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THEN&NOW
THE IAEA TURNS FORTY

The International Atomic Energy Agency turns forty at a time of hope and anticipation — moving beyond the confines of its own work as an intergovernmental body States created in July 1957 as the world's "atoms for peace" organization. A new millennium is at hand. People wonder how the next chapters in the nuclear age will evolve, and how safe and productive that age will be.

From the global perspective, tomorrow's nuclear age is emerging as far less threatening — and no less promising — than the one being left behind in the dust of the Cold War. Results of global nuclear cooperation over the past years renewed the hopeful 1950s' vision of "disarming atomic energy". Though there is still a long way to go, the day is drawing closer when no government finds "security" in nuclear weapons, and all States enshrine their commitments against the bomb's risks and uncertainties in lasting law. States took some giant steps over the past decade. The treaty to prevent the bomb's further spread was indefinitely extended. Countries in three more regions of the world bound themselves by forming nuclear-weapon-free zones. Nuclear testing was banned under a newly adopted global treaty. States agreed to new, and more intrusive, safeguards inspection measures for the IAEA's verification of their nuclear programmes. Talks opened for the international verification of nuclear disarmament. All these steps are charting a different course into the next century. Yet they bring new and difficult issues to the world's nuclear agenda.

In the IAEA's relatively short lifetime, the past ten years especially have been challenging and turbulent times. Setting the stage were far-reaching changes to the world's political landscape. External events swept nuclear issues and the Agency from the back to the front pages of newspapers and onto television screens. Reports raised both fears and expectations about the development of nuclear technology and the Agency's role.

This memorable period — the years 1986 to 1997 — is the focus of this edition of the *IAEA Bulletin*. The decade tested much of the world's common ground. It demonstrated the strengths, and weaknesses, of global action, and hence challenged the capacity, determination, and experience of an international organization and its members. In a real sense, the years brought out the best of the IAEA's character and tradition, and reconfirmed its role in governmental eyes as the world's central point for nuclear cooperation. *(See the Supplement inside for a chronology covering the IAEA's history.)*

For many observers, the decade was defined by three crises that deepened worries and desires for our own, and the planet's, mutual safety: it opened in 1986 with the tragic accident at the Chernobyl nuclear plant in the Ukraine, when the international community's responsiveness and commitment were tested. Less than five years later, in early 1991, the discovery of a secret nuclear-weapon programme in Iraq cast doubts on the world's ability to stop the spread of the bomb, and sharply questioned the capabilities of national operatives and IAEA safeguards to detect diversions. Within a year, the nature of the nuclear programme in the Democratic People's Republic of Korea (DPRK) was raising proliferation concerns, and the safeguards system was challenged again.

These events taught hard lessons that were not lost in briefing and meeting rooms. Governments incrementally moved to reinforce and strengthen global regimes for nuclear safety and safeguards in substantive and sometimes groundbreaking ways. They used the IAEA as their main collective instrument of action. A major result has been a much stronger legal framework for achieving and maintaining high levels of nuclear and radiation safety, and for verifying the exclusively peaceful uses of nuclear materials. At issue today is sustaining the momentum, finding ways and means to more fully fund and activate the new frameworks that have been put into place.

Beyond the crises stands a long list of less widely publicized events and developments over the past decade — in fields ranging from arms control to pest control — to

which the IAEA has responded. Many of the challenges concern basic human needs — for safe food, water, and energy, good health care, and a cleaner environment.

Heading toward the next millennium, the IAEA is starting major new chapters in its history. December 1997 will see a change of leadership at the top. After sixteen years in office, Director General Hans Blix passes the Secretariat's stewardship to a newly appointed leader, Dr. Mohamed ElBaradei of Egypt. He will become only the fourth Director General in the IAEA's history. *(See box.)*

Another new chapter is opening for nuclear safeguards, where the IAEA's inspectorate has been granted greater authority and rights of access, in efforts to build stronger capabilities to detect possible secret nuclear activities. States now are being asked to accept the legal document defining new verification measures. Still other chapters are opening in fields of nuclear and radiation safety, radioactive waste management, nuclear power, and technical cooperation. New strategies and approaches target the best "niches" for proven nuclear technologies, promote wider use of safety standards, and build up capabilities to enable more lasting and direct benefits in countries.

How these new chapters came to be outlined over the past ten years is the story of this special anniversary edition. How they ultimately will be written remains the subject of another time.—*Lothar Wedekind, Editor*

THE TOP JOB

When the IAEA Secretariat's top job changes hands this December, Dr. Hans Blix of Sweden will turn over the leadership to Dr. Mohamed ElBaradei of Egypt. During his sixteen years in office since 1981, Dr. Blix guided the IAEA through several crises — including 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. As observers have noted, under his direction the Agency accomplished much to enhance its authority and role in international affairs, and to bolster the international legal regime for nuclear energy. His analysis of the lessons of Iraq provided the framework for a strengthened safeguards programme approved by the Board in May 1997 — the most important development in international nuclear safeguards since the NPT safeguards system was set up in 1971.

Dr. ElBaradei was appointed to succeed Dr. Blix in June 1997 by a unanimous decision of the Agency's 35-member Board of Governors. The IAEA General Conference is expected to approve his appointment to an initial four-year term starting in December. Dr. ElBaradei holds the rank of Ambassador in the Egyptian Foreign Service. He 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, currently as Assistant Director General for External Relations.

Dr. ElBaradei becomes only the fourth Director General of the IAEA in forty years. The second was Dr. Sigvard Eklund, a distinguished Swedish scientist first appointed in 1961. Dr. Eklund was reappointed four more times and held the post for twenty consecutive years until he retired and was named Director General Emeritus. It was during his tenure that the main scientific and technical programmes, including supporting research and analytical laboratories, were established and developed.

At the top during the IAEA's formative years was Mr. Sterling Cole of the United States, the first appointed IAEA Director General who served from 1957-61. A US Congressman, he had been the Chairman of the Joint Committee on Atomic Energy of the US Congress.

ARMS CONTROL & VERIFICATION

SAFEGUARDS IN A CHANGING WORLD

Like a locomotive climbing mountainside rails, the world's regime to disarm the atom has steamed along over the past quarter century, twisting, turning, rolling, rising, sometimes without much fuel and on uneven tracks. Historic events of the past decade have tested the mettle of its frame and engineers.

States regard the IAEA as a key part of that global engine. The Agency's international safeguards system – the world's first for on-site verification of arms-control commitments — serves to ensure that States comply with their legal undertakings not to develop or produce nuclear weapons. Its elements include technical measures and on-site inspections carried out under safeguards agreements to verify the peaceful nature of nuclear activities.

Of all the events over the past decade, the case of Iraq challenged the engine's limits, and sought to exploit them. Unknown to the IAEA and undisclosed by any State that had strong suspicions, Iraq secretly pursued a nuclear-weapons programme in the 1980s, breaching its commitment under the Treaty on the Non Proliferation of Nuclear Weapons (NPT) and its safeguards agreement with the IAEA. The attempt was discovered in 1991, after Iraq's invasion of Kuwait triggered a UN response and the ensuing Gulf War. In the spring of 1991, the UN Security Council, under a ceasefire resolution, moved to dismantle and destroy Iraq's capabilities for weapons of mass destruction, setting up a Special Commission and authorizing the ways and means to do the job. The Council granted the IAEA unprecedented inspection rights to root out and eliminate the nuclear-weapons programme — rights that involved unlimited access to any place and any person at any time, unrestricted use of logistical measures, and the application of new verification techniques. Member States also provided access to information, including satellite imagery. The inspections had the collective weight, and sanctions power, of the Council behind them.

The special operation in Iraq had international legal authority far beyond that found in IAEA comprehensive safeguards agreements. Even so, the IAEA's Iraq Action Team faced a demanding task, not free of Iraqi resistance. The most publicized event: the four-day detention of Agency inspectors in September 1991 in a Baghdad parking lot, after they had uncovered key documents.

Today — six years, more than 1000 inspections at over 200 different sites, and hundreds of interviews later — the clandestine Iraqi nuclear-weapons programme has been uncovered and its components destroyed, removed or rendered harmless. To ensure it is not reconstituted, a system of long-term monitoring and verification carried out by the Agency's Nuclear Monitoring Group is now in place, working with support of the UN Special Commission. Yet the relevant nuclear know-how remains in the country. *(See adjacent box.)*

Baghdad's challenge sparked critical evaluations of what went wrong and what to do about it. The review process would take more than five years, and ultimately lay the foundation for a strengthened safeguards system. *(See box, page 7.)*

Photo: Prof. Maurizio Zifferero, Leader of the IAEA Iraq Action Team until shortly before illness claimed his life in June 1997.

LESSONS FROM A BIG TEST

The problems that the IAEA and the NPT regime faced in Iraq were not unique to nuclear non-proliferation. Any other 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.

The world is unlikely to ever 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.

...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 materials and cheating the IAEA's material accountancy. The IAEA was seen by many as having failed its (presumably) first diversion detection text; 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. 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.

— Excerpts from David Fischer's new book on the IAEA's history. See the back cover of the Supplement to this edition for more information about it.

The Iraqi case had radically changed the political environment and raised the stakes. It altered how States perceived their own national security vis-a-vis IAEA safeguards. As a result, they were more willing to extend greater latitude to the Agency in interpreting its rights and obligations, though not at first. Some States strictly saw the IAEA's job as verifying States' declarations, not to conduct "fishing expeditions" to seek out undeclared material. There was also considerable political sensitivity about the IAEA's use of information acquired other than from the State itself, in particular information acquired through "national technical means".

A sign of what could be achieved came in 1991 and 1992, when IAEA Director General Blix secured three measures he deemed essential if the IAEA were to be able to prevent another State from trying to follow Iraq's example. As David Fischer, author of a new book about the IAEA, recounts: First, the Agency's

Board of Governors reaffirmed the IAEA's right to carry out a special inspection in a State that had accepted comprehensive safeguards, if needed to confirm that all nuclear material that should be under safeguards had been reported to the IAEA.

Second, the Board of Governors agreed to provide the IAEA with greater access to information. As Dr. Blix put it, the IAEA could not scour the territories of numerous non-nuclear-weapon States party to the NPT "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 States concerned.

Third, the Board of Governors agreed that the backing of the Security Council would be essential if a nation blocked effective verification of its safeguards agreement with the IAEA. That came on 31 January 1992, when the Council's President issued a declaration on behalf of its members, represented at the meeting by their Heads of State or government. The Council considered that the proliferation of all weapons of mass destruction constituted a threat to international peace and security and its members would take appropriate measures in the case of any violation reported by the IAEA.

So initially reinforced, the system was unexpectedly tested again, in the Democratic People's Republic of Korea (DPRK) in early 1992. Like Iraq, the country was party to the NPT and had concluded a comprehensive safeguards agreement with the Agency. Questions arose almost from the start, when the Agency found discrepancies concerning declared amounts of plutonium. When the Director General formally demanded a special inspection, the DPRK rejected it. The IAEA Board found the DPRK in breach of its safeguards agreement and reported it to the Security Council, which backed the Agency. Events cascaded from there, including rounds of high-level political talks between the DPRK and the United States. In October 1994, the two countries signed an Agreed Framework that included provisions to freeze key elements of the DPRK's nuclear programme and to have the IAEA verify it.

The situation largely prevails. The Agency's ongoing verification includes having inspectors continuously stationed in the DPRK, and ensuring that nuclear installations subject to the freeze are actually frozen. Other issues originally identified by the IAEA remain unresolved. The DPRK still has not complied fully with its safeguards agreement, and the Agency has not yet gained access to information needed for a comprehensive picture of the nuclear programme. Questions remain about the completeness of the initial declaration of nuclear activities. As past events have shown, how the issues are ultimately resolved may well depend upon factors outside the Agency's control.

The DPRK case seriously challenged the integrity of the system, and still does. But as author David Fischer points out, the first new verification approaches paid off:

- The IAEA detected a mismatch between the plutonium that the DPRK presented to it as products or in waste using sophisticated analytical techniques. This led the IAEA to conclude that the DPRK had understated the amount of plutonium it had separated.
- The IAEA Board of Governors 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.
- The IAEA was 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 demonstrated 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 breached its safeguards agreement, reporting violations to the Security Council.
- For the first time (except in the abnormal circumstances of Iraq) the Board 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.

TOWARDS A STRONGER SAFEGUARDS REGIME

New safeguards measures adopted this year have opened a groundbreaking new track. They are the outgrowth of governmental and IAEA efforts since 1991 to give the safeguards system more teeth — a much greater chance to discover possible secret nuclear activities. The IAEA Board of Governors in May 1997 adopted a model protocol to comprehensive safeguards agreements that grants the inspectorate broader rights of access to sites and information. States accepting the protocol will provide additional information on nuclear and related activities. Moreover, the IAEA will have greater access to activities and locations to detect clandestine nuclear programmes.

The protocol is the direct outcome of a two-part process for achieving a strengthened and more cost-effective safeguards system. Part-1, approved by the IAEA Board in 1995 and being implemented now, includes:

- Environmental sampling at locations to which the IAEA has access for design information verification or inspections. It is considered a powerful tool for detecting the presence of undeclared activities at or near declared nuclear sites.
- "No-notice" inspections at the strategic points of all nuclear facilities.
- The Agency's right of access to records of activities carried out before a safeguards agreement enters into force, to help ensure that all material has been declared. The Board in 1995 confirmed the right.
- Use of advanced technologies that can operate unattended to transmit information to IAEA headquarters.

Part-2 measures incorporated in the protocol include:

- An "expanded declaration" to provide information on activities related to the nuclear fuel cycle. This will help give the IAEA a better understanding of a State's nuclear programme, its future directions, and the kinds of nuclear activities the programme's infrastructure could support.
- Access to any place on a nuclear facility site, to any decommissioned facility, and to any other location where nuclear material is present; to nuclear-related manufacturing and other locations identified by the State in its expanded declaration; and to other locations identified by the IAEA.
- The use of environmental sampling and other measures at these locations.

It will take some years before the strengthened system is fully and generally operative. The IAEA has initiated the process of acceptance by governments, and some already are taking steps to adhere to the protocol.

In Vienna, the Agency's immediate challenge is to integrate and adequately fund its conventional and new safeguards operations, with an eye to greater overall efficiency and effectiveness. IAEA Deputy Director General for Safeguards, Bruno Pellaud, sees it as a transition to a "two lane, or two speed" safeguards system — with one lane for States having only a safeguards agreement in force, and the other lane covering States that have added the protocol to their safeguards agreements and accepted the new, Part-2 verification measures.

This new Strengthened Safeguards System, he says, will make the work of the IAEA difficult and complex. But he is convinced that with the combined efforts of Member States, the Agency's Board, and its Secretariat, the challenge will be met.

Valuable experience has been gained through trials of some measures — including remote monitoring, environmental sampling, and closer cooperation with State nuclear-control authorities — as well as through an import/export reporting scheme approved by the IAEA Board in 1992. The scheme today encompasses 52 States, including most nuclear suppliers.

—Based on papers and statements by Dr. Hans Blix, Bruno Pellaud, and Richard Hooper, Director of the IAEA Safeguards Division of Concepts & Planning and project leader of the "93+2" safeguards development programme.

Photo: Inspections in Iraq. IAEA inspector Demetrius Perricos (centre) now carries responsibilities that include safeguards in the DPRK.

As warmer winds calmed the global security environment in the 1990s, a third major test arose. In March 1993, South Africa announced to a startled world that it had dismantled its nuclear-weapons programme — before it acceded to the NPT as a non-nuclear-weapon State in July 1991 and signed an IAEA comprehensive safeguards agreement not much later. The news prompted the IAEA to augment its safeguards team in South Africa with, among other specialists, nuclear-weapon experts. The team's assignment was extended to include assessing the status of the former weapons programme and ascertaining that all its related nuclear material had been recovered and placed under safeguards.

The job to verify the correctness, and for the first time the completeness of a State's declared nuclear programme, was tough. South Africa's extensive nuclear fuel cycle required considerable resources to inspect and it required help from South African authorities for access to facilities and operating records. Over the months that followed, the team thoroughly examined detailed records, visited sites, and verified the inventories of nuclear materials in South Africa. As a result, it was able to document the timing and scope of the former nuclear-weapons programme. The work enabled the IAEA to conclude that there were no indications to suggest that South Africa's initial declaration of nuclear material to the Agency was incomplete or that the nuclear-weapons programme had not been completely terminated and dismantled.

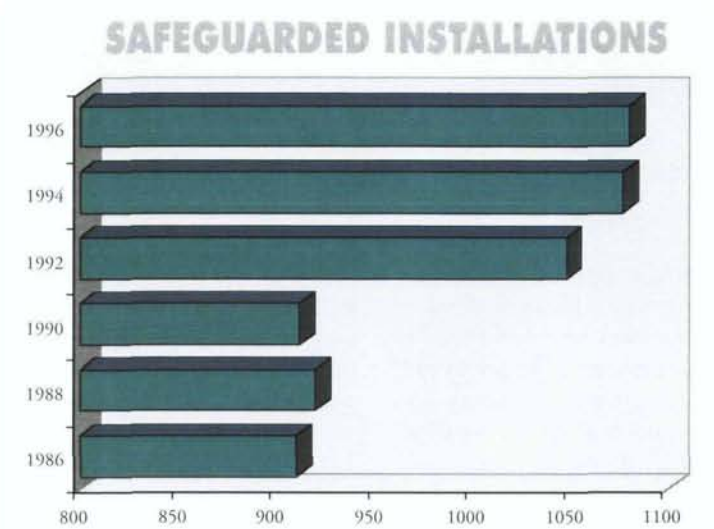
The case broadened the IAEA's verification experience, and demonstrated key factors at play. For its part, South Africa offered every opportunity for access to any location the IAEA inspectorate deemed necessary to fulfill its tasks. This enabled the Agency to effectively apply new verification techniques and make valuable use of external information. As importantly, the case helped show what is possible when a government credibly pursues a policy of nuclear transparency.

Behind the headline cases were less highly publicized demands on the regime, including the safeguards component. The dissolution of the Soviet Union in the early 1990s meant that Russia and three newly independent States would have nuclear weapons on their territories — Belarus, Kazakhstan, and Ukraine, each of which since has opted to join the NPT and accept comprehensive IAEA safeguards agreements. It also brought the issue of stopping illicit nuclear trafficking to the global and IAEA agendas. *(See box, page 10.)*

Elsewhere, the Agency's role was being recast as more States formed nuclear-weapon-free zones that call for IAEA verification. New regional zones since 1985 include those in the South Pacific (Rarotonga Treaty), in South East Asia (Bangkok Treaty), and in Africa (Pelindaba Treaty). They join zones set up earlier in Latin America and the Caribbean (Tlatelolco Treaty), as well as those in regions having no human populations (Antartica Treaty, Outer Space Treaty, and the Seabed Treaty). The zones now cover most of the Southern Hemisphere. Customizing the zonal approach, two major countries, Argentina and Brazil, codified renunciations of nuclear weapons. They opened their large nuclear programmes to joint inspections, formed a bilateral inspectorate, and in 1994 concluded a quadripartite agreement accepting comprehensive IAEA safeguards. Then in May 1995, the parties to the NPT, today numbering 185 countries, extended the Treaty indefinitely, and thereby the permanency of associated IAEA safeguards. As the 1990s draw to a close, ongoing progress in nuclear disarmament places other verification tasks on the table as warheads are dismantled. A net result is that more nuclear materials and installations have come under IAEA safeguards and verification over the past decade, as new agreements are activated with non-nuclear-weapon States, and the nuclear-weapon States seek to verify their arms cuts. *(See graphs and box at right.)*

Not lost in this changing picture is the challenge of costs. Spending for safeguards, and other IAEA programmes, has seen little growth in real terms over the past decade, and in several cases following the breakup of the Soviet Union, deep cuts were imposed that extrabudgetary contributions from some States only partly offset.

Steps to minimize costs are built into the IAEA's Strengthened Safeguards System. Measures taken or under consideration target the "optimization of resources", often linked to better use of



Nuclear installations under IAEA safeguards

modern communications, new verification technologies, and automated office systems. They include expanding the use of the IAEA's two regional safeguards offices in Toronto and Tokyo; concluding a partnership agreement for joint safeguards operations with the European Atomic Energy Community inspectorate; reducing the frequency of inspections at certain facilities; greater use of unattended measurement and surveillance equipment with remote transmission of data; considering more regional safeguards offices to save travel costs and facilitate inspections; expanded training of inspectors; and joint use of equipment and analytical laboratories by the IAEA and State nuclear-control authorities.

The steps are expected to keep the strengthened programme cost-neutral over time, once higher start-up expenses are met. Right now,

RISING STOCKS

Dismantling of nuclear warheads is releasing large quantities of plutonium and high-enriched uranium, adding to global stockpiles from civilian reprocessing of nuclear fuel and placing new demands on IAEA verification. By the end of 1996, the Agency was safeguarding materials including:

- 53.7 tonnes of separated plutonium. Just over sixteen tonnes, or about 2000 "significant quantities" (roughly the equivalent of some 2000 warheads) were safeguarded in non-nuclear-weapon States.
- 528.2 tonnes of plutonium in irradiated fuel.
- 4.5 tonnes of recycled plutonium in fuel elements in reactor cores.
- 20.8 tonnes of high-enriched uranium, amounting to 616 significant quantities. Just over ten tonnes, or about 300 significant quantities, were safeguarded in non-nuclear-weapon States.
- 48,620 tonnes of low-enriched uranium and 105,431 tonnes of source material (natural or depleted uranium and thorium).

Of all these materials, only separated plutonium and high-enriched uranium can be directly used in nuclear weapons. Still, all of the safeguarded material must be inspected and its uses verified.

In response to global concern about growing separated plutonium stocks, the IAEA began in 1993 to create a database on the amounts in civilian nuclear programmes and closely followed the work of its Member States which are in the process of identifying additional confidence-building measures relating to the safe handling, storage, and disposal of plutonium.

ANTI NUCLEAR-TRAFFICKING

A troubling concern of the 1990s surrounds the spectre of stolen nuclear materials being traded or sold on the black market. Many reported cases of illicit trafficking in nuclear materials focused global attention on the problem in the early and mid-1990s, and led to concerted efforts to combat the smuggling. In April 1996, the Nuclear Safety and Security Summit in Moscow underlined the importance of preventing the problem, and agreed on a programme of joint action.

In some areas, States have turned to the IAEA for assistance. As early as 1992, the Agency began helping successor States of the Soviet Union to apply effective preventive measures. It also encouraged them, and other States, to ratify and apply the 1987 Convention on the Physical Protection of Nuclear Materials, and to apply the IAEA's guidelines on physical protection, to guard against the theft or diversion of nuclear material in global transport and at nuclear facilities.

The IAEA's programme against illicit trafficking covers a number of components related to prevention, response, training, and the exchange of information. While national authorities carry the responsibility to combat illicit trafficking in their countries, effective action requires close cooperation among States and international organizations. Over recent years, States have asked the Agency to assist relevant national authorities and regional and global organizations in various ways. The programme includes the development and operation of a reliable database on incidents of illicit trafficking. Since October 1996, the Agency has provided authoritative summary information of confirmed cases to its Member States and certain international organizations working with the IAEA on the problem. Most confirmed cases so far, about 150 over the 1993-97 period, have involved low-enriched or natural uranium in small quantities and radioactive sources. Some cases have involved high-enriched uranium or plutonium. Attempts have been made to illegally sell the materials. Also, cases involving weapons-grade material in small quanities deserve attention in the context of non-proliferation, since larger quantities of nuclear material having strategic value could be accumulated. In general, the unauthorized use or movement of radioactive material can endanger the lives of people handling it and can threaten public safety.

The IAEA plans to continue assisting countries in the development of national systems for the control of nuclear materials and providing technical support related to areas of physical protection. Also planned is continued interaction with Member States and international organizations, such as customs and other authorities mainly responsible for detection, prevention, and control.— *Based on reports by Svein Thorstensen and Anita Nilsson.*

future financial needs are hard to pin down, though it's clear more resources are needed. One major uncertainty: how many States, and when, will accept the new verification measures and allow the IAEA to start implementing them.

After years of negotiations stalled in Geneva, a Comprehensive Test Ban Treaty was approved and opened for signature by the UN General Assembly in September 1996. The organization to verify the commitments of States party to the Treaty is being set up in Vienna. Though prospects for the Treaty's early entry into force are cloudy, it has near-universal backing to drive a deeper nail into the coffin of nuclear testing.

Up ahead may be an agreement to cut off the production of fissile material for nuclear weapons. If one is concluded, as David Fischer points out, more materials could come under IAEA verification from the five declared military nuclear powers — China, France, Russia, United Kingdom, and United States — and the three remaining States that are operating unsafeguarded nuclear plants, India, Israel, and Pakistan. Pending future treaty provisions, the States may be required 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.

During the decade, States entrusted the IAEA inspectorate with new tasks for the international verification of arms control and nuclear disarmament. It already verifies about twelve tons of ex-military plutonium and highly enriched uranium in storage in the USA. Under a Trilateral Initiative with the USA and Russia, the dimensions of further verification arrangements are being closely examined for fissile materials released from weapons programmes.

No one should under-estimate the new assignments, notes Bruno Pellaud, IAEA Deputy Director for Safeguards. In remarks at an International Policy Forum in the USA earlier this year, he reviewed major issues confronting the global community:

"The process of nuclear disarmament will pose challenges to domestic, regional, and international security, to economic growth and to environmental protection. Even the beginning steps being taken by the United States and Russia are not without problems: dismantling the tens of thousands of warheads is creating a surplus of plutonium and highly enriched uranium which is no longer needed for defense programmes, and that plutonium and highly enriched uranium demands protection and prudent disposal. Concerns remain that those materials might be stolen through force or guile, or that relations between the United States and Russia might sour and today's surplus materials might be used to jump start a resurgent nuclear arms race.

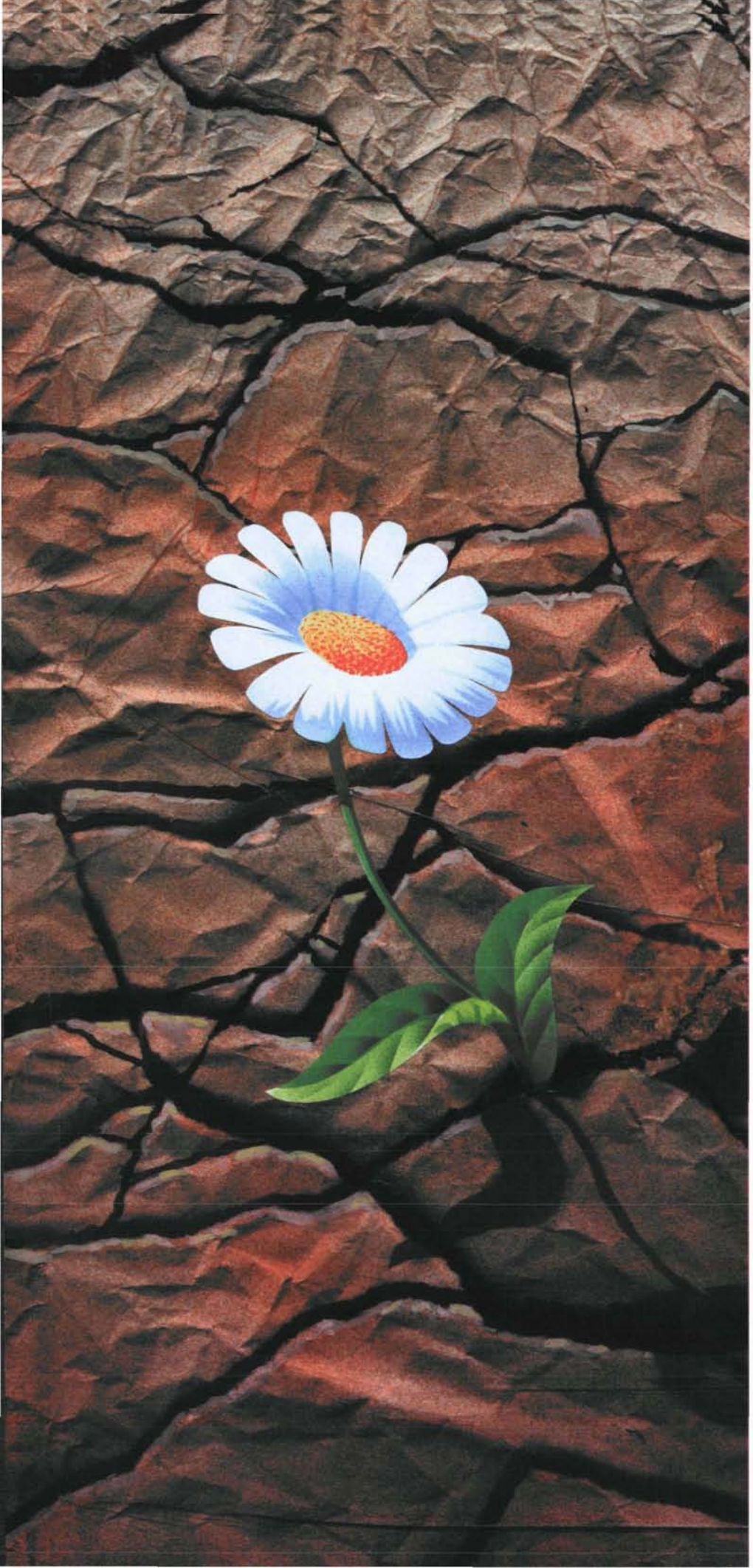
"If the storage and disposition of those fissile materials is carried out in a prudent manner, Russia and the United States may agree to further arms reductions, other nuclear-weapon States may begin to reduce their arsenals independently or in lock-step, and the international community will be more effective in efforts to prevent any further proliferation of nuclear weapons.

"The international community, in particular the IAEA, will need to find ways to meet the challenge of a verification assignment that goes beyond the experience accumulated so far in the area of non-proliferation."

Concerning the IAEA's emerging role, he said that preliminary work has started, within the framework of the Trilateral Initiative, to set up a verification system that "may ultimately parallel the non-proliferation IAEA safeguards system". He emphasized that talks are still in early stages, with many legal, technical, and financial details to be worked out on questions related to the nature, scope, and specific requirements of verification. The overall objective is to provide credible assurances that fissile materials submitted for verification are not used again for nuclear explosive purposes.

—Lothar Wedekind, based on contributions, papers, and articles by Dr. Hans Blix, Bruno Pellaud, Dr. Mohamed ElBaradei, Ms. Jan Priest, Ms. Laura Rockwood, Richard Hooper, Dirk Schriefer, Ms. Merle Opelz, Berhan Andemicael, David Fischer, David Sinden, Thomas Shea, Ms. Anita Nilsson, Garry Dillon, Demetrius Perricos, Adolph von Baeckmann, and Svein Thorstensen.

Photo: A storage facility being built near Ozyarsk, Russia will house material from dismantled nuclear weapons. President Yeltsin has said the IAEA will be asked to verify that this material is not reused for weapons. Recently Director General Blix (left) and senior IAEA officers met with Russian officials and visited the construction site. (Credit: IAEA)



FROM DR

Atomic energy inspired high and lofty dreams generations ago — of electricity so cheap to generate that people everywhere could have it...of cars, trains, and flying machines that would run on longlife powerpacks...of desalting ocean waters and turning arid deserts green. As David Fischer recounts in his rich history of the IAEA, many people then so fiercely awakened to the atom's dark side in the warn-torn 1940s later strongly embraced the 1950s cause of harnessing its brighter future. Winston Churchill saw the peaceful atom as a "perennial fountain of world prosperity". He was not alone among the day's politicians or scientists.

Alongside deep fears and stark realities of the post-war years, those early dreams set the imperatives, popular images, and expectations for the peaceful development of atomic energy, and the roles of the IAEA. Not all the dreams withstood the tests of time, and some died early. But many more were studied, pursued, and demonstrated in research laboratories, hospitals, and farmer's fields. They yield lasting results societies benefit from today.

The past decade's major events and political changes transformed the global picture significantly, and left their signature on the IAEA's programmes for peaceful nuclear cooperation. Chernobyl, the Gulf War, the Iraq inspections, alarms over global warming, health problems of "hidden hunger", agricultural threats in Africa and Latin America, concerns over radiological safety at

EAMS TO NEW REALITIES

old nuclear dumping and testing sites in the Arctic seas and the South Pacific— all commanded action. They tested the capabilities of nuclear-based tools and the readiness of the IAEA to mobilize its own and others' analytical, laboratory, and technical resources for investigating, solving, and preventing serious problems.

Now, as the decade unwinds, nuclear technologies, like many others, increasingly are tested on commercial and developmental, not military, fronts. The world's changed global security climate and rising concerns about social and environmental threats to the earth's "sustainable development" are key reasons why. States meeting at the UN's Earth Summit in Rio in June 1992 set targets for the next century, adopting the document called Agenda 21. They revisited the Agenda — examining water, food, environmental, and other problems — and gauged progress at a UN special session in June this year. On many key issues, they found the distance to go long and hard, the politics difficult, and the costs high.

At another key event — when Parties in May 1995 gave permanent life to the Treaty on the Non-Proliferation of Nuclear Weapons and associated IAEA safeguards agreements — States strongly reaffirmed governmental interest and support for global nuclear cooperation through IAEA channels. They lauded Agency approaches and initiatives for the transfer of peaceful nuclear technologies, especially for strengthened technical cooperation and nuclear safety programmes. Renewed efforts were needed, they said, to adequately fund and support them.

So newly challenged and directed, today's global picture is framed in familiar fields of long-held dreams and new realities. The dream of health for all...and the reality of child malnutrition. The dream of food in every hand...and the reality of eroding soils. The dream of fresh water to drink...and the reality of drying wells. The dream of a safe environment to live in...and the reality of polluted air.

Nuclear energy — fresh from long years of being saddled and strained by polarizing images of "mushroom clouds" and "perennial fountains"— can make new and important contributions for sustaining basic human needs. Proven tools and expertise are at hand. Supported through targeted IAEA projects, people in countries around the world are demonstrating how their dreams to overcome some hard realities can drive and sustain their own futures, and their nation's social and economic development.

—Lothar Wedekind

Mansour Shahein and his family are part of a modern day "atomic" dream in Maradja, Egypt. On a farm in arid countryside, they grow wheat, fruit trees, sugar cane and other crops on lands that once were desert. Their fields, and others like it in this oasis village, rely totally on water tapped from seventy kilometres underground. Where the water comes from — seepage from the Nile river or an aquifer deep below the sands— and how long the wells will last, no one yet knows. They are now beginning to find out. Egyptian hydrologists are gathering data about the groundwater's origins and capacity using isotopic methods of investigation. What they learn will help them better manage the water supply or identify other sources that can prolong the years of harvests for Manzour and farming families

in Maradja. The IAEA is supporting their efforts through a regional water project extending beyond Egypt to Morocco, Senegal, and Ethiopia. Less than one percent of the world's total fresh water resources is found in the Middle East and North Africa. As scientists explore their region's water lifelines, isotope techniques could hold the answers to sustain scarce and fragile resources.

—based on a report by David Kinley, IAEA Division of Public Information.

FOOD FOR MORE OF THE WORLD

By sheer numbers alone, the challenge is daunting. About 840 million people — one of every five women, men, and children in developing countries — are hungry and malnourished. Less than thirty years from now, an estimated 680 million more hungry people, mostly in our poorest societies, will live among the world's projected population of 8.3 billion. The bottom line: the food we produce has to be better conserved and distributed, or otherwise food production has to grow by more than seventy-five percent between now and then.

Solving food problems is not easy, and all the tools and knowledge at our disposal are needed. Over the past decades, important strides have put more food in the hands of people. Food production has grown, in some countries dramatically. Overall, each of today's 5.8 billion people has more food than people had twenty years ago, when the world's population was four billion. Yet clearly much more needs to be done.

The IAEA's work over the past decade, jointly with the UN Food and Agriculture Organization (FAO), has faced different sets of challenges. In some countries, specialists have zeroed in on technically helping them to protect and preserve the food resources they have, and prevent losses of indigenous crops and livestock to pests or disease. Elsewhere, the target has been on ways for enriching harvests through plant, soil, water, and other food-related research. (*See report page 16.*) Countries have attained significant results in the process.

Soil scientists in Bangladesh and Zimbabwe are applying nature's ways to overcome problems of crop nutrition. Over the past decades, they further demonstrated the effectiveness of using natural "biofertilizers" to increase crop yields. Their work involves fertilizers produced by rhizobia bacteria. Detailed studies to analyze crop nutrients and growth are done using isotope techniques. When rhizobia treatments are applied to seeds of suitable pulse crops, such as peas or soybeans, they stimulate the production of root nodules that can biologically produce nitrogen from the air and stimulate plant growth. Zimbabwe field trials have shown that rhizobium biofertilizers more than doubled soybean yields, out-performing crop fields treated with expensive ammonium nitrate fertilizer. In Bangladesh, studies found that the biofertilizers typically can increase the harvest of grain legumes by about one-fourth. Larger scale production, now planned through a demonstration plant, could lead to potential savings of about US $30 million a year by reducing the country's need to import grain and chemical fertilizers. The IAEA has launched separate model projects in Zimbabwe and Bangladesh to further support national efforts.

In Asia overall, grain legume production has grown by an average of twenty-five percent using biofertilizers. Pakistan recently introduced one for rice estimated to bring benefits of $133 million annually in terms of higher yields and lower use of chemical fertilizers.

In Romania, farmers have benefitted from other types of isotope studies, ones directed at more efficient use of chemical fertilizers. By tailoring field applications of nitrogen and phosphorus to the studies' results, farmers achieved yield increases for maize worth $217 million a year — and saved $60 million in fertilizer costs.

In Mexico, the USA, Libya, Tanzania's Zanzibar Island, Chile, Belize, Guatemala, Honduras, and El Salvador, project teams have successfully battled insect pests threatening crops and livestock. A key common tool of the campaigns: the radiation-based technology known as the sterile insect technique (SIT), a biological method developed at the Agency's laboratories and transferred to the field by FAO/IAEA technical staff and scientists. The com-

bined value to agricultural economies from the use of SIT in these campaigns exceeds $3.5 billion per year.

Most benefits accrue from campaigns in the USA and Mexico, where the New World Screwworm, a fly which attacks livestock, was eradicated in 1991. The pest found its way to Libya in the early 1990s, and was eradicated there in 1992 at a cost of $60 million. The timely campaign saved North Africa's agricultural economies fifty times as much as it cost, in terms of losses avoided and benefits gained. Another devastating insect, the Medfly, was eradicated in Chile, netting the country benefits valued at $500 million per year, mainly through access to Asian export markets.

In Zanzibar — where the battle is against tsetse flies and the disease trypanosomosis it can inflict — the families of Jozani village measure benefits of eradication in other ways. Before the campaign about ten years ago, they simply saw no cattle around because of the constant threat of disease. Today the community rears more than 300 head of cattle for meat, milk, and hides. An IAEA-supported project is now providing technical assistance for SIT's use against the tsetse fly on mainland Africa, starting in Ethiopia.

Elsewhere throughout Africa, the challenge is to free livestock from another serious health threat, rinderpest or "cattle plague". When the regional eradication campaign began in the late 1980s, the disease was found in fourteen African countries. Today it is restricted to relatively isolated pockets, where IAEA-supported animal vaccination programmes and disease monitoring are being done. Such high levels of immunity have been achieved that it's been possible to stop mass vaccination, saving several hundred million dollars a year. Some of the twelve countries in an IAEA project have or will soon make international declarations of freedom from rinderpest. Once all do likewise, Africa could realize economic benefits to agriculture of over $900 million a year.

In China and Peru, a common challenge is to boost crop production. Plant breeders are using mutation techniques to help meet specific needs. In China, among the latest achievements stand eleven new rice varieties. They were planted in fields of a million hectares over six provinces. Rice production there grew by 380,000 metric tonnes, at an estimated value to farmers of more than $50 million. In the oxygen-thin Peruvian highlands, new varieties of cereal signal harvests even under a harsh and variable climate. Seeds of a mutant variety of barley Peru produced now are being distributed to 200,000 people resettling Andean farms. Within three years, they should be growing on about 40,000 hectares of highland.

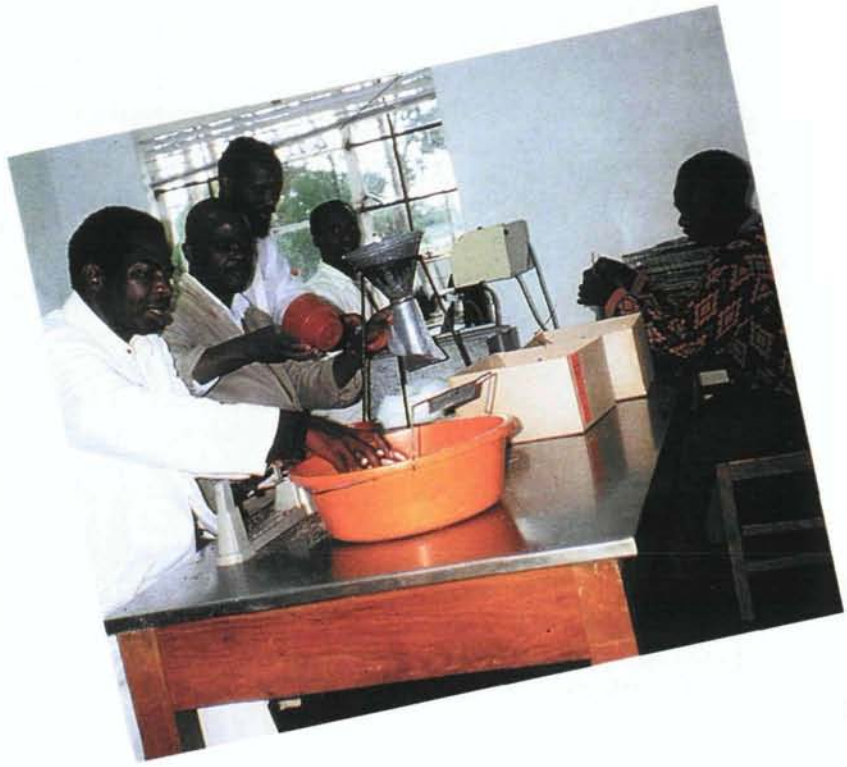
These achievements show the Agency's multi-dimensional roles and the practical benefits that nuclear tools can help countries attain. Results are closely linked to team efforts typically engaging expertise and resources among IAEA partner organizations and scientific networks, spearheaded by the Agency's Seibersdorf Laboratories through its joint FAO/IAEA laboratory and other branches. The transfer channels extend to three regional arrangements for countries in Asia and the Pacific, Latin America, and Africa, where twenty-one countries have joined since 1990. A key is research, and over the past decade, the IAEA directly financed research and demonstration activities valued at over $43 million. Nearly 2000 research contracts and agreements were put in place in some ninety industrialized and developing countries, in agriculture, hydrology, and a range of other fields.

Over the past thirty years, global food production has grown about eighty percent, serving more of the world. Over the next thirty, projections are it needs to grow another seventy-five percent. Just to keep up. — *Lothar Wedekind, based on reports by James Dargie, Royal Kastens, David Kinley, Ali Boussaha, and Paulo Barretto.*

Photo: Green fields in Zimbabwe. (Credit: Kinley/IAEA)

ADVANCING RESEARCH

Research in agricultural fields keeps advancing in the 1990s, and IAEA and FAO scientists working with counterparts worldwide are contributing in important ways.



ANIMAL HEALTH

About ten years ago, scientists realized that a nuclear-based diagnostic technique — enzyme-linked immunosorbent assay, or ELISA — could overcome many technical problems and be effectively applied for nearly all major diseases affecting livestock in developing countries. In the 1990s, the Joint FAO/IAEA Division developed methodologies and approaches for transferring ELISA technologies efficiently. Standardized and validated kits tailored for the developing world now are used by authorities in seventy countries, including many engaged in an intensified global campaign against rinderpest, or "cattle plague". The ELISA technique today is a key management tool to monitor progress in support of other animal health campaigns worldwide: foot-and-mouth disease, which has been eradicated from Europe, Indonesia, and Uruguay and is being wiped out in the Americas; brucellosis, where a blueprint now exists for its eradication across Europe and Arabia; trypanosomosis, nearing eradication in Zanzibar and now targeted for elimination in parts of Ethiopia.

SOIL&WATER

About two-thirds of all river water is used for agriculture, and scientists are looking closely at how to achieve more with less. Through IAEA-supported research, they are studying a practice called "deficit irrigation" using neutron probes to investigate and evaluate soil moisture and crop water requirements. So far, some positive results have been seen. In Argentina, researchers found that cotton growers could achieve high yields by using half as much water during the vegetative and flowering stages, and no irrigation whenever the soil moisture content is ninety percent or higher. In Brazil, irrigating with half as much water at certain growth stages netted higher yields for bean and corn crops. In Morocco, the technique was applied to develop better water management schemes for sugar-beet and wheat.

PEST CONTROL

Through work of the IAEA's Seibersdorf Laboratories, the radiation-based sterile insect technique (SIT) has become the bane of pests ravaging crops and threatening animal and public health. Over the past decade, working through global research networks, scientists have zeroed in on biotechnological approaches to improve the applicability and effectiveness of the technique against fruit flies, specifically the Mediterranean fruit fly, or Medfly. They now have developed a genetic technology designed to optimize the rearing of male flies and reduce the overall costs of applying SIT in the field. In other research, scientists recently recorded the first confirmed case of genetic transformation in the Medfly, a breakthrough that offers the chance to develop strains of the species that can be more effectively and economically used for insect control campaigns incorporating SIT.

FOOD SAFETY

National laws and global trade agreements require food to be free from contaminants that provide unacceptable risks to human health, and in more

and more cases, consumers also are demanding that the food they buy causes no undesirable environmental effects. Taken together, these developments have intensified research to monitor food, water, and other environmental materials for chemical contaminants (including biotoxins), and in the case of food, pathogenic microorganisms as well. Easy to see is that the number of analyses is enormous. Conventional methods usually require expensive equipment and reagents, and they are time consuming. Now being more closely looked at is the use of immunoassays as screening methods for organic contaminants, such as pesticides, which offer advantages in terms of costs and time for analyzing large numbers of samples. But the method holds disadvantages as well, and scientists involved in IAEA-supported research are examining technical factors affecting potential applications, as well as potential costs. In the case of pesticides, the cost of developing an assay is about $100,000. Nevertheless, kits for over thirty pesticides are now commercially available that in some cases show a cost saving of three hundred percent compared to one alternative method. Another potential screening tool widely used in other fields, thin layer chromatography, or TLC, is gaining a fresh look for monitoring pesticide residues from advances in biotechnology. Methods have been developed that adequately check if a foodstuff complies with international food safety requirements, and scientists in twelve countries now are evaluating the methods under a newly started research project.

IMPROVING CROPS

Known as plant or crop breeders, scientists have tried since civilization began to develop and cultivate the world's crops, numbering about 80,000 edible plants today. It's a hard job: after centuries of painstaking work, less than thirty species, but thousands of varieties, provide nearly all the world's food. Over the past decade, DNA probes and related molecular biological methods, combined with mutation techniques and diagnostic radioactive isotopes, particularly have quickened the pace through greater understanding of plant variations. Laboratories in developing countries are engaged in work through an FAO/IAEA programme that facilitates the transfer of DNA probes and methods. Advances in using radiation-based techniques also keep being recorded. One technique now is used to develop varieties of date palm resistant to Bayoud disease in Algeria, Morocco, and Tunisia where fifteen million trees have been killed by the fungal pathogen. As a result of research combining induced mutations, conventional breeding techniques, and biotechnology, new varieties of linseed, rapeseed, soybean, and sunflower are becoming commercially important. Two new varieties of linseed were registered in Canada in 1993 and 1995. Over recent decades worldwide, scientists at the Agency's Seibersdorf Laboratories have irradiated about 22,000 samples of seeds, vegetative materials, and *in vitro* cultures that were sent to laboratories in over 100 countries, including seeds used for molecular biology research. Worldwide, over 1800 mutant varieties of crops and plants have been developed, most of them using radiation-based techniques.

FOOD QUALITY

Research over the past ten years has more firmly demonstrated that the technology of irradiation is safe and effective for ensuring the hygienic quality of food, especially products such as chicken, seafood, meat, and spices. Recent advances have enabled its application as a quarantine treatment of fresh fruits and vegetables against insect pests; research was jointly sponsored by the IAEA, FAO, and World Health Organization. National and international food regulatory bodies have moved in the 1990s to endorse irradiation, issuing standards and policies governing its wider application. A major breakthrough came in May 1996. The United States Department of Agriculture accepted irradiation as a quarantine treatment against fruit flies in fruits and vegetables, enabling national trade from Hawaii to mainland states of papaya, lychees, and other commodities. The action is heightening interest in the technology among developing countries seeking expanded global markets for their products.

— Based on reports contributed by Raymond Nance, Paisan Loaharanu, Felipe Zapata, Martyn Jeggo, and other staff of the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture.

Photo: Scientists at the Soil Productivity Research Laboratory in Marondera, Zimbabwe, work closely with the IAEA in agricultural fields.

BRINGING BENEFITS HOME

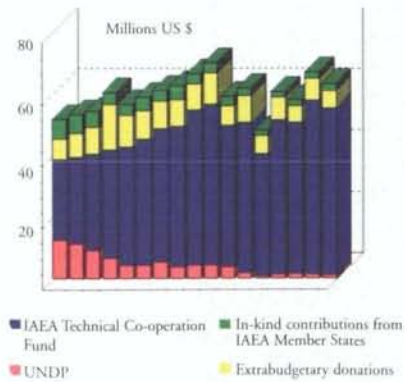
Countries in the developing world have received almost US $800 million in IAEA technical support over the past forty years. In 1958, technical programmes aimed at building national capacity in nuclear science and technology were carried out in forty-two countries. By the end of 1996, new and more targeted programmes reached ninety-five countries. These activities — all financed from voluntary contributions of Member States — are now increasingly aimed to produce greater social and economic benefits for the farmer and environmentalist, physician and patient and other end users of nuclear science and technologies. The challenge of redefining the Agency's strategy for technical cooperation was set in motion in 1994 by a Policy Review Seminar of Member States. The focus was on three themes: strengthening radiation protection and waste management infrastructures; the need for systematic country planning; and increasing the impact of IAEA technical cooperation by reaching the technology's end users. For guidance, a Standing Advisory Group on Technical Assistance and Cooperation was formed with representatives from Member States, to help ensure that new targets are met.

Becoming a partner in national development is a new thrust of the IAEA's technical cooperation programme. But the Agency is not a "development" organization, and it has no related field offices or large pool of funds. Its traditional role has been catalytic — in areas of research, development, and demonstration of nuclear-based "solutions". Expanding these benefits beyond the demonstration phase requires funds, project management, and operational support that exceed the Agency's traditional resources. "Partners in Development" is the new term for the process of connecting technology to the end users, and the active engagement of a broader community of interests. A new generation of "Model Projects" launched over the past decade represent the wave of the future. They must meet tough criteria: respond to priority national and regional needs; produce sizable economic and social impacts; employ nuclear technologies only when they have distinct advantages over others; and attract strong governmental commitment. As such, they stimulate a "problem solving" approach, and a very intensive dialogue between the Agency and governmental partners, so that the projects reach well beyond the counterpart institutions to beneficiary communities and their citizens.

The Agency has launched several broader policy initiatives to better coordinate the uses and applications of nuclear technologies for greater economic and social impacts. In years to come, the Model Project approach will be expanded through "Country Programme Frameworks" that identify priority activities in each developing Member State, and "thematic planning" that singles out the most significant technical solutions for duplication across several countries. These new mechanisms will ensure that IAEA development partnerships are focused on where they can produce the greatest benefits. The first thematic plan now becoming operational is in radiation protection — meeting the Agency's Safety Standards that are a statutory pre-condition for all activities involving ionizing radiation. Significantly, one of every three Model Projects proposed for 1997-98 reflect radiation safety priorities.

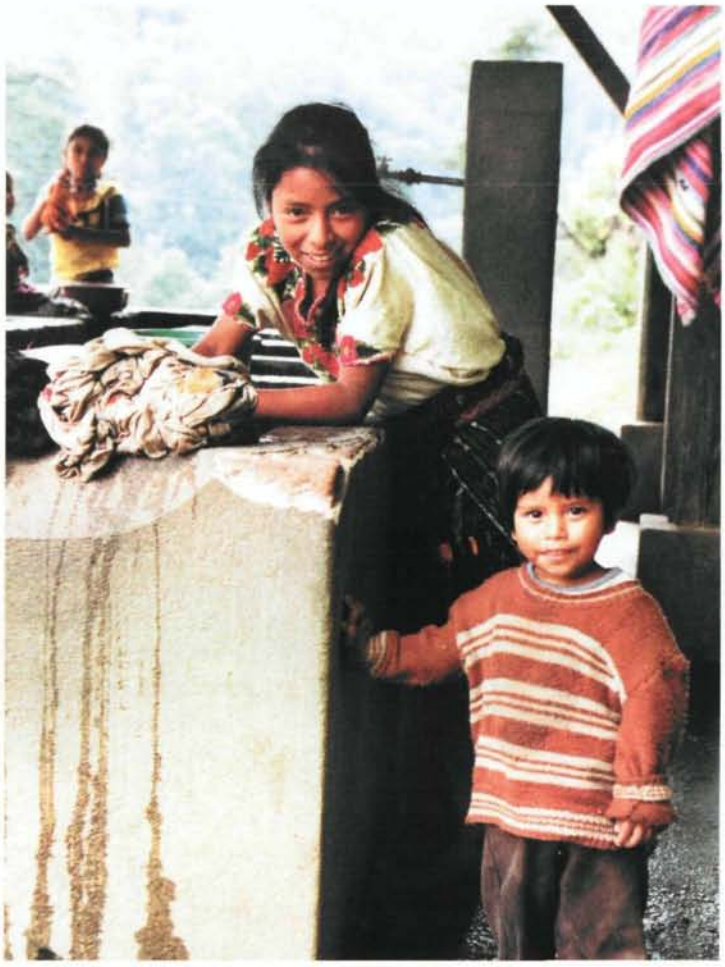
In some countries, the combination of increased investment, demonstrated technology, and a more vibrant commercial sector is moving the development process forward quickly; in many others, it will take more time. The past decade has seen the IAEA better position itself to meet the needs of its Member States, regardless of their level of development or technological sophistication.

—Based on reports by Mr. Qian Jihui, IAEA Deputy Director General for Technical Cooperation, and Royal F. Kastens of the Department.



$2.01 was the amount 12-year-old Joseph Santore and his friends gave the IAEA back in 1958, to help kick off contributions for the Agency's technical cooperation work. Today's resources top $60 million in support of over one thousand projects. Yet the challenge remains to effectively fund activities, and the 1990s saw some hills and valleys that negatively affected programmes. The Agency and its Member States are looking closely at trends and ways to maximize efficiency and stabilize available resources.

SUSTAINING WATER LIFELINES



Faces around the world visibly frame the imperative of sustaining our freshwater resources:

- More than one in four people still lacks clean water supplies.
- On a global scale, the rate at which we are withdrawing freshwater resources is more than double the rate of population growth.
- Nearly seventy percent of all freshwater is used for the rising demands of food production.

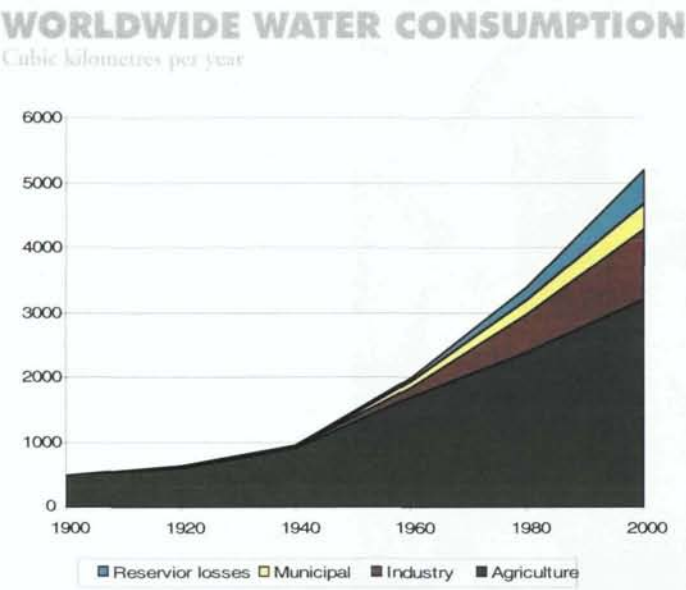
Behind the numbers are special problems in growing population and industrial areas. There, pressures on resources are mounting, and freshwater often has to be transported from dammed reservoirs far away, or carried in vessels from distant wells. In many areas, local rivers and groundwater are new homes of chemical and other sources of pollution.

For the IAEA's technical support cadre, the realities are confronted on local, national, and regional levels in more and more countries. Work has correspondingly intensified over the past decade to sharpen capabilities for assessing, monitoring, and preserving water resources with the tools of isotope hydrology. Central aims have been to assist water authorities in using these techniques to improve the efficiency of water use, identify and prevent sources of pollution, and map the birth and life expectancy of groundwater resources. Some 150 technical cooperation projects totalling $19 million were put into action over the past decade to assist altogether sixty-three countries in water-related areas. In the process, more than 550 young scientists have been trained to apply isotopes in investigations to improve the management of water and other natural resources in these countries. At the same time, countries have renewed their interest in technologies for producing more water, specifically in the use of nuclear energy for desalting seawater, an old atomic dream that is nearing tests of the marketplace again. *(See box, next page.)*

A large part of the earth's water resources is not safe, clean or renewable, and finding new reserves is costly. Often, the technology is not yet at hand to economically exploit potential resources locked deep inside the earth's crust. Experts say that greater steps are needed to conserve and use water more efficiently,

Photos: Children at an old well in Guatemala. (Marshall/IAEA).

FRESHWATER FROM THE SEA



Economics are changing — water is an increasingly expensive commodity — and the technology is advancing rapidly. As water needs mount in large regions of the world, experts over the past decade have started looking more closely at systems to tap abundant oceans and seas. Among the candidates are facilities coupled to nuclear power plants that produce the electricity for the energy-intensive process of desalting seawater. The idea is not new: nuclear desalination was explored decades ago, and demonstrated in Japan and Kazakhstan. But for the wider water marketplace, it was too expensive. The method still is costly, but the gap is closing. Costs generally have become competitive with those of alternative desalination systems using other sources of energy supply.

Through IAEA programmes, more than twenty countries are involved in assessments of the technology's potential. One study focused on North Africa, analyzing needs and possibilities in Algeria, Egypt, Libya, Morocco, and Tunisia. Analysts found that nuclear seawater desalination could be a technically and economically feasible option. In the mid-1990s, efforts intensified to more closely look at the economic competitiveness of systems. Many desalination and reactor systems were screened, leading to identification of three practical options for demonstration plants.

Future cooperative projects now are planned in countries including China, India, the Russian Federation, and the Republic of Korea, which recently hosted an international symposium that reviewed the latest technological and economic developments in the context of water needs. Large-scale use is some years away, but more demonstration plants for desalting seawater may soon line shores.— *Based on report by Toshio Konishi.*

and IAEA-supported research is leading to some solutions in agricultural fields. *(See report on page 16.)*

Other water-saving measures include improving irrigation techniques and preventing water losses as high as forty percent from transportation, distribution, and storage systems. At the core of solutions stands our knowledge of earth's water cycle, and how freshwater resources are renewed. A longstanding network of monitoring stations the IAEA runs with the World Meteorological Organization collects key data on the isotope content of rainwater. They are used for regional and global circulation models. Analysts can investigate how the earth's changing climate affects the sustainability of our water resources. The pioneering databank today serves as a global reservoir of pooled knowledge that can lead to greater understanding of how earth's dynamic cycles recreate and renew our water supplies.

Strides have been made to bring water to more people. By 1997, the world's collective efforts in the 1990s had given nearly 800 million more people access to safe drinking water. — *Lothar Wedekind, based on reports by Yuecel Yurtsever, David Fischer, and Royal Kastens.*

HEALTH FOR ALL: REDIRECTING THE VISION

Noble and all too needed, the goal of "health for all" into the next century has driven the medical profession to new heights throughout the past decade. In its latest global status report, the World Health Organization reports significant progress in campaigns against a body of major human diseases — including smallpox, polio, leprosy, and the disabling Chagas disease.

But changing patterns of how and where we live have brought other, in some ways more troubling, challenges to national and global health agendas. Many problems are attributed to negative ripple effects of urbanization — overcrowded cities, polluted air and water, poor and unsafe living conditions, and strained health resources, especially for preventive care. Cancer became a serious and more visible problem in developing countries. So, too, did "hidden hunger", or malnutrition, particularly in children; illnesses linked to food contamination; deaths from re-emerging infectious diseases such as malaria; and sickness caused by health dangers in our environment.

At the start of the 1990s, more than 600 million men, women, and children lived in large cities in developing countries that are threatened by lack of food, water, and adequate health care. More than half of the developing world's citizens could be concentrated in urban areas when this decade closes. Undeniable interconnections between political, social, and economic conditions, and the state of our health, emerged magnified from the decade.

The fast-developing picture accelerated the need to find out more about the detection, prevention, and treatment of diseases. More countries turned to the IAEA's expertise and specialized health and analytical services. IAEA health-related projects today number 175, up seventy-five percent over the past fifteen years. The investment is valued at nearly $48 million over that period for improving national health-care capabilities at hospitals, clinics, and laboratory facilities. By the mid-1990s, most of the Agency's 125 Member States had set up medical programmes involving uses of nuclear tools, ranging from radiopharmaceuticals, to nuclear analytical techniques, imaging systems, and radiotherapy.

Especially in the 1990s the Agency's programmes in human health have adjusted to better fit the changing needs and conditions. Outreach efforts were broadened and objectives finetuned for specific problems that can best be met by nuclear techniques. Among them stand the early diagnosis and treatment of cancer, the assessment of nutritional deficiencies in women and children, the timely detection of communicable diseases, and the accurate measurement of radiation doses to patients.

The upswing in demands and related programme adjustments are opening new windows of opportunity for better health care through nuclear applications in more countries. They also identified new doors that must be unlocked to sustain progress.

● Diagnosis and treatment of cancer has advanced considerably over the past decades. In industrialized countries, "cure" rates have doubled since the IAEA was formed in the 1950s, achievements generally attributed to earlier and better diagnostic screening and to advances in surgery, radiation, and chemotherapy treatments. In developing countries, however, more help is needed as cancer takes a stronger hold. With national research teams, the IAEA is coordinating clinical trials in radiotherapy to improve treatment and control of the disease. New treatment centres also are being supported. In Mongolia, nearly 2400 patients were treated at a new teletherapy centre within its first five months. In Ghana, the first of three planned radiotherapy centres now serves cancer patients who otherwise had to seek expensive

Photo: Children in Viet Nam. (Tuong Linh for UNESCO/ACCU)

treatment overseas, or go without it. To evaluate radiation treatments against global standards, a joint IAEA/WHO programme has expanded its network of services.

In Thailand, Uruguay, and other countries of Asia, Latin America, and Africa, communities need help for potentially crippling children's health problems. Some notable strides are linked to greater use of highly sensitive nuclear techniques, sometimes teamed with biomedical methods. Their reliable and affordable application now is supporting effective national screening programmes of all-too-common thyroid deficiencies in newborn babies and children.

Because its effects are too often masked and overlooked, "hidden hunger", or malnutrition, can take on serious proportions. By the mid-1990s, health experts reported that nearly 800 million people in developing countries were chronically undernourished. Most at risk are women and children living in poverty. Though nuclear-based techniques are no substitute for nutritional deficiencies, they do support improved health monitoring and research programmes to uncover and prevent cases of hidden hunger. Joining with global partners, IAEA-sponsored research and field projects now extend to more than thirty countries. The work has identified improvements to the dietary treatment of severely malnourished children and alerted health practitioners to specific diet deficiencies of protein, vitamins, zinc, iron, and iodine needed for proper nourishment and growth. As importantly, it has led to stronger public health programmes in more countries, including Chile, Sri Lanka, and Venezuela, for setting nationally recommended nutritional requirements. Now planned is distribution of a "toolkit" of proven isotope techniques that countries can readily use in their nutrition programmes.

More needs to be known about the causes and health effects of environmental pollutants contaminating our air, water, and food. Over the past decade, more than forty countries have intensified cooperative research and analysis of non-radioactive pollutants, including mercury and pesticide residues, through Agency programmes. Air pollution, particularly fine particles, has drawn close attention, since particulates can settle deep in lungs, potentially causing serious illness or death. Findings add to valuable data shared through an established global network of centres that collects and analyzes airborne samples. The work helps health and environmental authorities more effectively identify and monitor pollutants as part of health protection measures.

In different ways, other types of radiation technologies are being used to remove pollutants from industrial emissions before they enter the atmosphere. One method, known as electron beam processing, gained ground over the past decade through demonstrations in several countries with Agency support. In Poland, an industrial-scale demonstration plant for removing sulphur dioxide and nitrogen oxide — causes of "acid rain" and linked to respiratory diseases — from emissions at coal-burning power plants. Demonstrated costs of the cleaning process are lower than conventional systems. Other countries now interested include Brazil, Bulgaria, China, and Mexico.

Alarming reports of food contamination over the past decade became a driving force

for greater interest in the technology of food irradiation. Foodborne illnesses traced to contaminated poultry and meats led the United States to approve food irradiation's commercial use for the products, since the technology cleans them of contaminating microorganisms. At the international level, Golden Rule #1 of the World Health Organization's ten-point food safety advisory issued in the 1990s encourages consumers to choose poultry treated with ionizing radiation whenever they can.

● Medical research laboratories worldwide continue to be tested by new and resurging infectious diseases. In Latin America and Africa, IAEA-supported work initiated over the past decade aims to improve diagnostic capabilities. Researchers are being trained in the use of biomedical techniques, including radioactive DNA probes, for more effectively diagnosing communicable diseases, as a step to help control them. Chagas disease in parts of Latin America, malaria in Africa, and tuberculosis in other regions are among diseases under study.

Progress is important: the re-emerging threat of malaria, for instance, still is known to strike more than 300 million people in 103 countries and claimed the lives of one million children alone in 1995. Against Chagas disease, the fight is gaining ground: WHO reports that ongoing efforts in Argentina, Bolivia, Brazil, Chile, Paraguay, and Uruguay soon will eliminate the disease.

● In Asia, eye surgeons have long been served by Sri Lanka's eye bank. More than 10,000 Sri Lankans have regained their vision with the bank's help, and surgeons in sixty countries have received tens of thousands of corneas needed by their patients. With the IAEA's assistance through a regional project of thirteen Asian countries over the past decade, such medical services are expanding. They include a new medical bank in Colombo that sterilizes membranes, tendons, and other tissues needed to treat severely injured patients such as burn victims. The bank is intended to serve health needs throughout the region.

Sri Lanka's facility reflects heightened interest among more countries in radiation sterilization of medical products for hygienic and safety reasons. By the mid-1990s, the technology had become the preferred method to sterilize about half of all the disposable needles, scalpels, and other medical supplies used in hospitals, clinics, and medical centres around the world.

Through these and other avenues, vital progress is being made to more strongly arm countries against emerging and re-emerging dangers to human health. In key applications, nuclear and related techniques can give doctors unparalleled insights into what is happening in the human body without the need for incisions or surgery. Other tools enable researchers to track and analyze causes and sources of potential health hazards, so that steps can be taken to prevent them. In no small measure, the work is helping to extend the reach of key medical technologies, to bring into closer view the global vision of health for all.

— Lothar Wedekind, based on reports by Ms. Jordanka Mircheva, Robert Parr, Ms. Carla Fjeld, John Castelino, Vitomir Markovic, G. Ghopinathan Nair, David Kinley, and Paisan Loaharanu.

Photo: Patients being helped at the National Cancer Institute in Bogotâ. (Perez-Vargas/IAEA)

CHERNOBYL'S CHALLENGE

Health affects attributed to radioactive fallout from the tragic Chernobyl nuclear plant accident in April 1986 commanded keen attention over the past decade, among the public and scientific communities alike. Key studies were done to help clarify a controversial picture greatly shaped by public fears and perceptions about the potential dangers of radiation exposure. Radioactive fallout from the accident was mainly concentrated in Belarus, Russia, and Ukraine, but it also came down at low concentrations over much of the Northern Hemisphere. Within weeks of the explosion, scientists working through the IAEA's laboratories at Seibersdorf, Austria, and at its Marine Environment Laboratory in Monaco were collecting and analyzing earth, food, water, and other samples to monitor and assess the health and environmental impact of the fallout beyond the former USSR's borders. Seibersdorf analytical teams proved instrumental in coordinating and supporting campaigns in parts of Austria and neighbouring countries. Monaco's tracking teams found that sinking ocean particles had taken Chernobyl radioactivity rapidly to depths of two hundred meters along the Mediterranean coastline within a month of the accident.

In the 1990s, the IAEA co-sponsored two projects with the World Health Organization and other global partners that included scientific assessments of Chernobyl's radiological health effects. The health teams of the International Chernobyl Project in mid-1990 included one hundred physicians and scientists from twelve countries that closely looked at only specific groups of people living in affected areas of Belarus, Russia, and Ukraine. Key technical and medical monitoring support came from experts of the Agency's radiation safety and dosimetry services at IAEA headquarters in Vienna and at its Seibersdorf Laboratories. The health teams found significant health disorders, most of them not related to radiation exposure directly but to other social, economic, and environmental factors. Roughly nine of every ten people living in contaminated settlements — and about seven of ten living in *un*contaminated villages — thought they had, or might have, an illness due to radiation exposure, even though medical examinations found they did not. The finding focused greater attention on psychological health issues raised by the accident. Teams spent most of their time with children, and found cause for real concern. Their detailed but limited examinations did not rule out the chance that cases of thyroid cancer linked to high radiation exposure would rise in the future.

In 1996, about five years later and ten years after the accident, more than 800 experts from seventy-one countries and twenty organizations reassessed the picture, from health, environmental, and other perspectives. The venue was a major scientific conference in Vienna co-sponsored by six organizations of

the UN family, including the IAEA, and two regional agencies. The landmark event served to consolidate an international consensus on the accident's consequences, report proven scientific facts, and clarify technical information and prognoses that could be, and have been, misunderstood. The major health findings addressed both short- and long-term effects.

Regarding radiation-related thyroid cancers, the experts reported a sharp increase among children from the affected areas. By the end of 1995, three children had died of the cancer, and about 800 cases had been diagnosed in children under 15 years of age, living mainly in northern Ukraine and Belarus. These effects have been the only major public health impact from radiation exposure documented to date. In the future, thyroid cancers might arise in several thousand adults who were young children at the time they were exposed to radiation from the accident. Experts recommended continued monitoring of these affected groups to detect early signs. They noted that thyroid cancers generally can be successfully treated surgically and by medication.

Long-term health effects from Chernobyl radiation exposure had not been detected by 1996, although they could not be ruled out for the future. Experts urged close monitoring of cancer registries and further investigations to determine ongoing public health impacts and to confirm predictions. Regarding psychological health disorders and symptoms, the conference confirmed significant cases of anxiety, depression, and other illnesses among affected populations. These health effects, not caused by radiation exposure, were more generally related to other factors, notably the Soviet Union's dissolution and sudden economic and political changes.

The accident's immediate victims were among the emergency workers, who were exposed to high doses of radiation. Altogether 237 workers were admitted to hospitals and 134 were diagnosed with acute radiation syndrome. Of these, 28 died within the first three months, and at least fourteen additional patients have died since 1986, not necessarily due to radiation exposure. Two other people died in the explosion, and one from presumed heart failure.

In affected areas, severe environmental impacts were short term because of rapid radioactive decay, and no sustained impacts on people or ecosystems have been observed. Environmental monitoring continues, and it's expected that low-level radioactive contamination of lands will persist for decades. Over the past decade, much work has been directed through IAEA and other global channels toward protecting people living in these areas and rehabilitating affected lands. They include radiation protection measures; medical monitoring systems; and agricultural countermeasures to lower the radioactive content in milk and other food products to acceptable levels. Through its joint work with the FAO, the IAEA sponsored work by nearly forty scientists in nineteen countries who prepared comprehensive guidelines in 1994 of effective measures that have been demonstrated and put into place. Additionally in 1994, combined efforts of the IAEA, WHO, FAO and other organizations led to international guidelines that clarify the problem of when authorities should intervene and take protective measures for public health and safety in a radiological emergency. The intervention criteria are important, since they help to maintain credibility and confidence in decisions and prevent the kind of problems arising after the Chernobyl accident. Then, neighbouring countries set varying standards for foods that confused the public and disrupted trade.

Broader issues related to radiation health effects, and how the public hears and learns about them, commanded attention in 1994 in France, where four hundred policymakers, journalists, and nuclear experts from over fifty countries met at an IAEA-sponsored conference. Among problems addressed were the public's understanding of radiation's actual and perceived health and environmental risks, a problem linked closely to how well scientists and the media communicate the facts about radiation.— *Lothar Wedekind, based on IAEA documents and reports by John Richards, Abel Gonzalez, Franz-Nikolaus Flakus, Malcolm Crick, and David Kinley.*

Photo: "Let there always be sunshine", a painting by schoolchildren in Kiev done after the accident.

ENERGY & ENVIRO
THE DRIVE FOR SAFER, CLEANER D

The world's drive toward safer and cleaner development overcame some big hurdles during the past ten years, only to see more challenges arise. One major question echoed ever louder: how will governments decide to *fuel* and engineer the drive into the next century?

The echo resounded from some events taking place twenty-five years ago. Then, the international human environment conference in Stockholm brought many "green" issues out of scientific laboratories, and the first oil shocks jolted and jaded energy development prospects. In the 1990s, the complex set of challenges seemed to merge on the global conference stage: rising electricity demands in Helsinki in 1991; stark environmental threats in Rio de Janeiro at the 1992 Earth Summit; world population growth rates in Cairo in 1994; problems of over-crowded megacities in Istanbul and hunger in Rome in 1996; and the Earth Summit revisited in New York in 1997. Ahead in Kyoto in early December 1997 is the complex topic of global warming. Governments want a global treaty on climate change and will meet to debate its provisions.

Hovering above it all have been the dramatic political changes in Europe after the breakup of the Soviet Union. These changes opened the window to energy, environmental, and safety problems in countries of the former Soviet bloc.

The overriding message on all these fronts: some important progress has been made, but not enough to celebrate yet. In the political, environmental, and economic flux, ensuring sustainable development will not be easy, quick, or cheap.

At the IAEA, the far-reaching demands became the backdrop for laying a stronger legal and technical foundation to support safe, clean, and competitive nuclear energy development for countries using or thinking of using that option. Countries also sought to demonstrate more clearly how the whole range of nuclear technologies can help solve specific energy and environmental problems. Major platforms built for the new foundation include:

- A strengthened and more integrated global safety regime for key areas of nuclear power, radiation applications, and radioactive waste management. It covers new legal agreements and strengthened safety services. *(See box, page 31.)*
- More specialized technical support to countries for achieving better nuclear power plant performance, upgrading or dismantling older plants, developing advanced types of power reactors, managing growing stockpiles of spent nuclear fuel, and comparing overall energy and electricity options under particular conditions.
- Technical assistance and research projects targeted to help more countries establish and upgrade their regulatory infrastructure for the safe uses of nuclear and radiation technologies, and to improve waste management capabilities in all fields.
- Scientific support of assessments associated with "historical" radioactive wastes from past nuclear practices, and of customized applications of nuclear-based techniques in investigations of climate change, environmental pollution, and marine ecological threats. *(See box, page 37.)*

As the decade opened in 1986, twenty-six countries were getting ready to mark a milestone of nuclear power experience: their 397 electricity-generating plants collectively neared four thousand years of commercial operation. The Chernobyl accident in April changed everything, and ushered in trying times at the IAEA. Within five

Photo: A climb to the top at Bugey plant in France, where most households, businesses, and industries rely on electricity produced by nuclear energy plants. (Credit: Setboun/Rapho Agence de Press Photographique)

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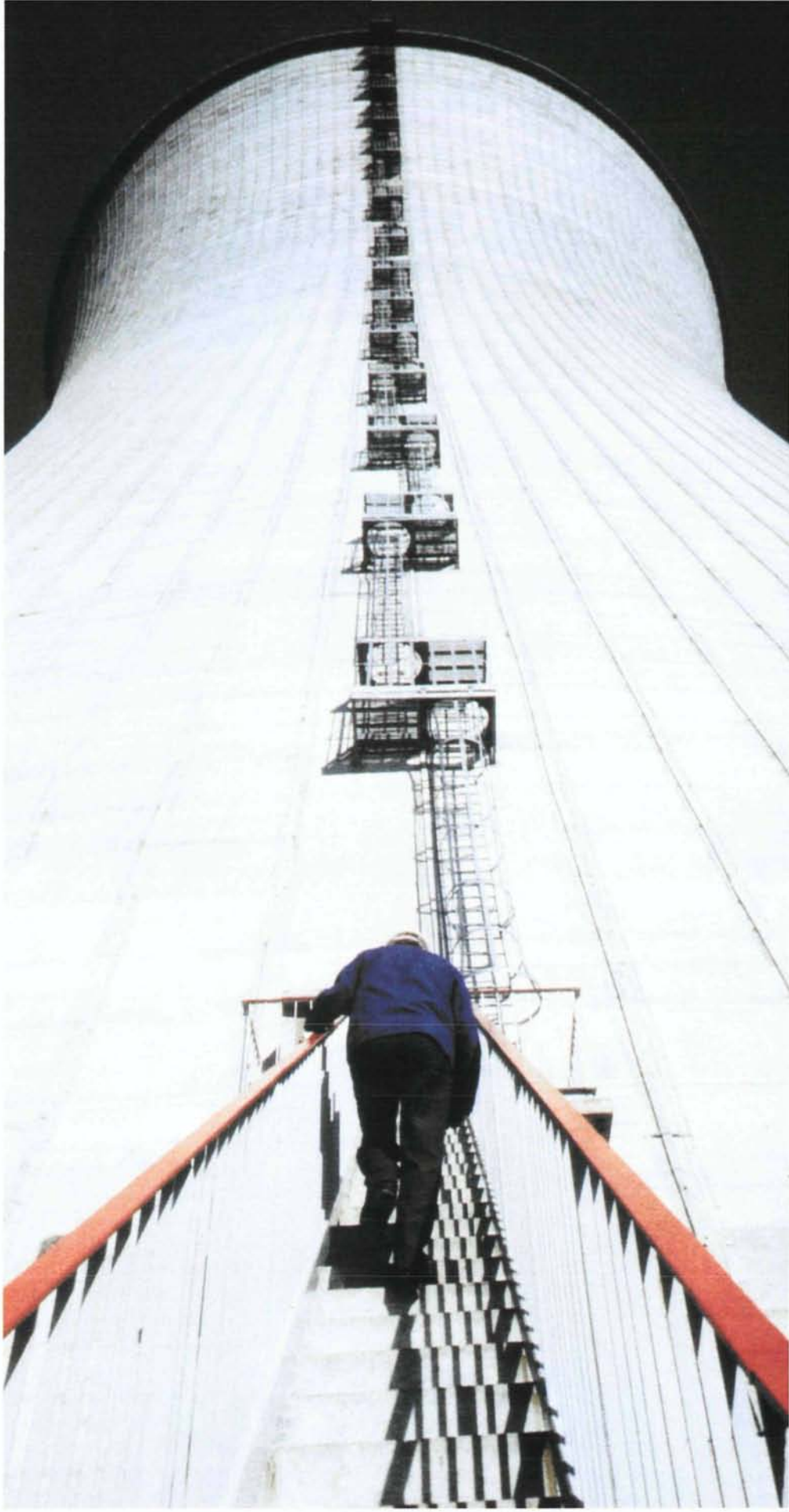
EVELOPMENT

months of the accident, States working under the international spotlight at the Agency issued their first responses: they negotiated and adopted two new global legal agreements on nuclear safety, delivered the first authoritative account of the accident, and set in motion plans for expanded safety services and assistance. Throughout the decade, the legal and technical safety regime was reinforced, and today more new elements still are being considered. Just as important, social, health, food, environmental, and nuclear scientists joined together to clarify the actual and potential consequences of the Chernobyl accident. (*See page 24.*)

For nuclear power development, the technical impact of the accident — affecting essentially a small group of Soviet-designed plants operating in only a few countries — extended, like its fallout, well beyond national borders. Lessons learned magnified the imperative of securing an industry-wide "safety culture". Steps to reinforce the safety net quickly gained momentum for business and environmental reasons, and to help win back public support lost in many countries. A few industries and governments sought to phase out their nuclear power programmes, while others suspended or postponed construction and planned projects. On



HOW SERIOUS?

Assessing the seriousness of global warming threats — and evaluating existing and potential responses — has challenged scientists for years. By the mid-1990s, an international scientific consensus had emerged: the 2500 experts taking part in studies of the International Panel on Climate Change (IPCC) issued a report with a guarded but direct message: if energy technologies remain unchanged and demand increases substantially, average temperatures might rise between one and 3.5 degrees Centigrade over the next century. This could cause sea levels to rise fifty centimeters, with ensuing flooding of coastal lowlands and tropical islands, an increase in weather extremes, and damage to forests and croplands. The IPCC outlook has been challenged, but has not been changed.

The issue is complex, and projections harbour considerable uncertainties. To understand more fully and quantify the changing climate picture, scientists need extensive data and powerful analytical tools and models. Among them are isotopic techniques. Using them, scientists examine historical records by taking measurements of ice cores, ancient groundwater, lake deposits and sediments, and estimate the impact of human activities from the results. This information supports forecasting potential effects on forest ecosystems, desertification, and water resources, as well as the possible occurrence of floods and droughts. Isotope methods also prove essential for determining precisely the atmospheric budget of greenhouse gases, especially their sources and sinks, to enable prediction and identification of the impacts of climate change.

Long-term studies also are tracking how carbon moves and sinks in oceans, seas, and lakes. From their laboratories in Monaco, IAEA scientists over the past decade intensified work to investigate the transfer of carbon from its source to ocean depths, work which combines collection and analysis of sinking marine particles with isotope studies.

In support of research, the World Meteorological Organization (WMO) in Geneva and the IAEA operate a global network for tracking and analysis of key isotopes in precipitation. By the mid-1990s, the network contained data from more than 450 locations worldwide.

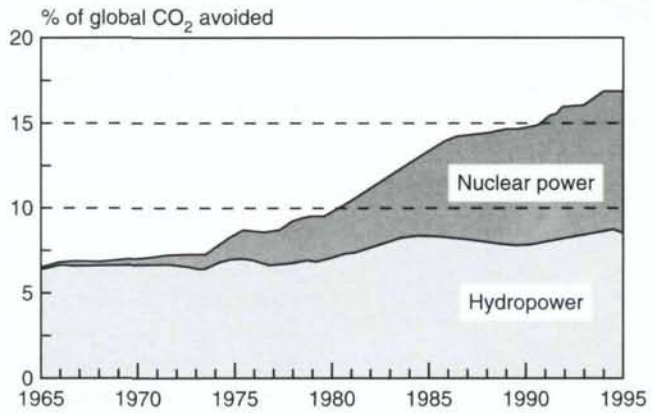
Other IAEA-supported programmes enlist experts in joint evaluations of responses to the threat of global warming, often pro-

record, most governments took a longer, qualified view, staying in favour of nuclear's safe expansion or of steps to keep the option open.

By the mid-1990s, the future of nuclear power looked dimmer. But lights were still on — a good share of them literally powered by nuclear energy. About five new nuclear plants per year — forty-seven altogether — have come on line since 1986, based on reports to the Agency's database. Nuclear's share of total electricity worldwide has held steady, rising only slightly in the 1990s to reach seventeen percent by 1997. Today, more countries than ever are generating one-quarter or more of their total electricity using nuclear power — seventeen States in 1996, seven more than ten years ago (among them Newly Independent States). By 1997, more than 440 nuclear plants were on line in thirty-one countries. They collectively produced about fifty percent more electricity than the Soviet Union produced from all sources ten years ago.

Seen by forecasters, the overall energy picture looked daunting as the years passed. By 1997, projections indicated that world energy demand would grow rapidly into the next century. Analysts said growth would be fastest in developing countries in order to keep up with rising populations and economic growth. Over the longer run, energy demand could climb anywhere between fifty and seventy-five percent in the next twenty-five years, according to the World Energy Council. Any rate of growth will stay closely tied to fossil fuel combustion. In 1997, these fuels continue to provide nearly eighty-five percent of all commercial energy used. When burned to generate electricity, fossil fuels also release carbon dioxide and other greenhouse

AVOIDANCE OF CO_2 EMISSIONS BY NUCLEAR AND HYDROPOWER



viding them with customized computer-based tools for analysis. A multi-agency project called Decades was started in the 1990s to support comparative assessments of energy options, specifically for generating electricity. Results of comparative studies reported over the past decade show far lower emissions of carbon dioxide in countries using nuclear and hydropower extensively than in countries burning large amounts of coal for electricity generation. Globally, nuclear power generates about seventeen percent of the world's electricity. That production has helped countries avoid a good share of carbon dioxide emissions, about eight percent of the world's total in 1995, or roughly as much as hydropower helped avoid.

In addition to nuclear, IAEA projects help develop other "clean" energy sources such as geothermal energy. In countries like El Salvador and the Philippines, Agency-sponsored projects have helped to evaluate and further develop geothermal resources. Nuclear analytical techniques helped to reliably assess temperature and fluid flows deep inside El Salvador's old volcanoes, and to identify potential new fields for development. Data can help save millions of dollars in drilling costs and lead to other savings. Geothermal production in El Salvador is already expected to cut oil import costs by about $9 million.

— Based on reports by Klaus Froehlich, Ms. Lucille Langlois, Ms. Jane Gerardo-Abaya, Florin Vladu, David Kinley, and Murdoch Baxter.

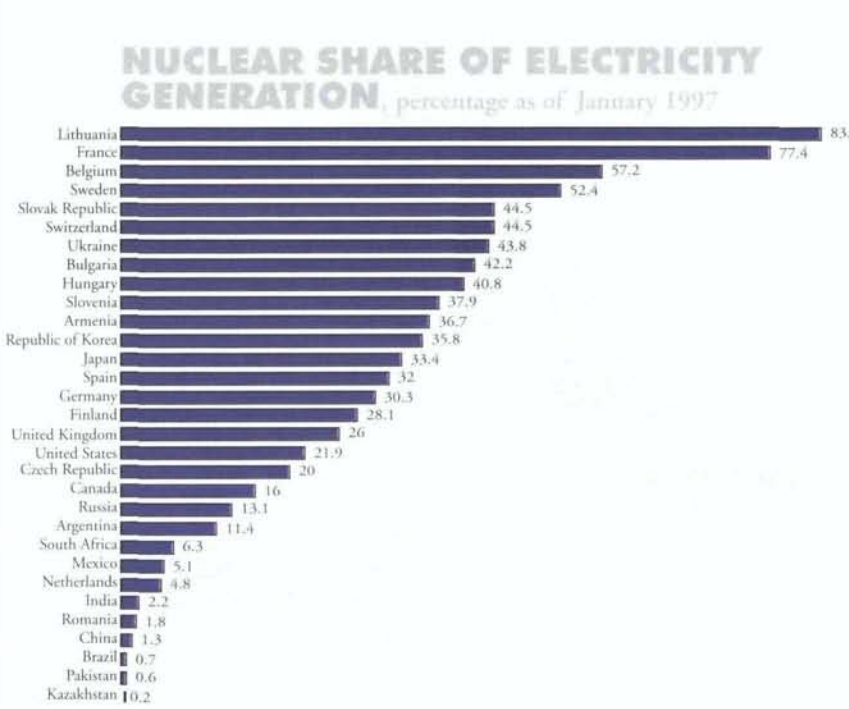
gases into the atmosphere. Less than fifteen percent of total energy comes from carbon-free hydropower and nuclear power, the two main alternative options. At present, only about one percent of all energy used comes from solar and other renewable sources. As environmental issues and notably global warming command closer watch, more people wonder what is in store, and what can be done today. (*See box above.*)

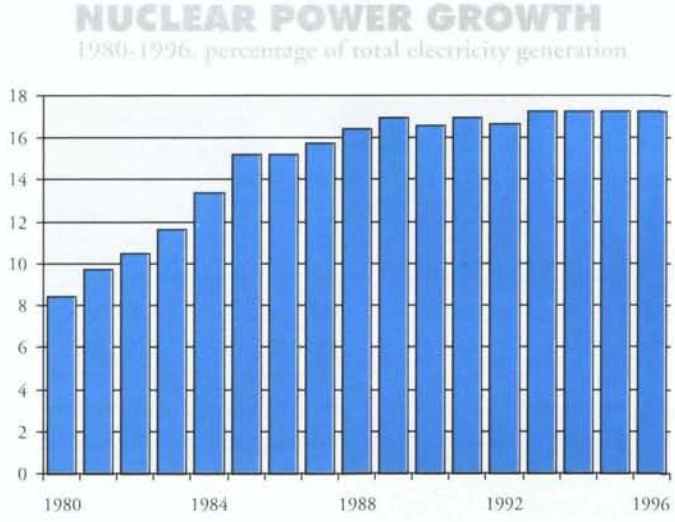
In the energy marketplace of the past ten years, political and economic changes have been influencing directions and thinking, too. Studies still find that electricity consumption and economic growth go hand-in-hand, even as conservation and other efficiency measures have worked to hold down overall energy growth rates.

As the decade moved on, other changes materialized to affect energy trends, including those of nuclear power. In some industrialized countries, "least-cost" generation options became more important in increasingly deregulated electricity markets. One result was greater political and economic pressures on nuclear plant performance. In other countries, confronted with leaner times, a central challenge for the nuclear industry became preserving a cadre of personnel with the necessary expertise and operational experience. In countries with emerging market-oriented economies, the pocketbook became a problem: financing the monthly earnings of highly trained nuclear plant staff raised energy and safety concerns transcending national boundaries.

Worldwide, nuclear industries were nearing another milestone by the mid-1990s: collectively, their plants approached eight thousand combined years of nuclear operating experience.

In developing countries, trends in nuclear development stayed mixed. Some States, as those in Asia, invested heavily in nuclear-fueled plants to free





themselves from dependence and costs of foreign supplies, chiefly oil, or from heavy reliance on coal. China's average electricity use grew ten percent a year during the past decade, and plans call for sixteen large coal and nuclear plants to help meet demands into the next century.

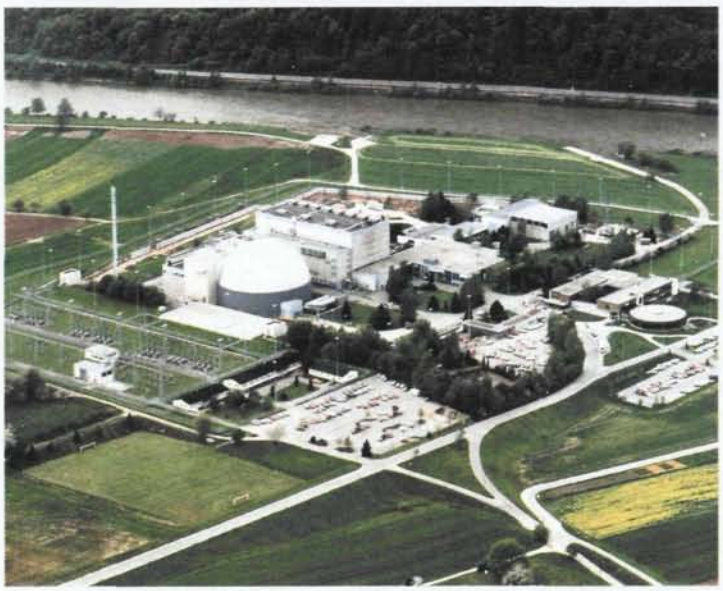
At the start of the decade, in 1986, the World Bank estimated at an IAEA meeting that an investment in electric power then valued at $522 billion (not including interest) would be needed through 1995 to meet projected rising electricity demands in developing countries. That amount represented roughly sixty percent of all the money spent on weapon systems in just one year of the past decade. Even now, the shortage of generating capacity in developing countries persists, and financing any energy project, particularly capital-intensive nuclear projects, remains a stiff challenge. About seven of every ten households in the developing world have no electricity.

Throughout the 1990s, the World Bank, IAEA, and other organizations grappled with the financing picture. Special projects and programmes assisted specific countries in identifying and evaluating different types of financing arrangements. Viable approaches emerged that were applied in several countries.

Other experts took aim at another drawback for many developing countries: the large size of typical commercial nuclear plants compared to the capacity of national grids. They again reviewed the need and market for smaller generating units, and Russia, Argentina and other developing countries emerged as potential suppliers of smaller nuclear power reactors. Possible greater use of such smaller units was studied, though mainly for non-power applications such as the supply of heat for residential and industrial needs, or for desalination facilities. (*See box, page 20.*)

Generally on the economic side, studies showed nuclear power holding its own against competing fuels. Analyses done in association with other organizations showed that nuclear power costs were roughly equal to those of coal, and in some cases to natural gas in terms of generating costs. One aspect of nuclear power — the relatively low cost of fuel — showed an upturn in the 1990s. The uranium market rebounded signif-

SAFETY FIRST



Milestones were achieved over the decade, and others are near, that fortify the global legal framework for nuclear and radiation safety. States put into place new international agreements under Agency auspices that legally bind them to achieve and maintain high levels of safety. Over the past decade, national authorities also increasingly drew guidance from, or entirely incorporated into their regulations, advisory safety standards issued through the Agency's longstanding work. Some of these were newly revised or structured in the 1990s.

The coming challenges for States supported by the IAEA will be to effectively implement the legal agreements, and to secure greater compliance with established safety standards. They are designed to help countries avoid losses from serious accidents. At industrial radiation processing facilities, several serious accidents involving workers occurred over the past decade that could have been prevented. In two new reports, IAEA specialists analyzed the most recent serious accidents and drew attention to specific lessons that should be learned from them.

The strengthened legal framework includes the:

- **Convention on Nuclear Safety.** States adopted this milestone agreement in 1996 that commits them to achieve and maintain high safety levels. They are obligated to meet international benchmarks in major areas of regulation, management, and operation of land-based nuclear power plants. A central feature is a peer review process of national reports on steps States have taken to fulfill their obligations. The first review meeting has been set for April 1999. Through August 1997, forty countries were parties to the Convention, including nearly all States having nuclear power programmes. Sixty-five countries have signed it.

- **Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.** This agreement — negotiated by States meeting at the IAEA over the past two years — was adopted in September 1997 at a Diplomatic Conference in Vienna. It covers applications in the civilian sector and obliges parties to take appropriate steps for ensuring the safe and environmentally sound management of radioactive waste and spent fuel, and for preventing accidents with radiological consequences. It includes peer reviews of national reports at periodic meetings.

- **Protocol to Amend the 1963 Vienna Convention on Civil Liability for Nuclear Damage and Convention on Supplementary Funding.** States have negotiated these two instruments at the IAEA in the 1990s that together revise the international regime for nuclear liability. They were adopted by States meeting at a separate Diplomatic Conference in Vienna in September 1997.

- **Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency.** These two Conventions were adopted in 1986 within months of the Chernobyl accident. The first one establishes an early alert and notification system for potentially severe nuclear accidents that could involve radioactive fallout crossing national borders. Notification is made to the affected States directly, or through the IAEA, which set up an Emergency Response System as its focal point. As its name implies, the assistance Convention obliges States to facilitate

emergency support and to notify the Agency of their available experts, equipment, and other materials for providing assistance. As of August 1997, seventy-eight States were parties to the notification Convention, and seventy-four States to the assistance Convention.

● **Convention on the Physical Protection of Nuclear Material.** This agreement, which entered into force in 1987, addresses security of materials during international nuclear transport by obliging parties to ensure the protection of nuclear material within their territory or on board their ships or aircraft. In 1992, the first Review Conference was held in Vienna at which parties reconfirmed their commitments. They also expressed their conviction that it provides an appropriate framework for global cooperation in protection, recovery, and return of stolen nuclear material and in the application of criminal sanctions against those who commit criminal acts involving nuclear material. As of August 1997, fifty-seven States were parties.

The IAEA's advisory nuclear and radiation safety standards include the:

● **International Basic Safety Standards for Protection Against Ionizing Radiation and the Safety of Radiation Sources** (BSS). A milestone was achieved in the mid-1990s when an unprecedented international effort involving the IAEA, WHO, and three other organizations led to revised global radiation standards. The BSS cover general and detailed requirements for a broad range of activities, and are an outgrowth of a vast amount of new scientific information accumulated over the past decade. They follow 1990 recommendations of the International Commission on Radiological Protection (ICRP), which introduced lower radiation dose limits for workers and the general public. The BSS also incorporate the Commission's recommendation that exposures from more than one source of radiation should be taken into account, including potential hazards from accidents. Supplementing the BSS are a range of supporting documents that provide specific guidance in applying the standards.

● Nuclear Safety Standards (NUSS). A backbone in the field, the extensive NUSS advisory codes and guides cover nuclear power plants. Topics are related to governmental organization, siting, design, operation, and quality assurance. NUSS codes and some guides were revised over the past decade, steps that included issuance in 1996 of fifteen documents on quality assurance. Separate Agency safety standards cover design and operational aspects of research reactors.

● **Radioactive Waste Safety Standards (RADWASS).** Developed through a programme started in the early 1990s, these standards draw upon extensive safety documentation on waste management issued by the Agency since its formation. They cover an extensive range of topics related to the safe management, including storage and disposal, of wastes from nuclear facilities, hospitals, industry, and research. Also addressed are waste discharges, decommissioning of facilities, and environmental restoration. The leading document was issued in 1995 and establishes the basic principles and concepts for safe radioactive waste management. These are now being elaborated in supporting documents.

● **Regulations for the Safe Transport of Radioactive Materials.** First issued in 1961, these advisory regulations define the basic rules now largely adopted throughout the world for transporting virtually all radioactive material. Their objective is to protect the public, transport workers, property, and the environment from the effects of radiation exposure during transport. A revised edition was issued in 1996. It takes into account the ICRP's 1990 recommendations and the Agency's Basic Safety Standards. It also introduces a new type of package for air transport that must meet more stringent criteria than existing types. A number of safety guides support the regulations.

For all Agency standards, their collective profile was uniformly raised in recent years. A renewed and more uniform preparation and review process was initiated in the mid-1990s under the responsibility of a newly created Department of Nuclear Safety. Also established was a set of five separate advisory bodies. Each has a membership of about fifteen senior governmental officials that work from harmonized terms of reference to review and guide the safety standards programmes.—*Based on reports by Abel Gonzalez, Director of the IAEA Division of Radiation and Waste Safety, and staff of the Agency's Legal Division.*

Photo: One of Germany's nuclear power plants that together provide about thirty percent of the country's electricity.

icantly. Global assessments about its resource base and production also became more thorough. Key data from Russia and other former Soviet-bloc countries were made available for the first time at an IAEA technical meeting.

For the IAEA's involvement in nuclear power, the decade's unfolding economic and environmental realities translated into new challenges and opportunities. Overall, technical programmes became more closely bound to plant safety, performance, and waste-related issues.

An overriding aim was to assist more countries in building better capabilities for safe and reliable nuclear operations within the framework of the Agency's international standards.

Over the past fifteen years, Agency-supported technical assistance projects invested $100 million in training and hardware support related to nuclear safety. This support went primarily to the seventeen developing countries using or considering use of nuclear power. Agency technical assistance included helping to build an on-site training simulator for nuclear plant operating staff, the first of its kind, in Hungary, for which surplus parts from idled plants in Germany and Poland were used. In the early 1990s, the Agency was one of the first organizations to point out deficiencies at Bulgaria's Kozloduy plant. These findings spurred assistance through the IAEA's expanding safety programmes. The Agency also flagged the need for greater combined efforts to confront problems at that plant and others like it in Central and Eastern Europe. In Bulgaria, technical assistance has since expanded to cover seismic evaluations, as it does in several other countries. The aim is to help make sure nuclear units withstand earthquakes, even those rated higher than the one Japan's reactors withstood successfully during the decade.

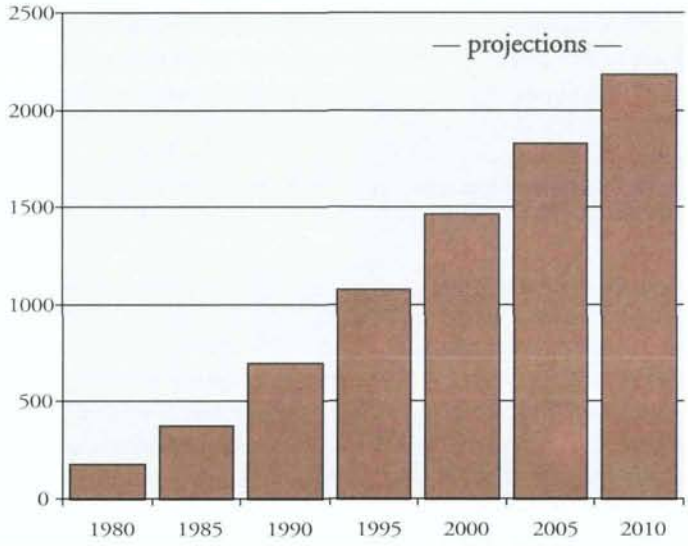
Importantly, Agency efforts helped put in place better preventive maintenance and operational controls at nuclear plants over the past ten years. Through programmes to modernize training approaches and instrumentation systems, the work extended beyond the Chernobyl-type units to encompass other reactor types. A far greater share of incidents at plants also were peer-reviewed and technically analyzed for "lessons learned". IAEA-supported or initiated global information networks and safety services linked with national regulatory systems provided a central mechanism.

Worldwide, nuclear plant performance improved throughout the 1990s. Agency evaluations tracked a common indicator — the "energy availability factor", measuring how close to capacity the units perform. The factor rose nearly seven percent in the 1990s, and by 1996 was approaching an eighty percent average. Another indicator — energy losses from plant outages — dropped to below five percent, approximately equal to that of fossil-fuelled plants. Also gaining ground was the operational performance of nuclear fuel at light-water reactors, the predominant type in operation. In the 1990s, IAEA-supported fuel research expanded to twenty-six countries and three international organizations. Technical assistance in fuel behaviour studies was extended to newly independent countries in Eastern Europe and to the types of fuel used at reactors in operation there.

Next generation plants, as they are popularly known, were introduced in some countries during the decade. Common goals for new designs include greater reliability, better economics, and enhanced safety. Annual investment in research and development of different types of advanced nuclear plants grew to an estimated $2 billion in 1996. Most attention focused on "evolutionary" concepts that build upon today's best features and add others. By 1996, some types of advanced reactors came on line or were nearing operation in the Far East, Europe, and North America, while others will take longer to develop and demonstrate. IAEA international working groups on advanced reactor design development are at the forefront of cooperative work. The experts meet periodically to exchange experience and advise the Agency on research needs, particularly involving technical and information links between researchers in developing and industrialized countries. Another type of future nuclear energy system drew more interest over the decade in Japan, France, Russia, and at the European Nuclear Research Centre (CERN). It relies on machines called accelerators that produce high energy pro-

TOTAL PLUTONIUM GENERATION

in tonnes, by year



ton currents. An attraction is that these systems, when merged with fission reactor technologies, hold the promise of producing electricity using nuclear fuels, while at the same time destroying plutonium and long-lived radioactive materials.

New realities at the "back end" of nuclear's fuel cycle meant adjustments had to be made. Managing greater amounts of spent fuel became a pressing issue in many countries, and took on high priority at the Agency. In 1985, the world's cumulative inventory of spent fuel was about 30,000 tonnes of heavy metal. Volumes by the turn of the century are now estimated six times that high, and Agency analysts foresee steady though slower growth beyond that time. Although considerable, these volumes are far smaller and more easily isolated from the environment than waste from fossil fuel plants, which is mostly released into the atmosphere. Used nuclear fuel is either reprocessed or prepared for containment in engineered storage facilities. So emplaced for extended time periods, its radioactivity level decays significantly. In support of national efforts to keep fuel safely stored and managed, the IAEA expanded its technical, research, and advisory services. Mainly involved are countries starting up storage facilities or those studying how spent fuel behaves under storage conditions extending beyond fifty years.

For receiving most types of radioactive wastes, more engineered disposal sites had opened or were in planning by 1997. But political decisions slowed progress toward plans for construction of deep geological repositories engineered to hold high-level radioactive wastes and spent fuel. (*See box, page 39.*)

From other directions, the spectre arose of what some called a "plutonium economy". The end of the Cold War saw the dismantling of nuclear weapons and the controlled entry of plutonium into the civil marketplace. The USA has declared fifty tonnes as surplus, and it is assumed Russia will also release as much. Overall, concerns were principally compounded by several factors: an expanded reprocessing industry for the recycling of plutonium, and delays in commercializing more fast-breeder reactors, which are able to burn plutonium. These factors together contributed to rising global plutonium inventories. *(See graph.)*

Action launched through the Agency included setting up a database and methodology to track inventories and reliably project them; developing guidelines for safe handling and storage of large amounts of separated plutonium; and developing a methodology to address concerns related to nuclear proliferation from the standpoint of different fuel-cycle concepts. The IAEA has helped to negotiate controls required to prevent the potential reuse of ex-military plutonium for weapons and to protect the public from its radiation.

Other issues arose just from the industry's advancing age. Countries marked the fortieth anniversary of nuclear power as a commercial energy source in the mid-1990s, and many plants are decades old. Renewed interest surfaced in what the *Financial Times* called "the science of nuclear gerontology". More than one hundred plants worldwide were nearing retirement at a typical age of forty. Many of them are destined to be decommissioned, a process involving site cleanup and restoration. Others are being refurbished and upgraded to extend their lifetimes by about

twenty years. More countries began to seek guidance through IAEA channels to learn the best practices being followed in the industry for "life extension" and for experience acquired in decommissioning and site restoration. Importantly, the Agency recently issued interim guidelines for such activities to more fully elaborate its safety standards.

Age-related issues, among others, also affected the world's several hundred research reactors, whose uses range from scientific investigations to the production of radioisotopes used in medicine and other fields. Most of these reactors were built in the 1960s.

A particular technical, as well as political, issue was the disposal and safe storage of used fuel from research reactor facilities. About sixty countries are now operating research reactors. When most of these were built about twenty-five years ago, it was assumed that the spent fuel would eventually be shipped back to its foreign suppliers, chiefly the United States and former Soviet Union.

Agency efforts intensified in the mid-1990s to assess the situation and help operators of research reactors identify and take remedial measures. The work encompassed fact-finding missions, training courses. and advisory technical services on the best ways to store the spent fuel. It also involved working with governmental authorities in the USA, Russia, and other countries on further steps that could be taken. The USA has established a programme to take back any spent fuel it had originally supplied to fuel research reactors, and as the decade closed, authorities in the Russian Federation were being encouraged to do likewise.

What is the outlook at this stage? Long before the decade closed, it became apparent that nuclear power prospects, and the future of related IAEA programmes, would depend on several key factors. As David Fischer writes in his history of the Agency, they include:

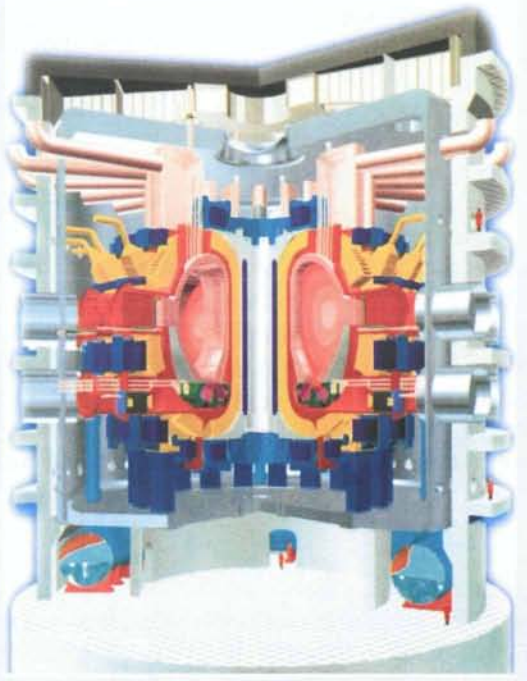
- Future demand for electricity, especially in Asia, where growth trends appear strongest.
- The relative cost of generating electricity by burning fossil and nuclear fuels.
- Stagnating demand for electricity in most countries of North America and Western Europe. In most of these countries, the only rapidly expanding source of energy for electricity generation is natural gas.
- Maintaining a superior safety record for nuclear energy, including its waste products, to counterbalance the memories of Chernobyl.
- Persuading the public that radioactive waste can be disposed of without endangering the health of future generations. The technology is available, but public confidence is lacking.
- And finally, how seriously the world takes the threat of global warming, which stems largely from "greenhouse gases" emitted by fossil fuels. This applies particularly to North America and Western Europe. There, 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 two Asian countries, China and India, where energy consumption and burning of coal seem bound to grow massively in the next century.

At the global level, Mr. Fischer's review finds that world energy development may be going off course if the nuclear option is rejected. 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 the Panel with a considerable amount of material, he notes, 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." Subsequently, the head of the International Energy Agency of the Organization for Economic Cooperation and Development (OECD) noted in a statement to a UN meeting that "nuclear energy [had] accounted for the greater part of the lowering of carbon intensity of the energy economies of the OECD countries over the last 25 years."

Nonetheless, Mr. Fischer concludes, "...the past years have shown how difficult a task it will be to persuade energy authorities and governments, in almost all 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."

"MINI-SUNS" FOR ENERGY

Teams of the world's best and brightest scientists took on major technical challenges during the past decade to move the world closer to demonstrating the power of nuclear fusion, the energy source which powers the sun and stars. Under Agency auspices, global co-operation was expanded in the late 1980s through a four-party initiative that includes Japan, Russia, the European Union, and the United States, and is known as the International Thermonuclear Experimental Reactor, or ITER (see illustration: note the size of the model compared to the people in front of it). The project was set up to confirm the scientific, and address the technical, feasibility of fusion as a potentially safe and environmentally acceptable source of energy. Fusion's main fuels — deuterium and tritium, one extracted from seawater and the other bred from abundant lithium — and its end product, the inert gas helium, are neither toxic, radioactive, nor do they contribute to the "greenhouse effect". In late 1990, scientists successfully completed the conceptual design of the ITER tokamak fusion reactor, and two years later they started an engineering design phase whose intensive work will run through most of this decade. So far, the four parties have not formally committed themselves to build the fusion device, and some technical and financial questions have arisen. Besides the ITER project, other fusion concepts are being investigated internationally, work recorded and shared through IAEA-supported global conferences, research programmes, and the IAEA's scientific journal *Nuclear Fusion*.



If technical and economic barriers can be overcome, the decade's extensive efforts could bring the promise of fusion-generated electricity closer to being successfully tested in the 21st century's marketplace.

— Based on reports by Thomas Dolan, Franz-Nikolaus Flakus, and David Fischer.

Just where the world's drive for safer, cleaner energy development will lead remains to be seen. Maybe superconduction or commercial thermonuclear fusion (*see box above*) will come true far earlier than now believed possible. Scientists — like those working at the International Centre for Theoretical Physics in Italy run by UNESCO with IAEA support — may achieve breakthroughs in solar energy or other promising energy sources, as they did decades ago with the commercial use of nuclear energy.

For the IAEA, its evolving roles in years ahead almost certainly will be influenced by answers to the big question posed at the outset — how governments decide to fuel and engineer the energy drive ahead. The Kyoto conference on climate change in December, among other events, may help dictate the pace of progress on an important front. — *Lothar Wedekind, based on reports by Dr. Hans Blix, Victor Mourogov, Zygmund Domaratzki, Morris Rosen, Juergen Kupitz, Poong-Eil Juhn, John Cleveland, Boris Guerguiev, K.V. Mahadeva Rao, Iain Ritchie, Ms. Candace Chan-Sands, Bela J. Csik, Viktor Arkhipov, Noboru Oi, James Finucane, Arnold Bonne, Royal Kastens, Ms. Lucille Langlois, Leonard Bennett, Ms. Evelyne Bertel, and David Fischer.*

BY LAND, ATOP MOUNTAINS AND ON THE HIGH SEAS

The past ten years have seen many countries call upon the Agency's scientific and technical expertise for assessments of radiological conditions and environmental pollution threats. Most widely publicized was the response to the 1986 Chernobyl accident. (*See page 24.*) In the early to mid-1990s, countries requested the Agency's assistance in response to some serious concerns:

● IAEA scientists at the Marine Environment Laboratory were called to Kuwait's shores after the Gulf War in 1991 to survey and analyze pollution damage caused by blazing field fires which burned 500 million barrels of gushing oil. Preliminary results were part of the world's first published environmental assessment in the prestigious science journal *Nature*. Surprisingly, they showed that the greatest hydrocarbon pollution was within a radius of approximately 400 kilometers of the sources. By 1992, the oil pollutants had degraded, with only resistant compounds left, and contamination levels dropped to half of 1991 values. The rate of reduction fell by 1993, thought to stem from resumption of commercial tanker traffic and associated "routine" oil spills. Concentrations of oil pollutants in the seas peaked in August 1991, when tests showed significant toxicity to marine larvae, an effect that decreased significantly by 1993. This experience demonstrated how nuclear techniques can be effectively combined with other methods to trace the origins and movement of oil pollution, and help assess damage.

● Along the shores of the Caspian Sea and the Black Sea, in Thailand and other countries, Agency teams confronted other problems over the decade. In the Caspian region, for example, support went to five countries for environmental monitoring campaigns to find out why the sea level is rising, and how to prevent its flooding of cities and farmlands. Another global project with the Swedish International Development Authority includes isotope studies of agricultural pesticide runoff which threatens coastal regions and the livelihood of fisheries.

About eighty percent of all marine pollution is caused by human activities on land: sewage disposal, industrial wastes, and chemical pollutants. In 1995, States adopted a global action plan hailed as the first programme to lead to more "sustainable interaction" between people and the oceans. The challenge may engage the Agency's expertise. More than a dozen ways in which this expertise might contribute to the action plan's goals and principles have been prepared.

● In countries of Eastern and Central Europe, awareness of radioactive contamination from uranium mining and milling increased and it became a serious health and environmental concern. In 1993 and 1995, the Agency initiated efforts to help countries assess the situation and begin to restore contaminated lands through effective remedial measures. By 1997, fifteen countries were participating in two remediation projects, with some results already published by the Agency. New projects have been initiated in countries including Bulgaria, the Czech Republic, and Slovenia.

● In the Arctic Seas, an extensive project from 1993-96 assessed potential health and environmental impacts of radioactive waste dumped in shallow waters near the Novaya Zemlya nuclear test site. The waste included spent fuel in six submarine reactors and in the fuel assembly of an icebreaker ship reactor. Under the auspices of the International Maritime Organization and in accordance with its responsibility under the London Convention to prevent pollution by dumping, the IAEA launched a study involving more than fifty experts from fourteen countries. The study found that the present and future radiological risks to typical local population groups from the dumped wastes are small. It also concluded that, on radiological grounds alone, a remedial action programme was not warranted. Experts noted that limited environmental monitoring should be considered in order to detect any changes in the condition of dumped highly radioactive wastes. In the mid-1990s, IAEA marine scientists were also asked to support studies of past radioactive waste dumping sites in areas of the northwest Pacific Ocean. They joined two scientific expeditions jointly carried out by Japan, the Republic of Korea, and Russia. A report is expected this year.

● In Kazakhstan in 1994, an expert group assessed the former nuclear test site known as Semipalatinsk. Of concern were radiological conditions for about 40,000 people living outside but close to the test site boundary, above which radioactive plumes from nuclear tests had passed. The expert group found that people living in these settlements were not at radiological risk. It also found, however, that land very near the test site had not been restricted and was being reoccupied. The team found radiation levels in these areas high enough to justify urging authorities to bar people from settling there for safety reasons.

● Heightened concerns over natural radon levels in houses and buildings were loudly voiced throughout the decade, mainly in countries of Europe and North America. Global awareness was further raised at an international conference on high levels of natural radiation in 1990 in Iran. Specialists from thirty countries attended the meeting, which was co-sponsored by the IAEA, WHO, and other bodies. Throughout the early 1990s, the IAEA and European countries sponsored a five-year radon research programme that analytically supported national monitoring campaigns. More than fifty countries took part in fifty-one separate projects which involved the laboratory analysis of radon measurements taken outdoors, at work sites, and in homes.

● An advisory group of experts from seven countries, the IAEA, WHO, and United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) was organized in late 1995 to assess questions raised by those Marshall Islanders who had been evacuated from the former nuclear test site at the Bikini Atoll. The Bikini people were relocated to the Marshall Islands before the start of nuclear testing in the mid-1940s. Scientific radiological studies over the past decades, as well as recent patterns of their relocation, had not convinced them that they could safely return to the atoll to live. The advisory group concluded that technically and financially feasible remedial measures could be taken to allow the Bikini people's rehabitation in line with international radiological protection principles. If the measures were taken, the group recommended monitoring of foodstuffs to ensure the strategy's effectiveness. Further Agency-sponsored activities in support of the Bikini people's concerns are under consideration.

● An assessment of the present and future radiological situation at the former nuclear test sites at the Mururoa and Fagataufa atolls in the South Pacific was launched in 1996. The study, which was requested and is being principally financed by France, is under the guidance of an International Advisory Committee of global experts. Eleven laboratories in nine countries are participating in the analysis of terrestrial samples, and six laboratories in six countries in the analysis of marine samples. A sampling and surveillance campaign was conducted in July 1996. Closely involved in monitoring and analytical work are scientists of the IAEA's Seibersdorf Laboratories and its Marine Environment Laboratory. As the advisory committee reported at meetings this year, the study is progressing on schedule for completion in the early part of 1998.

— Based on IAEA documents and reports by Ms. Kirsti Sjoeblom, Gordon Linsley, Murdoch Baxter, Ms. Candace Chan-Sands, Pier Roberto Danesi, and Jasimuddin Ahmed.

SHOWING THE WAY

The challenge of demonstrating the safety of radioactive waste storage and disposal assumed greater proportions over the past decade. Most concerns emanated from political decisions to delay plans to build or open repositories engineered to handle highly toxic and radioactive spent fuel and nuclear waste. Some countries initiated expensive cleanup campaigns to counteract past waste storage and disposal practices in military and civilian areas. In most countries, however, more technical progress was quietly being made to demonstrate solutions to both real and perceived problems.

An IAEA survey in the mid-1990s showed that experience is being broadly applied. There are more than one hundred disposal facilities worldwide, ranging from engineered underground vaults to geological repositories for wastes classified as low or intermediate level (LILW). Another forty-two repositories were under development. They all rely on multiple protective measures and operational and institutional controls. Agency efforts focused on assisting countries by promoting the transfer of proven technologies and approaches through technical missions, research programmes, safety services, and other channels. Work also was renewed with some countries interested in setting up regional, or multinational, repositories whereby one country hosts a site accepting wastes from others. The IAEA identified and reported on both the "pros and cons" of such an approach.

For disposal of high-level radioactive wastes and spent fuel, demonstration plans moved ahead, albeit slowly, often because of lengthy technical and political review processes. Most countries facing the issue do not envisage starting up deep geological disposal repositories until well into the next century. That does not mean there is a backlog of waste piling up. In nearly all these countries, nuclear waste is contained in engineered interim storage facilities that allow it to cool safely over decades. The Agency's technical assistance during the decade included supporting extensive joint research programmes on the performance of high-level waste forms and containers under repository conditions, and safety assessments of underground disposal facilities for other types of wastes.

The Agency broke some new ground when it supported a six-month international assessment of scientific studies analyzing the performance of the Waste Isolation Pilot Plant in the USA, now in the final stages of governmental review. Organized jointly with the OECD Nuclear Energy Agency, the assessment was conducted in 1996-97 by experts in the fields of geology, environmental protection, and nuclear and radiation safety. Their report supported the scientific studies and found them technically sound. The pilot plant is designed to permanently dispose of plutonium and other long-lived wastes generated by defense-related activities, including contaminated tools and clothing. It is engineered more than one kilometer underground at a site in New Mexico. The schedule calls for it to begin receiving wastes in May 1998, pending approval of the US Environmental Protection Agency and the Environment Department of New Mexico.

— Based on reports by Kyong Won Han, Jorma Heinonen, Ms. Candace Chan-Sands, and Arnold Bonne.

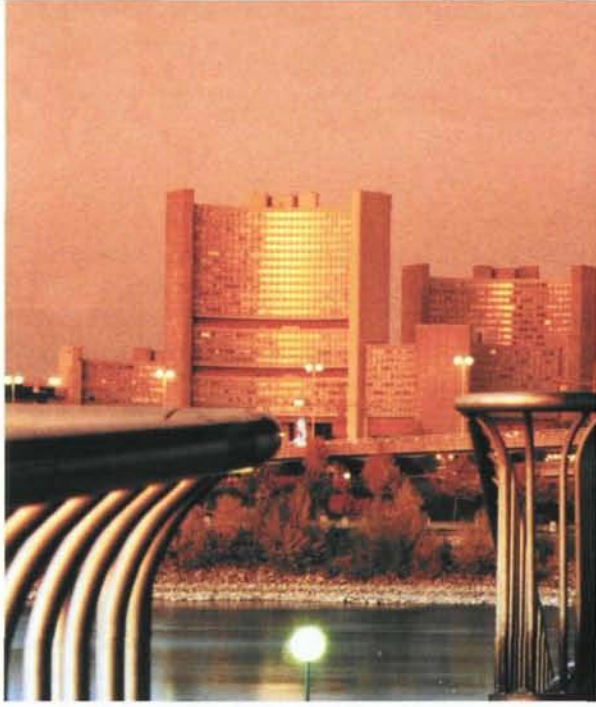
Photo: One of the protective means of safely containing radioactive wastes is known as vitrification (from the Latin "vitrus"- glass). Glass is used to solidify high-level wastes as one protective step before disposal. Here molten glass is shown being poured from a platinum crucible into a steel bar mold.

BACK TO THE FUTURE: THE CHANGING WORLD AROUND US

1972	1997
POPULATION	
World population stands at 3.8 billion people, over 70% of whom live in developing countries.	Total population hits 5.85 billion, an increase of two billion over 1972, and grows by 81 million people a year. About 80% of the world population now live in developing countries.
URBANIZATION	
About 38% of humanity live in towns and cities, only three of which have more than ten million inhabitants.	About 47% of humanity live in or near cities, eighteen of which have more than ten million inhabitants. Thirteen of these "megacities" are in developing countries.
	AIR POLLUTION
More than 200 million cars, most of them in industrialized countries, aggravate localized pollution problems.	Nearly 500 million cars are on the roads in industrialized and developing countries, where many cities now have hazardous pollution levels. Transboundary pollution has become a regional and global issue.
	THE EARTH & CO_2
About sixteen billion tonnes of carbon dioxide, a gas linked to global warming, are released into the air annually, atmospheric concentration stands at 327 ppm.	CO_2 emissions from burning fossil fuels and other sources are approximately twenty-three billion tonnes per year. Atmospheric concentrations surpass 360 ppm — about 20% higher than levels one hundred years ago.
FRESH WATER	
About 2600 cubic kilometres of fresh water are used annually, mostly for irrigation.	Fresh water use has risen by nearly two-thirds to 4200 cubic kilometres a year. Water problems are severe: 1.4 billion people — one-fifth of the world population — lack access to safe drinking water, and one-tenth lack water for proper sanitation.
ENERGY MIX	
Fossil fuels make up 94% of the world's energy mix.	Fossil fuels account for 90% of the world's energy mix, up 3% from 1991 and indicating a rising trend after the low of the 1980s.
	ELECTRICITY
Electricity accounts for about 21% of total energy production. On a yearly per capita basis, consumption is about 1400 kilowatt-hours (kWh). By region, consumption stands at approximately 8200 kWh in North America, 3100 in Western Europe, 2800 in Eastern Europe, 565 in Latin America, 396 in South East Asia, 240 in Africa, and 143 in the Middle East and South Asia. Total world electricity generation is about 5000 terawatt-hours, of which nuclear power supplied less than 2% (80 TWh).	Electricity accounts for about one-third of total energy production. The world's per capita consumption reaches 2200 kWh in the mid-1990s. By region, disparities still reign: consumption stands at 13,000 kWh in North America, 5400 in Western Europe, 4200 in Eastern Europe, 1500 in Latin America, 1200 in South East Asia, 500 in Africa, and 500 in the Middle East and South Asia. Total electricity generation stands at about 13,000 TWh, with the share of nuclear approximately 2200 TWh, or 17%.
	ARMS CONTROL
Countries spend US $836 billion (at 1995 prices) on arms and armed forces. The five declared nuclear-weapons States conduct 57 nuclear tests. By the end of the year, 70 non-nuclear-weapon States had become Parties to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), which had come into force in March 1970.	Global military spending is about US $800 billion. Before adoption of global nuclear test ban in 1996, seven more tests are carried out, raising the total reported since 1945 to more than 2040. Reductions in arms spending continue, but about 6000 strategic nuclear bombs remain in Russia and the USA. By July 1997, the number of States joining the NPT reaches 185, including 180 non-nuclear-weapon States and all five declared nuclear powers. Cutbacks in military spending yield a "peace dividend" in excess of US $900 billion, the UN reports, but whether surplus funds are being used for social and economic development is difficult to track.

Information based on reports in the *Financial Times*, 4 June 1997, and the *Bulletin of Atomic Scientists*, May/June 1996, IAEA publications, databases.

IAEA 2000
CHALLENGES OF NEW FRONTIERS



During the last ten years, members of the IAEA have been persistent in taking action on two vital fronts: verification to help halt the spread of nuclear weapons and measures to ensure the safe use of nuclear energy in a sustainable global energy mix. At the same time, the approaches to the transfer of beneficial nuclear techniques for development were reinvigorated. The outlook now is for further reliance on the Agency as the single institution through which governments can consult, negotiate and conduct global action in the nuclear field.

The recent strengthening of the Agency's safeguards system to verify non-proliferation undertakings — involving greater access to information and locations and the use of new and advanced techniques — responds to the need of the international community for improved global and regional security. It will also provide an improved basis for future collaboration in the peaceful uses of nuclear energy. It underpins the nuclear-weapon-free status of Latin America, Africa, South East Asia and the South Pacific, all of which have called on the Agency to provide verification services. While the chief mandate remains verification to help limit the further spread of nuclear weapons, the Agency has already been requested to verify the dismantling of South Africa's former nuclear-weapon programme and to enforce Security Council measures for the destruction of Iraq's clandestine efforts to acquire nuclear weapons.

Looking ahead, the safeguards system of verification stands ready to perform other vital functions for international security — for example, that of facilitating the reduction of nuclear weapons worldwide. Even the vision of a nuclear-weapon-free world is deserving of practical consideration and preparation. As nuclear weapon stocks are reduced there will be a need for assurance that nuclear material from dismantled weapons does not go into new weapons. At the same time, the assurance that new countries are not acquiring such weapons will be even more important than it is today. In the nuclear disarmament process, international verification is likely to have a role. Under a trilateral arrangement between the Russian Federation, the USA and the IAEA, a study is being made of one new verification task that may be undertaken by the Agency.

Although individual countries bear the full responsibility for safety of nuclear activities under their jurisdiction and control, confidence in matters of nuclear safety depends greatly on a record of safe operation worldwide. The IAEA has played an increasingly important role in developing global international norms for nuclear safety which, together, now form an international legal infrastructure for nuclear activities. The Agency can take pride in this brisk development — a sizeable and solid body of standards and guidelines and, indeed, a number of binding conventions: the "Chernobyl" conventions on early notification of nuclear accidents and emergency assistance, the convention on the safety of nuclear power plant operation, the convention on the safe management of radioactive waste and spent fuel, which we hope will soon be in force, and the agreement to improve the regime for liability in the event of accidents. Concurrently with this normative development, States are increasingly cooperating —often through the Agency — to provide practical assistance and advice on the maintenance of high safety standards. The Agency will be called upon to facilitate the implementation of the new international arrangements and, no doubt, will be the centre for further evolution of international law in the safety area. The growing evidence of a record of high safety and efficient operation of nuclear facilities demonstrates the progress that has been made, while shortcomings which have been identified point to the further agenda of work.

The dramatic global political developments of the last ten years have allowed the international community to give renewed attention to the fundamental issues of human welfare — devel-

opment and the environment. This new situation enhances the role of the Agency in the fields of energy and technology transfer. It is evident that with populations still increasing and with unequalled rates of economic growth in many parts of the world, the global demand for energy will continue to rise. At the same time there is a greater awareness of the need to preserve healthy local environments and to avoid further global environmental damage — through climate change, desertification and the loss of bio-diversity. There are only a limited range of economically viable options currently available for the large-scale generation of electricity and other forms of energy which are needed. Nuclear power is one of these. It is a potential major contributor to an environmentally sound, carbon-free global energy supply. A sustained nuclear safety record — in operation as well as waste disposal — and sustained objective information is needed for the potential to be fully used. The IAEA has an important role in both regards.

In the area of nuclear techniques, the Agency is now focusing on the transfer of technology in ways that bring maximum benefit to the countries concerned, in particular the end-users. This involves the Agency working, for example, with medical and agricultural institutes, and with doctors and farmers — those best able to make direct use of the techniques. There are many tangible benefits — some rather spectacular, like the eradication of insect pests from large areas; some less visible but equally impressive, such as the identification of new water resources using isotope techniques and the reduction of atmospheric pollution through the use of accelerator technology.

Although much nuclear technology transfer can be left to the all powerful market, much remains, especially at the introductory stage, where Agency assistance will make a big difference.

In an era of rapidly growing interaction among States, it is not surprising that governments are relying increasingly on multilateral mechanisms to meet new needs. This leads to three considerations. First, how do we best use the various multilateral mechanisms to meet these new needs. Collaboration and coordination are clearly a key. The Agency has much good experience here — for example, in hosting a joint programme with the FAO in using nuclear techniques to increase food production, in conducting marine environmental research in joint projects with UNEP, and in radiation safety in our close collaboration with UNSCEAR. New areas of cooperation have also opened up in recent years: in arms control, with the Secretariats charged with implementing the bans on chemical weapons and nuclear testing; in the evaluation and remediation of radiation contamination, where the Agency has worked with the WHO and others; and in the efforts to prevent the illegal trafficking of nuclear and radioactive materials, where we have worked with the World Customs Council. These interactions are essential and require constant attention to ensure effectiveness and efficiency.

Secondly, some important questions arise about the overall structure of the multilateral system. Decisions will need to be made about the assignment of new responsibilities among its various elements. For example, it has been widely observed that the system has no one centre for the consideration of energy issues. The considerable expertise that exists in the IAEA in the general field of energy must be fully used in any system-wide forum.

Third is the question of resources. The international system has been increasingly under pressure to improve efficiency and effectiveness, and the Agency has played its full part. The strengthening of the safeguards system is accompanied by an emphasis on increased efficiency. New approaches to technology transfer have the same twin objectives. Administrative systems are constantly under review and new technologies offer promise of further efficiencies. Voluntary contributions will continue to finance some of the new activities Member States want the IAEA to pursue but they cannot be a substitute for regular funding of core activities. To do more with less will remain a challenge!

It is my conviction that the legal and technical foundations that have been laid and the services that have been developed over the past decade through the Agency will help lead the world to safer and more secure use of nuclear energy and nuclear techniques. Major challenges have been encountered and the Agency has emerged stronger from successfully meeting them. Major new roles have been assigned and are being performed. With the continued active engagement of Member States, the Agency and its staff can confidently look to the challenges over the horizon.

— Dr. Hans Blix, IAEA Director General.

The IAEA is facing new realities and challenges as the world approaches the next century. Three fundamental challenges have emerged:

The first concerns the role of nuclear energy for sustainable development — an issue that embraces nuclear and radiation safety, waste disposal, the physical protection of nuclear materials, and measures against illegal nuclear trafficking. The second concerns the IAEA's ability to credibly verify States' non-proliferation pledges, and its role in verifying future arms-control measures. The third concerns the role of multilateralism, a challenge accentuated by the end of the Cold War, and one witnessed in the declining financial resources of the UN system and other intergovernmental organizations.These challenges point to dual needs — for continuity and for adjustment.

Nuclear power is regarded by many States as having an important role to play in the energy mix over the next few decades. With the growing demand for energy and electricity, and under the shadow of the greenhouse effect and acid rain, the nuclear power option will continue to be explored or followed in many parts of the world. The choice to make use of it is a national decision, and the Agency's cooperative role will be adjusted to focus on key areas of energy assessments and nuclear power development with those countries who want to make use of it.

Outside the electric power area as well, other applications of nuclear energy are essential in many fields, including health, agriculture, and hydrology. The IAEA will need to focus on those applications where the nuclear techniques offer a comparative advantage over other available techniques — in other words, where they have found a demonstrated "niche". The transfer of technology for social and economic development is a major function of the IAEA in its own right. New directions of the Agency's technical cooperation programmes now put them on the path of becoming an even more important vehicle for sustainable social and economic development.

The key to the use of nuclear energy in all its forms is safety. New safety-related conventions are in place, raising the need of implementing them. Important in this respect is the need to accelerate practical assistance to States in areas of nuclear legislation; setting up infrastructures for radiation protection and for waste management and disposal; and advisory safety services for nuclear operations and radiation and waste practices.

The verification of nuclear energy's peaceful uses contributes to international security in many parts of the world. It has become an important component of the national security profile in more than 180 States, and essential for nuclear trade. States have therefore supported efforts for strengthening the IAEA's safeguards to provide more comprehensive assurances and a more cost-effective system. It is to be hoped that they would become party to the new protocol to strengthen safeguards at the earliest possible date. Other developments in the verification field, including the emergence of regional nuclear-weapon-free-zones and the Agency's possible verification of nuclear disarmament, signal ways in which the IAEA is challenged to contribute further to the world's security goals.

In the coming years, no dramatic increase in financial resources to the Agency is expected. This reality calls for more focused IAEA programmes and more clearly defined priorities where the Agency's core competencies and comparative advantages are clearly established. The IAEA will have to shed itself of activities that are obsolete or could be more efficiently implemented by others in and outside the UN system. Better and new financing arrangements, particularly for technical cooperation and for new verification tasks, will be required. Further steps will be needed to streamline the Agency's structure, and to continue the process of other reforms. The aim will be to save resources that can go into programme activities, and to provide governments with even better return on their investment.

As we move ahead, an overriding challenge will be to make the IAEA more effective, efficient, and responsive to the needs of its Member States. This could be achieved by avoiding a North-South divide, or other divides, and by equal commitment by all to the Agency's twin objectives: international cooperation for progress and consolidation of international security. These are aims that are worth pursuing in earnest. There are many opportunities, and much work, ahead in our common efforts to achieve them. *—Dr. Mohamed ElBaradei, the Agency's Assistant Director General for External Relations, & IAEA Director General-Designate.*

MORE THAN JUST THE FAX

World Wide Web home pages, "e-mail", and databanks on the Internet all became part of the Agency's "cyberspace" world of information services over the decade. New skills and systems have been cultivated and developed to serve the growing demands for information and cost-efficiency of the Agency's governmental, public, and technical audiences. At the same time, more specialized training was needed to help staff to use computer applications productively in their work and to introduce them to the wonders of the "mouse" and frustrations of "search tools" needed to navigate the "Web". Today, almost all Agency staff have access to electronic information services from their offices. Networks are designed and planned to reach databases and systems needed for specific jobs. Administrators access electronic travel planning, procurement bids, timekeeping, and financial systems. Technical staff coordinate meetings and use electronic mail to jointly draft documents. Managers of cooperation projects and research contracts exchange status reports on-line with their national partners worldwide.

Although rooted in the 1970s, the Internet first became popularly used in this decade. Before then, the Agency had used a number of private networks for exchange of electronic mail and access to a small number of on-line databases. By 1993 the Internet was already eclipsing other networks for electronic mail.

To take advantage of the power and reach of another fast-emerging Internet communications product, the World Wide Web, the Agency started its *WorldAtom* service in the early 1990s. Today its pages are accessed tens of thousands of times monthly by scientists, students, government officials, and journalists to obtain information from electronic publications and periodicals, official statements, legal agreements, and conference and meeting documents. All IAEA programmes now regularly publish information about their 1300 projects via the Internet, and on-line databases provide access to nuclear power status information, nuclear applications, nuclear physics, and nuclear safety information.

Internet tools also were applied to improve or develop information services restricted to staff use. One important outcome — the On-line Administrative Staff Information System (OASIS) — covers managerial guidelines, procedures, manuals, staff notices, and official records. It also links to other on-line services. They include "country files" systems that integrate nuclear-related information that the Agency's Member States report to its many databases, or are accessible from global networks integral to programmes. One recent link is the new "GovAtom" service. It provides working papers of the Board of Governors and other restricted information to authorized users in Member States. In addition to these outlets, Member States now routinely send information to the Agency via the Internet, or other electronic means.

More library services of the Vienna International Centre have also been put on-line. Increasingly, information about the Library's collections of print and audio-visual materials is available on CD-ROM or in other electronic forms to Agency staff and other users. Also strengthened is the Library's own access to electronic sources of documents. An example is the United Nations Optical Disk System, which not only speeds delivery of UN documents, but also reduces the local storage requirements.

The Agency's pioneering International Nuclear Information System (INIS) expanded its coverage in cyberspace over the decade. In 1991, the INIS scope was expanded to

PRIS...RRDB...NDIS...GOVATOM...AGRIS...RasaNet...WorldAtom...NuSafe...EEDB...MDIS...CINDA...INIS...

cover environmental and economic aspects of non-nuclear power production. By 1997, ninety-nine IAEA Member States, as well as thirty-four other countries and organizations, participated in the INIS network.

The wider use of smaller, more powerful personal computers during the past ten years has opened new avenues. In 1991, INIS started CD-ROM services, and today more users are accessing INIS data from the compact disks than in any other way. A new, more powerful and flexible computer operating platform is being developed to improve connections with users.

Other improvements take advantage of the skyrocketing amount of information becoming available electronically. A software package called FIBRE (Friendly Input of Bibliographic Records) has been developed for data to be sent more easily into the INIS database via the Internet. Now being upgraded is the INIS collection of full-text information from microfiche to electronic media for distribution on CD-ROM. Additionally, INIS and its global partners launched a Web home page in 1996 to broaden awareness of its services and of links to other nuclear information sources.

A frequently asked question is how well developing countries are served by the new electronic tools and services. Over the past decade, training and computer support services have targeted important needs. Staff working at INIS national centres are being trained in all aspects of information technology, especially as they relate to INIS operations. National infrastructures for computerized transmission and receipt of INIS information also were targeted in efforts to upgrade electronic capabilities.

Additionally, research and outreach efforts have been strengthened over the decade through the Agency's extensive global network for nuclear data services supporting a wide variety of nuclear physics and related studies. By 1997, forty-one developing and industrialized countries were using the Nuclear Data Information System on line for responding to more than four thousand requests, almost four times as many as in 1992.—*based on reports by Jerry Barton, Claudio Todeschini, Ms. Wendy Bartlett, and Hans Lemmel.*

VALUE FOR MONEY

When the decade began, the Agency had fewer Member States and staff to serve. In 1986, there were 112 Member States and just over 1900 professional and support staff at headquarters, liaison offices in Geneva and New York, safeguards offices in Toronto and Tokyo, and research laboratories and centres in Monaco, Trieste (Italy), and Seibersdorf (Austria). By 1997, fifteen further countries had joined, and about three hundred more staff had been hired, as the decade's developments placed greater demands on programmes and services. Many of these professional men and women were recruited from developing countries: by 1997, nearly one-third of professional and higher category staff were from developing countries, a ten percent increase over 1985. The representation of women in these categories has grown as well by approximately six percent, reaching eighteen percent in 1996. For all organizations with the UN Common System, the decade brought increasing calls from Member States for "efficiency gains", "value-added" services, and organizational reforms to programmes and their management. The Agency has initiated steps leading to lower overhead costs for running the organization. And, as noted throughout this special anniversary edition, programme adjustments were made in response to technological developments of the Information Age and to difficult challenges emanating from the changing Nuclear Age. Holding steady, however, throughout the decade was the Agency's budget under its Member States' policy of zero growth for spending. In the early 1990s, the budget was cut when cash-flow problems mounted following the breakup of Soviet Union. Extra resources to fund expanded safety-related and other programmes have come largely from the voluntary contributions of Member States and through national support programmes that provide experts, equipment, and services to the Agency. — *Based on reports from staff in the Agency's Department of Administration.*

IAEA SYMPOSIA & SEMINARS

OCTOBER 1997

Symposium on International Safeguards
Vienna, Austria (13-17 October)

Regional Seminar on Nuclear Techniques for Optimizing the Use of Nutrients and Water for Maximizing Plant Productivity and Environmental Preservation
Piracicaba, Brazil (27-31 October)

NOVEMBER 1997

International Conference on Physical Protection of Nuclear Materials: Experience in Regulation, Implementation and Operation
Vienna, Austria (10-14 November)

Symposium on Upgrading the Fire Safety of Operating Nuclear Power Plants
Vienna, Austria (17-21 November)

International Conference on Low Doses of Ionizing Radiation: Biological Effects and Regulatory Control
Seville, Spain (17-21 November)

MARCH 1998

International Symposium on Modern Trends in Radiopharmaceuticals for Diagnosis and Therapy
Lisbon, Portugal (30 March-3 April)

MAY 1998

FAO/IAEA International Conference on Integrated Management of Insect Pests through Nuclear and Related Techniques
Penang, Malaysia (29 May-2 June)

JUNE 1998

International Conference on Topical Issues in Nuclear, Radiation and Radioactive Waste Safety
Vienna, Austria (15-19 June)

SEPTEMBER 1998

Seminar on Approaches and Practices in Strengthening Nuclear Safety, Radiation Protection and Waste Management Infrastructures in Countries of Eastern Europe and the Former USSR
Prague, Czech Republic (28 September-2 October)

POSTS ANNOUNCED BY THE IAEA

Nuclear Safeguards Inspector (97/SGO-4), P-4 position.
Closing Date: 31 December 1997.
Technical Officer (97/059), Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture, P-4 position.
Closing date: 24 November 1997
Director (97/058), Division of Physical and Chemical Sciences, D-1 position.
Closing date: 24 November 1997
Unit Head (97/057), Division of Budget and Finance, P-3 position.
Closing date: 24 November 1997
Section Head (97/052), Russian Translation Section, P-5 position.
Closing date: 10 November 1997
Director (97/051), Division of External Relations, D-1/D-2 position.
Closing date: 7 November 1997

Senior Translator (97/047), English Translation Section, P-4 position. *Closing date: 3 November 1997*
Plasma Physicist (97/050), Division of Scientific and Technical Information. P-3 position.
Closing date: 3 November 1997
Chemist (97/049), Division of Scientific and Technical Information, P-3 position.
Closing date: 3 November 1997
Development Programmer (97/048), Division of Scientific and Technical Information, P-2 position.
Closing date: 3 November 1997
Medical Radiation Physicist-SSDL Officer (97/054), Division of Human Health. P-4 position.
Closing date: 10 November 1997
Section Head (97/053), Division of Human Health. P-5 position.
Closing date: 10 November 1997

Industrial Chemist (97/701), Division of Physical and Chemical Sciences,. P-3 position.
Closing date: 3 October 1997
Performance Monitoring Engineer (97/055), Division of Technical Services, Department of Safeguards, P-3 position.
Closing date: 10 November 1997.

Readers' Note: These are abridged versions of full listings sent to governments, UN offices, and other outlets. Complete listings of IAEA job vacancies — and information about working for the Agency — also are accessible over the IAEA's *WorldAtom* Internet services at http://www.iaea.org, or by writing the IAEA Division of Personnel, P.O. Box 100, A-1400 Vienna, Austria. See the inside back page for the official electronic mail address, telephone number, and facsimile.

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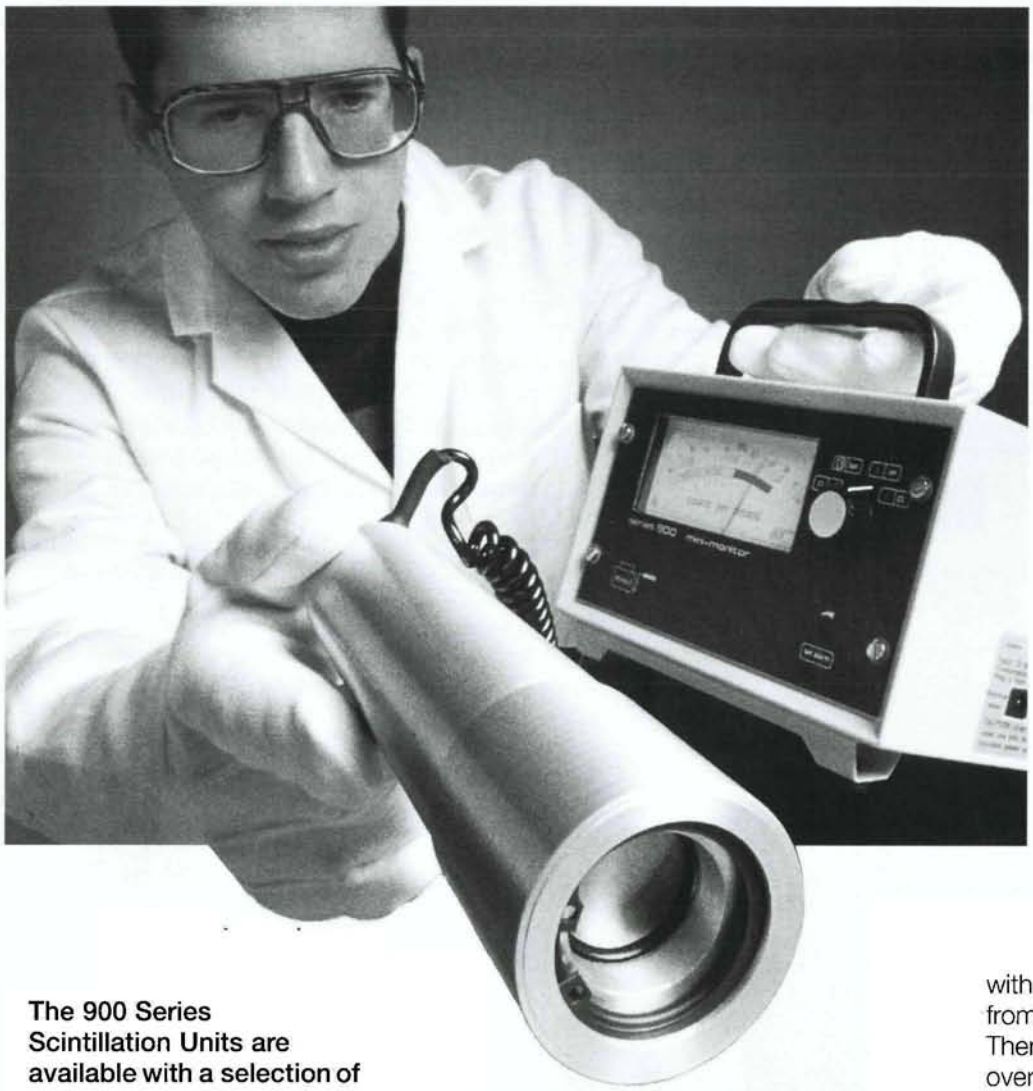

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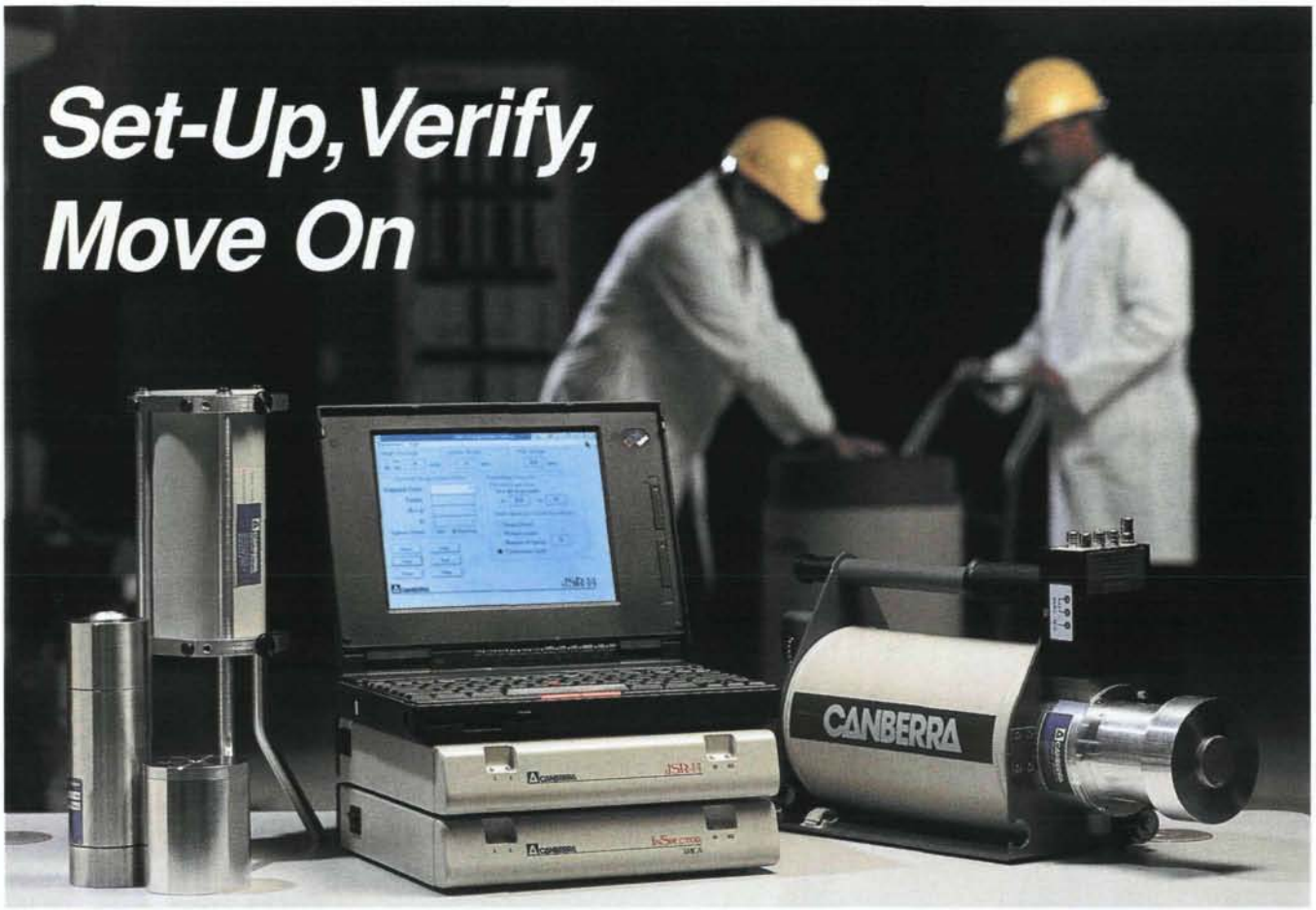

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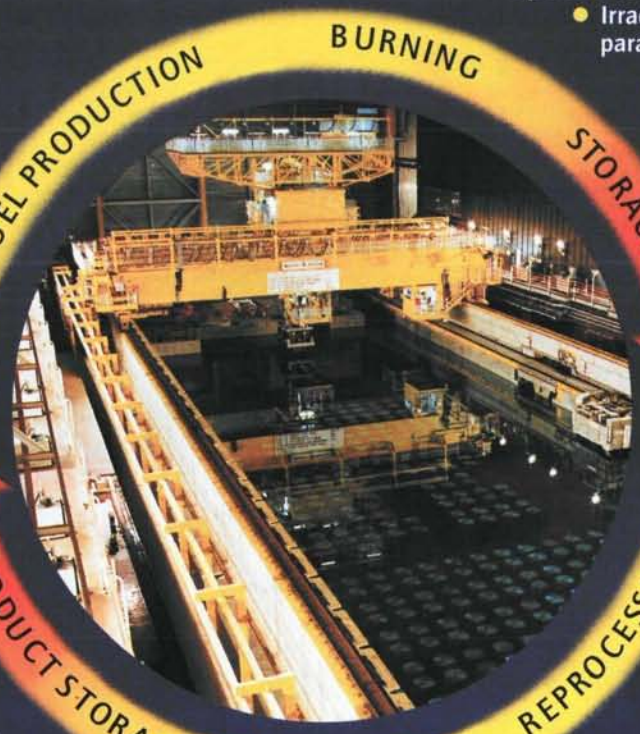

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Tel: (43-1) 2060-21270
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DIRECTOR GENERAL: Dr. Hans Blix
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LAYOUT/DESIGN: Ms. Hannelore Wilczek
CONTRIBUTORS TO DEPARTMENTS: Ms. S. Dallalah, Ms. B. Amaizo, Ms R. Spiegelberg
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IAEA MEMBER STATES

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Albania
Argentina
Australia
Austria
Belarus
Brazil
Bulgaria
Canada
Cuba
Denmark
Dominican Republic
Egypt
El Salvador
Ethiopia
France
Germany
Greece
Guatemala
Haiti
Holy See
Hungary
Iceland
India
Indonesia
Israel
Italy
Japan
Korea, Republic of
Monaco
Morocco
Myanmar
Netherlands
New Zealand
Norway
Pakistan
Paraguay
Peru
Poland
Portugal
Romania
Russian Federation
South Africa
Spain
Sri Lanka
Sweden
Switzerland
Thailand
Tunisia
Turkey
Ukraine
United Kingdom of Great Britain and Northern Ireland
United States of America
Venezuela
Viet Nam
Yugoslavia

1958
Belgium
Cambodia
Ecuador
Finland
Iran, Islamic Republic of
Luxembourg
Mexico
Philippines
Sudan

1959
Iraq

1960
Chile
Colombia
Ghana
Senagal

1961
Lebanon
Mali
Zaire

1962
Liberia
Saudi Arabia

1963
Algeria
Bolivia
Côte d'Ivoire
Libyan Arab Jamahiriya
Syrian Arab Republic
Uruguay

1964
Cameroon
Gabon
Kuwait
Nigeria

1965
Costa Rica
Cyprus
Jamaica
Kenya
Madagascar

1966
Jordan
Panama

1967
Sierra Leone
Singapore
Uganda

1968
Lichtenstein

1969
Malaysia
Niger
Zambia

1970
Ireland

1972
Bangladesh

1973
Mongolia

1974
Mauritius

1976
Qatar
United Arab Emirates
United Republic of Tanzania

1977
Nicaragua

1984
China

1986
Zimbabwe

1991
Latvia
Lithuania

1992
Croatia
Estonia
Slovenia

1993
Armenia
Czech Republic
Slovakia

1994
Former Yugoslav Republic of Macedonia
Kazakhstan
Marshall Islands
Uzbekistan
Yemen

1995
Bosnia and Herzegovina

1996
Georgia
Moldova

Eighteen ratifications were required to bring the IAEA's Statute into force. By 29 July 1957, the States in bold face had ratified the Statute.
Year denotes year of membership. Names of the States are not necessarily their historical designations.
For States in italic, membership has been approved by the IAEA General Conference and will take effect once the required legal instruments have been deposted.

The International Atomic Energy Agency, which came into being on 29 July 1957, is an independent intergovernmental organization within the United Nations System. Headquartered in Vienna, Austria, the Agency has more than 100 Member States who together work to carry out the main objectives of IAEA's Statute: To accelerate and enlarge the contribution of atomic energy to peace, health, and prosperity throughout the world and to 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.

IAEA headquarters, at the Vienna International Centre.

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IAEA TURNS 40

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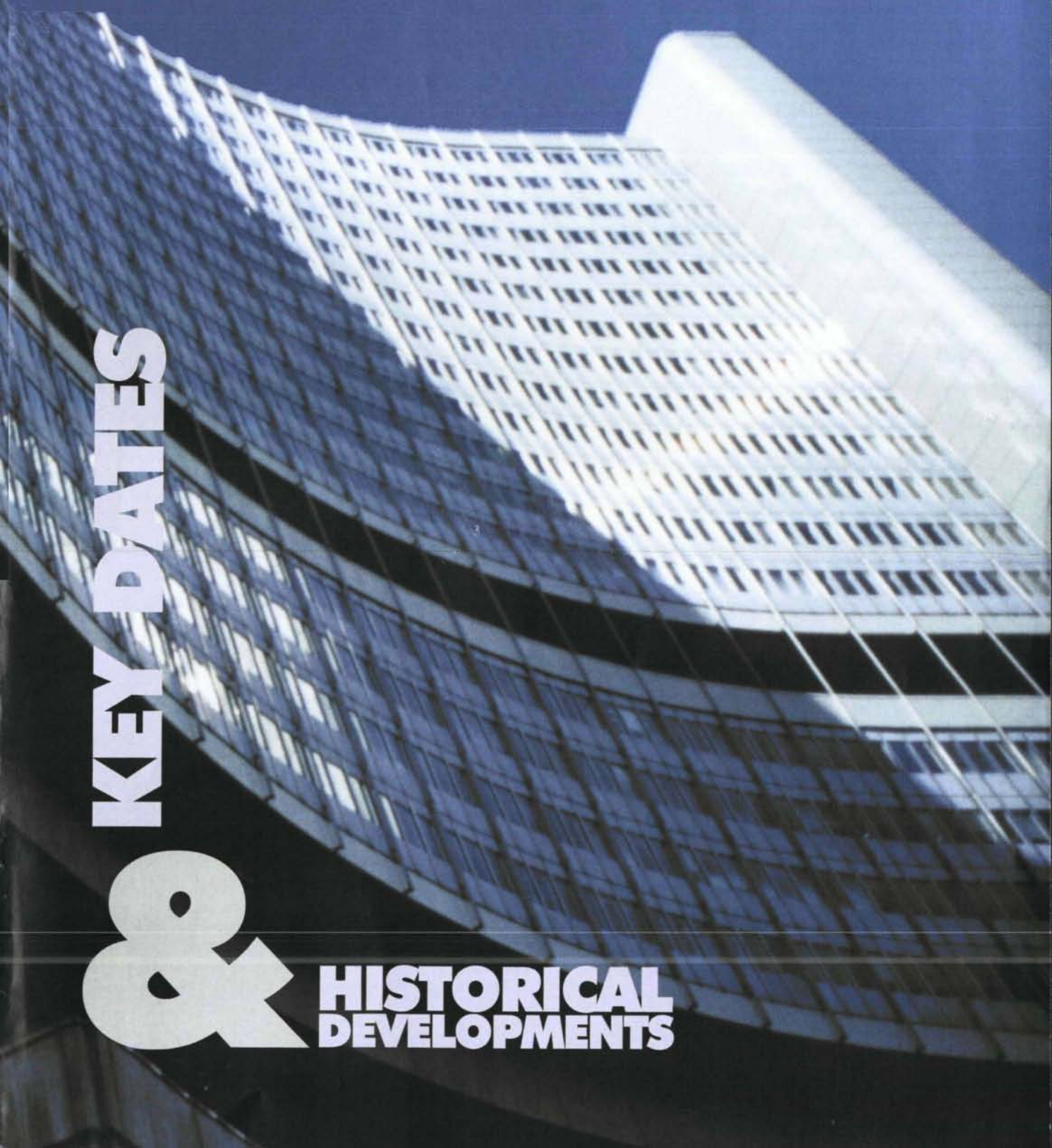

KEY DATES & HISTORICAL DEVELOPMENTS

This chronology and associated links to selected historical material are available electronically over the IAEA's WorldAtom Internet services at http://www.iaea.org.

Compiled and written by Lothar Wedekind, based on staff reports published in Agency periodicals and publications, including the *IAEA Bulletin, IAEA Newsbriefs, IAEA Yearbook,* and *Annual Reports,* various media sources covered in the IAEA's *Daily Press Review,* as well as information from the *Law & Practices of the International Atomic Energy Agency* by Paul Szasz, and external sources including David Fischer's two recent books, *Towards 1995: The Praspects for Ending the Proliferation of Nuclear Weapons* (UNIDIR, 1993), and *A History of the International Atomic Energy Agency: The First Forty Years* (IAEA, 1997), Lawrence Scheinman's *The International Atomic Energy Agency and World Nuclear Order* (RFF, 1987), and the *International Law of Nuclear Energy,* edited by Mohamed ElBaradei, Edwin Nwogugu, and John Rames (Nijhof Publishers, 1993).

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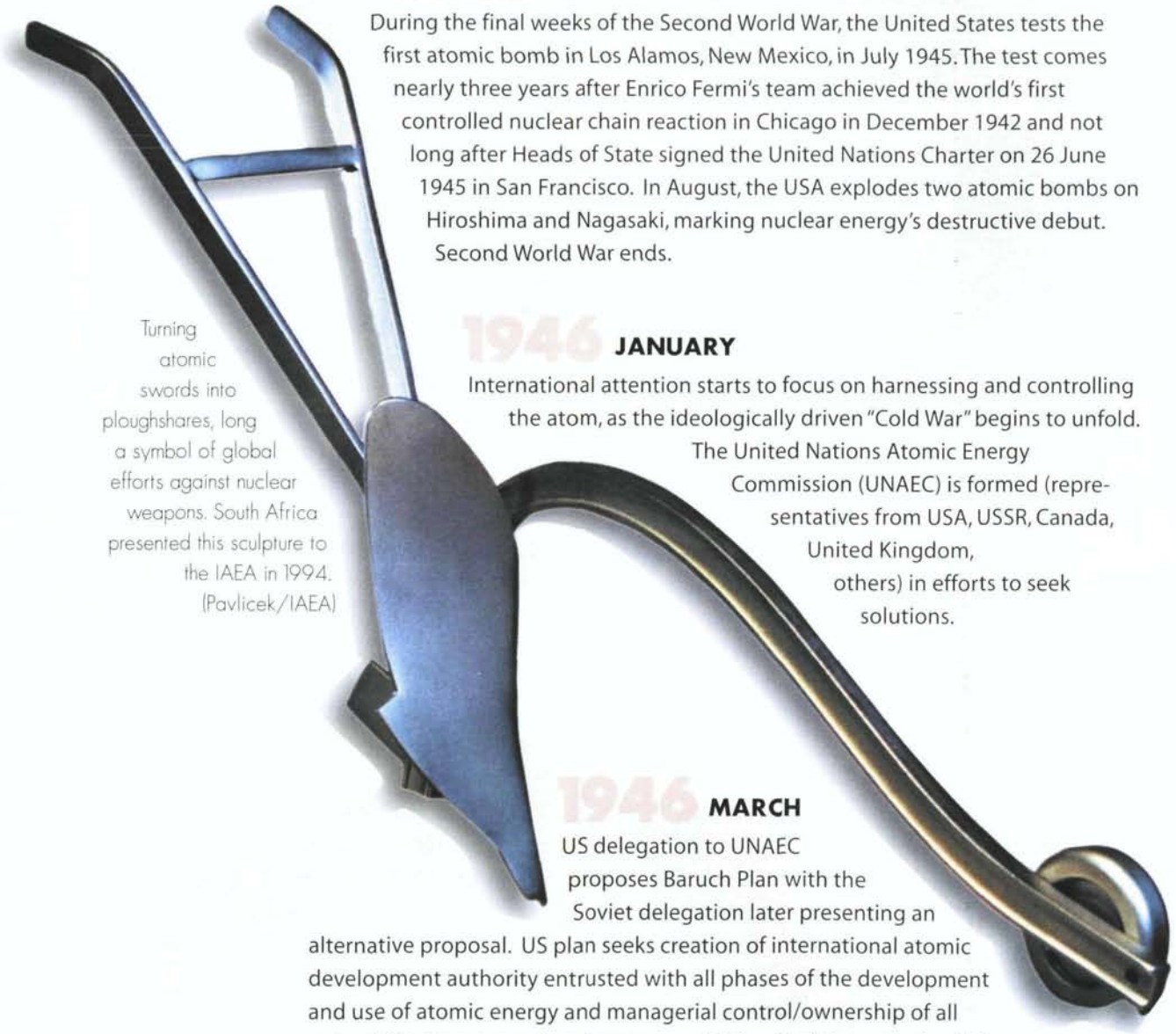
International Atomic Energy Agency, Vienna, Austria (July 1997)

THE FORTIES & THE TERRIBLE SWORD



Turning atomic swords into ploughshares, long a symbol of global efforts against nuclear weapons. South Africa presented this sculpture to the IAEA in 1994. (Pavlicek/IAEA)

1945 JULY/AUGUST

During the final weeks of the Second World War, the United States tests the first atomic bomb in Los Alamos, New Mexico, in July 1945. The test comes nearly three years after Enrico Fermi's team achieved the world's first controlled nuclear chain reaction in Chicago in December 1942 and not long after Heads of State signed the United Nations Charter on 26 June 1945 in San Francisco. In August, the USA explodes two atomic bombs on Hiroshima and Nagasaki, marking nuclear energy's destructive debut. Second World War ends.

1946 JANUARY

International attention starts to focus on harnessing and controlling the atom, as the ideologically driven "Cold War" begins to unfold. The United Nations Atomic Energy Commission (UNAEC) is formed (representatives from USA, USSR, Canada, United Kingdom, others) in efforts to seek solutions.

1946 MARCH

US delegation to UNAEC proposes Baruch Plan with the Soviet delegation later presenting an alternative proposal. US plan seeks creation of international atomic development authority entrusted with all phases of the development and use of atomic energy and managerial control/ownership of all potentially dangerous atomic energy activities. Soviet proposal calls for international convention prohibiting production and use of atomic weapons for mass destruction. UNAEC over the next three years fails to reach agreement.

1949 SEPTEMBER

The Soviet Union carries out its first nuclear weapons test, signalling arms race and effectively ending UNAEC's role.

THE FIFTIES & ATOMS FOR PEACE

1952

UN General Assembly formally dissolves the UNAEC, which had been inactive since July 1949. In October, the UK tests a nuclear weapon. The USA tests the first hydrogen bomb in November.

1953 DECEMBER

"Atoms for Peace" speech by US President Eisenhower before UN General Assembly. Its main proposal calls for "the governments principally involved" (naming the USA and Soviet Union) to make joint contributions from their stockpiles of normal uranium and fissionable materials to an international atomic energy agency set up under the UN. Among the agency's responsibilities would be to store and safeguard the material and to "devise methods" whereby it would be allocated to serve the "peaceful pursuits of mankind".

1954

The USA amends its Atomic Energy Act to permit peaceful international nuclear cooperation, leading to bilateral agreements with a number of States. In the USSR, the world's first nuclear power plant is commissioned at Obninsk.

1955 APRIL

In Washington, DC, work begins on drafting the Statute of the International Atomic Energy Agency (IAEA) with the participation of governmental representatives from Australia, Belgium, Canada, France, Portugal, South Africa, United Kingdom, and USA. Later, in early 1956, group expands to twelve with representatives from the USSR, Czechoslovakia, India, and Brazil.

1955 AUGUST

Beneficial uses of nuclear power are showcased at the UN's First International Conference on Peaceful Uses of Nuclear Energy in Geneva, a landmark scientific meeting of more than 1500 delegates. Dr. Homi Bhabha, the eminent Indian physicist, serves as President.

1956 OCTOBER

In New York, States approve the Statute of the IAEA at a conference of 82 States at the UN. It incorporates responsibilities for both the control and development of nuclear energy for exclusively peaceful purposes. Global political crises make headlines: in the Middle East, conflict over control of the Suez Canal, and in Hungary, the Soviet Union's intervention.

1957

Mr. Sterling Cole

The Agency's Preparatory Commission begins work in February toward the first General Conference in October. The IAEA Statute enters into force 29 July, by which time 26 States had deposited their instruments of ratification. In October, delegates from 59 States attend the first General Conference of the IAEA in Vienna, Austria, for three weeks. They appoint Sterling Cole, from the United States, as first Director General and approve $4.1 million programme of activities. Mr. Cole assumes post, after the interim term as Acting Director General of the Preparatory Commission's Executive Director, Paul Jolles of Switzerland. The former Grand Hotel on Vienna's Ringstrasse is selected as the temporary headquarters of the Agency. ***Board of Governors:*** Dr. Pavel Winkler, of Czechoslovakia, is elected as the IAEA's first Board Chairman. As provided by the Agency's Statute, the first Board includes 23 Member States: Argentina, Australia, Brazil, Canada, Czechoslovakia, France, Guatemala, India, Indonesia, Italy, Japan, Korea, Pakistan, Peru, Portugal, Romania, Sweden, Turkey, Union of South Africa, USSR, United Arab Republic (Egypt), United Kingdom, and USA. ***Regional nuclear bodies:*** In March, six European countries sign the "Rome treaties" establishing the European Atomic Energy Community (Euratom) and the Common Market. In December, countries agree to set up the European Nuclear Energy Agency of the Organization for European

The former Grand Hotel, the IAEA's first headquarters.

Economic Cooperation (today the NEA of the OECD). Actions led to formation of other regional nuclear bodies around the world. ***Global events:*** The Soviet Union announces the launching of the first satellite into outer space, the unmanned Sputnik-I.

1958

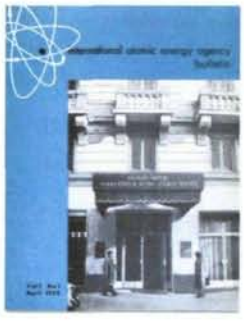
In July, the Soviet Union and Western countries meet in Geneva on nuclear arms control, discussing the feasibility of detecting underground tests. Also in Geneva, the UN convenes the Second International Conference on Peaceful Uses of Nuclear Energy, which opens more technical and scientific information to the international community about most aspects of the civil nuclear fuel cycle except for uranium enrichment. ***IAEA developments:*** The IAEA initiates its technical assistance programme with a modest fund of $125,000 — which includes $2.01 a New York school boy and his classmates voluntarily contributed to the Agency. The IAEA sends its first mission to Latin America to study need for a regional centre. A panel of health and safety experts is set up for preparation of a manual on the safe use of radioactive sources. Canada offers to provide to the IAEA at no cost three tons of natural uranium to meet the first request for nuclear fuel, which was made by Japan for a research reactor. The United States donates two mobile radioisotope laboratories to the Agency that can be transported for use by researchers in other countries. The IAEA begins concluding research contracts with laboratories and other scientific institutes, awarding its first contract to the Vienna Chemical Institute for a study of the factors controlling the distribution of fission products in the biosphere. In November, the first Scientific Advisory Committee to the IAEA's Director General is formed, composed of Dr. Homi Bhaba of India, Sir John Cockcroft of the UK, Prof. Vasilij S. Emelyanov of the Soviet Union, Mr. Bertrand Goldschmidt of France, Dr. Bernhard Gross of Brazil, Dr. Wilfrid B. Lewis of Canada, and Dr. Isidor Rabi of the USA.

One of the two mobile radioisotope laboratories donated by the USA.

In 1958, the IAEA received a gift of $2.01 from Joseph Santore, a schoolboy in New Rochelle, New York, who organized a collection among his classmates to help the development of nuclear science. He is shown here with his mother; Dr. Ralph Bunche, Under Secretary General of the United Nations; and Mr. Sterling Cole, Director General of the IAEA.

1959 APRIL

In February, the issue of liability for nuclear accidents appears on the global agenda, as the IAEA convenes the first meetings of a panel of experts examining the question of civil liability and State responsibility for nuclear hazards. The IAEA and World Heath Organization (WHO) jointly sponsor the Agency's first scientific meeting, with thirty-eight experts from 22 countries attending the seminar on medical radioisotope scanning. In April, the first edition of the *IAEA Bulletin,* the International Atomic Energy Agency's quarterly journal, is published. By mid-year, the IAEA becomes a scientific publisher, having issued nine publications. They include the first manual in the IAEA's Safety Series, *Safe Handling of Radioisotopes*; the first volume of a three-volume *International Directory of Reactors*; and the first volume of a two-volume *International Directory of Radioisotopes and Labelled Compounds*. In September, the Agency convenes its first scientific conference, on the application of large radiation sources in industry, in Warsaw. In Monaco in November, the IAEA, jointly with the United Nations Educational, Scientific and Cultural Organization (UNESCO), convenes a pioneering scientific conference on the disposal of radioactive wastes. In Switzerland, a team of IAEA experts conducts the Agency's first safety evaluation of a nuclear research reactor. In the Soviet Union, the first nuclear-powered ship, the *Lenin*, is built.



THE SIXTIES & THE RISING HOPES

1960

France explodes a nuclear weapon in tests, becoming the fourth State to declare itself a nuclear-weapons power. ***IAEA developments:*** The Agency awards its first research grant to an Indian scientist for research at the Massachusetts Institute of Technology in the USA on solid state physics. In April, the IAEA Board of Governors adopts the Agency's official emblem and seal. In October, the Agency begins publication of its first scientific periodical, the quarterly *Nuclear Fusion* journal.

1961

Dr. Sigvard Eklund

Dr. Sigvard Eklund from Sweden, a physicist who served as Secretary General of the 1958 UN Conference in Geneva, is appointed as the IAEA's second Director General. The scientific and technical character of the Agency comes more sharply into focus. First nuclear inspections under IAEA safeguards system take place at a research reactor in Norway. The IAEA's Laboratory opens in Seibersdorf, Austria, near Vienna, opening a novel channel for cooperative global nuclear research. The Agency signs a trilateral agreement with Monaco and the Oceanographic Institute headed by Jacques Cousteau for research on the effects of radioactivity in the sea, an action that eventually leads to creation of a Laboratory today known as the IAEA's Marine Environment Laboratory. In September, the IAEA convenes the first major global conference on plasma physics and controlled nuclear fusion in Salzburg, Austria; more than 500 scientists attend. Through various programmes, the Agency emphasizes the development of radiation health and safety standards; sharing experience in areas of waste disposal; and explaining the beneficial uses of radioisotopes in medical, agricultural, industry, and other fields. It issues the first international regulations for the safe transport of radioactive waste. ***Nuclear-weapon-free zone:*** At a time when atmospheric testing of nuclear bombs is growing to average more than one explosion per week, States adopt the Antarctic Treaty, the first regional approach to non-proliferation. It demilitarizes that vast, but unpopulated area, and bans all nuclear weapons and nuclear testing in the region. ***Environment:*** The IAEA and World Meteorological Organization (WMO) initiate a joint global network for surveying the content of hydrogen and oxygen isotopes in precipitation, which serves to monitor tritium releases associated with nuclear testing and today is widely used in studies of water cycles and global climate change. ***Global events***: In Berlin, East Germany begins to build the wall dividing the city and symbolizing the Cold War.

First nuclear inspections under IAEA safeguards system take place in 1961 at a research reactor in Norway.

1962

In May, the IAEA convenes its first major symposium on nuclear reactor safety, reviewing the safety picture from the global perspective. In June, the IAEA Board approves the Agency's *Basic Safety Standards for Radiation Protection*, upon which countries can, and do, base their national standards and regulations (subsequent editions, the latest in 1994, update the standards). ***Global events:*** In October, in the Caribbean, the Cuban missile crisis rivets international attention on the proliferation dangers of the nuclear age, and initiates a consultation process among Latin American countries for denuclearizing the region. Reflecting a global concern about the possible spread of the bomb, US President Kennedy warns that the world could see more than twenty countries acquiring nuclear-weapons capabilities by the mid-1970s.

1963

The USA and Soviet Union, in the aftermath of the Cuban crisis, begin to seek common ground in areas of nuclear arms control. The Partial Nuclear Test Ban Treaty is negotiated, co-sponsored by the USA, Soviet Union, and UK. It bans nuclear tests in the atmosphere, underwater, and in outer space. ***IAEA developments:*** The IAEA safeguards system is extended to large reactors, an important step in the internationalization of bilateral safeguards agreements. In Cairo, the first regional

radioisotope centre is established under IAEA auspices for training researchers from countries in the region.

1964

The Oyster Creek nuclear plant in the USA is built for electricity generation at price many countries find affordable. It heightens interest in nuclear power plants for electricity generation. The IAEA moves to establish greater capabilities in areas of technology transfer, setting up its Department of Technical Assistance as well as a Joint Division with the Rome-based Food and Agriculture Organization (FAO) of the United Nations. In Trieste, Italy, the IAEA inaugurates the International Centre for Theoretical Physics, which serves as a research and training centre for scientists from developing countries. (Today it is operated by UNESCO with the Agency's support.) In Geneva, the Third UN International Conference on the Peaceful Uses of Nuclear Energy convenes in August, under the presidency of Prof. Emelyanov of the USSR. ***Nuclear testing:*** China becomes the fifth country to test a nuclear weapon.

1967

The Tlatelolco Treaty for the Prohibition of Nuclear Weapons in Latin America opens for signature (enters into force 25 April 1969) in Mexico. It establishes a nuclear-weapon-free zone covering Latin America and the Caribbean. Requires comprehensive IAEA safeguards. A year later, Mexico becomes the first country to place its entire nuclear programme under IAEA safeguards in accordance with the Treaty.

1968

An idea that Ireland first formally proposed as early as 1958 bears fruit: following extensive negotiations, the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) is finalized and opens for signature. It essentially freezes the number of declared nuclear-weapon States at five (USA, Soviet Union (now Russia), UK, France, China), who are obligated to make "good faith" efforts toward disarmament. Other States grouped as non-nuclear weapon States, who are required to forswear the nuclear weapons option and to conclude comprehensive safeguards agreements with the IAEA on their nuclear materials. The Treaty provides for these States to receive

The opening of the IAEA Seibersdorf Laboratories in 1961 opened a new channel for cooperative global research.

assistance for the transfer of technology for peaceful applications of nuclear energy. Treaty review conferences are set at five-year intervals over 25-year period. *(Treaty enters into force in March 1970 and in 1995 is indefinitely extended by Parties. Membership in July 1997: 185 Parties; non-members include Brazil, Pakistan, India, Israel, who refrain for specific political or security reasons. By mid-1997, Brazil had taken steps to join the Treaty.)* ***Health care:*** The WHO joins the Agency's programme for the postal distribution of dosimeters for measuring radiation doses to patients at radiotherapy centres, strengthening efforts to promote achievement of international standards.

1969

Applications of nuclear and radiation technologies in fields of agriculture, medicine, industry, and other fields continue to make inroads globally, particularly in developing countries. Nuclear power serves as an energy source during the historic Apollo missions, as three astronauts place an atomic generator on the moon.

The 1960s saw growing use in developing countries of nuclear and radiation technologies for health care.

THE SEVENTIES & THE DUAL CHALLENGE

1970

The IAEA sets up a Safeguards Committee to advise the Agency on its responsibilities under the NPT, which enters into force in March. In May, the IAEA begins operating the bibliographic reference database, the International Nuclear Information System (INIS), with participating Member States, distributing Atomindex, computer tapes, and microfiche. The IAEA Board had given the green light for its establishment in February 1969, but imposing restrictions (lifted in 1972) for controlling the growth and cost. By mid-decade, thirty-five countries had agreed to take part in INIS, thus ensuring that the system would cover at least 90% of the sources of the world's nuclear publications.

1971

Austria's Kurt Waldheim, who later became UN Secretary General and President of Austria, was Chairman of the Safeguards Committee.

The Zangger Committee (named after Swiss Prof. Claude Zangger) is formed, composed of NPT States engaged in major exports of nuclear plant equipment or materials, in efforts to interpret NPT provisions related to exports of nuclear material. Committee draws up trigger list of items whose export would require IAEA safeguards. In Geneva, the UN convenes the Fourth International Conference on the Peaceful Uses of Nuclear Energy in September, drawing 1800 delegates from 79 countries. In Vienna, the IAEA Safeguards Committee completes its work, which includes a model comprehensive safeguards agreement for non-nuclear-weapon States party to the NPT. Finland becomes the first country to sign an NPT safeguards agreement with the IAEA.

1972

UN Conference on the Human Environment is held in Stockholm. Discussions include nuclear energy's environmental benefits; "greenhouse effect". The IAEA starts a two-year "market survey" to assess nuclear power prospects in developing countries, with a focus on the demand for smaller-sized power reactors, and launches its first agreement for standing regional technical co-operation in the nuclear field, the Regional Cooperative Agreement (RCA) for Asia and the Pacific, which today has 17 participating countries. The Agency further intensifies programmes on environmental protection and the safe management of nuclear wastes. In London, a Conference under the auspices of what today is the International Maritime Organization (IMO) adopts a convention banning sea dumping of wastes, identifying the IAEA as the competent body regarding recommendations on radioactive wastes.

1973

The oil crisis puts energy issues at the top of the global agenda, as oil supplies from members of the Organization of Petroleum Countries (OPEC) are restricted and prices quadruple. Nuclear power prospects initially brighten, then wane as high energy prices change economic conditions and lead to energy measures that over time help to slow demand.

Apollo-12 astronaut Charles Conrad at the IAEA.

IAEA developments: In April, the IAEA and Euratom sign an agreement for the implementation of safeguards provisions under the NPT, a major step forward in international verification. The IAEA Board of Governors is expanded to 34 Member States, including the Federal Republic of Germany and Italy as designated members and permitting election of more developing countries. The Agency hosts three Apollo-12 astronauts who placed the first atomic power generator on the moon in 1969. With the WMO, the IAEA launches a postal dosimetry service for intercomparisons using data from weather stations around the world; this complements the global network of hydrology laboratories for isotope analysis of the world's water resources.

1974

With the first NPT review conference on the horizon, nuclear safeguards and non-proliferation issues rise higher on global agenda. On 18 May, India explodes what it describes as a "peaceful" nuclear device in tests. In the United States, steps are taken to reinforce the non-proliferation regime and policy on nuclear exports, a process leading to review of nuclear fuel cycles from the standpoint of prolif-

In 1979, the IAEA moved from downtown Vienna to its new headquarters at the Vienna International Centre.

eration risks they may pose. ***Nuclear safety:*** The IAEA inaugurates its Nuclear Safety Standards Programme (NUSS) to develop codes and guides that would be revised over time for nuclear power plant safety in design, construction, operation and other areas. ***Nuclear power:*** For the first time, the IAEA serves as a channel for supplying nuclear fuel for power reactors, concluding contracts for enriched uranium with the US Atomic Energy Commission for supply to Mexico and Yugoslavia. ***Nuclear fuel cycle:*** The IAEA begins studying the possibility of regional nuclear fuel cycle centres for reprocessing nuclear fuel and for waste management.

1975

In London, the US and other major suppliers of nuclear materials from industrialized countries meet secretly for the first time to draw up new rules for nuclear exports. The meeting follows discussions in Moscow in late 1974 between the USA and Soviet Union on the establishment of such a group, which would come to be called the "London Club". At the IAEA's Seibersdorf Laboratories, construction is completed on special facilities for the Safeguards Analytical Laboratory, the coordinating centre of a global network of analytical laboratories for analyzing samples of plutonium, uranium, and other materials.

1976

Jointly with the WHO, the IAEA establishes a global network of Secondary Standards Dosimetry Laboratories for promoting global standards in the safe use of radiation sources in medicine, industry, and other fields.

1977

In September, the Nuclear Suppliers' Group reaches agreement on export controls of sensitive nuclear technology, issuing a list called the "London Guidelines". (Fifteen years later, after the Iraqi case, the Group agreed to require full-scope IAEA safeguards as a condition of supply to non-nuclear-weapon States.) In Vienna, the International Nuclear Fuel Cycle Evaluation (INFCE) begins to assess the interrelated problems associated with peaceful uses of nuclear energy and any risk they may pose of further proliferation; concludes in 1980. The work further reinforces support for IAEA safeguards as a central element of the non-proliferation regime. The safeguards agreement between the IAEA and Euratom enters into force, coordinating their respective inspection responsibilities and bringing under IAEA verification all nuclear plants and reprocessing and enrichment facilities in Euratom non-nuclear-weapon States. ***Nuclear power conference:*** Following up the previous four UN conferences, the IAEA convenes a major global conference in Salzburg on nuclear power and its fuel cycle; nearly 2000 delegates attend.

1978

The United States enacts the Nuclear Non-Proliferation Act, setting restrictions on exports of nuclear technology and reaffirming support to strengthening the IAEA and its system of comprehensive nuclear safeguards. Requires full-scope safeguards as a condition of nuclear supply. ***Fusion:*** The IAEA launches a series of workshops, known as INTOR, on the concept of a large, "next generation" fusion reactor.

1979

Opening of Vienna International Centre along the Danube. The IAEA moves to new headquarters from downtown Vienna. In the United States, headlines report a nuclear power plant accident on 28 March at the Three Mile Island site, near Harrisburg, Pennsylvania. Becomes the first nuclear plant accident to draw extensive international attention. Post-accident studies report negligible radiation releases. The accident causes no loss of life or injury, but leaves the nuclear unit destroyed, and the utility with extensive and lengthy cleanup operation at costs estimated at exceeding $1 billion. In Vienna, an IAEA expert group is formed and establishes guidelines on emergency planning and response.

THE EIGHTIES & THE CHANGING AGENDA

1980

In Geneva, the Second Review Conference of the NPT is deadlocked, arriving at no agreed concluding declaration. Two issues dominate: nuclear supplies and a nuclear test ban. Later that year, the UN General Assembly adopts a resolution to convene an International Conference on the Peaceful Uses of Nuclear Energy (PUNE) with the IAEA's contribution. (The Conference, which was to take place in 1983, is not actually held until 1987.) At the IAEA, Member States create the Committee on Assurances of Supply (CAS) to establish procedures in global nuclear commerce and cooperation of transfers for peaceful uses in line with non-proliferation aims. The Agency launches the Power Reactor Information System, a computerized database that becomes the world's most authoritative source of nuclear power status and trends.

1981

Dr. Eklund and Dr. Blix.

In June, Israel attacks the French-built Tamuz nuclear research reactor in Iraq on the suspicion that it was being used for nuclear weapons research. The reactor was under IAEA safeguards. The attack draws harsh international criticism. In November 1981, IAEA Director General Eklund reports to the UN Security Council on the Tamuz matter. *IAEA leadership:* In September, the General Conference appoints Dr. Hans Blix, former Minister of Foreign Affairs in Sweden, as Director General for an initial term of four years beginning in December 1981.

1982

Progress in global nuclear cooperation is assessed as the IAEA marks its 25th anniversary in Vienna. Taking further steps in support of regional cooperation, the Agency concludes the ARCAL agreement for promotion of nuclear science and technology in Latin America, which today has nineteen member countries. The IAEA and NEA work to expand the operation of the Incident Reporting System, a databank for analyzing plant events of significance to safety that today is jointly operated by the two agencies. In September 1982, the Israeli delegation's credentials are rejected by the IAEA General Conference. The United States, in a reaction to the rejection, temporarily withdraws support from the IAEA.

1983

In February, Director General Blix reports to the Board on the outcome of discussions concerning the USA's withdrawal, welcoming the USA's decision to resume its participation in the Agency. A landmark IAEA Conference on Radioactive Waste Management is convened in Seattle, USA, at which international experts agree that the technology is available for the safe disposal of radioactive waste.

1984

China joins the IAEA, as part of its policy of opening to the international community. The Joint Division of the IAEA and FAO marks its 20th anniversary of cooperation for agricultural development. The Agency carries out a new global survey to determine the availability of and market for smaller-sized nuclear power plants. Three organizations — the IAEA, WHO, and FAO — set up the International Consultative Group on Food Irradiation to advise governments on safety, regulatory, and other aspects of applying the technology, in which interest is heightened for reasons related to public health and global trade.

1985

At the Third Review Conference of the NPT in Geneva, Parties do not adopt a final declaration because of disagreement on key issues related to disarmament and the transfer of peaceful nuclear technologies. In November, the first summit meeting takes place between newly elected leader of the Soviet Union, Mikhail Gorbachev and US President Ronald Reagan.

1986

On 26 April, a disastrous nuclear power plant accident at the Chernobyl site in the USSR destroys unit-4 of the reactor, causes deaths and injuries, and releases radiation across national boundaries; it is first internationally

The IAEA becomes the site for post-accident review conference following the catastrophic nuclear power plant accident at Chernobyl in April 1986. The review provided the world's first authoritative account of the accident.

detected and reported by experts in Sweden and Finland. In August, the IAEA becomes the site for post-accident review conference, which provides the world's first authoritative account of the accident. Analytical services of the IAEA's Laboratories in Vienna, Seibersdorf and Monaco are mobilized to support assessments of Chernobyl's radiological impact. In September, following work of preparatory groups of experts, IAEA Member States adopt two international conventions on early notification of a nuclear accident and emergency assistance and response, and endorse an expanded nuclear safety programme. An Emergency Response System is set up at the Agency in support of the conventions. Issues of nuclear plant safety, radiological protection, waste management, health, and environment begin to dominate global, and IAEA, agendas, and nuclear power's future is reassessed in many countries. ***Non-proliferation:*** In December, the Rarotonga Treaty enters into force, for establishing a nuclear-weapon-free zone in the South Pacific. Requires comprehensive IAEA safeguards. ***Health care:*** The IAEA initiates the first regional project on radioimmunoassay of thyroid-related hormones, involving 123 laboratories in 13 Asian and Pacific countries, that over a 10-year period would significantly enhance diagnostic services and screening programmes for thyroid deficiencies.

1987

The IAEA Board of Governors expands from 34 to 35 Member States so as to provide a seat to China. The Convention on Physical Protection of Nuclear Materials, under IAEA auspices, enters into force. It requires Parties to ensure the protection of nuclear materials during international transport on their territories or under their jurisdiction. In October, delegations of the world's four major programmes in nuclear fusion — from the European Community, Japan, USA, and USSR — agree to recommend to their respective governmental authorities the start of collaborative work under IAEA auspices on the design of an international thermonuclear experimental reactor (ITER), with preliminary studies to start in early 1988. In November, the Agency works to mobilize resources in Member States in response to a request from Brazil for emergency assistance following a radiological accident at Goiânia involving an old radiation source whose mishandling claimed the lives of four people and hospitalized others. Extensive cleanup activities are foreseen and initiated at the site.

1988

A deadly livestock disease spread by the New World Screwworm surfaces in Libya and threatens North Africa. The IAEA, FAO, and other agencies join forces to eradicate the insect using a radiation-based technology (sterile insect technique) developed at the Agency's Seibersdorf Laboratories in the 1960s, and since effectively used in Mexico, Chile, Guatemala, Tanzania, and other countries. They launch a programme in 1989 that rids Libya of the pest by June 1992, about a year earlier and millions of dollars less than estimated.

1989

The IAEA submits a report to the United Nations on the practical contributions of nuclear energy and the Agency's activities to environmentally sound and "sustainable development". The document critically examines the conclusions of the World Commission on Environment and Development with respect to nuclear energy, which were submitted to the UN in 1987. ***Radiological safety:*** For the first time, the USSR issues a public report on the 1957 radiological accident at a military site at Khshtym in the Southern Urals.

THE NINETIES & THE NEW REALITIES

1990

The Fourth NPT Review Conference takes place in Geneva; no final declaration is issued. October sees the reunification of East and West Germany. Reflects political developments in Eastern Europe that dramatically signal the closing period of the Cold War and the dissolution of the Soviet military and political bloc. ***Nuclear safety:*** In May, the IAEA and Nuclear Energy Agency of the Organization for Economic Cooperation and Development initiate the International Nuclear Event Scale (INES) to standardize the reporting of nuclear incidents and accidents worldwide. ***Radioactive waste:*** The IAEA Board approves preparation of a series of safety standards covering radioactive waste management. In September, IAEA Member States adopt a Code of Practice on the International Transboundary Movement of Radioactive Waste. ***Nuclear non-proliferation:*** Argentina and Brazil issue a Declaration on Common Nuclear Policy. ***Regional cooperation:*** The African Regional Cooperative Agreement for Research, Development and Training Related to Nuclear Science and Technology (AFRA) enters into force; its membership today includes 21 countries in the region.

1991

China, France announce intention to sign the NPT; Zambia, Tanzania, South Africa, and Zimbabwe accede in May, June, July, and September, respectively. In September, South Africa signs safeguards agreement with IAEA. Argentina and Brazil move to set up common system of verification for the peaceful use of nuclear energy, including acceptance of comprehensive IAEA safeguards.

1991 JANUARY/FEBRUARY

Gulf War. UN coalition of States militarily moves against Iraq to enforce UN Security Council resolutions demanding Iraq's withdrawal from Kuwait, which it invaded in August 1990. In the battles, Iraqi nuclear facilities are significantly destroyed.

1991 APRIL/MAY

In April, as part of ceasefire terms of the Gulf War, nuclear inspections in Iraq are required under UN Security Resolution 687, which demands dismantling Iraq's nuclear, chemical and biological weapons capabilities, to be overseen by newly formed UN Special Commission. The IAEA sets up Iraq Action Team to carry out its responsibilities under the Security Council resolution and nuclear inspections begin in May 1991. Safeguards strengthening measures are discussed by IAEA Board of Governors.

1991 MAY/JUNE

In May, global experts meet at the International Symposium on Electricity and Environment, in Helsinki, which the IAEA sponsors with international partners. Discussions focus on comparative assessments of nuclear and other major electricity generation sources. In late May, the results of International Chernobyl Project are reported (year-long project involving more than 100 scientists and four international organizations, including the World Health Organization, Food and Agriculture Organization, Commission of European Communities, and United Nations Scientific Committee on the Effects of Atomic Radiation). Study assesses the radiological situation in 2225 settlements in three republics (Belarus, Russia, Ukraine), covering about 825,000 people. Not included are the "liquidators", or decontamination workers at the Chernobyl plant after the accident. Among the people surveyed, the project teams find significant health disorders, but no health effects that could be attributed to radiation exposure. They caution, however, that increased thyroid cancers among exposed children are possible in the future, and they urge continued monitoring. ***Nuclear safety in Eastern Europe:*** In June, an IAEA project on the safety of older Soviet-designed nuclear plants in Bulgaria, Czech Republic, Slovakia and Russia reports serious safety deficiencies at most plants compared to Western levels. Technical and financial assistance is expanded through the Commission of the European Communities, World Association of Nuclear Operators, and other avenues.

1991 SEPTEMBER/DECEMBER

Nuclear inspections in Iraq: In September, international headlines are made by sixth IAEA inspection team, which is detained for four days by Iraqi authorities who question their rights of access to documents and buildings the team wants to inspect. Security Council is engaged to

resolve dispute and team subsequently leaves with evidence of a clandestine Iraqi programme for the enrichment of uranium, including global procurement efforts to obtain key components for centrifuge process. ***IAEA membership:*** In September, the General Conference approves membership of newly independent Baltic States — Estonia, Latvia, Lithuania. Ukraine and Belarus inform IAEA of change of official designations. USSR informs IAEA that it will not be able to pay its membership dues (about $20 million for 1991), precipitating financial crisis. IAEA 1992 budget is cut 13% overall. In December, USSR officially dissolves; Confederation of Independent States is announced. Breakup of Soviet Union signals end of Cold War period.

1992 JANUARY/FEBRUARY

In New York, the Security Council, in a Summit Declaration of 31 January, states that "the proliferation of all weapons of mass destruction constitutes a threat to international peace and security." It specifically underscores the "integral role" of fully effective IAEA safeguards and its members' resolve to take "appropriate measures" in case of any violation brought to the Council's attention by the IAEA. From Moscow, new Russian President Boris Yeltsin informs IAEA that the Russian Federation will continue former USSR's membership in Agency; officials state they will take all feasible measures to pay dues. ***Disarmament/ nuclear security:*** End of Cold War is seen as generally warming international political climate, improving prospects in areas of non-proliferation and arms control. President Yeltsin announces major arms reductions; states that Russian Federation has control of nuclear weapons (strategic A-bombs are also located in Ukraine, Kazakhstan, Belarus). IAEA proposes assistance in verification of nuclear materials from dismantled nuclear weapons in former USSR. ***Safeguards:*** In February, the IAEA Board considers various measures, and adopts several, for strengthening the Agency's safeguards and verification system. Significantly, the Board reaffirms the Agency's right to request special inspections in States having comprehensive safeguards agreements.

1992 APRIL

The Democratic People's Republic of Korea (DPRK) signs NPT-safeguards agreement with the IAEA, which enters into force in April 1992. IAEA inspections begin in the DPRK in May 1992. Syria states it agrees to conclude NPT-safeguards agreement. Libya, Iran give assurances to IAEA senior officials that their nuclear programmes are only for peaceful purposes. China and France accede to the NPT in March and August, respectively. Among newly independent States emerging from the former USSR, Estonia, Uzbekistan, and Azerbaijan become parties to the NPT. Working with authorities in these and other countries, the IAEA initiates preparatory activities for the future application of safeguards in newly independent States. In Brussels, the IAEA Director General and Commissioner of Euratom endorse an agreement for a "New Partnership Approach" in the application of safeguards within the European Union designed to be more effective and efficient.

In April 1991, the Agency set up its Action team to conduct nuclear inspections in Iraq as required under UN Security Resolution 687. Nuclear inspections began a month later.

1992 JUNE

The UN Conference on Environment and Development — the "Earth Summit" — in Rio de Janeiro, Brazil, in June adopts Agenda 21, a document calling for action to ensure the world's sustainable development. The IAEA is made the focal point for issues related to nuclear waste. The environmentally conscious Club of Rome (group studying global issues) announces it has reversed its earlier opinion and now supports the future development of nuclear energy, with qualifications on safety, in light of the environmental problems associated with burning of fossil fuels. The IAEA launches a major inter-agency project, called Decades, on the comparative assessment of different energy sources for electricity generation. It builds upon global expertise and computer tools and models developed through IAEA-supported

After the government's decision to abandon a former nuclear-weapon programme, South Africa in 1994 presents a symbol to the IAEA of its commitment to peaceful uses of nuclear energy.

activities since the early 1970s. Also drawing greater interest are IAEA-supported programmes for radiation and nuclear applications targetted at industrial efficiency and environmental protection. ***Nuclear safety:*** Multilateral assistance package is formulated for nuclear-safety improvements at Soviet-designed nuclear plants operating in Central and Eastern Europe (includes IAEA technical support, with overall co-ordination by CEC on behalf of OECD Group of 24 industrialized countries).

1992 NOVEMBER/DECEMBER

In Rome, the first global conference on nutrition, co-sponsored by the FAO and WHO, issues a "world declaration" squarely focusing on the problems of nutrition and health. It is adopted by government ministers and senior policymakers from more than 150 countries. Interest further increases in IAEA-related work in this field, through applications of isotopes in health and nutrition studies, which today extends beyond 30 countries.

1993

NPT Conference preparations: With the question of its extension on the line, the Fifth NPT review conference takes on greater importance. The Preparatory Committee holds first meeting in New York in May. Support is voiced for work of IAEA, and efforts to strengthen international safeguards. In April, the 28-member Nuclear Suppliers Group adopts stronger controls on nuclear exports, requiring comprehensive IAEA safeguards. Belarus joins the NPT in February. In December, Algeria's Foreign Minister declares that his country resolves to adhere to the NPT, a step it later takes. ***Nuclear safety/radiation protection in former USSR:*** A co-operative IAEA/UNDP programme is launched to assist newly independent States in building up their systems for radiation protection and nuclear safety, specifically with respect to the control and use of radiation sources. ***Radiological assessments:*** A four-year project is launched by the IAEA in co-operation with Russia and Norway to assess the effects of sea dumping of radioactive wastes in the Arctic Seas. ***Arms control/disarmament:*** The United States and Russia sign the second Strategic Arms Control Reduction Treaty (START-2), under which their respective nuclear arsenals would fall to about 3500 warheads by the year 2003. Under START-1, the two sides had committed to reducing their strategic nuclear weapons to about 6500 each by the year 2000. Though both treaties require destruction of missiles and bombers, not their warheads, the two countries begin to voluntarily dismantle surplus nuclear weapons.

1993 JANUARY

The long-awaited Convention on the Prohibition of Chemical Weapons, which had been debated over the past 25 years, opens for signature. Its provisions indicate a greater willingness among States to grant strong rights and responsibilities to an international verification authority, holding some implications for the evolution of the IAEA's safeguards system. The Convention's Secretariat is headquartered in The Hague, Netherlands.

1993 FEBRUARY/MARCH

Nuclear non-proliferation and safeguards issues move higher on the global agenda, following developments in the DPRK and South Africa. ***Regarding the DPRK***, "inconsistencies" emerge from the IAEA's analysis of samples and measurements from its safeguards inspections, opening the question of whether the DPRK has more plutonium than it declared to the Agency. IAEA seeks to resolve differences with authorities, to no avail. The government in March announces its intention to withdraw from the NPT because of what it called threats to its supreme interests. The move follows the IAEA Board of Governors' adoption of a resolution holding the DPRK in non-compliance with its safeguards agreement because the Agency is not being allowed to verify the completeness and correctness of the DPRK's previously declared nuclear inventory. Specifically, DPRK authorities

Protecting cattle against the plague known as rinderpest, targeted for eradication soon throughout Africa.

denied the IAEA access to sites that are considered critical to the Agency's verification activities in the country. In May 1993, the UN Security Council backs the IAEA's position and urges the DPRK to reconsider its intended NPT withdrawal. In June 1993, following bilateral talks between the USA and DPRK, it is announced that the DPRK had "suspended" its withdrawal decision. More talks ensue and the IAEA continues its efforts to carry out its verification activities. ***Regarding South Africa***, President de Klerk announces in March that the country abandoned its former nuclear-weapons programme before signing the NPT because the reasons for keeping the nuclear option had disappeared. He invites the IAEA to visit sites involved in the former programme, as part of its overall verification in the country. IAEA technical teams visit South Africa for that purpose in May and June.

1993 JUNE

The IAEA Board begins consideration of a safeguards development programme called "93+2" to strengthen the effectiveness of safeguards and improve the system's efficiency. Among other aims, the proposals seek broader IAEA access to information and sites under comprehensive safeguards agreements so as to verify the absence or existence of undeclared nuclear activities.

1993 SEPTEMBER

The IAEA General Conference adopts resolutions supporting actions to strengthen the Agency's safeguards, nuclear and radiation safety, and technical cooperation activities. ***IAEA membership:*** Seven countries move to join the IAEA: Slovakia, Czech Republic, Marshall Islands, Armenia, and Kazakhstan are approved by General Conference in September; Lithuania and Uzbekistan officially become members in November 1993 and January 1994, respectively. ***Physical protection:*** A conference in Vienna on the Convention on the Physical Protection of Nuclear Material reaffirms the Parties' full support of the agreement and the sound basis it provides for physical protection during international transport.

1994

Possible new verification tasks: Steps under the auspices of the Conference on Disarmament are taken to negotiate a Comprehensive Nuclear Test Ban Treaty, under which some States then see a verification and supporting role for the IAEA. Consultations also continue between the USA and the IAEA concerning the US initiative to place under IAEA safeguards some of the excess nuclear material released from weapon programmes. Separately, the USA and Russia announce the establishment of a working group on the subject of nuclear arms reduction and the possibility of putting a portion of fissionable material under IAEA safeguards. Talks also continue regarding the possible IAEA role for plutonium storage, in light of the material's release from dismantled nuclear-weapons and the high level of existing commercial stocks. In Africa, prospects brighten that a nuclear-weapon-free zone treaty will be concluded. ***Radiological assessments:*** The Agency completes a preliminary radiological assessment of the Semipalatinsk nuclear test site in Kazakhstan at its request. Results show that radiation doses to people in the area are low, but that certain areas should continue to be restricted and that more studies are needed on levels of plutonium in soil and of radionuclides in drinking water. ***Technical cooperation:*** As part of efforts for strengthening programmes, a Policy Review Seminar sets in motion the process of redefining the Agency's strategy for technical cooperation. The meeting focuses on three themes: strengthening radiation protection and waste management infrastructures; the need for systematic country planning; and increasing the impact of IAEA technical cooperation by reaching the end users of technology. Among the results are newly defined Model Projects, Country Programme Frameworks, and thematic planning as major elements of the new strategy. ***Animal health:*** An extensive joint project of the IAEA and FAO in Africa reports significant results in helping countries eradicate "cattle plague", or rinderpest, a deadly viral livestock disease devastating to their agricultural economies.

In February 1994, the IAEA supervised the shipment of the final consignment of spent fuel from Iraq to the Russian Federation.

1994 JANUARY/FEBRUARY

Iraq nuclear inspections: In February, the IAEA supervises the shipment from Iraq of the final consignment of spent fuel, which is sent to Russia under contract. The operation removes all declared nuclear-weapons-grade materials from Iraq; the IAEA's work continues under a long-term plan for monitoring and verification of Iraq's nuclear activities. ***Waste dumping:*** In February, a ban on sea dumping of radioactive wastes at sea takes effect under the London Dumping Convention; the IAEA's technical role under the Convention is to define radioactivity levels below which material may be considered exempt from this provision. ***Safeguards & non-proliferation:*** Kazakhstan joins the NPT in February. In March 1994, the quadripartite safeguards agreement (IAEA, ABACC, Argentina, Brazil) enters into force, under which the two countries accept comprehensive IAEA safeguards on all their nuclear activities. Further steps are taken with respect to the Tlatelolco Treaty in Latin America for establishing a nuclear-weapon-free zone; the Treaty enters into force for Argentina and Chile in early 1994, bringing closer into view the Treaty's full implementation.

1994 JUNE/JULY

The DPRK announces its withdrawal from the IAEA; its safeguards agreement with Agency remains in force. The action follows the Board of Governor's resolution of 10 June, in which it again urged the DPRK to fully co-operate with the IAEA in its attempts to verify nuclear activities and suspended non-medical technical assistance to the country. The UN Security Council, which had been kept informed of safeguards developments in the DPRK, continues to back the IAEA's position. Following the private visit of ex-US President Jimmy Carter to the DPRK for talks, the governments of the USA and the DPRK schedule further talks on the nuclear situation and other matters in Geneva; the USA states no progress can be made unless the DPRK fully accepts IAEA international safeguards. IAEA safeguards inspectors remain in the DPRK to monitor operations at the experimental nuclear power plant, which was refuelled in May/June. Because of restrictions on its access during the refuelling campaign, the IAEA states that it can no longer verify the history of the reactor's core and that it cannot rule out the possible past diversion of nuclear material. Regarding the fuel that was removed over the summer, the Agency states it is under safeguards and has not been diverted.

1994 SEPTEMBER

Two milestones in nuclear safety are reached: One is the Convention on Nuclear Safety, adopted in June, which opens for signature at the IAEA General Conference in Vienna. Stands as the first international legal instrument that binds countries to basic safety standards for land-based nuclear power plants. Forty nine countries sign it. The Conference adopts a resolution for starting preparations on an international convention on the safety of radioactive waste management and disposal. Second, the IAEA Board approves the new edition of the *International Basic Safety Standards for Protection Against Ionizing Radiation and the Safety of Radiation Sources*, which the Agency developed working with five other organizations. The Standards incorporate international consensus on key issues of radiation safety.

Austria was among the first signatories of the Convention on Nuclear Safety.

1994 OCTOBER/NOVEMBER

Bilateral talks between the USA and the DPRK result in an "agreed framework" concluded in Geneva 21 October. The DPRK agrees to "freeze" its present nuclear programme and the USA agrees to assist in efforts to provide light-water reactors, which would be under full-scope IAEA safeguards, for electricity generation. The IAEA-DPRK safeguards agreement remains valid and in

WorldAtom, the IAEA's Internet services on the World Wide Web was officially launched in June 1995 and featured during that year's regular session of the General Conference in September.

full force but full compliance is not foreseen until a significant portion of the reactor project is completed. In November, an IAEA team visits the DPRK and confirms that facilities subject to the freeze are not in operation and that construction has stopped. The Agency establishes the continuing presence of its safeguards inspectors in the DPRK. ***Radiation issues:*** In October, the IAEA International Conference on Radiation and Society held in France, draws 400 governmental policymakers, specialists, and media from 51 countries. Sessions explore ways to improve communication and comprehension of radiation risks. ***Trafficking:*** In November, the IAEA brings together governmental experts on issues of illicit trafficking in nuclear materials, in response to growing concerns over reports and an IAEA General Conference resolution of September 1994. Role of IAEA examined in assisting States to counteract such trafficking.

1995 JANUARY/FEBRUARY

Argentina and Algeria officially join the NPT, on 10 and 12 January respectively. Following its accession to the NPT in 1994, Ukraine concludes an agreement with the IAEA on the application of safeguards. ***Food & agriculture:*** Gauging progress over the past decades, reports indicate that nearly 1800 new mutant varieties of 150 crop species have been released for planting in 52 countries, mostly by national plant breeders and frequently with FAO/IAEA support, using radiation-based techniques.

1995 MARCH/APRIL

At meetings in March, the IAEA Board endorses the Director General's proposal for a Standing Advisory Group on Technical Assistance and Cooperation (SAGTAC), whose twelve members from developing and industrialized Member States will provide advice on programme strategy, policy, and effectiveness. In April, Belarus, which along with Kazakhstan and Ukraine inherited nuclear weapons on its territory following the dissolution of the Soviet Union, officially signs its comprehensive safeguards agreement with the IAEA.

1995 MAY/JUNE

The NPT, under which most safeguards agreements with the IAEA are concluded, is indefinitely extended on 11 May at the Review and Extension Conference in New York. Although Parties do not agree on a Final Declaration, they adopt a set of principles that include statements reaffirming support for Agency safeguards and technical assistance programmes, and the need to adequately fund them. The Conference sets 1996 as the target date for the conclusion of a Comprehensive Test Ban Treaty (CTBT), which States are negotiating at the Conference on Disarmament in Geneva, and underlines the aim of achieving a nuclear-weapons-free world. ***Information technology:*** The Agency's pioneering International Nuclear Information System (INIS) marks its 25th year of operations. The IAEA officially launches its public Internet services on the World Wide Web. Called *World Atom*, the service features a range of information and documents about global nuclear developments and the Agency's work. ***Safeguards:*** The IAEA Board approves the Agency's implementation in consultation with Member States of certain measures (Part-1 measures) proposed under the safeguards "93+2" development programme. They include, for example, broader access to information regarding sites and activities relevant to States' nuclear programmes, and environmental sampling at locations to which the IAEA has access under comprehensive safeguards agreements. It agrees to consider Part-2 measures, namely those requiring complementary legal authority, later in the year.

1995 JULY/AUGUST

Shortly after the NPT Conference concludes, China conducts a nuclear test, and France, in line with its stated intention to sign the test ban treaty, announces its "final"

A study to assess the radiological conditions at former nuclear test sites in the South Pacific took root in late 1995.

series of nuclear tests in the South Pacific. The testing is strongly criticized and opposed by countries in the region. In a letter to IAEA Director General Blix, France asks the Agency to conduct a radiological study of the Mururoa and Fangataufa atolls once the tests have been completed; the Agency studies the request. ***Inspections in Iraq:*** New disclosures emerge concerning Iraq's former secret nuclear programme, following information provided by a high-level defector, Iraqi Gen. Hussein Kamel. Revelations include that Iraq had embarked on a "crash" nuclear-weapon programme in 1990-91 but that plans were thwarted for technical and other reasons. Withheld documents and data are received by the IAEA Iraq Action Team for examination.

1995 SEPTEMBER

States meeting at the IAEA General Conference adopt a resolution expressing grave concern over resumption of nuclear testing and stating their expectation that a Comprehensive Test Ban Treaty will be concluded in 1996. Other adopted resolutions endorse the Agency's efforts to strengthen safeguards and technical co-operation programmes, and condemn Iraq for withholding information from the IAEA about its nuclear-weapon programme in violation of its obligations under Security Council resolutions. ***Nuclear data services:*** Following a meeting at the IAEA, global experts emphasize the ongoing importance of the IAEA's nuclear data services developed over the past decades. The services today include a global network of data used by researchers in more than 40 countries in fields such as medicine, industry, and energy, and a data centre maintaining the world's most comprehensive collection of nuclear and atomic data libraries. ***Safeguards laboratories:*** A new "clean" laboratory is set up at the Agency's SAL facilities in Seibersdorf, for analysis of environmental samples collected during safeguards inspections. ***Nuclear medicine:*** More than 95% of the Agency's developing Member States are reported to have set up nuclear medicine services for improved health care and diagnosis. An IAEA survey finds that more than 2000 gamma cameras for medical uses have been installed in 78 developing countries.

1995 OCTOBER

Energy issues. In Vienna, the Agency and other organizations jointly convene the International Symposium on Electricity, Health, and the Environment, where experts review the record and options for sustainable energy production and electricity generation. They specifically review results of the inter-agency Decades project for assessments of energy options and their impacts. ***UN anniversary:*** The United Nations officially marks it's 50th anniversary on 24 October as the international community critically assesses its achievements, roles, and future directions.

1995 NOVEMBER/DECEMBER

At the request of governmental delegates in Geneva, the Agency responds to questions about legal, organizational, and financial matters relative to the administration and verification of a Comprehensive Test Ban Treaty. Any substantive functions that might be assigned to the IAEA would require prior approval of the Agency's policy-making bodies. ***Radiological assessments:*** The IAEA advises the French Foreign Minister that in principle it will conduct the requested radiological study of the Mururoa and Fangataufa atolls, pending conclusion of a formal agreement on how the study would be organized and conducted. In December, the IAEA convenes an Advisory Group in response to a request from the Marshall Islands to review the current radiological conditions at Bikini Atoll, former site of nuclear testing by the USA. The scientific group reviews existing data on the radiological situation there to further reassure the local people, and recommends additional tests on various foods from Bikini at the IAEA's Seibersdorf Laboratories as part of remedial measures that could be taken. ***NWFZs:*** In New York, the UN General

Some of the 800 governmental delegates at the widely covered Chernobyl Conference held at IAEA headquarters in Vienna in 1996.

Assembly adopts a resolution inviting States to sign and ratify the Treaty on the African Nuclear-Weapon-Free Zone (called the Pelindaba Treaty), under which the IAEA is the verification body. At the fifth summit meeting in Bangkok, leaders of seven countries belonging to the Association of South East Asian Nations (ASEAN) sign the text of a South East Asian Nuclear-Weapon-Free Zone; the "Bangkok Treaty" obliges States to conclude a comprehensive safeguards agreement with the IAEA. ***DPRK:*** In New York on 15 December, the DPRK and the Korean Peninsula Energy Development Organization sign a contract on the supply of two 1000-megawatt light-water reactors, at a total cost of $4.5 billion. Construction is expected to be completed in 2003. Contractual terms also obligate the DPRK to permit the IAEA to resume safeguards inspections of facilities not covered by the nuclear freeze; to remain a party to the NPT; and to comply fully with the IAEA safeguards agreement when a significant portion of the project is completed but before delivery of the key nuclear components. ***Safeguards and non-proliferation:*** At the December meeting of the IAEA Board of Governors, Mexico reports that Cuba on 5 December signed amendments to the Tlatelolco Treaty, brightening prospects for the Treaty's full entry into force. The IAEA Board discusses details of Part-2 measures for strengthening Agency safeguards, including a proposed protocol to existing comprehensive safeguards agreements under which measures could be implemented. ***Scientific events:*** The scientific world marks the 100th anniversary of the discovery of X-rays on 28 December 1895 by German scientist Wilhelm Roentgen.

1996 JANUARY

The world marks the 100th anniversary of the discovery of radioactivity in January 1896 by French scientist Henri Becquerel. ***IAEA developments:*** The IAEA restructures its former Department of Nuclear Energy and Safety into two separate Departments -- the Department of Nuclear Energy and the Department of Nuclear Safety. The Agency publishes the latest edition (1996) of its advisory *Regulations for the Safe Transport of Radioactive Material*, which were first issued in 1961 and form the basis of national, regional, and international regulations worldwide.

1996 MARCH

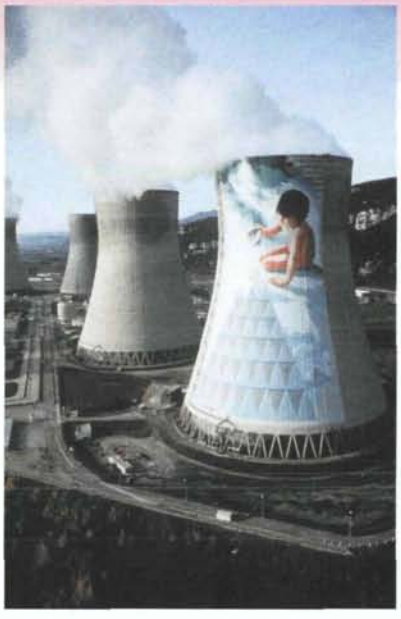
The UN Security Council on 27 March unanimously adopts a resolution to bring into force a mechanism for monitoring sales or supplies to Iraq of certain items or technologies that could be used for the production or acquisition of banned biological, chemical, and nuclear weapons. The mechanism, developed by the Sanctions Committee, UNSCOM, and the IAEA under previously adopted Security Council resolutions, is to be operated by a joint unit of UNSCOM and the IAEA. ***Rarotonga Treaty:*** At a ceremony in Fiji on 25 March, France, the USA, and the UK sign protocols to the South Pacific Nuclear Free Zone Treaty that bind them not to use nuclear force or the threat of its use in the region; ban the stationing of nuclear weapons on any territory in the region; and prohibit testing of nuclear weapons there. (The world's other two declared nuclear-weapon powers, Russia and China, already are party to the protocols relevant to them.)

1996 MARCH/APRIL

In March, a four-member IAEA technical team completes a mission to the Mururoa and Fangataufa atolls to help lay the groundwork for the radiological study of the French nuclear test site. In April, the study's International Advisory Committee holds its first formal meeting at IAEA headquarters to outline action plans for its task and working groups.

1996 APRIL

At a ceremony in Cairo on 11 April, the African Nuclear-Weapon-Free Zone Treaty opens for signature. Among those invited to attend are IAEA Director General Hans Blix and IAEA Assistant Director General Mohamed



Safety and safeguards: A global convention on nuclear safety takes effect in October 1996, and new verification measures are approved in May 1997.

ElBaradei; the Agency's support of the negotiations on the Treaty included adoption of relevant General Conference resolutions and the provision of advice on technical and legal aspects. ***Nuclear and radiation safety:*** Hundreds of delegates attend the International Conference One Decade After Chernobyl: Summing up the Radiological Consequences, in Vienna organized by the IAEA, European Commission, WHO, and a number of other organizations. Results document the actual consequences, drawing upon conferences held by WHO in November 1995 and by Ukraine, Russia, Belarus and the European Union in March 1996, and recommend additional steps that are needed to assist the victims and improve the safety of Chernobyl-type plants (RBMK reactors). At a nuclear safety forum preceding the Conference, international experts review remedial measures that have been taken over the past decade and issue recommendations for further safety improvements, and associated financial support to upgrade RBMK safety. ***Moscow Summit:*** Leaders of the Group of Seven countries and the Russian Federation meet in Moscow at a Nuclear Safety and Security Summit hosted by President Yeltsin 19-20 April. Among its conclusions, the Summit recognized the importance of nuclear power as an energy source consistent with goals of sustainable development; emphasized commitments to an international nuclear safety culture and to strengthening the IAEA safeguards and verification system; and noted the importance of global cooperation against illicit trafficking in nuclear materials.

1996 JUNE

In its consideration of the second part of measures to strengthen safeguards, the IAEA Board of Governors agrees to establish a special Committee to negotiate a new legal instrument that would be attached to existing comprehensive safeguards agreements. The instrument would define, among other things, the nature of additional access to information and to nuclear-related locations for the Agency's safeguards inspectors. The Committee begins its work in July.

1996 JULY/AUGUST

International teams of scientists collect terrestrial and marine samples at the Mururoa and Fangataufa atolls under the IAEA's radiological study. Samples will be shared with a range of laboratories for analysis, including the IAEA's Laboratories in Seibersdorf, Austria, and in Monaco. The study's International Advisory Committee states that its members intend to visit the sites in late 1996 and to report on the study's progress at that time.

1996 SEPTEMBER

Ushering in the 40th year of the Agency's international service, delegates from more than 100 countries attend the IAEA General Conference in Vienna 16-20 September. The Conference adopts resolutions on a range of subjects, including the strengthening of safeguards and technical co-operation activities. At the Conference, a "Trilateral Initiative" is launched at a meeting of IAEA Director General Hans Blix, US Secretary of Energy Hazel O'Leary, and Russian Minister of Atomic Energy Viktor Mikhailov. They consider practical measures to fulfill statements made by the US and Russian Presidents in April 1996 concerning the IAEA's verification of weapon-origin fissile materials, which represents an important first step for international verification of nuclear disarmament. ***Nuclear test ban:*** At the United Nations in New York on 10 September, the General Assembly overwhelmingly approves the Comprehensive Test Ban Treaty by a vote of 158 to three. The Treaty will have its own verification arm,

the implementing organization will be located near IAEA headquarters in Vienna. ***IAEA leadership:*** Director General Blix advises the Board that he will not be available to serve beyond his present term which expires in December 1997.

1996 OCTOBER

The Convention on Nuclear Safety enters into force on 24 October, with 27 States Parties and 65 signatories. Preparations continue for a first meeting of Parties in early 1997 to discuss the Convention's review process and periodic reporting requirements, among other matters. ***IAEA Statute:*** On 26 October, the IAEA marks the 40th anniversary of the opening for signature of its Statute. More than 70 countries signed the Statute at a conference in New York on 26 October 1956; the Agency officially came into existence ten months later, in July 1957. ***Information technology:*** The Agency introduces an Intranet computer service called *Oasis* for more efficiently disseminating administrative and programme-related information to staff. ***Chemical weapons:*** The UN announces that the Chemical Weapons Convention will enter into force on 29 April 1997, having attained the necessary 65 ratifications; it has been signed by 160 countries, including all five declared nuclear-weapons powers.

1996 NOVEMBER

Under their Trilateral Initiative, the USA, Russia, and the IAEA take the first steps to expand international verification of weapons-usable nuclear materials through the application of IAEA safeguards. Delegations including Bruno Pellaud, head of the IAEA's Department of Safeguards, and senior Russian and US officials visit three sites in the US for demonstrations of technology and discussions on the inspection process. ***UN Security Council:*** IAEA Director General Blix briefs the Security Council on the Agency's ongoing nuclear inspections in Iraq and in the DPRK, where the Agency maintains a continuous inspector presence. He emphasizes that the technological know-how for weapons production remains in Iraq and that the IAEA is continuing its rigorous implementation of the long-term monitoring and verification plan, and with its in-depth appraisal of Iraq's reissued "full, final, and complete" declaration of its nuclear programme. Concerning the DPRK, he reports

A scientific project assessing former nuclear waste dumping in the Arctic Seas concluded in 1996.

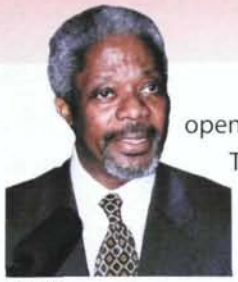
that technical talks to date have not resolved outstanding issues, and the country remains in non-compliance with its IAEA safeguards agreement. ***Waste management:*** In London at the IMO, States adopt a protocol that supersedes the original Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter ("London Convention 1972"); the IAEA has some responsibilities under the Convention related to radioactive wastes. ***Radiological assessments:*** The Agency completes its three-year study, the International Arctic Seas Assessment Project, and submits its summary report to the Parties of the London Convention. The study concludes that the current radiological risks represented by the dumped wastes are small and the future risks to typical local population groups also are small. It finds no justification on radiological grounds alone for a programme of remedial action.

1996 DECEMBER

In Suva, Fiji, the International Advisory Committee for the Study of the Radiological Situation at the Atolls of Mururoa and Fangataufa meets for technical visits and assessment of progress. Members report that analysis of samples taken earlier in 1996 is continuing, and that the study's results are expected in 1998.

1997 JANUARY/FEBRUARY

The Board Committee negotiating the draft protocol to expand the IAEA's legal authority for implementing strengthened safeguards measures nears completion of a final draft document for the IAEA Board in May. ***Radioactive waste convention:*** The sixth session of the



UN Secretary General Kofi Annan

open-ended Group of Legal and Technical Experts preparing the draft of a convention on the safety of radioactive waste management prepares to submit the draft document to the IAEA Board in June. Unresolved issues include the question of whether the convention should cover the safe management of both spent fuel and radioactive waste in one text. ***Nuclear liability:*** The final stages are reached in extensive preparatory work on a draft protocol to amend the 1963 Vienna Convention on Nuclear Liability and to draft a Convention on Supplementary Funding. The Standing Committee which is preparing the two instruments -- which together will revise the international nuclear liability regime -- submits the draft texts to the IAEA Board for consideration at its March meetings, with a view to the Agency's convening of a Diplomatic Conference later this year. ***United Nations:*** In New York, Mr. Kofi Annan of Ghana takes office as United Nations Secretary-General, succeeding Mr. Boutros Boutros-Ghali of Egypt.

1997 MARCH/APRIL

At its March meeting, the IAEA Board considers the first candidates for appointment of the next IAEA Director General to succeed Dr. Blix, who is retiring after four consecutive four-year terms. ***Disarmament:*** At their Helsinki Summit in March, Presidents Clinton and Yeltsin agree to start negotiations on cutting nuclear arsenals to 20% of Cold-War levels, in an accord to be called START-3, once the Russian Duma ratifies START-2. They agree to extend the deadline for destroying missiles and silos set out in START-2 from the year 2003 to the end of 2007. ***UN reform:*** In New York, UN Secretary-General Annan announces a 10-point process for structurally and administratively reforming the United Nations. ***Trafficking:*** In April, Namibia becomes the 50th country to join the IAEA's programme on illicit trafficking in nuclear materials, which supports efforts in Member States. ***Nuclear safety:*** At their first preparatory meeting in April, Parties to the Convention on Nuclear Safety set the framework for their respective peer reviews of national reports on measures for ensuring the safety of nuclear power plants. The first review meeting is set for April 1999. ***Climate change:*** Global experts meet in Vienna at an IAEA symposium to examine the role that isotopes play in understanding the complex processes affecting climate changes, and in investigating historical records.

1997 MAY

Opening a new chapter in nuclear safeguards, the IAEA Board takes a major step by granting the IAEA's safeguards inspectorate broader rights. At meetings on 15-16 May, it approves a Model Protocol additional to safeguards agreements setting out new measures through which countries would accept stronger, more intrusive verification on their territory. ***Chemical weapons:*** In The Hague, IAEA Director General Hans Blix speaks at the first session of the Conference of States Parties to the Organization on the Prohibition of Chemical Weapons, calling for greater cooperation among international verification bodies in years ahead. ***Nuclear power status:*** The world's number of operating nuclear power plants climbs above 440, with new plants starting up in three countries in 1996, the IAEA reports. Worldwide, seventeen of the 32 countries with plants rely on nuclear power for 25% or more of their total electricity production.

1997 JUNE

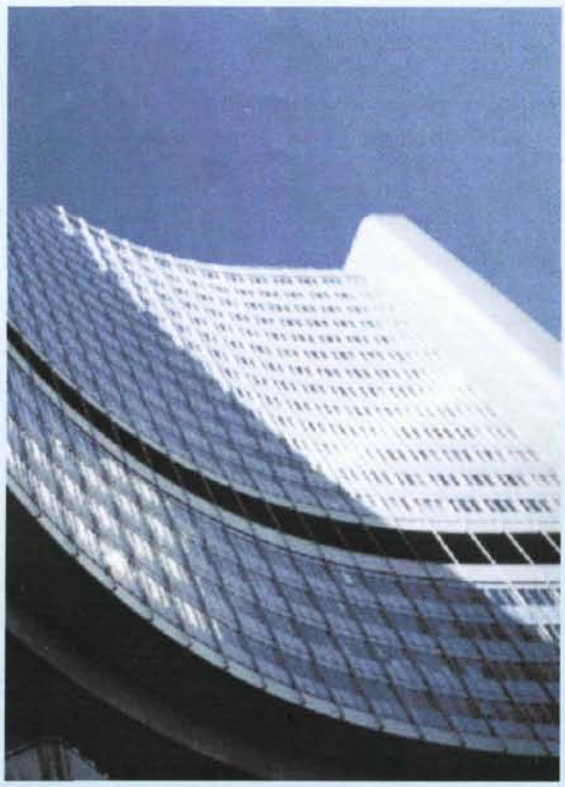
At its meetings in June, the IAEA Board receives reports from the Director General on developments related to safeguards and technical cooperation. Among other matters, the reports note the Agency's continuing inability to verify the correctness and completeness of the DPRK's initial declaration of nuclear material; the ongoing work to clarify aspects of Iraq's past nuclear programme; and progress through the Trilateral Initiative on the verification of fissile materials released from the military sector. Dr. Blix further informs the Board that he has sent letters to Foreign Ministers of States having IAEA safeguards obligations to initiate the

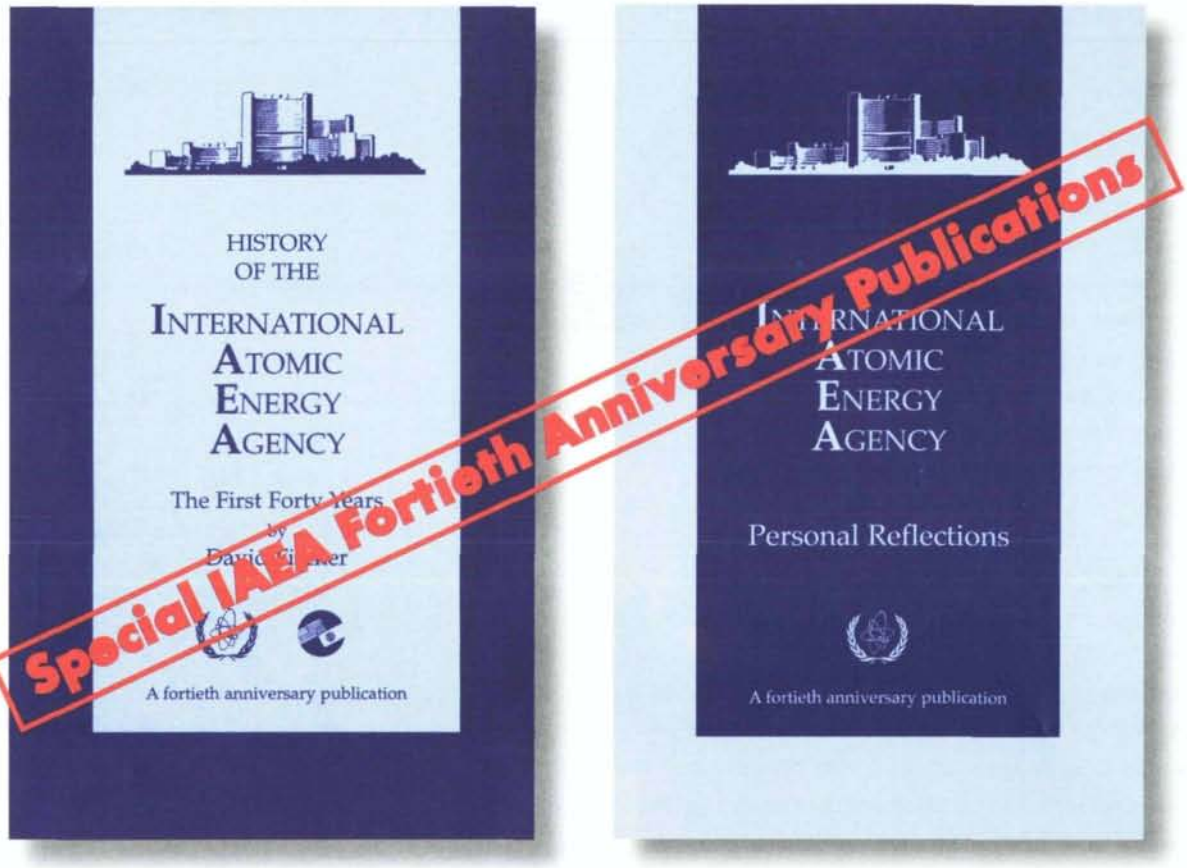
IAEA Director General-Designate Mohamed ElBaradei

acceptance process for the new measures under the Model Protocol. Regarding technical cooperation, the reports point to the continuing record-high levels of implementation of the Agency's projects in more than 90 countries, and to the need for greater and more stable resources to maintain and strengthen the programme. On other matters, the Board approves two Diplomatic Conferences for early September: the Diplomatic Conference on Liability for Nuclear Damage, at which States will be asked to adopt a draft protocol to amend the 1963 Vienna Convention and the text of a Convention on Supplementary Funding; and the Diplomatic Conference on the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, which covers applications in the civilian sector. ***Director General appointment:*** The Board selects Dr. Mohamed ElBaradei of Egypt as its candidate to succeed IAEA Director General Blix. Dr. ElBaradei is presently the IAEA's Assistant Director General for External Relations. The appointment moves for approval by the IAEA's 125 Member States at the IAEA General Conference in September. ***Energy & plutonium:*** The changing realities affecting nuclear power development and its fuel cycle, including issues related to the disposition of rising plutonium stocks, are examined at an IAEA symposium in June. ***Water needs:*** Options for the use of nuclear energy at plants for desalting seawater are reviewed in the Republic of Korea at an IAEA symposium. ***Earth Summit revisited:*** The UN General Assembly convenes a special session on sustainable development in New York. Addressing the session, Dr. Blix emphasizes the fundamental importance of energy, issues of waste safety and nuclear energy's environmental benefits. ***Denver Summit of the Eight***: In a final document, leaders of the world's eight major industrialized countries underline their commitments to nuclear safety and security, and to the IAEA's global role.

1997 JULY

On 29 July, the IAEA officially turns 40.





To mark the fortieth anniversary of its founding, the IAEA is issuing a set of two books: a history and a collection of personal reflections.

The history was undertaken in conjunction with the Monterey Institute of International Studies, Monterey, California, which commissioned David Fischer as author. David Fischer took part in the negotiations on the Statute of the IAEA in Washington in the mid-1950s and served on the Preparatory Commission for the Agency. From 1957 to 1976 he was the Agency's Director for External Relations and subsequently Assistant Director General. The text of the history covers the period since the time of the Atoms for Peace speech by US President Eisenhower at the General Assembly of the United Nations in December 1953. The author assesses the main achievements and setbacks in the history of the IAEA and what can be learned from them.

The reflections in the second book are written by a group of distinguished scientists and diplomats who were involved in the establishment or subsequent work of the IAEA. It represents a collection of less formal "essays" which offer a complementary and personal view on some of the topics considered in the full history.

The books will be issued in September 1997 to mark the anniversary of the first meeting of the IAEA's General Conference. They are available separately or as a set.

History of the International Atomic Energy Agency:
The First Forty Years *by David Fischer*
(18 x 24 cm; hard cover; approx. 550 pages) AS 480

The International Atomic Energy Agency:
Personal Reflections
(18 x 24 cm; hard cover; 311 pages) AS 260

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