess small amounts of spent fuel and thus separate small quantities of plutonium, but it is not regarded as a reprocessing plant.

INFCIRC. Information Circular — one of a series of unclassified, general purpose IAEA circulars used to bring to general notice the contents of an important document or an important decision or communication such as the text of a convention or agreement concluded by the IAEA or under its auspices. Examples are the text of the 'Guiding Principles and General Operating Rules Governing the Provision of Technical Assistance', the 'Convention on the Physical Protection of Nuclear Material', the IAEA's Safety Standards as well as the IAEA's various safeguards systems, all safeguards agreements, and the contents of the 'trigger list' and the NSG Guidelines.

IPS. International Plutonium Storage — a proposed scheme for storing surplus separated plutonium under the control of the IAEA so as to prevent governments from stockpiling it. The IAEA's Statute authorizes the IAEA to require deposit, with it of 'any excess' of separated plutonium as a safeguards measure (see Article XII.A.5 of the Statute, reproduced in Annex 1).

Isotopes. Diverse atoms of the same element having the same number of protons in their nuclei but different numbers of neutrons. The isotopes of any element have essentially the same chemical characteristics and are very difficult to separate from each other by a chemical process. Thus the commonly used isotopes of uranium, ^{235}U and ^{238}U, can, as a rule, only be separated from each other by physical means such as gaseous diffusion or gas centrifugation. However, the physical properties of different isotopes of the same element may be very different; for instance, one isotope may fission readily while another will do so only with the greatest difficulty. An isotope is specified by its atomic mass number — the total number of protons and neutrons in its nucleus — as well as by the symbol denoting its chemical element (e.g. ^{235}U or ^{233}U, which are the fissile isotopes of uranium).

Light water reactor (LWR). A reactor moderated and cooled by ordinary 'light' water (see also 'heavy water reactor'). The LWR is today the most common type of power and research reactor).

Material balance area (MBA). An area inside or outside a nuclear plant that is constructed or laid out in such a manner as to make it possible to measure, count or otherwise determine every movement of nuclear material into or out of it, as well as nuclear material held within it (i.e. the 'physical inventory' of nuclear material). Typical MBAs are the bay in which spent fuel is stored and the core of a power reactor.

Megawatt. A million watts or a thousand kilowatts. Today a 'megawatt electric', or MW(e), is the unit most frequently used to denote the capacity or normal maximum operating output — in terms of electricity generated — of a large electrical power plant (using conventional or nuclear fuel, or a renewable source such as a hydroelectric station). A megawatt thermal or MW(th) denotes the amount of heat generated by a plant operating at full capacity. The output of a research reactor is usually denoted in terms of MW(th). Roughly three megawatts of heat (MW(th)) are needed to generate one MW(e).

MUF. 'Material unaccounted for'. In the application of safeguards, MUF is defined as 'the difference between book inventory and physical inventory', in other words the difference between the amount of nuclear material calculated to be in a plant or in an MBA (see above) — the 'book inventory' — and the amount that is actually there (the 'physical inventory'). When the operator of a nuclear plant takes stock (makes a physical inventory) of the material in the plant, the amount of material found may differ from the amount that has been calculated to be there; any difference is termed MUF. The calculation of what material should be there is made by taking the amount found at the previous physical inventory, adding all inputs and estimated production and deducting shipments, burnup, measured discards, estimated losses, etc. If the difference, i.e. the amount of MUF, is significant, the cause of the difference must be established.

Non-nuclear-weapon State. The NPT uses this term but does not define it. However, by inference every State that does *not* qualify as a nuclear weapon State — in other words every State that had *not* manufactured and exploded a nuclear weapon or other nuclear explosive device before 1 January 1967 is ipso facto a non-nuclear-weapon State for the purposes of the Treaty, even if that State has since, like India, exploded such a device or, like South Africa, manufactured several nuclear weapons or is, like Israel, believed to possess a considerable number of nuclear weapons.

Non-Proliferation Act of 1978 (NPA). This United States Act substantially amended (in the direction of much stricter controls on nuclear exports) the Atomic Energy Act of 1954 which had been the basis for the US "Atoms for Peace" programme from 1954 until 1978.

NPT or the Non-Proliferation Treaty. 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 in Geneva from 1965 to 1968 which resulted in a US–Soviet agreed draft text in 1967. When all nations taking part in the negotiations had reached agreement on the complete draft text of the NPT in 1968, it was submitted to the United Nations General Assembly. The General Assembly commended it on 12 June 1968 and expressed its hope 'for widest adherence'. 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 — now the Russian Federation — the United Kingdom and the USA). The Treaty was extended indefinitely in May 1995.

Nuclear Energy Agency (NEA) of the OECD. The Nuclear Energy Agency (NEA) of the Organisation for Economic Co-operation and Development (OECD) was established in 1958 as the European Nuclear Energy Agency of the Organization for European Economic Co-operation (OEEC) which had been created after the Second World War to administer the Marshall Plan (the OECD was the successor to the OEEC). At the end of 1995, the NEA's membership included all members of the European Union as well as Australia, Canada, Japan, the Republic of Korea, Mexico, New Zealand, Norway, Switzerland, Turkey and the USA, in other words, all European, Far Eastern and Australasian countries that already had market economies before 1989, as well as Mexico. In 1996, the Czech Republic and Hungary joined the NEA.

Nuclear fission (see fission reaction).

Nuclear fuel cycle. The series of chemical and physical operations needed to prepare nuclear material for use in a reactor and to dispose of or recycle the nuclear material after its use in the reactor. Existing fuel cycles begin with the mining of uranium ore, which is then processed into uranium concentrate, transformed into uranium oxide, uranium metal or enriched uranium, fabricated into reactor fuel, and used in a reactor. After 'burnup' in a reactor the 'spent fuel' is removed. After the spent fuel has cooled it may be reprocessed for recovery of the remaining uranium and produced plutonium for re-use in a reactor (thus 'closing' the fuel cycle) or it may be temporarily and eventually permanently stored as unreprocessed spent fuel (the 'once-through' fuel cycle).

Nuclear material. "Source material" and "special fissionable material" (i.e. 'fissile material') as defined in the Statute and in the safeguards systems of the IAEA. For safeguards purposes nuclear material means natural uranium in any form — uranium concentrate, uranium oxide, uranium metal and other uranium compounds — as well as the fissile materials ^{235}U and ^{233}U and the various isotopes of plutonium. The definition of "source material" in the IAEA Statute also covers thorium — except in the form of ore — and various other isotopes of uranium.

Nuclear reactor. A machine fuelled by fertile or fissile nuclear materials in which a controlled fission reaction takes place, in the process of which neutrons are emitted and heat is produced. In a nuclear power reactor, the heat is used to produce steam which drives a turbine, which in turn drives an electric generator. In a research reactor the neutrons emitted are usually used for experimental purposes (e.g. to study the effects of radiation), but the reactor may be used for training, for testing how materials perform under intense radiation and for producing radioisotopes (radioactive isotopes, chiefly used in medicine and in various branches of research). A production reactor is used for the large scale production of weapon grade plutonium (^{235}Pu) or tritium (used in boosted fission and in hydrogen warheads).

Nuclear Suppliers' Group (NSG) Guidelines ('London Guidelines'). A set of Guidelines that most of the main suppliers of nuclear plants and materials agreed to in London in 1975–1977 (reproduced in document INFCIRC/254 of February 1978 and addenda). The Guidelines were revised in 1992 and reproduced in document INFCIRC/254/Rev. 1/P.1 and addenda and modifications.

Nuclear weapon State (NWS). Under Article IX.3 of the NPT, a nuclear weapon State is a State "which has manufactured and exploded a nuclear weapon or other nuclear explosive device prior to I January 1967". Five States are covered by this definition: China, France, the Russian Federation, the United Kingdom and the USA.

Plutonium. An artificial element almost exclusively produced today by the operation of nuclear reactors. When the nucleus of a uranium-238 atom captures an extra neutron (usually emitted by the fissioning of another nucleus in a nuclear chain reaction), the uranium-238 is eventually transmuted into plutonium-239. Plutonium-240 is produced when a plutonium-239 nucleus captures a neutron instead of fissioning under the impact of the neutron. The longer low enriched fuel is irradiated in a nuclear power reactor, in other words, the higher its burnup, the more plutonium-240 is built up in its fuel. Plutonium-240 complicates the construction of a nuclear warhead because of its high rate of spontaneous fission. This can result in unacceptable radiation exposure to persons manufacturing or handling the warhead, as well as premature fission. Hence, plutonium-239 is the preferred isotope for making nuclear weapons. But the USA demonstrated in the 1960s that high enriched uranium containing plutonium-240 (what proportion has not been disclosed) can be used as a nuclear explosive. Plutonium is also used as a fuel in fast breeder reactors, and plutonium mixed with uranium oxide is used as ‘MOX’ (mixed oxide) fuel in certain light water power reactors. Such uses are known as plutonium recycle.

(Plutonium) recycle. Use of plutonium as part of the fuel for a nuclear reactor. The plutonium may replace or partly replace uranium-235 and thus ‘enrich’ the fuel.

Radioisotope. The radioactive isotope of an element. Radioisotopes are extensively used in numerous branches of research and clinical medicine. They can be combined in minute quantities with stable isotopes of the same element and, since they emit radiation, they can be used as ‘tracers’ to follow the course and indicate the quantity of that element as it moves through living animal or plant tissues, determine the biological role of the element, indicate the most effective way of using the element (for instance as a fertilizer) or trace its course through the global water cycle.

Reprocessing. Chemical treatment of spent fuel so as to separate the plutonium and the remaining uranium from the unwanted waste products.

SAGSI. The lAEA’s Standing Advisory Group on Safeguards Implementation.

Significant quantity (SQ). The approximate amount of nuclear material that the IAEA has estimated a State would need to manufacture its first nuclear explosive device. In defining an SQ the IAEA takes into account matters such as the degree of enrichment of the material as well as any process that may be needed to convert the material into a nuclear explosive. For material that can be used directly as an explosive, the SQ is the same as the ‘threshold amount’ (see below).

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 waste products (fission by-products) to sustain the economical operation of the reactor.

Thermonuclear fusion. The formation of a nucleus of an atom by the fusion of the nuclei of two lighter atoms (such as the fusion of the nuclei of two hydrogen atoms to form the nucleus of a helium atom). In the process ‘binding energy’ is released, chiefly in the form of heat. Thermonuclear fusion is the process that provides most of the energy of the sun and other stars. It is also the process that takes place in the detonation of a hydrogen bomb (i.e. a thermonuclear warhead). If and when it becomes possible to control this process in a reactor, ‘controlled thermonuclear fusion’ could provide very large quantities of usable energy.

Threshold amount. The approximate amount of fissile material needed to make a nuclear explosive device. On the advice of its expert safeguards committee, SAGSI, the quantities that the IAEA estimates would be needed for this purpose are based on a United Nations 1967 report, *Effects of the Possible Use of Nuclear Weapons* (document A/6858, UN, New York (6 October 1967). The estimates make allowance for the amount of fissile material that is likely to be lost in manufacturing the device.

Threshold State. As used in this book, this term denotes a country that is not a nuclear weapon State in terms of the NPT, but which has not formally renounced the acquisition of nuclear weapons and is operating unsafeguarded nuclear facilities that can make nuclear weapon material. In 1990, this term fitted Argentina, Brazil, India, Israel, Pakistan and South Africa (and, despite their renunciation of nuclear weapons, the Democratic People's Republic of Korea and Iraq). In certain respects, Ukraine might have qualified. In 1997, the term fitted India, Israel and Pakistan.

Trigger list. A list of nuclear and other materials, plants, components thereof and equipment whose export to a non-nuclear-weapon State should, according to the NPT, 'trigger' the application of IAEA safeguards. If nuclear material is exported, safeguards must be applied to that material. If a plant is exported, or a component thereof, or equipment or non-nuclear material (e.g. heavy water), safeguards must be applied to the nuclear material which that plant, component, equipment or non-nuclear material will process, use or produce. The safeguards trigger list was originally drawn up in 1974 by the 'Zangger Committee', a group of representatives of exporting countries party to the NPT (the Committee took the name of its Chairman, Claude Zangger of Switzerland). The list is revised from time to time. It forms part of the NSG Guidelines.

Uranium enrichment. The process of increasing the proportion of atoms of the isotope uranium-235 above the level existing in natural (or depleted) uranium, i.e. above 0.71%. The methods of enrichment most commonly used are gaseous diffusion and gas centrifugation. Calutrons (electromagnetic isotope separation machines) were used during the Second World War and again by Iraq until they were destroyed in 1991. Chemical processes and laser separation have also been used experimentally to enrich uranium.

URENCO. Uranium Enrichment Company — created in 1970 by the signing of the Treaty of Almelo by Germany, the United Kingdom and the Netherlands.

Yellow cake. Uranium concentrate (U_3O_8). Uranium concentrates are converted into a gas (uranium hexafluoride or UF_6) in preparation for enrichment and use in a light water reactor, into uranium oxide (UO_2) for use in a natural uranium heavy water (CANDU) reactor and, into uranium tetrafluoride (UF_4) and then into uranium metal for use in a gas cooled, graphite moderated, natural uranium reactor.

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