

THE YEAR IN REVIEW: MAJOR ISSUES AND CHALLENGES

The International Atomic Energy Agency continued to play an important role in 2001 under the three pillars of its mandate — *technology, safety and verification*. In particular, it served as a catalyst for sustainable development through the transfer of nuclear science and technology, as a key contributor to global nuclear safety and as a cornerstone for nuclear non-proliferation. The Agency's programme of activities focused on: bringing about the development and transfer of peaceful nuclear technologies; building and maintaining a global nuclear safety regime; and guarding against the proliferation of nuclear weapons and strengthening the security of nuclear material and facilities.

This chapter presents the state of the 'nuclear world' in 2001 from the perspective of the Agency, along with a summary of its major activities and achievements.

TECHNOLOGY

Sustainable development

During 2001, as before, a range of different views on nuclear power was expressed. In April, at the ninth session of the Commission on Sustainable Development (CSD-9), Parties agreed to disagree on nuclear energy's role in sustainable development. The final text noted that some countries see nuclear energy as a substantial contributor to sustainable development, while others consider the two to be fundamentally inconsistent. However, the parties did reach unanimous agreement that "the choice of nuclear energy rests with countries".

The Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) reached agreement in November on implementation rules (referred to as the "Marrakesh Accords") for the 1997 Kyoto Protocol to limit greenhouse gas (GHG) emissions. For nuclear energy this is an important step towards attaching a tangible economic value to nuclear power's avoidance of GHG emissions, even though the Marrakesh Accords exclude nuclear projects from two of the three flexible mechanisms in the Kyoto Protocol that provide credits for GHG avoidance by States: the clean development mechanism and joint implementation (the third mechanism is emissions trading).

As the expert body on nuclear science and technology within the UN family, the Agency has been active as an information resource in the continuing CSD and UNFCCC processes. For example, the Agency contributed to the Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), which concluded, among other things, that nuclear power plants have the highest potential for GHG mitigation in the energy sector. The Agency has also been participating in the preparatory process for the August 2002 World Summit on Sustainable Development (WSSD) in Johannesburg. Nuclear science and technologies have had much to contribute to progress on *Agenda 21* — negotiated at the 1992 UN Conference on Environment and Development (the Rio "Earth Summit") — in such areas as agriculture, food safety, public health, industrial techniques, electricity generation and water resources development and management (Box 1).

Nuclear power around the world

Nuclear power continues to be an important part of the energy mix in many countries. At the end of 2001 there were 438 nuclear power plants in operation, corresponding to a total capacity of 353 GW(e), more than 10 000 reactor-years of cumulative operating experience and about 16% of

global electricity generation. Two new plants came on line during the year. While nuclear power is being generated primarily in a broad range of industrialized countries, 31 of 32 new plants under construction are in Asia or in Central and Eastern Europe.

For existing nuclear power plants, the most significant recent trend is a steady increase in availability factors through improvements in operational practices, engineering support, strategic management, fuel supply and spent fuel disposition. These have reduced generating costs and improved safety. Their cumulative impact is substantial — during the 1990s, availability increased by an amount equivalent to building 28 new nuclear power plants of 1000 MW(e) each. Among countries for which 2001 operating data are available, Argentina, Brazil, the Czech Republic, Germany, India, the Republic of Korea, Spain, the Russian Federation, Switzerland, Ukraine and the USA all increased their production of nuclear electricity to record levels.

For new plants, the outlook is mixed. New nuclear power plants are more attractive in countries experiencing a rapid growth in energy demand, or where indigenous energy resources are scarce, energy supply security is a priority or nuclear power is seen as an important way to reduce air pollution and GHG emissions. In Western Europe and North America, the two regions with the largest number of operating nuclear power plants, there were no firm plans for new construction through the end of 2001. However, in January 2002, the Government of Finland made a favourable decision “in principle” on a utility application to build a fifth nuclear power plant. In addition, the new US “Energy Policy”, released in May 2001, recommended government support for “the expansion of nuclear energy in the United States as a major component of...national energy policy”. During the year, Belgium and Germany took legislative actions to phase out nuclear power at the end of the lifetimes of their currently operating reactors.

Given low fuel costs and improved capacity factors, a well run, amortized nuclear power plant is often the least cost electricity generation option. There is thus growing interest in extending the lifetime of existing plants. By the end of 2001, six electricity plants in the USA had been granted extensions,

BOX 1. ISOTOPES — INDISPENSABLE TOOLS FOR STUDYING CLIMATE CHANGE

While it is widely accepted that recent global warming is largely a product of enhanced GHG concentrations in the atmosphere, great uncertainty remains regarding the relationships between specific parameters and climate phenomena, and regarding the impacts of climate change on the Earth's water cycle. The changes observed in the last few decades appear to be unprecedented compared with the history of changes in the Earth's climate. Understanding the causes of past climate changes is, therefore, an important part of climate change research. Isotopes are one of the most important tools to assist researchers in gaining insights into past climate changes, primarily by measuring changes in the distribution of oxygen and hydrogen isotopes in groundwater and sediments over time.

An international conference on ‘The Study of Environmental Change using Isotope Techniques’ was organized by the Agency in Vienna in April 2001. The conference reviewed the latest isotope techniques and their applications in global climate change research. Future research directions in the assessment of: the impacts of deforestation on water balance in the Amazon Basin; understanding of past climate variability and changes through continental and polar ice core records; characterization and understanding of the movement, mixing and residence times of oceanic water masses; and past climate changes recorded in groundwater in aquifers in Europe, Asia, Australia, Africa and the Americas were discussed. The conference recommended the establishment of a global network of isotope monitoring of large rivers along the lines of the Agency's global network for isotopes in precipitation. ■

increasing the licensed lifetime of each to 60 years. The owners of an additional 40% of operating US plants have indicated their intention of seeking license extensions — the US Nuclear Regulatory Commission expects this figure to eventually reach 85% or higher. In addition, the Ministry for Atomic Energy of the Russian Federation decided to extend the lifetimes of the Novovoronezh-3 and 4 plants by 15 years.

For nuclear power, innovation will be a key factor in closing the gap between near term scenarios that project only modest expansion (or even a decline) and most long term scenarios, which project a substantial expansion. The principal objectives of innovative concepts are low capital costs, short construction and start-up times, a very high level of safety, and proliferation resistance. Several small to medium sized designs seek to benefit from modular structures and systems for rapid on-site installation, economies of series production, easier financing and their potential appeal for countries with small electricity grids or power needs in remote locations. They may also be more appropriate for non-electric applications such as district heating, desalination and hydrogen production. Many advanced reactor designs are in various stages of development in national research programmes around the world.

There are two major international efforts on innovative reactor designs. The first is the Agency's International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO), which has a membership of 13 (i.e. Argentina, Brazil, Canada, China, Germany, India, Republic of Korea, Netherlands, Russian Federation, Spain, Switzerland and Turkey, as well as the European Commission) and is open to all interested Member States and organizations. The other is the Generation IV International Forum (GIF), which was initiated by the USA and currently has ten members. The GIF Charter was formally signed in 2001; this was also INPRO's first year of operation.

INPRO, in particular, seeks to promote innovations in nuclear reactors and fuel cycles to meet likely future needs in terms of economics, safety, environmental impacts, proliferation resistance and public acceptance. Its objectives are to ensure that nuclear energy is available to help meet 21st century energy needs and to engage both technology holders and users. The current focus is on defining user requirements, which can then be used to help design appropriate R&D strategies. Subsequently, Member States can examine innovative designs against these requirements.

Nuclear fuel cycle and waste management

The 'back end' of the fuel cycle saw important developments in Finland and in the USA. In May 2001, the Finnish Parliament ratified the Government's decision "in principle" to approve a final repository for spent fuel in a cavern near the nuclear power plants at Olkiluoto. Construction is scheduled to start in 2011, with operation scheduled to commence ten years later. Also in May, the US Department of Energy determined that the proposed Yucca Mountain disposal site in Nevada meets the Environmental Protection Agency's radiation standards set earlier in the year.

Recognizing that there are more countries interested in the science of deep underground storage and disposal, the Agency launched an 'International Network of Centres of Excellence for Demonstration and Training in Geological Disposal'. This network, which was built initially around the deep underground research laboratories made available by the Governments of Belgium and Canada, has now expanded to include Switzerland, the United Kingdom and the USA.

Turning to the 'front end' of the nuclear fuel cycle, a new edition of the "Red Book" — *Uranium 2001: Resources, Production and Demand* — was published jointly by the Agency and the OECD NEA. The Red Book is the foremost world reference on uranium supplies and includes the latest information on uranium exploration, production, resources and demand. A complementary study published by the Agency, *Analysis of Uranium Supply to 2050*, concluded that known resources are adequate to satisfy primary supply requirements through 2035 in a middle demand case, after which new resources would need to be developed.

Nuclear fusion

The world's leading fusion scientists and engineers completed a detailed engineering design for the 500 MW International Thermonuclear Experimental Reactor (ITER), which will demonstrate the scientific and technological feasibility of fusion energy. The Agency has supported activities related to the ITER project since its inception and the ITER Parties (Canada, the European Union, Japan and the Russian Federation) have asked for the Agency's continued support during the next phase leading to the construction of ITER. A site in Canada is under consideration and other offers of sites are expected from the European Union and Japan.

Technology transfer

Promoting the scientific, technological and regulatory capabilities of developing countries through technology transfer and capacity building are among the main tasks of the Agency's technical co-operation programme, with special emphasis given to technical co-operation among developing countries (Box 2). In 2001, which was a banner year for the programme, disbursements went up significantly to \$73.5 million from \$59.1 million in 2000. The major areas of activities were: human health (23%), safety (20%), food and agriculture (17%), applications of physical and chemical sciences such as isotope hydrology (14%), capacity building (7%), marine environment (7%), nuclear power (5%) and nuclear fuel cycle and waste management technology (4%). Of these disbursements, approximately 41% went towards equipment and 59% provided training, expert services, subcontracts, miscellaneous services and fellowships. The effectiveness of the Agency's technical co-operation programme can also be enhanced by the fostering of strategic partnerships that combine nuclear technologies and essential non-nuclear activities (Box 3).

Capacity building, which involves the promotion of local human resources development and technology transfer, has become a central theme in Agency activities directed at developing Member States. In this regard, thematic CRPs were introduced by the Agency with the purpose of combining capacity building with scientific research activities. An essential component of a thematic CRP is the pairing of senior researchers in developing and developed countries, with this pair supervising a research fellow from the same developing country in studies leading toward a doctorate or similar

BOX 2. SERVING HUMAN NEEDS — NUCLEAR TECHNOLOGY TRANSFER FOR SUSTAINABLE DEVELOPMENT

Technology transfer in relation to the Agency's technical co-operation activities was the focus of the Scientific Forum held in September 2001 at the 45th regular session of the General Conference. The forum provided an opportunity for dialogue between national, intergovernmental and non-governmental counterparts from different regions that share common development challenges.

The forum focused on three areas of technology transfer: promoting food security using isotopes and radiation to overcome basic ecological constraints; managing water resources by understanding aquifer dynamics; and improving human health using isotopes to develop new vaccines and diagnostic reagents. In his keynote address to the Forum, Jeffrey Sachs, Professor of International Trade at Harvard University, analysed the role of science and technology in industrialized and developing countries and pointed out that drawing leading scientists and engineers into the challenge of helping the world's poorest is a critical task that requires international donor support and action from international agencies such as the Agency. At the concluding panel discussion the experts examined ways in which "sci-tech" tools, particularly nuclear related technologies, could be better applied at national, regional and global levels to solve the pressing problems of food security, improving public health and developing clean water resources. ■

advanced degree. This will assist in building capacity in developing countries, particularly in the context of the general decline in the number of young people embarking on careers in the nuclear sciences. The individual doctoral work under the thematic CRP addresses the same research area, thereby providing a broad based approach to the research subject under investigation. In 2001, two thematic CRPs were under way in the fields of nuclear medicine and nutrition.

Sterile insect technique (SIT)

The tsetse fly is one of Africa's greatest constraints to socioeconomic development, severely affecting human and livestock health and land use. At their July 2001 summit in Lusaka, the Heads of African States and Governments approved an Action Plan for the Pan African Tsetse and Trypanosomosis Eradication Campaign (PATTEC).

The Agency is playing a major role in supporting the PATTEC initiative as SIT will be an essential component of a package of technologies that will be used. In 2001, the Agency's General Conference adopted a resolution welcoming the OAU's Action Plan and requesting the Agency, in co-operation with Member States and relevant international organizations, to continue supporting African Member States in the tsetse eradication endeavour. The FAO Conference in 2001 adopted a similar resolution.

To ensure the involvement of all stakeholders within and outside Africa, and in recognition of the importance of international co-operation in supporting the PATTEC initiative, the OAU formed a Policy and Mobilization Committee, under the chairmanship of its Secretary General, to guide PATTEC. The Agency, FAO and WHO are represented on this committee.

Food irradiation

The International Consultative Group on Food Irradiation (ICGFI) is composed of 46 Member States, more than half of them developing countries. The Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture serves as its Secretariat. ICGFI has been evaluating global developments in food irradiation; providing advice on its application to Member States and to the three co-sponsoring organizations — the Agency, FAO and WHO — and providing information to the Joint FAO/IAEA/WHO Expert Committee on the Wholesomeness of Irradiated Food and the Codex Alimentarius Commission. After completing its mandate of developing policy guidelines for the

BOX 3. BUILDING STRATEGIC PARTNERSHIPS FOR TECHNICAL CO-OPERATION

The benefits of the Agency's nuclear technology transfer to Member States can be maximized when this technology is combined with skills and know-how in other related fields. Strategic partnerships with related technical institutions help ensure that the transferred nuclear technologies achieve the desired impact.

A good example is in the field of tissue banking. The Agency has had considerable success in establishing training courses — now available through distance learning facilities — for irradiating tissue for use in operations. However, merely producing irradiated tissue is not enough. Awareness campaigns need to be launched to encourage the donation of tissue, and surgeons need to be trained to be able to transplant it in patients. Since these non-nuclear "forward and backward linkages" are not part of its normal activities, the Agency formed a partnership with the Musculo-Skeletal Transplant Foundation, a non-profit organization that can transfer the requisite skills. This and other such strategic partnerships will help ensure that the nuclear technology transferred to Member States will not only be used to create valuable products, but will be available on a sustainable basis. ■

Agency, FAO and WHO, and successfully contributing to efforts to facilitate the acceptance and application of food irradiation techniques over the last 17 years, ICGFI decided in 2001 to phase out its activities by 2004, paving the way for the establishment of a new organization with strong involvement of the private sector, especially the food industry. The structure of this organization will be defined at the ICGFI meeting to be held in November 2002.

Nutrition

An estimated 70% of all stunted children live in Asia, where 21% of infants are born undernourished. In addition, iron and iodine deficiencies continue to be major public health issues in the region. Isotope techniques are very effective mechanisms for evaluating the nutritional status of individuals and populations, measuring nutrient requirements and studying the bioavailability of vitamins and minerals. The Agency has been supporting these activities through several of its programmes in 2001. Of special importance is a regional technical co-operation project in Asia to study the bioavailability of added micronutrients in staple foods. China, Indonesia, Malaysia, Pakistan, Philippines, Thailand and Viet Nam participate in this project. Thus, wide acceptance of nuclear technologies by several governments in the East Asia and Pacific region to test the bioavailability of fortified foods has built partnerships that have strengthened efforts to fight malnutrition in that region. In addition, the Agency initiated steps to establish a partnership with the Asian Development Bank to deal with this problem.

An international Code of Practice for dosimetry

To assist Member States in standardizing their procedures for measuring the amount of radiation used to treat cancer patients, the Agency published a new Code of Practice for dosimetry. The development of this Standard took five years, involving several eminent medical physicists and review by more than 50 scientists from 20 countries. The WHO, PAHO and the European Society of Therapeutic Radiology and Oncology have also endorsed it. This Code is unique as its calculation approach is consistent for a variety of radiation beams and it is inherently simpler than earlier methods. It is expected to benefit radiation measurement laboratories all over the world; institutes in Algeria, Greece, Finland, Norway, Sweden and Saudi Arabia have already adopted the Code.

Depleted uranium

Military conflicts during the last decade involved the use of depleted uranium (DU) ammunition. The potential and reported consequences of exposure to DU residues for the local civilian population, peacekeeping forces and the environment have been the subject of public concern and media attention. The Agency therefore decided to hold a scientific seminar and training course to provide the proper scientific basis and adequate background information to its Member States for assessing DU's radiological and toxicological risks and consequences. The seminar and training course were organized in September in co-operation with UNEP and WHO. In related work, Agency and UNEP experts, at the government's request, began an assessment of the consequences of DU residues that may be present in Kuwait since the Gulf War.

Integrating isotope applications in national water development programmes in Africa

Isotope techniques are unique tools for obtaining hydrological information for sustainable groundwater resource management. As a result of the increased interest of the Agency's Member States in the application of these techniques, technical assistance in isotope hydrology has nearly tripled in the last five years. More than 65 technical co-operation projects in isotope hydrology are presently operational in Africa, Asia and Latin America to develop appropriate approaches for integrating isotope techniques with ongoing national water resource management programmes. Several regional projects have been developed to assist major government and donor supported freshwater programmes.

A chronic shortage of water is a major constraint for the socioeconomic development of southern Madagascar, which constitutes the least developed part of the country. To increase the availability of drinking water in this area, the Government has initiated a World Bank supported "500 Wells Project". In 2001 the Agency made available to the project authorities hydrogeological data collected using isotope techniques in similar geological strata in Madagascar. These data are being used to guide site selection for the drilling of these wells.

Using isotope techniques, the Agency also assisted in identifying the sources of nitrate pollution in the aquifer that supplies water to the city of Dodoma in the United Republic of Tanzania. The Government has used this information in developing criteria for land use restrictions and groundwater protection in the area.

SAFETY

National and international efforts continued during the year to enhance the global safety of nuclear power, an attribute that is vital to the credibility of nuclear technology. In 2001, there was further confirmation that since the Chernobyl accident safety performance has continued to show significant improvement around the world. This has been established through the Agency's own safety review missions and through the collection of information on operating experience and plant performance data by the World Association of Nuclear Operators (WANO). The positive trends in nuclear safety were confirmed at the second review meeting for the Convention on Nuclear Safety, when the Contracting Parties discussed the national reports submitted by States in 2001 and concluded that significant progress had been observed since the first review meeting in 1999. Also, the Council of the European Union (EU) issued a 'Report on Nuclear Safety in the Context of Enlargement', noting that a number of States seeking membership in the EU had embarked on the implementation of major modernization and safety improvement programmes. In spite of these positive developments, much remains to be done at the national and international levels to address the varying safety practices in different countries. In addition, in the aftermath of the events of 11 September 2001, the interrelationship between the safety and security of the use of nuclear technologies has been underlined.

In the past year, there have been notable developments with regard to the work of a number of expert bodies in providing authoritative findings and recommendations on nuclear safety related topics. Their advice constitutes important inputs to the development of the Agency's safety standards and many national safety regulations. For example, the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) focused on the risk of hereditary effects from exposure to radiation and concluded that such a risk was likely to be somewhat lower than previous estimates, requiring a downward revision of the previously used risk coefficients for hereditary effects. Also in 2001, the International Commission on Radiological Protection (ICRP) continued its work on revising and making simpler its recommendations on radiological protection that would place more emphasis on individual doses than collective doses. The International Nuclear Safety Advisory Group (INSAG) completed its work on key issues in strengthening safety culture and on maintaining knowledge, training and infrastructure for research and development. INSAG's advice on the latter stressed the need for greater efforts to ensure that knowledge, human resources and R&D support needed to maintain and improve the safety of nuclear activities continue to be available in the future.

The OECD NEA continued its efforts to stimulate international co-operation in safety research. For example, its project launched on the research in the nuclear regulatory context brought together regulators, researchers and licensees to discuss current challenges. It also continued to focus on the safety aspects of the management of long lived waste, addressing such issues as the retrievability of disposed waste or the step-wise decision making in the long term implementation process for geological repositories.

Public demands for reassurance on safety issues, with calls for greater transparency and accountability, are being widely voiced in many countries. The need, therefore, for a more effective and transparent international safety regime continues to be a high priority. An international conference on topical issues in nuclear safety, held in September 2001, highlighted some of the most important challenges facing the nuclear safety community. These included the safety of research reactors, maintaining competence for safety, risk informed decision making, the influence of external factors on nuclear safety, the safety of nuclear fuel cycle facilities and safety performance indicators. The conference underlined the central importance to all aspects of safety of a strong safety culture and management of safety.

Chernobyl

In March 2001, the Ukrainian Government selected the design for a new shelter to be built around the existing Chernobyl-4 'sarcophagus'. The European Bank for Reconstruction and Development agreed to this decision, paving the way for the development of technical specifications and for obtaining tenders for the work to begin.

In April and June, two major international conferences were held in Ukraine to mark the 15th anniversary of the Chernobyl accident. Their focus was on the lessons learned and the health effects of the accident. In addition to providing an update on the incidence of radiation induced thyroid cancer in individuals who were infants or young children at the time of the accident, both conferences reflected on other health problems in the affected region. They concluded that there was some evidence — as yet not conclusive — of an excess of leukaemia cases among the "liquidators" (involved in clean-up operations at the site in 1986 and 1987), who received significant radiation doses, but no significant increase in the incidence of leukaemia in the wider population. There were also some data indicating a possible increase in the incidence of solid cancers in the affected areas, but little or no evidence of any causal link to radiation exposure.

Strengthening the global safety regime

The development and adoption of international, legally binding conventions under the Agency's auspices has significantly contributed to the enhancement of nuclear safety worldwide. To date, conventions have been developed covering the safety of power reactors, radioactive waste and spent fuel management, early notification and assistance in the case of a nuclear accident or radiological emergency, and the physical protection of nuclear material. However, many States are not yet party to these conventions, certain key areas of nuclear activity are still not subject to conventions and some of the conventions that exist are not comprehensive in their coverage. Further efforts are needed to make these conventions universal and comprehensive and to consider other areas, such as the safety of research reactors (Box 4), in which codes of conduct or other types of international undertakings could be beneficial. An important new development in 2001 was the entry into force of the Joint Convention on the Safety of Spent Fuel and on the Safety of Radioactive Waste Management.

Since the major aim of the safety related conventions is to promote adherence to internationally agreed and respected safety objectives and principles, the development and maintenance of a comprehensive body of safety standards is a second key element for the establishment of a comprehensive safety regime. Over the past few years, the Agency has been working intensively to update, complete and raise the quality and visibility of the set of safety standards that covers the entire range of nuclear activities, including nuclear, radiation, waste and transport safety. These standards define what is necessary to achieve a high level of safety. Although the number of States using the Agency's safety standards directly or as the reference basis for national nuclear safety regulations has been increasing, acceptance of the standards by all States and relevant intergovernmental organizations remains a high priority objective.

Agency safety services

The Agency continued to assist States in applying its standards by providing education and training, promoting information exchange on best safety practices, and rendering a broad range of safety services (Box 5). The nuclear safety services offered by the Agency — such as operational safety reviews, design reviews and regulatory reviews — continued to be in great demand. The main challenges here are ensuring that the advice and assistance provided by the Agency are explicitly underpinned by the safety standards and that the practical experience of applying the standards generates feedback to improve the next generation of safety standards.

The benefits of the international peer reviews and other services are demonstrated by the increasing degree to which follow-up missions find that identified safety problems have been resolved. In the past year, the Agency has begun to develop a more holistic approach — an ‘integrated safety evaluation’, which by drawing together results from existing appraisal services, provides a diagnosis of a State’s overall nuclear safety profile and identifies those areas where safety enhancements should be focused.

During 2001, the Agency’s nuclear safety review services and assistance were availed by countries of Central and Eastern Europe, the former Soviet Union, South East Asia and the Pacific and the Far East. For example, an expert team assembled by the Agency assessed the safety of the design of the Temelin-1 nuclear power plant in the Czech Republic. In China, assistance continued to be provided for the improvement of nuclear safety at the Qinshan Nuclear Power Corporation and expert missions reviewed the design of the newly constructed Tianwan nuclear power plant, providing recommendations on severe accident mitigation and the reactor protection system. Also, the Agency, at the request of the Korean Peninsula Energy Development Organization (KEDO), completed a design safety review of the LWR project that KEDO is implementing for the Democratic People’s Republic of Korea (DPRK).

Safety and security of radiation sources

An important safety issue for the Agency is the safety and security of radioactive sources. In the past year, the Agency’s Action Plan on these issues was revised and expanded aiming, among other things, at promoting self-assessment of national protection arrangements, provision of more guidance and assistance in locating ‘orphan sources’ and responding to emergencies. The revised plan foresees the development and implementation of a universal system of labelling of radiation sources so that

BOX 4. ADDRESSING THE SAFETY OF RESEARCH REACTORS

An area of continuing concern is the safety of research reactors. In the past year, the Agency initiated a range of measures towards the establishment of a comprehensive, internationally accepted safety regime for these reactors. In addition to work performed on safety standards, incident reporting and regulatory supervision, the Agency identified some key concerns — such as degraded equipment, inadequate fuel storage, lack of regulatory oversight as well as the absence of adequate funding and the lack of a clear plan on how to make the best use of the reactors. Responding to these concerns, the Agency decided to implement an internationally agreed action plan for research reactors that includes: an assessment survey to acquire comprehensive information on the safety status of research reactors worldwide; preparation of a Code of Conduct on the safety of these reactors; a review of the Agency’s assistance programmes to ensure that priority is being given to issues of highest safety relevance; and strengthening of monitoring activities on the safety of research reactors under project and supply agreements. In implementing the latter action, for instance, the Agency conducted Integrated Safety Assessment of Research Reactors (INSARR) missions in Greece, where the operational safety aspects of the “Demokritos” research reactor were reviewed, and in Australia, where the Preliminary Safety Assessment Report for the Replacement Research Reactor to be built at Lucas Heights was examined. ■

individuals are immediately aware of the potential hazards. While concern with respect to potential malicious acts in connection with orphan sources exists, public health effects due to inadvertent exposure are an equally important concern. This was demonstrated at the end of 2001 when two powerful radioactive sources were found unshielded in a remote area of the Republic of Georgia. The Georgian incident also serves as an illustration of the much larger problem of orphan sources that deserves prompt attention.

Safe transport of radioactive material

In spite of the outstanding safety record of those transporting radioactive material, many States and regional groups, in particular small island developing States and other coastal States, have expressed concern over the impact — on people, the economy and the environment — of a potential accident during the transport of this material by sea. The 2001 General Conference adopted a resolution that called for several actions, including urging those States shipping radioactive material and spent fuel to provide assurances to potentially affected States that their national regulations are in accord with the Agency's Transport Regulations. It also called for efforts to examine and further improve measures and international regulations relevant to the international maritime transport of radioactive material, including spent fuel. The resolution welcomed the practice of some shipping States and operators of undertaking timely consultations with relevant coastal States in advance of shipments and invited others to do so. Recognizing that uniform implementation and interpretation is an important prerequisite to an international transport safety regulatory regime, the resolution also noted that during 2001 the relevant international organizations had incorporated into their respective regulatory documents the requirements of the Agency's Transport Regulations. These modal regulations (for air, sea and land transport) were all in force at the international level as of 1 January 2002.

Radiological protection of patients

Medical practice involving the use of ionizing radiation accounts for about 95% of human exposure from human made sources of radiation. Accidents during medical treatment with radiation continue to occur, frequently with severe consequences. The increasing importance of the issue of radiological protection of patients is, among other things, witnessed by the fact that during 2001 four major

BOX 5. UPGRADING RADIATION, WASTE AND TRANSPORT SAFETY INFRASTRUCTURES

Providing assistance for upgrading national radiation, waste and transport safety infrastructures continued to be a priority for the Agency in 2001. Radiation Safety Regulatory Infrastructure peer review missions were sent to Niger, Philippines, Thailand and Venezuela. Based on an assessment of its inter-regional Model Project on Upgrading Radiation Protection Infrastructure, which was implemented between 1995 and 2000 in 52 States, the Agency concluded that, despite the progress made in many countries, the situation in many other countries remained unsatisfactory. The development of legislative and regulatory infrastructures will still require years of national effort in many States, with continuous government commitment, in order to comply with the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources (BSS). To achieve this objective, full implementation of national work plans agreed to by the relevant governments is a prerequisite. In 2001, two new Model Projects were started to allow some 30 more States to upgrade existing radiation protection infrastructures with the Agency's assistance. It is expected that, through the establishment of a national notification, authorization, inspection and enforcement system for the control of radiation sources and materials, the regional Model Projects will contribute to enhanced protection and security of the public. It is further expected that the successful implementation of these projects will improve the level of compliance by States with the principal requirements of the BSS and, consequently, contribute to a safety based approach to the application of nuclear technologies. ■

publications of the ICRP were devoted to various aspects of radiation protection in medicine. During the year, the Agency investigated accidental exposures of radiotherapy patients in Panama and Poland, where, due to human errors in the data entry of the treatment plans and an electrical fault, a number of patients were treated with doses up to 100% higher than those prescribed. To highlight this concern, the Agency, together with the European Commission, PAHO and WHO, organized a conference in Málaga, Spain, on the radiological protection of patients in diagnostic and interventional radiology, nuclear medicine and radiotherapy.

VERIFICATION

Strengthening the safeguards system

Since the early 1990s, the Agency has been involved in strengthening its safeguards system, bearing in mind the importance of achieving the universal application of the Agency's safeguards system, consistent with the respective safeguards undertakings of Member States. In 2001, this effort took several forms. Additional protocols were concluded, comprehensive State level evaluations became a more central feature of the system and technological improvements had a positive impact on the implementation of safeguards measures (Box 6).

The Model Additional Protocol, approved by the Board of Governors in May 1997, is the key tool for strengthening the safeguards system. By concluding an additional protocol a State undertakes to provide a broad range of information about all aspects of its nuclear fuel cycle and nuclear related activities, and to provide more access rights for Agency inspectors. This enables the Agency to provide credible assurances not only about the non-diversion of declared nuclear material, but on the absence of undeclared nuclear material and activities. During the year the number of States for

BOX 6. CHALLENGES FACING SAFEGUARDS AND NUCLEAR MATERIAL SECURITY

The Agency's ninth safeguards symposium, 'International Safeguards: Verification and Nuclear Material Security', was held in Vienna in October–November 2001. The topics covered the full range of current nuclear security interests, such as nuclear non-proliferation and disarmament, physical protection of nuclear material, illicit trafficking and future Agency verification roles.

The symposium addressed both proliferation challenges and opportunities for further progress in safeguards and nuclear material security. The challenges included: implementation and universalization of additional protocols; early implementation of integrated safeguards; and finding ways to meet the legitimate demands of the international community in ensuring adequate and reliable physical protection of nuclear material. Opportunities for strengthening safeguards and nuclear material security covered: developing new tools and capabilities; new concepts and approaches; increasing the role of technology in meeting the challenge of an expanding mandate in combination with the continued reality of financial constraints imposed on the Agency's budget; making more effective use of satellite imagery; and evolving new randomized inspection strategies.

Symposium participants noted that there was a need for: a stronger and better financed safeguards system; many more States with comprehensive safeguards agreements and Additional Protocols in force; integration of new safeguards measures with the traditional methods in a way that strengthens the entire system; a dramatic increase in national and international efforts, to ensure that all potential nuclear weapons material worldwide was secure and accounted for; and an amendment to the CPPNM.

In view of the 11 September attacks in the USA, a special session on combating nuclear terrorism was organized to discuss the potential threats posed by nuclear terrorism and outlined the activities already under way at the Agency to deal with such threats. ■

which additional protocols were concluded increased from 57 to 61, and the number of additional protocols in force rose from 18 to 24 (with one more being applied provisionally). Progress, however, remains slow. With regard to comprehensive safeguards agreements, in 2001 the number of States Party to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) that have not fulfilled their legal obligation to bring into force the required NPT safeguards agreement stood at 52 (54 at the end of 2000).

Evaluation of information about a State's nuclear programme for safeguards purposes is becoming an integral part of the process of deriving safeguards conclusions. The information collected is periodically updated and evaluated. This evaluation is critical to enabling the Agency to draw and maintain its conclusions about the State's compliance with its safeguards and non-proliferation obligations.

Technological developments have always had an impact on the way safeguards have been applied. During 2001 major progress was made in increasing remote monitoring.

Integrated safeguards

The measures contained in the Model Additional Protocol were meant to be "integrated" with existing ones to ensure the optimum combination — in terms of effectiveness and efficiency — of the measures available to the Agency under comprehensive safeguards agreements and additional protocols thereto. During 2001, a major achievement was the development of a conceptual framework for integrated safeguards, designed to ensure consistency in their implementation in States with similar fuel cycles, but at the same time to provide flexibility so that in each State the combination of safeguards measures can be chosen to ensure maximum effectiveness and efficiency. Integrated safeguards can be applied once the Agency, on the basis of its activities under the comprehensive safeguards agreement and the additional protocol, has drawn a positive conclusion about the non-diversion of declared nuclear material *and* the absence of undeclared nuclear material and activities in the State concerned. For the first time, an integrated safeguards approach was applied in a Member State, namely in Australia.

Implementation of safeguards agreements and additional protocols

The implementation of additional protocols was initiated in a number of countries, including some with large nuclear fuel cycles. Substantial resources were utilized for increased information collection, analysis and evaluation activities, such as the review of declarations pursuant to additional protocols. Complementary access under additional protocols was conducted 88 times in 13 States, in most instances in conjunction with inspections.

Iraq. For more than three years the Agency has not been in a position to implement its mandate in Iraq under UN Security Council Resolution 687 (1991) and related resolutions. As a consequence, the Agency cannot provide any assurance that Iraq is in compliance with its obligations under those resolutions. Since January 2000, the Agency has carried out annual inspections, pursuant to Iraq's NPT safeguards agreement, of the declared nuclear material remaining under safeguards in Iraq. These inspections do not serve as a substitute for the verification activities required by the relevant resolutions of the Security Council, nor do they provide the assurances sought by the Council. The Agency remains prepared to resume its Security Council mandated verification activities in Iraq at short notice.

DPRK. The Agency remains unable to verify the completeness and correctness of the DPRK's initial 1992 declaration, and is therefore unable to conclude that there has been no diversion of nuclear material. The work required to verify that all nuclear material subject to safeguards in the DPRK has been declared and placed under safeguards could take three to four years, with the full co-operation on the part of the DPRK.

Nuclear security

In the week immediately following the tragic events of 11 September 2001, the Agency's General Conference adopted a resolution that requested the Director General to initiate a thorough review of Agency activities and programmes relevant to preventing acts of terrorism involving nuclear and other radioactive materials. The response by the Secretariat has been immediate, with concrete measures being taken to expand the scope and reach of many of its security related and safety services.

The Agency has been engaged for a number of years in a variety of activities relevant to the prevention of acts of nuclear terrorism, including programmes to promote the physical security of nuclear facilities and nuclear and other radioactive material, help prevent and respond to illicit trafficking in this material, strengthen the emergency response systems of the Agency and Member States and enhance the safety and security of nuclear facilities. In these areas of activity, the Agency developed norms and guidelines, promoted international co-operation, provided expert advice, training and equipment. It also provided an expanding array of advisory services to States to better protect nuclear and other radioactive material against theft; as well as nuclear facilities against sabotage, and to manage and safely dispose of radioactive sources.

Through an ongoing regional technical co-operation project in Europe, the Agency has devoted significant efforts to the training of customs officials, border guards and police in detection techniques, use of equipment and response mechanisms for combating illicit trafficking in nuclear and other radioactive materials.

The first international conference on the security of nuclear material was organized by the Agency in Stockholm in May. The conference concluded that a comprehensive approach to security of material was warranted, considering both the risks for nuclear proliferation and possible radiation and health effects. The conference encouraged States to become parties to the Convention on the Physical Protection of Nuclear Material (CPPNM). It also highlighted the Agency's role in supporting measures at the national level through the development of norms and guides, and co-ordination of technical development and assistance to States in implementing security measures.

In November the Agency prepared a report outlining plans to expand and strengthen programmes for nuclear security. It also addressed the Agency's response to threats from acts of nuclear terrorism and highlighted the need for additional resources to cope with this newly emerging threat (Box 7).

The informal open ended expert meeting, first convened in November 1999, to discuss whether there was a need to revise the CPPNM completed its work in May. In response to the experts' recommendations, the Director General convened in December a group of legal and technical experts to prepare a well defined draft amendment to the Convention.

OUTREACH

In keeping with a new policy aimed at informing and engaging both existing and new constituencies, the Agency expanded its outreach activities. For instance, many more non-governmental organizations (NGOs) were invited to participate in the Scientific Forum at the Agency's 2001 General Conference, and more systematic contacts are being maintained with these NGOs and with other parts of civil society. In addition, efforts continued to optimize synergies with other international organizations. A notable example was the Revised Arrangements between the Food and Agriculture Organization and the Agency for the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture, concluded in December 2001.

The visibility of the Agency increased significantly during the year. In part, this was due to CNN's broadcast throughout the second half of the year of public service announcements describing the Agency and its main areas of activity. Moreover, in response to public interest in nuclear matters after the 11 September attacks in the USA, the Agency conducted a public information and media campaign on combating nuclear terrorism. Complementing these activities, the Agency's *WorldAtom* web site was redesigned.

MANAGEMENT

Over the past four years the Agency has conducted a comprehensive review of its management structure and operations. Of particular importance in this process has been the introduction of "results based programming and budgeting" — involving the formulation of programmes and budgets driven by a number of desired results that are articulated at the outset of the process, and against which actual performance is measured at the end of the programme and budget cycle. This has been accompanied by a proposed change to full *biennial* programming and budgeting. In this respect, 2001 was a transitional year for the Agency, which was marked by the incorporation of the initial components of the results based approach in the Agency's programme and budget. The consequence of the transitional year is that the Agency's fiscal cycle is now synchronized with those of other UN organizations.

As described in the *Medium Term Strategy*, the Agency's activities in 2001 were integrated under the three broad "pillars" of technology, safety and verification, and were distributed among six major programmes (increasing to seven starting in 2002). Often, the objectives to be achieved by these activities cut across programme and organizational structures. 'Matrix management' is the optimal

BOX 7. ENHANCING PROTECTION AGAINST NUCLEAR TERRORISM

United Nations Security Council Resolution 1373 (2001) of 28 September 2001 noted with concern the close connection between international terrorism and the illegal movement of nuclear material and, in that regard, emphasized the need to enhance co-ordination of efforts at the national, subregional, regional and international levels in order to strengthen a global response to this serious challenge and threat to international security. The Council also called upon all States to find ways of intensifying and accelerating the exchange of operational information, especially regarding, among others, the threat posed by the possession of weapons of mass destruction by terrorist groups, and to become parties as soon as possible to the relevant international conventions and protocols relating to terrorism.

In the same vein, the Agency's General Conference adopted a resolution on 21 September 2001 noting the importance of physical protection in preventing the unauthorized removal of nuclear material and the sabotage of nuclear facilities and nuclear materials by individuals or groups. The conference called on the Agency to thoroughly review its programmes relevant to preventing acts of terrorism and to report to the Board of Governors as soon as possible. In response to this request, the Director General prepared an initial report on protection against nuclear terrorism outlining plans for substantially expanding and strengthening the Agency's programmes in the areas of: physical protection of nuclear material and nuclear facilities; detection of malicious activities (such as illicit trafficking) involving nuclear and other radioactive materials; strengthening of State systems for nuclear material accountancy and control; security of radioactive material other than nuclear material; improving the security of nuclear facilities; response to malicious acts or threats thereof; the adherence to international agreements and guidelines; and enhancement of programme co-ordination and information management for nuclear security related matters. The report emphasized that the proposed activities were not a substitute for national measures, nor could they diminish the primary responsibility of the State for all matters of security. Rather, they were designed to assist Member State efforts in areas where international co-operation is indispensable to the strengthening of nuclear security. ■

mechanism for planning and implementing activities that require the application of different fields of expertise and multi-disciplinary approaches. As more cross-cutting areas are identified, the roles, responsibilities and accountability of the staff involved need to be clearly defined, and procedures for monitoring implementation and periodic reporting have to be established. Work was under way in 2001 to set up the necessary mechanisms and procedures for effective and efficient matrix management.

The reform process has been characterized by considerable restructuring within the Secretariat, and by the introduction of a corporate, 'one house' approach with the aim of improving co-ordination, efficiency and programme delivery. For example, new offices for policy co-ordination and for programme support were created. In addition, a new Office of Internal Oversight Services was established to consolidate and rationalize evaluation, management services, internal audit and investigation into one entity. And to improve 'customer focus' and streamline the information technology (IT) structure, a new IT Division and an IT Committee were established.

The preparation of the Agency's first full biennial programme and budget document, covering the period 2002–2003, entailed far more extensive and earlier consultations with Member States to establish their needs at the outset and obtain their views on programme content. This resulted in a revised and more focused programme structure.

Although the budgetary proposals for 2002–2003 cover the two years of the biennium, the Secretariat could only present a budget resolution for 2002. This was because the amendment to the Agency's Statute to enable the change to biennial budgeting can only take effect after the required number of Member States has formally accepted it. At the end of 2001, only 26 States had deposited their instruments of acceptance — well short of the required two thirds of the Agency's members.

Extensive consultations were conducted in the first half of the year owing to the need for increased funding for the technical co-operation and safeguards programmes, compounded by a compulsory cost of living increase in Vienna. After intensive discussions, a consensus was reached on funding for the 2002 budget.

CONCLUSION

The peaceful uses of nuclear energy will continue to be an important factor in economic development and in improving human welfare. In this regard, a capacity in nuclear science and technology is often an asset in its own right, contributing to broader technological development. Many challenges face the world today, including understanding and combating climate change, preserving the environment, feeding and protecting the health of the world's growing population, and supplying the water and energy needed for sustainable economic growth and development. Responding to these challenges requires concerted, collaborative efforts by Member States, international organizations and civil society. It also requires flexibility — the ability to adapt to changing circumstances to achieve common goals.

In 2001, the Agency remained active in fostering international co-operation for the peaceful uses of nuclear technologies, and in transferring these technologies to developing countries — but adequate investment and continuing innovation are essential to ensure that nuclear technologies remain viable. It continues to press for a comprehensive and effective nuclear safety regime — but, again, such a regime will be effective only if States adhere to it and invest in its necessary infrastructure. It has been laying the groundwork for a state of the art verification system — but such a system must be subscribed to, and above all must be underpinned by other parts of the non-proliferation regime. For the Agency's Secretariat and Member States to be able to move forward on all these fronts, active partnership is indispensable. The Agency is committed to reinforcing this partnership.