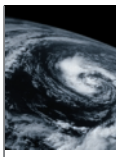
OVERVIEW

In 1999, the Agency Secretariat continued the reform process intended to ensure more effective delivery of a programme that would make a clear contribution to the needs of Member States. In particular, a Medium Term Strategy (MTS) was developed and changes to the programme and budget formulation process were initiated. Programme activities continued under all three of what the MTS identified as the "pillars" of the Agency's programme: *technology*, *safety* and *verification*. Measures were introduced to increase the synergy between the parts of the programme funded by the regular budget and the technical co-operation budget.

This overview is intended to provide a review of issues and developments in 1999 in the 'nuclear world' as seen from the perspective of the Agency and in the light of the Agency's own programme. It does not aim to be comprehensive. Rather it follows a number of selected themes: the present situation regarding nuclear power; the advantages of nuclear related techniques in food and agriculture, human health, water resources management and environmental monitoring; the Agency's efforts to create a global nuclear safety culture; the efforts to conclude Additional Protocols to safeguards agreements and move to integrated safeguards; outreach to non-traditional partners; and gaining a better understanding of the needs of Member States and ensuring a more efficient and effective response to them.



TECHNOLOGY

Nuclear power, fuel cycle and waste management

Present situation regarding nuclear power

Nuclear power is an important contributor to the world's electricity needs. In 1999, it supplied roughly one sixth of global electricity. As a capital intensive and advanced technology, some 83% of global nuclear electricity capacity is concentrated in the industrialized countries. The largest regional percentage of electricity generated through nuclear power last year was in western Europe (30%). The nuclear shares in France, Belgium and Sweden were 75, 58 and 47%, respectively. In North America, the nuclear share was 20% for the USA and 12% for Canada. In Asia, the figures were 43% for the Republic of Korea and 36% for Japan.

Despite this major contribution to regional as well as national electricity supply worldwide, there is no consensus on the future of nuclear power. In North America there have been no new orders for nuclear power plants during the past two decades and the number of operating reactors has started to decline. In Western Europe nuclear capacity will likely remain at about its present level for the next few years. There will be some unit capacity upgrades and life extension of existing plants. No country within this geographical area has currently decided to construct new nuclear plants, although Finland is considering this option. In Central and Eastern Europe, there is a debate over the need to complete the construction of partially built plants. A few will be completed and ageing units shut down, some earlier than originally planned.

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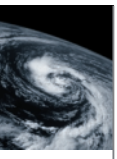


In Asia, planning for an expansion of nuclear power continues, particularly in China, India, Japan and the Republic of Korea. This is a region where the use of nuclear power is likely to grow over the short term. However, the East Asian financial crisis of 1998–1999 slowed down the large regional increase in energy demand that was earlier foreseen.

Any expansion of the contribution of nuclear power towards meeting global energy needs in a sustainable manner will require a number of criteria to be met: increased economic competitiveness; the use of advanced technologies for both electricity generation and new applications such as desalination; and improvement of public confidence, especially in relation to the safety of power plant operations and waste disposal.

During the past decade, fundamental changes in the electricity industry have taken place in many countries. Today, the supply of electricity is no longer a monopoly of governments or a few suppliers. Generation and marketing to final consumers are taking place in highly competitive environments. In 1999, the trend continued for short term pricing contracts to replace long term contracts, driven in part by the availability of low cost gas generating plants.

To compete with fossil fuelled units — and especially small gas units where an investment can often be recovered more rapidly than for a nuclear plant — nuclear power would need to offer lower initial investment costs and a reduction in operating and maintenance expenses. An integrated planning process that takes account of all these factors from the inception of a nuclear power programme can help efforts in this direction.

Notable features of recently built nuclear plants, particularly standardized ones, include considerably shorter construction times and lower operating costs. A number of factors account for this improved performance, including ongoing utility restructuring that includes modernized management approaches, in-depth training and the sharing of industry experience. The steady performance improvement worldwide over the past decade can be seen in various indicators released by the Agency and WANO that show sharp increases in capacity factors and decreases in unplanned reactor shutdowns.

Moreover, many existing nuclear plants are economic, particularly those which have had their capital investments depreciated or written-off. Today, with the exception perhaps of hydroelectric plants, well managed nuclear plants, with their low fuel costs and steadily declining operating and maintenance costs, are often among the least expensive power plants to operate. This advantage has been sufficient to encourage owners of existing plants to invest in life extension programmes and increases in total plant generating capacity. Competitive pressures and the ongoing restructuring of the power industry hold the potential for further cost reductions, particularly in consolidating management, operation and maintenance activities.

For both existing and new nuclear power plants, the Agency has assisted Member States to enhance competitiveness with due regard to safety. For example, it has provided analyses and expertise and assembled and made available information on reducing initial costs, extending plants lifetimes, improving performance and decreasing operational and maintenance costs.

At the 43rd regular session of the General Conference in 1999, Member States requested the Agency to help countries assess the role of nuclear power in the light of global environmental challenges and energy needs. It was agreed that such assistance should include facilitating access to relevant information about the importance of nuclear power in achieving sustainable development in developing countries and in mitigating greenhouse gas emissions.

The Agency made concerted efforts to provide information to Member States and international forums on the potential role of nuclear power in a follow-up to the Kyoto Protocol on climate change. As a part of this effort, three workshops were held on the potential role of nuclear power under the Clean Development Mechanism (CDM). It also included exchange of views with delegates to the 5th Conference of Parties (CoP-5) to the United Nations Framework Convention on Climate Change, in Bonn, and presentation of a paper on the potential use of nuclear power projects in developing countries for greenhouse gas mitigation under the CDM at an international symposium held in Ottawa, Canada.

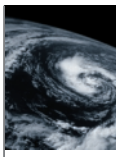
Two potential future applications of nuclear power are of particular interest: desalination and synthetic fuel production. A comprehensive study, co-ordinated by the Agency, on the overall economics of nuclear desalination as compared with the use of fossil energy was conducted. The results highlighted the conditions under which nuclear desalination would be competitive with fossil alternatives. Conclusions were derived both from calculations performed with the Agency's Desalination Economic Evaluation Programme computer software as well as from independent investigations in Member States.

In connection with synthetic fuels, an Agency CRP completed in 1999 provided supporting technical information for the High Temperature Engineering Test Reactor now undergoing startup testing in Japan. The project focused on using nuclear heat for steam reforming of methane to produce hydrogen and methanol, thermo-chemical splitting of water to produce hydrogen and the conversion of coal to synthetic fuels.

Although competitiveness may be one of the important factors in the nuclear debate, public acceptance is also critical. A change from generally positive to generally negative attitudes occurred in different countries for a variety of reasons. Decision makers were once prepared to accept technical arguments for nuclear power and technical safety assessments of reactors and waste disposal facilities. Now some have taken an anti-nuclear position and others have recognized that even where there are technically acceptable plans they still cannot proceed without winning public acceptance.

With regard to the nuclear fuel industry, an increase in fuel burnup, higher thermal rates, longer fuel cycles and the use of mixed oxide (MOX) fuels are key to improving the economics of the nuclear fuel cycle as a whole. Accordingly, utilities and fuel vendors have recently initiated R&D programmes directed towards improvements in fuel design and materials to provide safe and reliable reactor operation under the conditions mentioned above. In conjunction with these programmes, the Agency concentrated in 1999 on facilitating the exchange of information on improvements in the quality and properties of uranium dioxide and MOX fuels and control rods, improvements in fuel design and performance for high burnup operation, reduction of corrosion, and coolant technology optimization. An international symposium on MOX fuel cycle technologies for medium and long term deployment, held in Vienna in May, reviewed the status and development trends of plutonium recycling in nuclear power reactors.

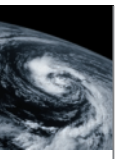
Numerous lessons emerged from the accidents at Three Mile Island and Chernobyl. It was clear that human factors had been a major



contributor to both accidents, and a better understanding of the human role in plant operation was needed. The industry has responded and continues to respond through modernized control room layouts that provide clear and essential information to operators, through improved training and procedures, as well as through internal and external audits of operational performance.

The Agency has a broad range of technical programmes covering reactor engineering and technology that allow the sharing of information on improving and monitoring plant performance and on advanced reactor technology developments and their applications. Nevertheless, the only clear and convincing demonstration of safety will be the safe performance of existing plants across the world over many years, and the avoidance of a major accident.

"The Agency has a broad range of technical programmes covering reactor engineering that allow the sharing of information on improving and monitoring plant performance."



A serious public acceptance issue today is the management of radioactive waste and spent fuel. While a major benefit of nuclear power is that it does not involve the emission of large quantities of air pollutants, including greenhouse gas emissions, it has a unique perception problem with regard to waste disposal, namely the widespread belief among the non-technical public that spent fuel and high level radioactive waste cannot be safely managed *in the long term*. However, managing these forms of waste in the short term while supervision can be guaranteed does not pose a problem and storage facilities for them have been built. At both power plants and research reactor sites, spent fuel can be safely and reliably stored in wet or dry facilities, although some storage facilities for spent fuel are now at or near full capacity. For the longer term, however, it is generally recognized that deep underground disposal is the most appropriate solution.

Plans for geological repositories in many countries proceeded slowly if at all in 1999. Many States are re-examining national policies, seeking to identify waste management solutions that are both safe and publicly acceptable, and to build confidence in those solutions. For example, greater attention is being given to the idea of placing waste deep underground but in a retrievable form, rather than treating geological disposal as a permanent, irreversible solution. It is now recognized that the trust of the public has to be obtained through continuous dialogue and exchange between all concerned parties so that it eventually becomes recognized that geological disposal is a safe and sound solution.

However, some progress was made in the field of radioactive waste management in 1999 *(see Box 1)*. In particular, an important step was taken in the USA with the opening of the Waste Isolation Pilot Plant for long lived, military origin waste at Carlsbad, New Mexico. This is the world's first deep geological waste repository.

RADIATION AND ISOTOPE TECHNOLOGIES

Advantages of nuclear related techniques in food and agriculture, human health, water resources management and environmental monitoring

In the Agency's Medium Term Strategy developed during the year, priority in the radiation and isotope technology programme was assigned to four subject areas: food and agriculture; human health; water resources management; and the environment. The present text describes some of the advantages of nuclear techniques in these areas and outlines some advances that occurred in 1999 (*see also Boxes 2–4*).

For food and agriculture, the advantages of nuclear techniques include: the provision of unique and quantitative data on rates of soil

erosion and nutrient and water dynamics in the soil–plant system; the possibility of developing, through mutation induction, new crop varieties with improved quality, yield and tolerance to stress; and the provision of essential tools for the analysis and identification of plants with useful characters. In animal health studies, isotopes can be used as simple, robust and sensitive markers for research.

They provide unique information on how feed is digested and used, enabling better diets and feeding strategies to be developed. In addition, isotope techniques have underpinned innovative products and approaches to improve reproductive efficiency and disease control. In pest management, the sterile insect technique offers clear advantages over chemical pesticides. And food irradiation is one of the few technologies which offers the ability to control spoilage and disease causing organisms and insect pests without significantly affecting the sensory and other attributes of the food.

In December 1999, the United States Department of Agriculture gave approval for the irradiation of red meat. At the end of the year several commercial irradiation facilities were under construction in the USA to treat large volumes of meat, especially ground beef, to eliminate pathogenic bacteria such as *E. coli*. A commercial irradiator specifically designed for treating fresh fruits and vegetables against fruit flies was under construction in Hilo, Hawaii, and is expected to be in operation by June 2000. These examples illustrate a positive trend in public opinion on the role of

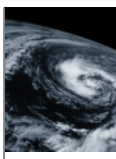
Box 1: **Availability of Waste Management Technologies and Need for Geological Repositories**

A symposium was held in Taejon, Republic of Korea, in August–September to review experience gained in implementing technologies to manage radioactive waste from nuclear power plants and the back end of the nuclear fuel cycle. The symposium was organized in co-operation with the OECD/NEA, the Korea Atomic Energy Research Institute, the International Union of Producers and Distributors of Electrical Energy, and the Nuclear Energy Institute. The symposium documented that:

- Proven technologies exist for managing low level radioactive wastes in ways that are safe, economical and environmentally sound, and considerable experience has been accumulated with these technologies in many Member States.
- More attention to waste minimization and volume reduction technologies have led to substantial reductions in the quantities and radioactivity content of solid wastes.
- Improvements continue to be made in the technologies for the treatment and conditioning of radioactive wastes, and in the methods that are used to investigate and select sites for waste disposal.
- Member States have a variety of options still under consideration for the management of high level waste and spent fuel, including long term storage of spent fuel, until the preferred disposal option becomes more clear.
- A few Member States with large nuclear programmes are making progress in developing concepts for siting disposal facilities for high level waste.

A conference held in Denver, USA, in November demonstrated that Member States are implementing a variety of options for managing spent fuel and high level waste. It was reported that:

- The USA, Sweden and a few other countries are opting for direct disposal but with more reliance on extended retrievability.
- France, Japan, the Russian Federation and the United Kingdom view spent fuel as a resource and are reprocessing spent fuel to recover plutonium for recycle in light water reactors as MOX fuels.
- A number of countries are investigating the partitioning and transmutation of long lived actinides to reduce the volume and activity of the waste.
- Other countries, particularly those with small nuclear programmes or fragile economies, are storing spent fuel, either in pools at reactors or in centralized facilities. ■



food irradiation. They also complement the ongoing work of the Agency in disseminating information to the public concerning the safety and benefits of food irradiation.

Reflecting the continuing trend in the use of radiation mutation to produce crop varieties with characteristics of economic importance, 93 new varieties were registered in the FAO/IAEA database. The total number has grown to 1961 varieties of more than 163 crop species in 62 countries. In related work through a CRP, radiation mutation of industrial crops (such as soybean, rapeseed and cotton) produced plant types with a wider range of desirable characteristics, specifically improved yield and oil quality. These plant types are expected to be released in the near future as new, improved varieties in several Member States.

Box 2: Zanzibar Farmers Reap Benefits Following Eradication of the Tsetse Fly

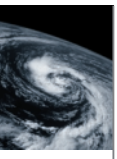
A team of agriculture/livestock economists concluded that eradication — under an Agency project — of the tsetse fly from Zanzibar, United Republic of Tanzania, using the sterile insect technique has resulted in significant gains in the livestock sector. Animals can be kept in farming areas where this was not possible before, and the elimination of trypanosomosis transmission permits the introduction of more productive cattle breeds. According to the report, whereas in 1985–1986 only every third farming household had cattle, in 1999 four of every five farmers were keeping cattle. Although more than one third of the total milk production in Zanzibar now originates from improved cattle breeds and there is substantial demand for cross-bred or pure-bred cattle among the people on Zanzibar, only about 5% of the cattle being maintained are improved breeds. On the basis of baseline data generated by the economists, it will be possible to assess how much of the new potential for livestock/agricultural development, which is based on the elimination of the tsetse and trypanosomosis problem, will be realized in the forthcoming years. ■

Hydrological applications of isotope techniques have gained worldwide prominence in recent years and are being used for a wide spectrum of problems encountered in water resources assessment, development and management. The technological and economic benefits of isotope applications have been demonstrated in many areas of hydrology.

Isotope techniques are an important tool also for understanding and reconstructing climatic conditions influencing the present and past hydrological cycles. General circulation models for simulating present day climatic conditions are improved by using data on the isotope composition of water in rain and snow. Periodic events such as El Niño produce significant, short term changes in precipitation patterns, and their impact on water resources management is being investigated by isotope techniques. Stable and radioactive isotopes also provide a unique tool for investigating the sources of atmospheric pollutants and their contribution to global warming.

Groundwater resources in most developed countries are commonly assessed with the use of isotope techniques. As an example of recent work, an improved assessment of the origin of flow in streams and rivers has been achieved in Latin America, Asia and Africa under Agency technical co-operation projects by using isotope techniques. In other work, it has been found that increased river discharge is responsible for the rising water level of the Caspian Sea as a result primarily of changes in the hydroclimatic conditions in the catchment area.

Another area of focus during recent years has been isotope applications in geothermal systems related to both the hydrological assessment of geothermal reservoirs as well as the characterization of dynamic changes induced in such reservoirs by exploitation. As a result of the experience and data gathered in practical applications of tracers/isotopes in geothermal applications under a regional technical co-operation project and a CRP, a guidebook has been prepared entitled *Isotopic and Chemical Techniques in Geothermal Exploration, Development and Use: Methods, Data Handling and Interpretation*.



In 1999, meetings were held with World Bank project managers to investigate dam management problems, and help Bank staff improve risk assessment tools and identify priority areas for isotope investigations. The resulting 'Thematic Plan on Dam Safety and Sustainability' identified goals and clarified the role of nuclear techniques in dam management as generating information to help end-users make decisions that guide, optimize and protect investments. A particular follow-up action was the organization in November of a training workshop on the use of isotope hydrology for dam safety and dam leakage studies, hosted by BATAN in Yogyakarta, Indonesia.

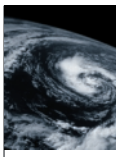
Applications of nuclear related techniques for human health are expanding. Most important is the radiation therapy of cancer as a curative technique and for pain relief in cases that are incurable. Another example is in diagnostic procedures under the broad heading of nuclear medicine. These procedures involve the administration of open radioactive sources internally which, being non-invasive in nature, provide important clues about organ functions and early detection of abnormalities. These diagnostic procedures support a broad span of medical specialities ranging from paediatrics to cardiology to psychiatry. A third area of application is the measurement of stable isotopes in tracking malnutrition, generally considered to be the best method for assessing the impact of people's intake of important vitamins and other nutrients. In all these three broad areas there have been significant Agency activities geared to Member State needs.

New options were recently introduced to study tissue viability by means of three dimensional imaging (tomography) of chemical processes. Another new approach involves localization of pathological processes even during the course of surgery. Positron emission tomography (PET) has increasingly been adopted in many developed and some developing countries for the diagnosis of a significant number of diseases including cancer, neurological disorders and coronary artery disease. The inauguration of a PET centre, supported by an

Box 3: **Importance of Food Irradiation**

The role of irradiation as a sanitary and phytosanitary treatment of food and agricultural commodities was highlighted at an FAO–IAEA–WHO conference on Ensuring the Safety and Quality of Food through Radiation Processing, held in Antalya, Turkey, in October. Among the main conclusions were the following:

- The safety and nutritional adequacy of foods irradiated with any dose and produced under good manufacturing practices are well established.
- The Codex Alimentarius Commission of the FAO/WHO Food Standards Programme has agreed to initiate procedures to amend the current Codex General Standard for Irradiated Foods to remove the previous upper dose limit.
- Irradiation has emerged as a viable, versatile and environmentally friendly treatment of food and agricultural commodities to satisfy relevant provisions of the Agreement on the Application of Sanitary and Phytosanitary Measures of the World Trade Organization.
- Irradiation should be considered as an integral part of efforts to ensure the microbiological safety of solid foods, especially those eaten raw or minimally processed, and to prevent cross-contamination during food preparation.
- Market trials and commercial sales of irradiated food carried out in the past ten years in some 15 countries have shown that consumers are willing to purchase irradiated products once they are informed of their safety and benefits.
- Irradiation is used routinely for ensuring the hygienic quality of spices and dried vegetable seasonings in more than 20 countries.
- A number of commercial irradiators for food processing have either been built in recent years or are being built, especially in the USA and in some Asian countries. ■



Agency technical co-operation project, in the Czech Republic in November marked an important landmark in this context. A major Agency activity in the field of radionuclide therapy included the promotion in Member States of treatment for metastatic bone pain by injection of open radioactive sources for temporary relief.

Radiation therapy over the last decade has increasingly used computer tomography scanning and magnetic resonance imaging for improved tumour definition for the localization of cancer. More accurate display of cancer tumours has increased the accuracy of systems, delivered under Agency technical co-operation projects, for patient immobilization and planning of treatment so as to ensure that the irradiated part of the patient only minimally exceeds the tumour boundary.

Box 4: Use of Isotope Techniques to Help Understand the Causes of Lake Level Rise in Ethiopia

The water level of Lake Beseka, located in the Ethiopian Rift Valley, has been rising continuously for several decades, resulting in the present surface area of about 40 km^2 as compared with 6 km^2 in 1967. The increased surface area has posed serious problems for environmental management, including inundation of grazing and cultivated lands, highways and railway tracks. Historically, the lake received recharge from precipitation, surface runoff in the catchment, groundwater discharge and surface runoff from nearby thermal springs. As the lake level has risen, the thermal springs are now submerged. A study conducted in the 1970s attributed the rising lake level to increased runoff from adjoining irrigated areas. However, stricter controls on irrigation runoff failed to check the rising lake level.

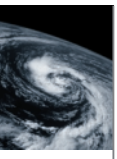
A multi-disciplinary study, including geophysical, hydrological, geochemical and modelling techniques, was carried out in 1999 to determine the cause(s) of the lake level rise. The results of early surveys had suggested that the principal cause may be the increased inflow from submerged springs in the southwestern portion of the lake. However, stable water isotopes, tritium and carbon-14 of dissolved inorganic carbon provided conclusive evidence that the lake level rise occurred as a result of a decrease in the lake outflow. ■

Environmental contamination is a global concern. The Agency carries out monitoring of marine radioactive contamination and also of non-nuclear contaminants in the marine environment (in collaboration with UNEP and IOC (UNESCO)). The behaviour of radionuclides in the ocean needs to be clearly understood to assess the possible environmental or human health consequences. This accumulated knowledge could then provide a basis for the rapid assessment of the impact of any possible future releases from accidents that might occur at coastal nuclear facilities or nuclear waste sites, or from the ocean transport of spent fuel or high level waste.

New remote measurement systems and wide ranging measurements in the world's oceans in 1999 continued to provide confirmation that global fallout from atmospheric bomb testing is still the main source of anthropogenic radionuclides in the ocean, although levels have declined substantially. Radionuclides have also been used to trace the transport of various pollutants (e.g. lead, persistent organic pollutants, etc.) within the ocean and through the marine food chain.

The radiation of electron beams provides an efficient technology to clean gaseous and liquid wastes from industries. A large project in Poland on the cleaning of flue gases from the burning of coal will result in the commissioning of a demonstration plant in 2000.

Again, in the sphere of environmental protection, technical and economic considerations have indicated that electron beam accelerators are most suited for the treatment of large quantities of water and wastewater. In addition, improvements in accelerators in recent years (increased power conversion efficiency and power output) have increased the practical possibilities of using this technology for the decontamination and desinfection of wastewater and drinking water. Following an Agency CRP, a number of countries have started engineering studies of the process.



SAFETY

International dimensions of safety

The Agency promotes a global nuclear safety culture comprising three elements: legally binding conventions, internationally agreed safety standards and measures to apply those conventions and standards. There were a number of significant events and issues from 1999 relating to these three elements (*see also Box 5*).

The Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency were adopted following the 1986 Chernobyl accident. In 1999, the Agency provided assistance to four Member States in relation to emergency situations.

The Convention on Nuclear Safety, which entered into force in October 1996, encourages countries with nuclear power plants to legally commit themselves to maintaining a high level of safety. As well as imposing obligations concerning specific issues such as the siting, design, construction and operation of nuclear power plants, the Convention obliges Contracting Parties to periodically submit reports on the implementation of the obligations for peer review at meetings of the Parties. The first of these review meetings was held in Vienna in April. During the two week meeting, the Contracting Parties reviewed each national report, along with questions and comments that had been submitted. A consensus Summary Report was adopted, outlining the main conclusions from the discussions and the issues identified as being important for future progress in improving nuclear safety. The Contracting Parties agreed that the review process had been of great value to their national nuclear safety programmes, referring not only to the 'peer review' by other Contracting Parties, but also to the self-assessment involved in producing the national reports. Although there were variations among Contracting Parties with regard to the levels from which they started implementation of Convention obligations

Box 5: **An Action Plan for the Safety of Radiation Sources**

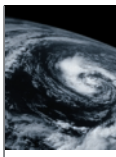
In recent years there have been a number of instances of serious consequences resulting from radiation exposures due to radiation sources and radioactive materials that, for one reason or another, were not under proper control ('orphan sources'). During 1999, the Agency was involved in responding to serious cases of overexposure from such sources in Turkey and Peru, and it continued to provide assistance to Georgia, where many sources have been discovered since the breakup of the Soviet Union.

In response to the continuing occurrence of such events, an Action Plan on the safety of radiation sources and the security of radioactive material was prepared. This sets out a programme of Agency work in the coming years that makes full use of existing activities such as the technical co-operation Model Project on strengthening radiation and waste safety infrastructure where necessary in Member States, and work with the WCO and INTERPOL on the prevention, detection and response to illicit trafficking. The main regulatory components of the Action Plan comprise Agency activities aimed at:

- Strengthening national regulatory programmes covering the safety of radiation sources and the security of radioactive materials, and the storage or disposal of disused sources;
- Detection and emergency response; and
- Recovery and remediation.

Training is an essential part of all these activities. Supporting components of the Action Plan are aimed at persons or organizations having an interest in seeing that the problem of orphan sources is addressed. These include metal recyclers, metallurgical plants and non-radioactive waste disposal facilities. The manufacturers and suppliers of monitoring or detection systems also form part of this group.

The Action Plan was endorsed by the General Conference in October. ■



and in the resources available for improvement programmes, it was noted that all Contracting Parties participating in the meeting are taking steps in the right direction.

During 1999, eight more countries ratified the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, bringing the total number to 13. The convention requires ratification by 25 countries to enter into force, 15 of which should be countries with operating nuclear power plants.

On 30 September, a criticality accident occurred at a uranium conversion facility in Tokaimura, Japan. A self-sustaining nuclear fission chain reaction (criticality) began spontaneously in a precipitation tank after several times more than the specified limit of a solution of enriched uranium had been added. Criticality continued intermittently for about 20 hours, until it was stopped by draining water from the cooling jacket around the precipitation tank and adding boron to the solution. Three workers who were in the building at the time criticality was reached suffered acute radiation sickness as a result of exposure to intense direct radiation (mainly neutrons) from the precipitation tank; one died on 21 December and another was still in hospital as of the end of 1999. Seven people working just outside the site and other people living within a 350 m zone around the location received doses above the annual limit for the public. Precautionary measures around the site were taken. In view of the severe on-site impact and the absence of any significant release of radioactive material off-site, the accident was rated at Level 4 on the International Nuclear Event Scale (INES), the highest rating since the scale was introduced in 1990.

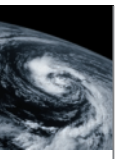
"An increasing amount of the Agency's safety related work is concerned with strengthening national regulatory bodies."

The Agency established contact with the relevant competent authority in Japan to ascertain the facts in order to respond to the many requests for information. Following discussions with representatives of the Government of Japan, the Agency sent an expert team to Tokaimura in mid-October to conduct a preliminary fact finding mission. The report of the expert team was published shortly after its return.

An investigation committee, established by the Nuclear Safety Commission of the Japanese Science and Technology Agency, issued its report in December. An underlying cause of the accident was a lack of awareness of the risk of criticality, which allowed the direct cause — violation of procedural regulations — to occur. The allocation of authority and responsibility between the Nuclear Safety Commission, the regulatory authorities and the operator was a contributory factor.

The accident also highlighted the lack of international safety standards for certain types of non-reactor facility, particularly in relation to criticality safety at these facilities. This lack had already been recognized, and a programme of work proposed to identify new standards that might be necessary.

Improving the safety of reactors in central and eastern Europe and the former Soviet Union has been a major objective over the past decade. An International Conference on Strengthening Nuclear Safety in Eastern Europe, held in Vienna in June, provided an opportunity to review what has been achieved and what remains to be done. The conference, organized by the Agency in co-operation with the European Commission and the OECD/NEA, involved presentations by all of the countries operating Soviet type reactors — Armenia, Bulgaria, the Czech Republic, Hungary, Lithuania, the Russian Federation, Slovakia and Ukraine — on their national status and plans. The conference concluded that considerable progress had been made, particularly in areas such as national legislative and regulatory frameworks and the independence and technical competence of nuclear regulatory bodies. A number of areas were identified as needing further attention,



including the enforcement authority of regulatory bodies, transferring appropriate responsibilities for safety to the operators and maintaining and enhancing an effective safety culture. Particular emphasis was placed on means for achieving the best possible improvements in safety with limited resources, such as greater exchange of information, and high quality safety analysis reports to provide a sound basis for prioritizing upgrades.

An increasing amount of the Agency's safety related work is concerned with strengthening national regulatory bodies. Regulatory issues are also a major focus of the programme on the safety of nuclear installations in countries in South East Asia, the Pacific and Far East (including States that currently have no nuclear power plants but are considering the nuclear power option). For the first time, the Agency's International Regulatory Review Team (IRRT) service received requests from Member States in western and northern Europe. The scope of the IRRT service has also been broadened to cover, if requested, radiation, radioactive waste and transport safety.

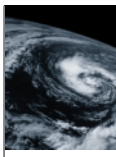
In recent years, regulators have increasingly felt a need to demonstrate the effectiveness of their activities. The Agency has started work on the development of tools for the assessment of regulatory effectiveness. New Agency safety standards on legal and governmental infrastructure for safety could be used as a basis for developing self-assessment tools for regulatory bodies.

A new service, the Transport Safety Appraisal Service (TranSAS), was introduced by the Agency to provide reviews, on request, of national implementation of the Regulations for the Safe Transport of Radioactive Material. The first TranSAS mission visited Slovenia in June/July and carried out an appraisal of the: legislative framework for the transport of radioactive materials and the associated division of responsibilities among competent authorities; approval procedures; and inspection and emergency preparedness arrangements. With the agreement of the Slovenian authorities, the mission report was presented to the General Conference in September. In Resolution GC(43)/RES/11, the General Conference encouraged Member States "to make use where appropriate of the Transport Safety Appraisal Service with a view to achieving the highest possible levels of safety during the transport of radioactive materials".

In a preliminary review to begin work on safety standards for the geological disposal of radioactive waste, the Agency's Waste Safety Standards Advisory Committee identified the areas of international consensus, as well as those areas in which expert opinion has not yet converged. Countries attending an International Conference on Geologic Repositories organized by the US Department of Energy in Denver, issued a joint declaration outlining areas of agreement. And an Agency conference in Córdoba, Spain, in March 2000 provided another opportunity to help develop consensus.

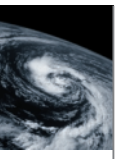
The issue of residual wastes — radioactive residues from past activities such as the testing of nuclear weapons or the mining and processing of metal ores — has become prominent in recent years. Some consensus on appropriate safety principles and criteria is gradually emerging: for example, new recommendations of the International Commission on Radiological Protection on the treatment of prolonged (chronic) exposure situations were approved in 1999 and will be published in 2000. To contribute towards consensus, and to disseminate information on national and international experience, the Agency organized a symposium in Arlington, USA. Discussions confirmed that diverse policies have been and are being adopted in affected countries. The meeting served to initiate exchanges on the reasons for these differences in approach and represented a step towards international convergence.

Residues of particular concern to a number of Member States are those from uranium mining and milling: these typically have relatively low concentrations of radionuclides, but the radionuclides are extremely long lived and the wastes can occur in very large amounts. The management of such wastes was the issue in Agency missions to Brazil and Tajikistan.



The Agency undertook a substantial special project to assist Member States in addressing the year 2000 computer problem. With the assistance of experts from Member States, it prepared guidance documents, aimed at operators of nuclear installations, radioactive waste management facilities and medical facilities using radiation generators or radioactive materials. Workshops were held on Y2K preparedness for nuclear power plants, waste management and medical facilities, and a workshop was held in November specifically to address contingency planning for nuclear power plants. The Agency also sent, on request, 20 missions to nuclear power plants in nine Member States to review and advise upon their Y2K preparations. The Agency's Emergency Response Centre was in operation to monitor developments in each of its Member States having nuclear power plants as local time passed through midnight from 31 December 1999 to 1 January 2000. All of the countries operating nuclear power plants confirmed to the Agency that no incident with direct safety impact had occurred at any nuclear power plant as a result of the immediate transition to the year 2000.

"An important key to strengthening safeguards is the increased use of short notice inspections within the routine inspection regime."



VERIFICATION

Importance of Additional Protocols to safeguards agreement and integrated safeguards

The Agency's safeguards system is designed to provide assurance about the exclusively peaceful use of nuclear material and facilities. It comprises extensive technical measures for independently verifying the correctness and the completeness of the declarations made by States about their nuclear material and activities. These measures relate primarily to the verification activities performed at facilities or other locations where States have declared the presence of nuclear material, equipment or relevant non-nuclear material subject to safeguards.

Since 1992 — in the aftermath of the discovery of Iraq's clandestine nuclear programme — the Board of Governors has adopted or endorsed different measures to strengthen the safeguards system (*see Box 6*). These new measures fall into two categories. The first includes measures to be implemented under the legal authority conferred by existing safeguards agreements. The second category includes measures to be implemented under the complementary legal authority conferred by Additional Protocols to safeguards agreements concluded on the basis of the Model Additional Protocol approved by the Board of Governors. When fully implemented in a State, the strengthening measures provided by a comprehensive safeguards agreement together with an Additional Protocol will allow the Agency to draw conclusions about both the non-diversion of declared nuclear material and the absence of undeclared nuclear material and activities in that State.

The combination of all safeguards measures available to the Agency under comprehensive safeguards agreements and Additional Protocols which allows these conclusions to be drawn while achieving maximum effectiveness and efficiency within available resources is referred to as integrated safeguards.

The development of the concept, plan and approach for integrated safeguards moved forward in 1999 under the direction of a group of Agency specialists. The project receives the support of a number of Member States and the technical advice of the Standing Advisory Group on Safeguards Implementation (SAGSI) and outside technical experts. The concept being developed involves a State level approach which combines integrated safeguards approaches for specific facility types with allowance for the nuclear fuel cycle in the particular State and other State specific features.

On 31 December 1999, 224 safeguards agreements were in force with 140 States (and

with Taiwan, China). Additional Protocols for 46 States had been approved by the Board of Governors. Eight such Protocols were in force and one was being implemented provisionally pending entry into force. In addition, measures contained in the Model Additional Protocol were being applied in Taiwan, China.

Throughout 1999, the Agency continued to negotiate Additional Protocols with States using the Model Additional Protocol as the standard. Progress is now needed towards achieving universal subscription to the Additional Protocol. Only then can the international community realize the full benefits of the strengthened safeguards system.

During 1999, considerable effort was devoted to the measures designed to strengthen the overall safeguards system. The Agency continued to place great emphasis on co-operating closely with State (or regional) systems for accounting and control of nuclear material so as to increase verification effectiveness and cost efficiency.

An important key to strengthening safeguards is the increased use of short notice inspections within the routine inspection regime that will give additional confidence about the declared operations of a facility. While limited frequency unannounced access is performed routinely in enrichment plants, a similar scheme of short notice random inspections

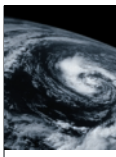
Box 6: **Measures to Strengthen Safeguards**

Under existing safeguards agreements

- Provision by States of design information on new facilities or changes in existing facilities handling safeguarded nuclear material;
- Voluntary reports by States on imports and exports of nuclear material and exports of specified equipment and non-nuclear material;
- Collection of environmental samples by the Agency in facilities and at locations where, under existing safeguards agreements, inspectors have access during inspections and design information visits;
- Use of unattended and remote monitoring of movements of declared nuclear material in facilities;
- Greater use of short notice inspections;
- Enhanced training of all relevant personnel;
- Closer co-operation between Agency and State (regional) systems for accounting and control of nuclear material;
- Enhanced collection and analysis of information derived from State declarations under safeguards agreements and from open sources.

Under the Model Additional Protocol

- Provision by States of information about, and inspector access to, all aspects of a State's nuclear fuel cycle;
- Provision by States of information on, and short notice inspector access to, any place on a nuclear site;
- Provision by States of information about and access to nuclear fuel cycle related R&D;
- Provision by States of information on the manufacture and export of sensitive nuclear related technologies, and arrangements for access to manufacturing and import locations in the State;
- Collection of environmental samples at locations beyond those provided under safeguards agreements;
- Acceptance of simplified procedures for inspector designations and issuance of multiple entry visas by the State for inspectors covering at least one year;
- Right of the Agency to make use of internationally established communications systems. ■



was developed and tested in 1999 for low enriched uranium fuel fabrication plants.

The development and use of advanced verification technology also continued in 1999. This included improved detectors, digital surveillance systems, new sealing devices and unattended verification systems. Recent technology advances have led to the introduction of remote monitoring systems. Remote monitoring may reduce the frequency of inspections, increase the capability for data review and evaluation and facilitate the remote detection and rapid response to any safeguards significant event. Its cost efficiency may vary depending on the particularities of the facility concerned and the State communications infrastructure.

Environmental sampling was being routinely applied in 1999 at facilities covered by comprehensive safeguards agreements after successful field trials in 11 Member States. The Agency's Clean Laboratory, located in Seibersdorf near Vienna, receives, handles and analyses samples and also distributes samples for analysis at laboratories belonging to the network of certified analytical laboratories. By late 1999, this network included eight laboratories in four Member States and within Euratom.

Environmental sampling has concentrated on the collection and analysis of swipe samples in enrichment plants and installations with hot cells. This is being done in order to detect any enrichment of uranium above declared levels and to confirm that hot cell facilities are not being used for undeclared activities such as plutonium production or separation. Under safeguards agreements, sampling may be extended to other types of nuclear facilities. At the end of the year, baseline samples had been collected in 12 enrichment facilities in 7 States and 77 hot cell complexes in 40 States and Taiwan, China.

For the Agency and for States that accept the provisions of the Model Additional Protocol, the preparation and handling of the related information represents a new endeavour. A computerized system known as the Protocol Data Information System was put in place in 1999 to treat all information supplied by States pursuant to their Additional Protocols, and to assist States in preparing the relevant declarations.

The confidentiality of sensitive information supplied by States is maintained under a stringent protection regime. In endorsing this regime in 1997, the Board of Governors emphasized the importance of confidentiality and the need for periodic reviews. The most recent review took place in June 1999.

To provide a comparative baseline for assessments, information on the nuclear programmes of States with comprehensive safeguards agreements in force is continuously evaluated and the findings reviewed annually. In 1999, baseline evaluations of the nuclear programmes of 18 States had been reviewed as compared with 10 in 1998 and 4 in 1997.

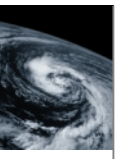
The Model Additional Protocol provides the authority and the mechanism for the Agency to exercise increased inspector access to relevant locations in a State, i.e. complementary access. By the end of the year, complementary access had taken place in Australia, Uzbekistan and Taiwan, China.

The sixth Review Conference of the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) was planned to be convened for the first time under the strengthened review procedures agreed upon in 1995 when the NPT was extended on an indefinite basis. In view of developments during the past five years, the Review Conference will engage the international community in examining how the Agency's strengthened safeguards system can most effectively continue to support the goal of nuclear non-proliferation. Crucial to this goal will be continued efforts to ensure that all States party meet their obligation to conclude safeguards agreements with the Agency and that they also conclude Additional Protocols.

OUTREACH

Reaching out to non-traditional partners

One of the strategic goals reflected in the Medium Term Strategy is effective interaction



with partners and the public. Special attention was given in 1999 to reaching non-traditional partners. A particular example was the Scientific Forum organized during the General Conference, entitled 'Sustainable Development: A Role for Nuclear Power?'. The participants came from national and international scientific research centres, international organizations and non-governmental organizations, and the nuclear industry. The Forum explored how nuclear power can be compatible with sustainable development objectives, and whether the potential for global climate change will justify nuclear expansion in more competitive markets. A fundamental conclusion was that new nuclear power must be competitive in its own right without government interventions and must maintain high safety levels if it is to contribute to sustainable energy development.

Also, a meeting on 'Nuclear Research Centres (NRCs) in the 21st Century' was held in Vienna in December. The meeting brought together senior managers of NRCs from 25 Member States. A major aim was to define ways to enhance mutual co-operation among NRCs under the current challenges they face. A number of recommendations emerged from the meeting, one of them calling on the Agency to play a role in facilitating interaction between NRCs on joint projects of mutual interest and benefit in the area of nuclear technology development and applications. A second meeting is planned to focus on the details of an initially small number of projects which Member States find of most importance.

MANAGEMENT

Gaining a better understanding of the needs of Member States and ensuring a more efficient and effective response to them

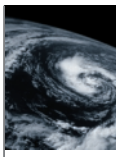
Throughout the year the Secretariat continued its management reform process. At the Senior Management Conference in January, special emphasis was given to a new approach to the programme and budget formulation process and to the efficiency of internal management. By the end of the year, a number of significant developments had taken place. Perhaps the most important was the decision that results based programming would be introduced — to the fullest extent possible — for the 2002–2003 biennium.

Meanwhile, the programme and budget for the year 2001, the initial proposals for which were prepared during the year, represented a transition. In anticipation of the introduction of results based programming, the draft programme and budget document contains *rationales*, *objectives* and *performance indicators* down to the subprogramme level. It was agreed by the Board of Governors that, as an exception, the period covered by the document would be one year only, so as to permit synchronization of the Agency biennial cycles with those of other United Nations organizations (i.e. beginning on an even numbered year).

"Perhaps the most important was the decision that results based programming would be introduced for the 2002–2003 biennium."

Proposals were put forward during the year, and approved by the Board, for the Agency — despite its statutory requirement for *annual budgeting* — to more fully utilize *biennial programming*. Thereafter, in September, the General Conference approved a change to the Statute that would allow *biennial budgeting* as a complementary measure (once the change has been ratified by the required number of States).

Programme Performance Assessment System (PPAS) evaluations were carried out in the first half of the year for Major Programmes 1, 2 and 3 (Nuclear Power and Fuel Cycle, Nuclear Sciences and Applications, and Nuclear, Radiation and Waste Safety). While it was recognized that programme priorities have to be agreed to by Member States, the PPAS evaluations provided valuable input through their recommendations to the



preparation of the programme and budget for 2001 as well as for the Medium Term Strategy (MTS).

The MTS detailed the Agency's longer term goals and the specific objectives for the five year period 2001–2005 and also specified the means proposed to meet these objectives. It aimed to show how the Agency expected to be perceived at the end of the five year time frame. The Strategy took a 'one house' approach in which all relevant activities, independent of their programmatic location, were integrated under the three broad "pillars" of technology, safety and verification. The general priorities under each goal in the MTS were indicated on the basis of the following criteria:

- Statutory responsibilities and legal commitments of the Agency;
- Decisions of the policy making organs of the Agency and the degree of priority attached by Member States to the various activities;
- Appropriateness of the Agency taking the lead vis-à-vis other institutions.

However, no attempt was made in the MTS to set detailed priorities, which would be expected to be established in future programme and budget proposals that will be developed on the basis of the Strategy and Member State comments thereon.

A further question that was discussed during the year was how the changing priorities for Agency programming in the nuclear applications field — under both the technical co-operation and regular programmes — might be identified. Two new methods proposed were to analyse the areas where Member State governments themselves are investing national funds, thus indicating national commitment, and to study the lending patterns of international financial institutions.

In an effort to improve synergy between programmes funded under the regular budget and technical co-operation programmes, a set of 'Management Principles for the Formulation and Implementation of the Technical Co-operation Programme' were formulated and approved. These principles, based on the concept of matrix management, provide a framework of accountability within the Agency in this area.

The other major theme for reform throughout the year was internal management practices. Following the Senior Management Conference, working groups were established to identify areas requiring streamlining and to propose appropriate changes. One of the important subjects singled out was delegation of authority for more effective management.

In recognition of the need for a change in approach, management training was taken up as a priority concern with the dual objectives of improving programme management and the effective use of resources, and creating a one house culture through Agency wide standards of good management practices. The key idea of the new management training policy was the development and implementation of a Management Certificate Curriculum, which relies almost exclusively on in-house facilitators, since the main focus is on management practices specific to the Agency. It is the first time that such a training programme has been developed in the United Nations system. By the end of the year, all the various modules of the curriculum had been pilot tested and the first full cycle organized.

A comprehensive human resources planning process was introduced to provide a closer linkage between programme requirements and human resources, and to reduce administrative work. The process will also serve as a basis for the preparation of forecasts of vacancies which will enable Member States to prospect earlier for candidates.