

# NUCLEAR ENERGY AND THE AGENCY: THE YEAR IN REVIEW

The Agency's fortieth anniversary year was marked by progress in substantive areas — and by reflection on past achievements and future challenges as the Agency moves into another decade of its history under the leadership of a new Director General. In the year under review nuclear energy continued to make a significant contribution to meeting the global demand for electricity and, in this regard, the Agency continued to act as a forum for assessing experience and sharing ideas on national and international developments. The meeting in December in Kyoto of the United Nations Framework Convention on Climate Change refocused attention on energy and the environment — and was an opportunity for the Agency to present its work on the costs and benefits of nuclear and other energy alternatives. There were further Agency contributions during the year to the United Nations system wide objective of sustainable development as articulated in 'Agenda 21' of the 1992 United Nations Conference on Environment and Development in Rio de Janeiro. Tangible impact was recorded, for example, in the Agency's involvement in insect pest eradication and proper water resources management. The year also witnessed the successful culmination of many years of work on the further strengthening of the international legal framework to help ensure that nuclear energy is used safely, and solely for peaceful purposes.

During the year the Agency operated on a regular budget of \$232 million, which represented a small increase (0.4%) over the level in 1996. The Agency also utilized almost \$24 million in extrabudgetary funds in support of its regular budget programmes. The activities undertaken with these extrabudgetary resources were vital to attaining the Agency's approved programme objectives. The target for contributions to the Technical Co-operation Fund (TCF) for 1997 was set at \$68 million, of which \$47.8 million was pledged by Member States. Regrettably, this represents the lowest ever percentage level pledged to the TCF target.

This review notes global developments in 1997 relevant to the safe and peaceful use of nuclear energy and, in that context, highlights the achievements of the Agency.

## Meeting global energy needs sustainably

In 1997, world electricity consumption rose some 3% over the figure for 1996 and nuclear energy continued to contribute about 17% to this consumption. If the nuclear generated energy had been produced by fossil fuelled energy with the current mix of fuels, total energy related carbon emissions would have increased by some 8%.

At the end of 1997, according to data reported to the Agency's Power Reactor Information System (PRIS), there were 437 nuclear power plants in operation. Of these, 152 reactors were in western Europe, 69 in eastern Europe, 123 in North America, 5 in Latin America, 11 in the Middle East and South Asia, 2 in Africa and 75 in the Far East. Three nuclear plants were connected to electricity grids, two in France and one in the Republic of Korea, representing 3555 MW(e) of electricity capacity. Construction started on three plants in China and two in the Republic of Korea, bringing the total number of plants under construction around the world at the end of 1997 to 37. This represents a total generating capacity of 26 813 MW(e). Eight reactors were shut down in 1997; five of them, in Canada, could be restarted in the future. Accumulated operating experience reached approximately 8500 reactor-years.

The largest contributor to the world installed nuclear capacity was the USA with 28%, followed by France with 18% and Japan with 12%. Germany's

contribution was 6% of the installed capacity, followed by the Russian Federation with 5.6%, Ukraine with about 4%, the United Kingdom with 3.7%, Canada with 3.4%, and Sweden and the Republic of Korea with about 3%.

In terms of nuclear power's contribution to national electricity production, the list is headed by Lithuania, where in 1997 approximately 80% of electricity was produced by nuclear, followed by France with 78%, Belgium with about 60%, Ukraine with 47%, Sweden with 46%, Bulgaria with 45%, the Slovak Republic with 44% and Switzerland and Slovenia with 40%. In an additional seven countries, more than 25% of the electricity was produced by nuclear power in 1997.

The fuel cycle infrastructure supporting nuclear power generation witnessed some significant developments. Uranium production increased modestly, with expanded or new facilities in Australia, Canada, Kazakhstan, Mongolia and the USA. Some 3200 tonnes of spent fuel were reprocessed in France, Japan, the Russian Federation and the United Kingdom. Around 200 tonnes of MOX fuel were fabricated during the year, marking a new high level of plutonium utilization for power generation. It is estimated that at the end of 1997 the inventory of separated plutonium amounted to some 170 tonnes.

### *Energy and the environment*

The ongoing discussions in the context of the Framework Convention on Climate Change highlight the continuing need for a better understanding of the comparative advantages and disadvantages of nuclear power vis-à-vis other sources of electricity generation. In response, the Agency has been working closely with other international organizations to develop databases and methodologies that permit comparative assessment of the costs and benefits of different energy options. Further case studies utilizing these tools were conducted with Agency assistance in two Member States in 1997.

### *Producing potable water*

An Agency symposium in May focused on seawater desalination using nuclear energy. The symposium, held in Taejon, Republic of Korea and organized in co-operation with the International Desalination Association, concluded that nuclear desalination is technically feasible and highlighted priority areas for further demonstration work. To promote wider co-operation in this area, the Agency established an International Nuclear Desalination Advisory Group.

Box 1

#### **Symposium on Nuclear Fuel Cycle and Reactor Strategies: Adjusting to New Realities**

Six working groups, with the participation of experts from Argentina, Canada, China, France, Germany, India, Japan, the Russian Federation, South Africa, Sweden, the United Kingdom and the USA, together with the OECD/NEA and the European Commission, summarized the common international understanding of the various nuclear fuel cycle issues into six key issues papers which covered:

- The global energy outlook;
- Plutonium management;
- Fuel cycles and reactor strategies up to 2050;
- The safety, health and environmental implications of the different fuel cycles;
- Non-proliferation and safeguards aspects; and
- International co-operation.

The 'new realities' considered included particularly the security and commercial aspects of the availability for peaceful use of nuclear material, particularly plutonium, released from former military programmes.

### *Fuel cycle options revisited*

Twenty years after the International Fuel Cycle Evaluation study, the Agency organized a symposium to examine nuclear fuel cycle options, with particular reference to the changed circumstances of uranium supply, availability of nuclear materials from former military programmes, the delay in the introduction of fast reactors and the development of new fuel cycle technologies (see Box 1). The symposium, held in June in co-operation with the OECD/NEA, the European Commission and the Uranium Institute, resulted in the publication of a set of summary key issues papers. The symposium also highlighted the interest in a continued international dialogue on fuel cycle matters, which led the Agency to establish an international working group for this purpose.

### *Spent fuel and radioactive waste management*

The management of spent fuel and radioactive waste continued to be an issue of great concern for many countries. While some countries have well developed programmes and facilities for these purposes, others face significant technical or public acceptance problems in managing accumulated spent fuel and in storing waste. Only limited progress is being reported by countries seeking to establish the necessary facilities. The Agency continued to assist countries in addressing these issues.

### *Plutonium management*

Nine States which separate, hold, process or use plutonium agreed on a document called *Guidelines for the Management of Plutonium* which, at their request, will be made available to Member States. The document sets out the policies which each government has decided to apply to the management of all plutonium in peaceful nuclear use. Although plutonium in military use is not covered, the States holding such material have indicated that they will ensure that plutonium in military use under their jurisdiction is, like other nuclear material, managed safely.

### *Radioactive waste and spent fuel management in the Russian Federation*

The Agency continued to act as the secretariat for the Contact Expert Group (CEG), which was established

in 1995 to assist in the co-ordination of international efforts to deal with the management of radioactive waste and spent fuel in the Russian Federation. Following a review in 1997 of reports by government ministries, institutes and organizations of the Russian Federation and the results of specialized studies, the CEG decided that it should continue to focus attention on the situation in the northwest region and made an appeal for wider support.

## Technology transfer: Reaping the rewards

### *Technical co-operation strategy*

The principles underlying the Agency's technology transfer strategy have been fast evolving over recent years. The idea of 'Model Projects' — projects that embody best practice design with emphasis on sustainable development — was first put into practice in 1994. Subsequently, 'thematic' planning was introduced, taking a global view of where and how a particular nuclear technology might best contribute to national development objectives and how the Agency might facilitate that contribution. For example, Country Programme Frameworks are established with Member States to ensure that co-operation projects fall within priority areas that can produce a significant impact. These principles, and the experience acquired in their use, were reviewed by the Agency's Standing Advisory Group on Technical Assistance and Co-operation (SAGTAC) and the findings consolidated into a succinct strategy document that was endorsed by the Board of Governors in December. This strategy, which sets out the principles that will in the future guide the direction of the entire technical co-operation programme, is a vital reference tool not only for the Agency, but also for partner countries and other development agencies.

### *Eradication of the tsetse fly from Zanzibar*

The tsetse fly (*Glossina austeni*) is an insect that spreads trypanosomiasis, an anaemia-causing disease, to cattle. Direct losses from this disease in Africa are estimated to range from \$600 million to \$1.2 billion per annum. In 1997 an independent group of experts reviewed an Agency technical co-operation Model Project that used

the sterile insect technique (SIT) to eradicate the tsetse fly from Zanzibar, United Republic of Tanzania. They confirmed the apparent eradication of the fly from the island (see Box 2).

### *Water resources development*

Several countries in Africa are currently facing acute water shortages that threaten public health and impede social and economic development. This has prompted the United Nations to include water among the set of priorities of the system wide initiative on Africa (UNSI) with the aim of ensuring sustainable and equitable freshwater resources. In support of national programmes in the water sector, the Agency established in 1995 a large technical co-operation regional Model Project which seeks to apply isotope hydrology in the assessment and further development of groundwater resources in North Africa. Results achieved under phase I of the project identified significant groundwater resources. On the basis of the experience gained, the Agency's activities are being expanded to other countries in eastern and southern Africa which suffer from droughts, land degradation and land shortages.

### *Training centre for nuclear power plant maintenance*

In the areas of nuclear power and nuclear safety, a unique maintenance training centre in Europe was established under a technical co-operation Model Project at the Paks nuclear power plant in Hungary. Work on full size WWER-440 power plant components and use of the systematic approach to training are two of the capabilities that have been introduced at the centre. The European Union is also supporting the project as part of its regional programme of assistance to upgrade WWER reactors in eastern Europe. This project represents a substantive contribution towards operational safety and performance in the nuclear power industries of Hungary and other eastern European countries employing WWER-440 power plant designs.

### *National nuclear legislation*

A comprehensive review of the nuclear legislation in 14 countries of eastern and central Europe and the newly independent States was carried out through intensive consultations with Member State parliamentary and

Box 2

### **Tsetse Eradication Operation on Zanzibar**

In spite of intensive monitoring, with more than 500 traps permanently positioned all over Unguja Island of Zanzibar, no wild tsetse flies were found after the reported capture of the last wild fly in September 1996.

- In 1986, before the FAO and UNDP initiated a six year phase of tsetse suppression using conventional methods, on average between 17 and 25% of the cattle population was infected with trypanosomes.
- The SIT was used against tsetse as a 'mop-up' operation to eliminate the remaining pockets of infestation. Almost eight million sterile male flies were released in the course of the campaign.
- In recent routine tests of more than 1000 cattle in 38 herds, the incidence of new trypanosome infections remained less than 0.1%.
- Following the recommendations of an independent group of experts: (a) releases of sterile males were discontinued in late December 1997; (b) measures were taken to carry out entomological surveys for one year and veterinary monitoring for two years; and (c) an action plan was developed to sustain the Tanga fly production facility in the coming years.

This marked the close of an integrated, area wide eradication campaign designed and managed by the Government of the United Republic of Tanzania and the Agency and supported by the International Fund for Agricultural Development (IFAD), the OPEC Fund and the Governments of Belgium, Canada, China, Sweden, the United Kingdom and the USA.

licencing authorities, experts missions and the exchange of information. During the year, assistance under Agency technical co-operation projects was provided in the preparation and review of draft legislation for Armenia, Georgia, Latvia, Lithuania, the Republic of Moldova and Ukraine.

## The safe use of nuclear energy

The future role of nuclear energy depends critically on a consistent, demonstrated record of safety in all nuclear applications. While the overall trend is positive and in general nuclear safety continued to improve around the world, a number of events during the year highlighted the need for continuous efforts to maintain and improve safety, even in long established programmes such as those in western Europe and North America. Following the report of a team of experts that identified serious management, training and safety culture problems, the Canadian electricity utility Ontario Hydro announced the intention to close seven reactors for an indefinite period. In the USA, the

Millstone nuclear power plant was shut down, with restart contingent on programmes to ensure substantial safety improvements. And the Swedish nuclear safety authority issued a requirement to managers from all nuclear power plants to submit by the end of 1997 detailed plans to guard against certain incidents that had occurred during the year.

### *The legal framework for nuclear safety*

Multilateral, legally binding agreements became increasingly important mechanisms for improving nuclear, radiation and waste safety around the world. There were three major developments in 1997. First, the Preparatory Meeting of the Convention on Nuclear Safety was convened in April to adopt rules of procedure, financial regulations and guidelines for the preparation of national reports which are to be reviewed at the first meeting of the Contracting Parties in 1999. As of the end of 1997, 42 States had adhered to this convention. Second, a Diplomatic Conference to adopt the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management was held in September (*see Box 3*). The purpose of the convention is to establish a legally

Box 3

### **Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management**

The Joint Convention addresses:

- The safety of spent fuel and radioactive waste from civilian sources, except for spent fuel held at reprocessing facilities unless declared to be subject to the convention by Contracting Parties;
- The safety of spent fuel and radioactive waste from military sources when declared as being subject to the convention by Contracting Parties;
- Safety requirements for the control of spent radiation sources, for discharges of radioactive materials into the environment and for the transboundary movement of spent fuel and radioactive waste.

The principles on which the Joint Convention are based are taken from the:

- Inter-agency *International Basic Safety Standards for Protection Against Ionizing Radiation and the Safety of Radiation Sources*;
- Agency's Safety Standards Fundamentals entitled *The Principles of Radioactive Waste Management*;
- Agency's *Code of Practice on the International Transboundary Movement of Radioactive Waste*.

The convention will enter into force after 25 States, at least 15 of which have operating nuclear power plants, have ratified it. The main mechanism for implementing the convention will be review meetings, for which Contracting Parties will be obliged to submit reports on how the obligations under the convention are being implemented in their own countries.

binding regime for ensuring that the basic safety principles for the management of radioactive wastes and spent fuel are implemented worldwide. Third, a Diplomatic Conference was held in September to amend the Vienna Convention on Civil Liability for Nuclear Damage and to adopt a Convention on Supplementary Compensation for Nuclear Damage. Among other things, these latter instruments enhance the amount of compensation for nuclear damage, including the cost of environmental damage and preventative actions.

### *Review and assessment services*

The Agency continued to provide a range of assessment and review services for the safety of nuclear installations. Such peer review services can contribute to the improvement of operational safety and the development of safety culture and also benefit the regulators and operators who provide the expertise for such services. In this way a truly global safety culture is being effectively encouraged. One element in the delivery of the services is the development of an 'integrated strategy on nuclear safety infrastructure' involving an assessment in countries receiving technical assistance of national capacities compared with the desired international standards. Improvements were made in the integration of the different services provided by the Agency — specifically the Operational Safety Review

Team (OSART), Assessment of Safety Significant Events Team (ASSET) and Assessment of Safety Culture in Organizations Team (ASCOT) services. Efforts were also made to improve the co-ordination of the Agency's services with the work of other international organizations in similar areas, such as peer reviews by the World Association of Nuclear Operators.

### *Safety of radiation sources*

The safety of radiation sources and the security of radioactive material continued to be a matter of special concern. As a priority matter, an Agency technical co-operation Model Project has been supporting the upgrading of radiation and waste safety infrastructures in some 53 developing countries — with the focus on the control of radiation sources.

Spent radium sources in many Member States are being collected, treated and conditioned in special campaigns. In 1997, the Agency, under a technical co-operation interregional project, assisted such campaigns in Croatia and Nicaragua. In addition, personnel from eight Member States were trained in conditioning methods.

Agency assistance was called upon during the year in relation to three specific incidents involving radiation sources. In Costa Rica, the Agency was asked to prepare

Box 4

### **The Protocol Additional to Safeguards Agreements**

The measures provided for in the new Additional Protocol include:

- Information about, and inspector access to, all aspects of the nuclear fuel cycle in States, from uranium mines to nuclear waste and any other location where nuclear material intended for non-nuclear uses is present;
- Information about, and inspection mechanisms for, fuel cycle related research and development;
- Information on, and short notice inspector access to, all buildings on a nuclear site;
- Information on the manufacture and export of sensitive nuclear related technologies and inspection mechanisms for manufacturing and import locations;
- Collection of environmental samples beyond declared locations when deemed necessary by the Agency;
- Administrative arrangements that improve the process of designating inspectors, issuance of multiple entry visas (necessary for unannounced inspections) and Agency access to modern means of communication.

Parties to safeguards agreements will subscribe to the Additional Protocol through the same process used for safeguards agreements.

a comprehensive assessment of a situation where more than one hundred radiotherapy patients were over-exposed, some with severe, and even fatal, consequences. In Georgia, where nine servicemen were exposed to radiation sources left behind in a former military camp, the Agency, in co-operation with WHO, was asked to help arrange emergency treatment and to assist in a survey to locate any additional lost sources. And in Bangladesh, the Agency's assistance was sought to recover a number of sources affected in a gas well explosion and fire.

### *Assessing the biological effects of low radiation doses*

The Agency and WHO, in co-operation with UNSCEAR, sponsored an international conference in Seville, Spain, to review the current state of knowledge on the biological effects of low doses and the regulatory approaches adopted on the basis of that knowledge. It was concluded that the currently accepted hypothesis — that any incremental dose of radiation, no matter how small, carries with it a corresponding (though small) increase in risk — remains the most radiobiologically defensible basis for radiation protection and regulation.

## Verifying the peaceful use of nuclear energy

The realization of the opportunities for arms control and disarmament depends critically on effective systems of verification. For the Agency the verification of nuclear non-proliferation and other peaceful use commitments remained the primary focus. However, discussions took place on the possible application of Agency verification measures to nuclear arms reduction undertakings.

### *Safeguards implementation in 1997*

In 1997, the Agency was applying safeguards at over 900 facilities in some 70 countries, involving more than 10 000 person-days of inspection. It did not find any indication that nuclear material which had been

declared and placed under safeguards had been diverted for any military purpose or for purposes unknown, or that safeguarded facilities, equipment or non-nuclear material were being misused. All the information available to the Agency supports the conclusion that the nuclear material and other items which had been declared and placed under Agency safeguards remained in peaceful nuclear activities or were otherwise adequately accounted for. However, the Agency is still unable to verify the initial declaration made by the Democratic People's Republic of Korea (DPRK). The measure of co-operation received from the DPRK did not increase and accordingly the correctness and completeness of the initial inventory of nuclear material declared by the DPRK could still not be verified at the end of the year. The DPRK continues to be in non-compliance with its safeguards agreement.

### *Strengthening of safeguards*

A major four year effort by Member States and the Agency came to a successful conclusion on 15 May with the approval by the Board of Governors of the Protocol Additional to Safeguards Agreements (*see Box 4*).

The measures in the Protocols supplement those previously approved by the Board for implementation under legal authority provided for under existing agreements. These measures, which were introduced progressively during 1997, include: additional information from States regarding facilities that once contained or will, in the future, contain nuclear material; the expanded use of unannounced inspections; the collection of environmental samples where inspectors have access; and the use of advanced technology to remotely monitor movements of nuclear material. Together with those approved previously, these measures provide the basis for a greatly strengthened and more cost effective safeguards system.

A key element of the strengthened safeguards system is a comprehensive review of all available information relevant to a State's nuclear activities. These regular evaluations, which commenced in 1997, provide an independent assessment of the correctness and completeness of the declared nuclear activities.

On the technical side, priority has been given to environmental sampling at enrichment plants and at selected facilities with hot cells. By the end of the year, baseline sampling had been completed at most of these

facilities. When sampling is completed, this technique will become part of the regular inspection programme.

By the end of 1997, six States had signed the Additional Protocol and the first Protocol entered into force with Australia. Negotiations were well under way with a number of States having major nuclear activities to conclude the Additional Protocol during 1998.

### *Efforts to verify nuclear arms reduction*

Under the 'Trilateral Initiative', the Russian Federation, the USA and the Agency have been exploring ways and means of verifying that the fissile materials removed from weapons programmes are not again returned to military use. The Minister of Atomic Energy of the Russian Federation, the Secretary of Energy of the USA and the Director General met again in September 1997 to review the progress made and to decide on future actions. Subsequently, as part of this ongoing process, a technical demonstration and workshop took place in the USA. The workshop focused on ways in which Agency inspectors could verify the presence of nuclear material without compromising confidential information about its precise form and content.

### *Security of material*

The Agency continued to receive reports from States on incidents of trafficking of nuclear material and radioactive sources. In 1997, 72 reports were received, 26 of which related to incidents occurring during the year. This indicates that deficiencies remain in arrangements for controlling these materials. In this connection, the Agency held a conference in November on physical protection (*see Box 5*).

Together with the Austrian and Hungarian customs authorities, the Agency undertook a large scale evaluation of border monitoring systems at its Seibersdorf laboratories.

### *Iraq*

The Agency's ongoing monitoring and verification activities have been in operation since August 1994. The Agency conducted a series of technical talks with the Iraqi counterpart to clarify various points in the full, final and complete declaration (FFCD) issued by Iraq on 7 September 1996. In April and October, the Agency delivered its third and fourth consolidated

Box 5

### **Conference on the Physical Protection of Nuclear Material: Experience in Regulation, Implementation and Operation**

Effective physical protection systems are vital for preventing the unauthorized movement of nuclear material from a controlled to an uncontrolled environment. States have long recognized this need and set up systems to protect the material within their jurisdictions. In response to increased interest and concern in the last few years about the risks associated with illicit trafficking, and to facilitate an increase in the exchange of information on physical protection, the Agency convened a conference in Vienna in November.

Papers were presented on regulatory systems, implementation of physical protection at facilities and during transport, as well as recent developments in the field. Measures to minimize the possibility of illicit trafficking and systems to protect against sabotage were also addressed.

Among the key points which arose were the:

- Continuing need to review and upgrade elements of physical protection systems, in particular the security of old facilities;
- Desirability of using, where practical, the advanced technologies now becoming available;
- Need to continue bilateral and multilateral exchanges of experience and information.

reports to the United Nations Security Council. The latter report provided an overview of the work done by the Agency in Iraq since it began implementation of its obligations under Security Council Resolution 687 of 1991.

## Inside the Agency

As evidenced by successive reductions in administrative and overhead costs, the Agency has remained committed to efficiency and economy. It has expanded programmes as required and reduced activities in some areas where the need for Agency action has declined. Nevertheless, the demand for Agency services exceeds the resources available through the regular budget, though extrabudgetary funding has filled part of the gap.

### *Increasing efficiency*

During 1997, the Agency's travel account was the subject of major reforms and the changes implemented produced significant savings. The new rules and arrangements will be reviewed in the light of the experience to date.

A revised staff appraisal system was introduced. One aim of the new system is to align staff performance assessment more closely to the objectives of the Agency's programmes. The first year's experience with the system has been assessed and further refinement of the process is expected.

Most of the documentation for the regular session of the General Conference in September was made available on the Internet. Documents of the Board of Governors also became available electronically to registered users.

### *Staffing*

Since 1982, the developing country share of Professional staff subject to geographical distribution has almost doubled and was close to 33% by the end of 1997. For senior officers — that is Directors and Deputy Directors General — it was even higher, at 36.4%.

The number of women in the Professional staff increased from 11.7% in 1982 to 18.6% in 1997. The figures for women in higher level Professional posts, i.e. P-5 and above, showed a greater increase: in 1982, the highest graded women in the Secretariat were two staff members at the P-5 level. In 1997, there were 11 women at this level and 6 in the D-1 grade.

### *Fortieth anniversary*

The fortieth anniversary of the Agency was marked by a number of events in Vienna and in Member States. Two special books were produced: a history of the Agency and a set of personal recollections.

### *Election of the Director General*

Hans Blix retired at the end of November as Director General of the Agency after 16 years of service. At the 41st regular session of the General Conference, Mohamed ElBaradei was elected as the new Director General by acclamation.

