ANNUAL REPORT 2002

Article VI.J of the Agency's Statute requires the Board of Governors to submit "an annual report to the General Conference concerning the affairs of the Agency and any projects approved by the Agency".

This report covers the period 1 January to 31 December 2002.

IAEA
International Atomic Energy Agency

GC(47)/2

Member States of the International Atomic Energy Agency

(as of 31 December 2002)

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THAILAND
THE FORMER YUGOSLAV REPUBLIC OF MACEDONIA
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UNITED ARAB EMIRATES
UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND
UNITED REPUBLIC OF TANZANIA
UNITED STATES OF AMERICA
URUGUAY
UZBEKISTAN
VENEZUELA
VIET NAM
YEMEN
YUGOSLAVIA, FEDERAL REPUBLIC OF*
ZAMBIA
ZIMBABWE

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* Name changed to Serbia and Montenegro as of 4 February 2003.

The Agency's Statute was approved on 23 October 1956 by the Conference on the Statute of the IAEA held at United Nations Headquarters, New York; it entered into force on 29 July 1957. The Headquarters of the Agency are situated in Vienna. Its principal objective is "to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world".

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The Agency's Board of Governors

The Board of Governors oversees the ongoing operations of the Agency. The Board comprises 35 Member States and generally meets five times a year, or more frequently if required for specific situations. Among its functions, it adopts the Agency's programme for the incoming biennium and makes recommendations on the Agency's budget for the General Conference.

In 2002, the Board considered the *Nuclear Technology Review 2002* and various activities related to nuclear science, technology and applications. In the area of safety, it considered the *Nuclear Safety Review for the Year 2001* and various related activities. It also approved an 'Action Plan for the Radiological Protection of Patients' and the development of an Agency safety standard on Preparedness and Response for a Nuclear or Radiological Emergency. It approved the Agency's activities in the area of nuclear security and the establishment of a Nuclear Security Fund. As regards verification, the Board considered the *Safeguards Implementation Report for 2001*. It approved a number of safeguards agreements and additional protocols and considered the Agency's work related to the conceptual framework for integrated safeguards. The situation with regard to the Democratic People's Republic of Korea was kept under constant review. The Board also approved the Agency's Technical Co-operation Programme for 2003–2004 and agreed to fix target figures for the Technical Co-operation Fund for each of these years. It also recommended for approval applications for membership from Eritrea, the Kyrgyz Republic and the Republic of Seychelles.

Composition of the Board of Governors (2002–2003)

Chairperson: H.E. Ms. Nabeela AL-MULLA
Ambassador, Governor from Kuwait

Vice-Chairmen: H.E. Mr. Antonio NÚÑEZ GARCÍA-SAÚCO
Ambassador, Governor from Spain

Mr. Şerban Constantin VALECA
Governor from Romania

Argentina
Australia
Brazil
Bulgaria
Burkina Faso
Canada
Chile
China
Colombia
Cuba
Czech Republic
Denmark
Egypt
France
Germany
India
Iran, Islamic Republic of
Japan
Kuwait
Malaysia
Morocco
Netherlands
New Zealand
Panama
Philippines
Romania
Russian Federation
Saudi Arabia
South Africa
Spain
Sudan
Switzerland
Turkey
United Kingdom of Great Britain and Northern Ireland
United States of America

The General Conference

The General Conference comprises all Member States of the Agency and meets once a year. It considers the annual report of the Board of Governors on the Agency's activities during the previous year, approves the Agency's accounts and the budget, approves any applications for membership and elects members to the Board of Governors. It also conducts a wide ranging general debate on the Agency's policies and programme and passes resolutions directing the priorities of the Agency's work.

The IAEA at a Glance

(as of 31 December 2002)

- **134** Member States.
- **58** intergovernmental and non-governmental organizations worldwide having formal agreements with the Agency.
- **45** years of international service in 2002.
- **2229** professional and support staff.
- **$243 million** Regular Budget for 2002, supplemented by extrabudgetary contributions received in 2002 amounting to **$43 million.**
- **$73 million** target in 2002 for voluntary contributions to the Agency's Technical Co-operation Fund, supporting projects involving **3351** expert and lecturer assignments, **2750** meeting and workshop participants, **2398** participants in training courses and **1632** fellows and visiting scientists.
- **3** international laboratories and research centres.
- **2** liaison offices (in New York and Geneva) and **2** safeguards regional offices (in Tokyo and Toronto).
- **132** approved Co-ordinated Research Projects involving **1818** active research contracts and agreements.
- **229** safeguards agreements in force in 145 States (and with Taiwan, China) involving **2400** safeguards inspections performed in 2002. Safeguards costs in 2002 amounted to **$70.8 million** in regular budget and **$15.1 million** in extrabudgetary resources.
- **15** national safeguards support programmes and **1** multinational support programme (European Union).
- **5 million** monthly visits to the Agency's *WorldAtom* web site.
- **2.3 million** records in the International Nuclear Information System (INIS), the Agency's largest database.
- **198** publications issued (in print and electronic formats) in 2002.

Abbreviations

ABACC	Brazilian–Argentine Agency for Accounting and Control of Nuclear Materials
ADB	Asian Development Bank
AFRA	African Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology
ARCAL	Co-operative Agreement for the Promotion of Nuclear Science and Technology in Latin America and the Caribbean
BWR	Boiling water reactor
CRP	Co-ordinated Research Project
CTBTO	Comprehensive Nuclear-Test-Ban Treaty Organization
ESTRO	European Society for Therapeutic Radiology and Oncology
Euratom	European Atomic Energy Community
FAO	Food and Agriculture Organization of the United Nations
FORATOM	Forum Atomique Européen
HWR	Heavy water reactor
IAEAMEL	IAEA Marine Environment Laboratory
IEA	OECD International Energy Agency
ICTP	International Centre for Theoretical Physics
IPCC	Intergovernmental Panel on Climate Change
IIASA	International Institute for Applied Systems Analysis
ILO	International Labour Organization
IMO	International Maritime Organization
INDC	International Nuclear Data Committee
INIS	International Nuclear Information System
IOC	Intergovernmental Oceanographic Commission (UNESCO)
ISO	International Organization for Standardization
LWR	Light water reactor
NEA	Nuclear Energy Agency of the OECD
OCHA	United Nations Office for the Coordination of Humanitarian Affairs
OECD	Organisation for Economic Co-operation and Development
OLADE	Organización Latinoamericana de Energía (Latin American Energy Organization)
OPANAL	Organismo para la Proscripción de las Armas Nucleares en América Latina y el Caribe
PAHO	Pan American Health Organization/WHO
PHWR	Pressurized heavy water reactor
PWR	Pressurized water reactor
RAF	Regional Africa
RAS	Regional East Asia and Pacific
RAW	Regional West Asia
RBMK	Light boiling water cooled graphite moderated pressure tube reactor (former USSR)
RCA	Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology
SQ	Significant quantity
UNAIDS	Joint United Nations Programme on HIV/AIDS
UNDESA	United Nations Department of Economic and Social Affairs
UNDP	United Nations Development Programme
UNECE	United Nations Economic Commission for Europe
UNECLAC	United Nations Economic Commission for Latin America and the Caribbean
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNFPA	United Nations Population Fund
UNICEF	United Nations Children's Fund
UNIDO	United Nations Industrial Development Organization
UNMOVIC	United Nations Monitoring, Verification and Inspection Commission
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation
WANO	World Association of Nuclear Operators
WCO	World Customs Organization
WEC	World Energy Council
WFP	World Food Programme
WHO	World Health Organization
WMO	World Meteorological Organization
WTO	World Trade Organization
WWER	Water cooled and moderated energy reactor (former USSR)

Note

- The *Annual Report* reviews the results of the Agency's programme according to the three "pillars" of **technology, safety** and **verification** — and also management — as presented in the *Medium Term Strategy*. The main part of the report, starting on page 13, follows the programme structure as it applied in 2002. The introductory chapter, "The Nuclear World in 2002", seeks to provide a thematic analysis, based on the three pillars, of the Agency's activities within the overall context of notable developments during the year. Additional information on specific issues can be found in the Agency's *Nuclear Safety Review, Nuclear Technology Review* and *Technical Co-operation Report* for 2002.

- Additional tables giving information on the:

  — Facilities under Agency safeguards or containing safeguarded material on 31 December 2002.

  — Co-ordinated Research Projects conducted by the Agency.

  are available on the Agency's *WorldAtom* web site (*http://www.iaea.org/Worldatom/Documents/Anrep/Anrep2002/*).

- All sums of money are expressed in United States dollars.

- The designations employed and the presentation of material in this document do not imply the expression of any opinion whatsoever on the part of the Secretariat concerning the legal status of any country or territory or of its authorities, or concerning the delimitation of its frontiers.

- The mention of names of specific companies or products (whether or not indicated as registered) does not imply any intention to infringe proprietary rights, nor should it be construed as an endorsement or recommendation on the part of the Agency.

- The term "non-nuclear-weapon State" is used as in the Final Document of the 1968 Conference of Non-Nuclear-Weapon States (United Nations document A/7277) and in the NPT.

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The Nuclear World in 2002

Introduction

Forty-five years after its founding, the International Atomic Energy Agency continues to serve as the focal point for worldwide co-operation in the peaceful uses of nuclear ***technology***, for promoting global nuclear ***safety*** and, through its ***verification*** activities, for providing assurances that international undertakings to use nuclear facilities and materials for peaceful purposes only are being honoured. What follows is a survey of worldwide nuclear related developments in 2002, and how they affected the work of the Agency.

Technology

Nuclear Technology for Sustainable Development

The World Summit on Sustainable Development (WSSD) met in August and September in Johannesburg to review progress made since the United Nations Conference on Environment and Development (UNCED), held in Rio de Janeiro in 1992, and to reinvigorate global commitment to sustainable development. The importance of energy as an essential prerequisite for socioeconomic development was emphasized in the 'Johannesburg Plan of Implementation' and the 'Johannesburg Declaration on Sustainable Development', which contrasts notably with the absence of an energy chapter in *Agenda 21*, the action plan from the Rio conference.

The Agency's work in nuclear applications and the relevance of Agency activities towards sustainable development were highlighted by the Secretariat in the work leading up to the WSSD. At the Preparatory Committee meetings, the Secretariat organized side events on 'Nuclear Applications and Capacity Building for Sustainable Development', and 'Integrated Coastal Zone Management — Issues, Technologies and Partnerships', and at the WSSD itself an event on 'Environment Friendly Control of Insect Pests'.

The major mechanism at the WSSD for prompting specific action in pursuit of *Agenda 21* objectives was the promotion of new partnerships among governments, businesses, non–governmental organizations and international organizations. Over 250 "Type 2 Partnerships", as they came to be known, were announced at Johannesburg, including four Agency led partnerships on 'Indicators for Sustainable Energy Development', 'Designing Country Profiles on Sustainable Energy Development', 'Application of Isotope Techniques for Sustainable Water Resource and Coastal Zone Management', and 'Application of Nuclear and Non-nuclear Techniques for the Monitoring and Management of Harmful Algal Blooms in the Benguela Coastal Region'. These partnerships involve a number of countries, academic institutions, international associations and UN system organizations.

Managing and Preserving Nuclear Knowledge

Recent trends have drawn attention to the need for better management of nuclear knowledge. One challenge is to ensure the availability of qualified people to sustain or even expand the present level of deployment of nuclear technology. A related concern is the potential loss of valuable knowledge, accumulated over past decades, due to ageing of the workforce. There are currently a number of national and international initiatives to reverse these trends.

For example, an encouraging development in the USA was the increase for the third straight year in enrolments in undergraduate nuclear engineering programmes. After declining from 1500 students in 1992 to about 450 in 1999, enrolment in 2002 rose to 1000. South Carolina State University and the University of South Carolina also announced that they will introduce new graduate and undergraduate nuclear engineering programmes. These will be the first such academic programmes in this area in more than 20 years in the USA.

Agency efforts in this area included the hosting of a meeting on managing nuclear knowledge, with senior experts from academia, industry and government. The meeting urged the Agency to lead activities towards preserving and enhancing nuclear knowledge by complementing and supplementing activities by governments, industry, academia and international organizations. The urgency and importance of these issues were confirmed at the Scientific Forum and through a resolution at the 46th session of the Agency's General Conference.

Nuclear Power Around the World

At the end of 2002, there were 441 nuclear power plants operating in 30 countries, representing a total capacity of 359 GW(e), more than 10 000 reactor-years of operating experience, 16% of global electricity generation and 7% of global primary energy use. Six new nuclear power plants were connected to the grid in 2002 — four in China, one in the Republic of Korea and one in the Czech Republic. Four plants were retired — Kozloduy-1 and 2 in Bulgaria and two units at Bradwell in the United Kingdom — and construction began on seven new plants, all in Asia.

Current expansion, as well as near term and long term growth prospects, is centred in Asia. Of 33 reactors currently under construction worldwide, 20 are located in Asia. Seventeen of the last 26 reactors to be connected to the grid are in the Far East and in South Asia. The greatest growth in nuclear electricity production in 2002 was in Japan.

Elsewhere the outlook is more mixed. In Western Europe the most significant possibility for new nuclear capacity is in Finland. In May 2002, the Finnish Parliament ratified the Government's "decision in principle" on the application by Teollisuuden Voima Oy (TVO) to build a fifth nuclear power plant. In September, TVO invited bids from reactor vendors. On the other hand, Belgium has now voted a nuclear phase-out policy into law, and the United Kingdom's White Paper on energy puts off any consideration of new nuclear capacity for at least another five years.

In North America, the United States Nuclear Regulatory Commission (NRC) approved four licence extensions of 20 years each (i.e. 60 years for each power plant), bringing the total number of approved licence extensions by the end of the year to 10. The NRC had 20 more applications under review and expected at least 9 more in 2003 and 10 more in 2004.

In the Russian Federation, the Government body responsible for electric and thermal power generation at nuclear power plants (ROSENERGOATOM) has begun a programme to extend licences at 11 plants. For example,

Innovation: A Key to Success in Competitive Energy Markets

The 21st century is likely to witness a rapid rate of technological change, increasingly competitive globalized energy markets and, particularly in developing countries, a substantial expansion in energy use to fuel economic development. For a technology to survive and flourish in this century, continual innovation is essential. This is widely recognized in the nuclear industry. In 2000, the year the Agency began its International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO), the US led Generation IV Project also began. The European Union has the 'Michelangelo Initiative'. And individual countries have developed national complementary innovation programmes.

In 2002, the Generation IV Project completed selection of six concepts for future international research — the gas cooled fast reactor, the lead cooled fast reactor, the sodium cooled fast reactor, the supercritical water cooled reactor, the very high temperature reactor and the molten salt reactor. The Agency published the final report of a study on innovative nuclear reactor development, completed with the OECD's IEA and NEA. In addition, a draft report on Phase 1A of INPRO was submitted to the project's steering committee for review. INPRO provides a global perspective on energy demands in developing countries and their future needs, incorporates the Agency's safeguards and safety expertise, and takes a global view of environmental impacts from the full fuel cycle.

Novovoronezh-3 received a five year licence extension (beyond the original 30 year period) in December 2001. In 2002, ROSENERGOATOM submitted an application for a 15 year extension for Novovoronezh-4 and it is currently preparing applications for 15 year extensions for three more units.

Of the world's 441 operating nuclear power plants, 345 have been in operation for 15 or more years, while 128 have been in operation for more than 25 years. In many countries nuclear reactors completed in the high growth decades of the 1970s and 1980s will shortly be nearing the end of their originally planned lifetimes. Many decisions will need to be taken on the relative merits of licence extension and decommissioning. Indeed, the speed at which licence extension and decommissioning experience is accumulating is accelerating, and the Agency is contributing to a corresponding acceleration in the rate at which new information is shared, best practices are disseminated and new knowledge is put to immediate and constructive use. However, there is still no international agreement on some of the key 'end points' for decommissioning, in particular on criteria for disposing of large amounts of very lightly contaminated construction materials and for releasing decontaminated land or buildings for general reuse. This lack of clear criteria is a significant impediment to planning decommissioning activities. However, the levels currently being discussed internationally to define the scope of regulatory control should, when they are agreed, help to address this and several other issues. The Agency also completed a report on licence extension costs and regulatory approaches in 12 Member States in November and began development of an international database on nuclear power plant life management.

Safe Management of Spent Nuclear Fuel and Radioactive Waste

Through 2002, global nuclear electricity production generated 255 000 tonnes of heavy metal (t HM) of spent fuel. Of this amount, 84 000 t HM went to reprocessing and 171 000 t HM to storage. The amount of spent fuel in storage is projected to increase to 260 000 t HM in 2015. Extended schedules for getting final repositories on line mean longer storage periods for spent fuel — up to one hundred years in some cases. Globally, there is sufficient capacity for the projected increase, although the potential exists for national shortages that need to be anticipated and resolved.

All radioactive waste can be contained safely for long periods of time. There is, however, broad technical consensus that storage in perpetuity is neither feasible nor acceptable, and that geological disposal provides the best means for the safe long term management of high level radioactive waste. Nevertheless, recognizing societal concerns, there is an increasing perception that such geological repositories might have to be kept open until such time as a future generation decides either to close them or retrieve the waste and dispose of it in some other manner. The Agency is currently in the process of updating safety standards on geological disposal to take account of this possible need for 'retrievability', while emphasizing the importance of not compromising long term safety.

Progress on final repositories included the February decision by the President of the United States of America to proceed with the Yucca Mountain disposal site, a decision effectively ratified by Congress in their subsequent vote to override formal objections by the State of Nevada. Commissioning of the site is scheduled for 2010. Finland's Parliament had already ratified in 2001 the decision in principle for a final disposal site at Olkiluoto for spent fuel from Finland's four operating nuclear power plants. In 2002, the Parliament ratified a further decision in principle to allow spent fuel from the planned new reactor to also be disposed of at Olkiluoto.

In Canada, the new Nuclear Fuel Waste Act came into force in November 2002. The Act requires nuclear utilities to form a waste management organization, which will submit options to the Government for the long term management of nuclear fuel waste, and also requires the utilities to set up a trust to finance long term waste management. Also in November, the European Commission proposed a directive on spent nuclear fuel and radioactive waste which would give priority to geological waste disposal and require Member States to decide on burial sites (national or shared) for high level waste by 2008 and to have the sites operational by 2018. For low level and short lived waste, disposal arrangements would have to be ready by 2013.

An international conference on 'Issues and Trends in Radioactive Waste Management', held in Vienna in December 2002, provided an update on some of the major issues in radioactive waste management, and introduced a range of new issues. The conference underlined the need for a greater recognition of the importance of the social and political aspects of radioactive waste management.

Research Reactor Fuel Repatriation

In 2002, the Reduced Enrichment for Research and Test Reactors (RERTR) Programme continued, with 20 reactors outside and 11 inside the USA completely converted from high enriched uranium (HEU) to low enriched uranium (LEU) and seven reactors partially converted. In addition, the US acceptance of research reactor fuel of US origin continued, with shipments of fuel from reactors in Denmark, Germany, Japan, the Netherlands and Sweden.

At a summit in May, the US and Russian Presidents agreed on the formation of a group of experts on non-proliferation to investigate near and long term bilateral and multilateral solutions for reducing HEU and plutonium inventories. Their September report included two options that are of particular relevance for research reactors: the use of Russian HEU to fuel selected US research reactors until they are converted to LEU; and the accelerated development of LEU fuel for both Soviet era design and US designed research reactors.

An initiative involving the Agency, the Russian Federation and the USA on the feasibility of returning research reactor fuel of Russian origin to the Russian Federation for management and disposition made some progress in 2002. Preparations are under way for the first shipment to take place from Tashkent, Uzbekistan, in 2003.

In August, 48 kg of 80% enriched uranium was removed from the Institute of Nuclear Sciences Vinča near Belgrade and flown to Dimitrovgrad, Russian Federation, where it is to be blended down for use in LEU fuels. Agency safeguards inspectors verified and sealed the material before its transfer. As part of the agreement that led to the HEU removal, the Nuclear Threat Initiative pledged up to $5 million for the cleanup of the Vinča Institute, including conditioning and packaging of the corroded spent fuel for shipment or dry interim storage, decommissioning of the 6.5 MW research reactor and addressing current problems with the low and intermediate level wastes stored on-site.

Nuclear Applications

The five Agency programmes in the field of nuclear sciences and applications have a unifying theme of serving basic human needs, and of providing nuclear and isotopic techniques to promote economic development in a clean and safe environment. In particular, the water resources, human health and food and agriculture programmes are of major relevance to the five key thematic and priority WEHAB areas (water, energy, health, agriculture and biodiversity) identified by the UN Secretary General to provide focus and impetus to the WSSD.

Teaming up to Manage the World's Water Resources

The Agency's water resources programme co-ordinates its activities with other national and international organizations that are active in the water sector. In 2002, the Agency assisted developing Member States in using effective tools for the assessment and monitoring of water resources, in particular groundwater resources, based upon the applications of isotope techniques. Indeed, monitoring and assessment of both the quantity and quality of groundwater resources is an integral part of nearly 75 technical co-operation projects operational in about 48 countries. In addition, substantial human resources and institutional capacity are being built through the provision of training and appropriate equipment for monitoring.

In recognition of its contribution to water resources management, the Agency was invited to be the lead organization for the UN system to mark World Water Day 2002. The celebrations were held in Vienna and stressed the role of science and technology in the use and management of water resources.

Nuclear Techniques for Better Health

The Johannesburg Plan of Implementation identifies certain priority areas such as HIV/AIDS, malaria, tuberculosis and cancer. In all of these areas the Agency, through its human health programme, is active on its own and in partnership with other organizations. For example, it is strengthening its collaboration with WHO/UNAIDS to make use of molecular techniques to monitor HIV/AIDS and related problems, and is contributing to trials for testing a new HIV/AIDS vaccine.

International Collaboration on Water Issues

The Agency has active collaborative programmes with the WMO, the World Bank, FAO and UNEP. Together with UNESCO, a Joint International Isotopes in Hydrology Programme (JIIHP) has recently been launched to improve implementation and co-ordination of the hydrological programmes of both agencies. The Agency will also be involved in the UN system's activities for the International Year of Freshwater. In addition, the Agency chairs the UN interagency committee on co-ordination for freshwater for 2002–2004. Under the WSSD partnership initiatives, the Agency has joined with UNESCO (in their 'Isotopes in Hydrology Programme' and the Intergovernmental Oceanographic Commission), International Council of Scientific Unions, International Association of Hydrologists and International Association of Hydrological Sciences in the application of isotope techniques for sustainable water resources and coastal zone management.

Another method, namely radiotherapy, is one of the earliest applications of radiation and remains a major modality available for cancer treatment. However, developing countries with 80% of the world's population have only one-third of the world's radiotherapy resources. These countries need support to adopt and develop various radiotherapy techniques and integrate them into their overall national cancer control programmes. In 2002, the Agency continued to transfer mature and established technologies to the developing countries through training, including the development of training material, expertise and guidance, in addition to the provision of equipment.

In the fight against malaria transmitting mosquitoes, research was initiated in 2002 to develop key components of the sterile insect technique (SIT) against these mosquitoes and to evaluate the feasibility of applying this technique in a field programme.

Promoting Food Security Through Nuclear Techniques

Together with FAO, the Agency devotes considerable resources to such agricultural issues as soil and water management and crop nutrition, plant breeding and genetics, animal production and health, insect and pest control and food quality and safety, with objectives that are closely aligned to the WSSD's Johannesburg Plan of Implementation.

In the spirit of the partnerships called for by the WSSD, the Agency has arrangements and relations with many organizations in the food and agricultural sectors. An example is the Rice–Wheat Consortium for the Indo-Gangetic Plains. A network has been established between national and international agricultural institutions that focuses on improving the productivity of rice and wheat in a sustainable fashion. The research agenda is supported by many countries and by regional and international funding and development organizations.

The tsetse fly continues to be a serious problem in many parts of Africa. As part of its efforts to combat this insect pest, the Agency became a member in July 2002 of the secretariat of the Programme Against African Trypanosomosis (PAAT). The Agency brings to PAAT its specialist knowledge of SIT for use in area wide eradication and control campaigns against tsetse. One of the chief functions of PAAT is to be a forum for the Pan African Tsetse and Trypanosomosis Eradication Campaign (PATTEC), which was formed as a result of the declaration of the OAU (now the African Union) Heads of State in July 2000 for the eradication of tsetse flies from Africa.

Technology Transfer and Capacity Building for Sustainable Development

Promoting the scientific, technological and regulatory capabilities of developing countries through technology transfer and capacity building is among the main tasks of the Agency's technical co-operation programme, with special emphasis given to technical co-operation among developing countries. In 2002, disbursements went up to $74.8 million, from $73.5 million in 2001. The major areas of activities were: human health (21%), safety (18%), food and agriculture (17%), applications of physical and chemical sciences (11%), water resources and environmental protection (8%), nuclear science (7%) and capacity building (7%).

Eradicating Rinderpest: A Major Livestock Killer

The Global Rinderpest Eradication Programme (GREP) aims at eradicating rinderpest from the world by the year 2010. This will be the first time that an animal disease, which has historically killed hundreds of millions of cattle, is eradicated globally. Support for the monitoring and verification process of GREP is provided by the Agency through its technical co-operation programme and through co-ordinated research by FAO and the Agency. The result has been the development of a capacity for the diagnosis of rinderpest in more than 40 countries in Africa and Asia.

Safety and Security

International Safety Standards

As required by its Statute, the Agency has been establishing safety standards since it was founded. The scope and application of the standards have gradually expanded with time. The rigour of the standards has also increased to reflect changing expectations about safety, and the process for establishing the standards has been improved to enhance the quality and authority of the product. The Agency's current safety standards reflect the 'best practice' in safety: the levels of safety that are considered to be achievable and that all Member States should strive to achieve.

The acceptance and application by States of the Agency's safety standards is an important element of the global nuclear safety regime. The Commission on Safety Standards (a standing body of senior government officials that provides guidance and advice to the Director General on the overall programme on regulatory aspects of safety) has developed a strategy for the revision of the standards. The aim of this strategy is to meet the changing needs of users and take into account new technologies, and implement an 'outreach' initiative to extend awareness of the standards and to promote their use. The strategy also supports closer links between the safety standards and measures to provide for their application, such as the Agency's advisory and review services on nuclear safety.

In this connection, a directive setting out basic obligations and general principles on the safety of nuclear installations, proposed for adoption by the European Commission to members of the European Union (EU), is aimed at introducing common safety standards for EU States and making them legally binding in those States. If the EU were to adopt and rely on the Agency's international standards, the effectiveness of the standards would be further increased.

Convention on Nuclear Safety

In April 2002, the second Review Meeting of Contracting Parties to the Convention on Nuclear Safety was held in Vienna at which the national reports submitted by Contracting Parties were reviewed. The Summary Report of the Meeting, addressing issues discussed and conclusions reached, is an important record of the Contracting Parties' views on the state of nuclear safety in their countries. The overall conclusions were encouraging, particularly in respect of legislation, regulatory independence, financial resources for regulatory bodies and operators of nuclear installations, implementation of safety improvements in installations built to earlier safety standards and emergency preparedness. At the same time, the meeting acknowledged that there are areas that warrant special attention, including the management of safety and safety culture, plant ageing and upgrading, maintaining competence and the effectiveness of regulatory practices.

In general, the Convention process appears to have persuaded many Contracting Parties to take measures to improve the implementation of their obligations and to further enhance nuclear safety. Recognizing the value of the various safety review missions and services, the Contracting Parties invited the Agency to submit a report to them identifying generic issues and trends observed in the course of performing nuclear safety review services.

Building Infrastructures for Greater Safety

Countries with expanding nuclear programmes can encounter difficulties in finding sufficient numbers of trained and experienced staff, while those with static or contracting programmes can struggle to find suitably qualified young people to replace retiring experienced staff. Therefore, education and training are essential to maintaining safety infrastructures. The Agency's strategic plans for education and training in nuclear safety and in radiation, waste and transport safety aim at addressing this concern by promoting self-sustaining capabilities in Member States, including 'training the trainers' and developing and disseminating standardized training materials for a wide range of courses. Furthermore, there is a need to strengthen efforts to pool, assess and effectively share existing and new technical knowledge and practical experience. The Agency is assisting Member States in developing nuclear safety networks to exchange knowledge among regional hubs and national centres using modern information technology tools.

Transport Safety

Ensuring the safe transport of radioactive material remains high on the international safety agenda. The Transport Safety Appraisal Service (TranSAS) was introduced by the Agency at the request of its Member States as one way of providing assurance that the Agency's Transport Regulations were being consistently implemented. The 2002 missions to Brazil and the United Kingdom, and the forthcoming missions to France, Japan, Panama and Turkey represent a significant development. In particular, France, Japan and the United Kingdom are major shippers of radioactive material, while Panama and Turkey control important waterways for international maritime transport. The publication of the full mission reports is also a significant step towards greater transparency with regard to the transport of radioactive material.

Nuclear Security

Combating the dangers of using nuclear and other radioactive material for malevolent acts was an important area of activity during the year. An Advisory Group on Nuclear Security was established in January to provide advice on the Agency's activities related to preventing, detecting and responding to malicious acts involving nuclear and

Protecting Radioactive Sources and Materials

To protect the public from the hazards of ionizing radiation, 'cradle to grave' control is essential for radioactive sources used in medicine, food preservation, water resources management and industrial applications. In the wake of the 11 September attacks in 2001, and the growing awareness of the potential for radioactive sources to be used in malevolent acts, source security has taken on a new urgency. A widespread problem involves sources that, due to loss, theft or abandonment, have fallen outside official regulatory control — the so-called "orphaned" sources.

The Agency and its Member States have been working to raise the levels of radiation safety and security associated with radioactive sources, focusing on countries with urgent needs. Nearly a decade ago, the Agency established the *International Basic Safety Standards for Protection Against Ionizing Radiation and for the Safety of Radiation Sources*, and has been implementing a technical co-operation project on upgrading radiation protection infrastructure to help improve the control of radioactive sources in developing countries. In addition, a draft 'Code of Conduct on the Safety and Security of Radioactive Sources' has been developed, focusing on those radioactive sources posing a significant safety or security risk. The Agency has also put forward recommendations to States for creating national source registries, securing orphaned sources and establishing measures to prevent malicious acts and activities involving nuclear and other radioactive materials. Activities are being carried out in the countries of the former Soviet Union, and recently an initiative was launched to locate, recover, secure and recycle orphaned sources worldwide. Assistance is also being provided to States to strengthen their border controls against illicit trafficking, and to improve their security of radioactive sources.

other radioactive materials and nuclear facilities. In March 2002, the Board of Governors approved specific proposals for protection against nuclear terrorism submitted by the Director General. The proposals encompass eight areas of activity. By the end of 2002, implementation of the activities was well under way, with new and revised standards, guidelines and methodologies under development, and a substantial increase in the number of assessment missions and training courses, especially those related to the physical protection of nuclear material and to illicit trafficking. An Agency wide confidentiality regime was established to enhance the protection of nuclear security related information. In addition, assistance was provided to States regarding legislation related to nuclear security, covering for example the control of radioactive sources, physical protection requirements, safeguards and import–export controls. The Agency maintained co-operation with other international organizations, such as Europol, Interpol, the Universal Postal Union and WCO.

Verification

Comprehensive Safeguards Agreements and Additional Protocols

The Model Additional Protocol to safeguards agreements, approved by the Board of Governors in May 1997, provides the legal basis for a significantly strengthened Agency safeguards system. When fully implemented in a State, the measures provided by a comprehensive safeguards agreement together with an additional protocol will allow the Agency to enhance its ability to draw safeguards conclusions about both the non-diversion of declared nuclear material and the absence of undeclared nuclear material and activities in that State.

In 2002, the Agency expanded its efforts to encourage wider adherence to the strengthened safeguards system, bearing in mind the importance of achieving the universal application of that system, consistent with the respective safeguards undertakings of Member States. Three outreach seminars were held, and bilateral consultations were pursued with a large number of States. During the year the number of States having concluded additional protocols rose from 61 to 67, and the number of additional protocols in force increased from 24 to 28. Thirteen States notified the Agency of their intent to conclude additional protocols. Nonetheless, progress continues to remain disappointingly slow, in particular with regard to the number of States with additional protocols in force. The Agency's outreach efforts also aim at the conclusion of safeguards agreements. Although the number of non-nuclear-weapon States Parties to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) that still had to conclude comprehensive safeguards agreements in accordance with their treaty obligations went down from 52 at the end of 2001 to 48 at the end of 2002, the number remained unacceptably high. In November 2002, Cuba acceded to the NPT as its 188th State Party. It has initiated negotiations with the Agency on concluding a comprehensive safeguards agreement.

The Board of Governors was presented with the completed conceptual framework for integrated safeguards, comprising the set of safeguards concepts, approaches, guidelines and criteria that govern the design, implementation and evaluation of integrated safeguards. The framework will help to ensure consistent, non-discriminatory implementation of integrated safeguards. During the year, work continued to strengthen the effectiveness and improve the efficiency of the safeguards system. In this regard, the Secretariat focused on: the State evaluation process; safeguards approaches, procedures and technology; increased co-operation between the Agency and State or regional systems of accounting for and control of nuclear material; and training and support activities.

Non-Proliferation Treaty

The first session of the Preparatory Committee for the 2005 NPT Review Conference was held in New York in April 2002. Participating States Parties acknowledged with appreciation the Agency's roles in implementing NPT safeguards, strengthening the security of nuclear material, promoting nuclear safety and facilitating co-operation in the peaceful uses of nuclear energy, technology transfer and nuclear applications.

Democratic People's Republic of Korea

The Agency continued to be unable to verify the correctness and completeness of the initial declaration by the Democratic People's Republic of Korea (DPRK) of nuclear material subject to safeguards in accordance with its

NPT safeguards agreement with the Agency. At the request of the United Nations Security Council, however, the Agency, between November 1994 and December 2002, monitored the "freeze" of the DPRK's graphite moderated reactors and related facilities in accordance with the "Agreed Framework" between the DPRK and the USA, and until the end of December maintained a continuous inspector presence at the Nyongbyon site.

In October it was reported by the USA that the DPRK had a uranium enrichment programme that had not been declared to the Agency. The Secretariat requested clarification from the DPRK, but no response was received. On 29 November, the Board adopted a resolution demanding that the DPRK comply fully with its NPT safeguards agreement, respond urgently to the Secretariat's enquiry and provide all relevant information regarding the reported enrichment programme. The DPRK rejected the Board's resolution. On 12 December, the DPRK notified the Agency that the following day it would lift the "freeze" and resume nuclear power generation operations. The DPRK asked the Agency to immediately remove its seals and cameras from all facilities subject to the freeze. The Secretariat then urged the DPRK not to take unilateral steps related to seals or cameras and to agree to an urgent meeting of technical experts to discuss practical arrangements involved in moving from the freeze to normal safeguards operations. However, on 22 December, ignoring the Agency's requests, the DPRK unilaterally impeded or removed all the seals and cameras installed for verification purposes. The DPRK then demanded that the Agency withdraw its inspectors immediately. On 31 December, the inspectors left the DPRK and the Agency's verification activities were suspended.

Iraq

From December 1998 until November 2002, the Agency was not in a position to implement its Security Council mandated activities in Iraq. The Agency's activities were limited to physical inventory verification, pursuant to Iraq's NPT safeguards agreement, of the nuclear material placed under safeguards. Agency inspectors verified the presence of the nuclear material in question in January 2002. In September 2002, after a series of talks, Iraq decided to allow unconditionally the return of United Nations and Agency weapons inspectors pursuant to their respective Security Council mandates. Subsequently, in November, the Security Council adopted Resolution 1441 (2002), under which inspections in Iraq were resumed. The verification activities carried out by the Agency pursuant to Security Council Resolution 687 (1991) and subsequent resolutions, in particular Resolution 1441 (2002), included: follow-up with the Iraqi authorities on Iraq's "Currently Accurate Full and Complete Declaration", received on 8 December 2002; on-site inspections; collection of environmental samples at known and new locations; satellite imagery analysis; gamma radiation monitoring; interviews; and re-verification of the nuclear material under safeguards. No evidence of ongoing prohibited nuclear or nuclear related activities was detected. However, by the end of the year, verification activities were still going on and at that time no firm conclusions could be drawn.

Outreach

As a result of political developments during 2002, there was a sharp increase in interest in the Agency and its work. While part of this interest was in response to the worldwide discussion of the threat of nuclear and radiological terrorism, developments in Iraq and the DPRK also resulted in wide media coverage of the Agency and its involvement in these issues. To meet this increased interest, the Agency adopted a proactive media and communications policy to communicate, on as wide a basis as possible, the Agency's important role under its three pillars of technology, safety and verification.

Management

Within the framework of the results based approach, 2002 represented the first year of implementation of the programme for the 2002–2003 biennium. Towards the end of the year, preparation began of the *2002–2003 Mid-Term Progress Report*, intended to inform Member States — on the basis of the activities so far implemented, the outputs delivered and the resources utilized — of any factors that have affected implementation and any adjustments that are necessary to ensure achievement of the planned outcomes by the end of the biennium. Throughout the year, planning continued — in consultation with Member States — on the proposed programme

for 2004–2005. In December, the corresponding budget estimates were prepared and the overall draft programme and budget document issued.

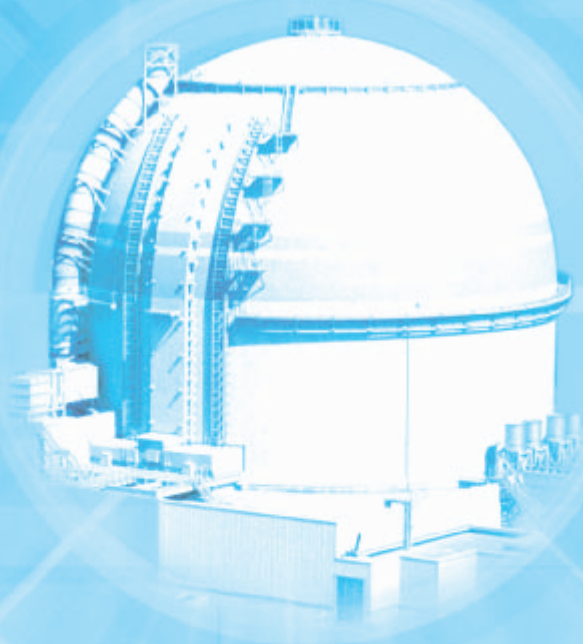
Another key component of programme enhancement is a review of management practices and processes. In July the Agency engaged the services of an external consulting firm to conduct such a review. In its report the consulting firm commended the Agency for its consistent responsiveness to Member States, its willingness to be self-critical and engage in reform, and its performance under the stress of an expanding programme combined with a zero real growth budget. A number of areas for improvement were highlighted, including: simplifying some management processes, modernizing support services and delivery mechanisms, and developing a comprehensive change management strategy. But a key conclusion of the firm, which validated previous findings of the Agency's internal and external auditors, was that the mechanisms for identifying and achieving cost savings are in place. In fact, the consulting firm concluded that a sustained focus on identifying savings had in the end been counterproductive because it hampered sensible investments in people, processes and modernized support systems. It was the firm's view that the focus should be on measures to enhance effectiveness which, in the long term, would enhance quality and achieve savings.

Conclusion

The year 2002 was exceptionally busy for the Agency, particularly in the field of verification. Acting under the authority provided to it by safeguards agreements and additional protocols, the Agency continued to provide assurance of the peaceful uses of nuclear energy. Moreover, as the world's intergovernmental global forum for scientific and technical co-operation in the peaceful uses of nuclear technology, it was also active in the areas of nuclear technology applications and nuclear safety. The Agency achieved many successes during the year: initiating and supporting radiotherapy services; extending the tsetse fly eradication programme in Africa; and exploring new and safer methods of detecting land mines. The Agency also continued to promote the need for a strong safety culture, demonstrate nuclear power's relevance in meeting global energy needs, highlight acceptable waste management solutions, and introduce technological innovations.

There are many challenges and problems still facing the Agency and its Member States. These include the need to: strengthen the safeguards and non-proliferation regime and extend its application; upgrade nuclear safety around the world; establish a strengthened nuclear security framework; assess the role of nuclear power for sustainable development; and promote the application of nuclear techniques. Dealing with these challenges requires concerted, co-operative international action.

Technology



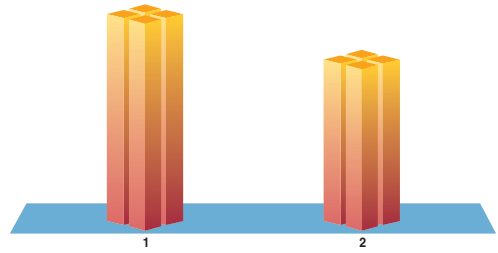
Nuclear Power

Objective

To increase the capability of interested Member States to implement and maintain competitive and sustainable nuclear power programmes.

Regular budget expenditure: $4 128 142

Extrabudgetary programme expenditure (not included in chart): $1 198 032



1. Engineering and Management Support for Competitive Nuclear Power: $2 320 546
2. Nuclear Power Technology Development and Applications: $1 807 596

Key Issues and Highlights

- The Agency organized a symposium on nuclear power plant life management to address issues related to licence extension, retirement and decommissioning. As more nuclear power plants approach their original design lifetimes, decisions on such issues are becoming increasingly pressing.
- A new initiative was launched to harmonize the Agency's quality standards with the ISO 9001:2000 international standards.
- Interim results of the International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) were presented at various international conferences, and were submitted in full in a draft report to the INPRO Steering Committee in December.
- The Agency assisted in convening a conference on nuclear desalination in Marrakesh, and also completed publications on desalination design concepts and on the market potential of this technology. Furthermore, the Power Reactor Information System (PRIS) database was expanded to cover non-electrical applications (i.e. industrial heat, district heating and desalination) and decommissioning.
- Preserving knowledge on fast reactor technology was the objective of a new initiative launched by the Agency.

Engineering and Management Support for Competitive Nuclear Power

Nuclear power plants are ageing around the world. Figure 1 shows that more than a third — 130 plants — have operated for more than 25 years. With ageing, with capital investments fully written off, and with liberalizing electricity markets in many countries, it is increasingly important to know when to extend a plant's operating life, when to choose retirement and decommissioning, how to most cost effectively implement whichever path is chosen and how to get the maximum performance out of a valuable asset in the meantime.

In 2002, the Agency published a technical document on cost drivers for the assessment of nuclear power plant life extension which analyses data on licence extension costs and regulatory approaches in 12 Member States. It is the first international study published on the costs of plant licence extension.

The Agency is also participating in a study on decommissioning strategies and costs, initiated by the OECD/NEA. As a result of the Agency's involvement, ten non-OECD countries are involved in the study, thereby widening its international dimension significantly.

With respect to the ageing nuclear workforce and the challenge of transferring knowledge to the next generation, the Agency has been carrying out several activities for nuclear power plant personnel. These cover human resources management, defining core competencies that must be maintained for power plant operation and the effectiveness of alternative training programmes. For example, the 'Systematic Approach to Training' (SAT) minimizes competency gaps and continuously provides feedback to enhance nuclear power plant safety and reliability. A technical document was published on the effectiveness of

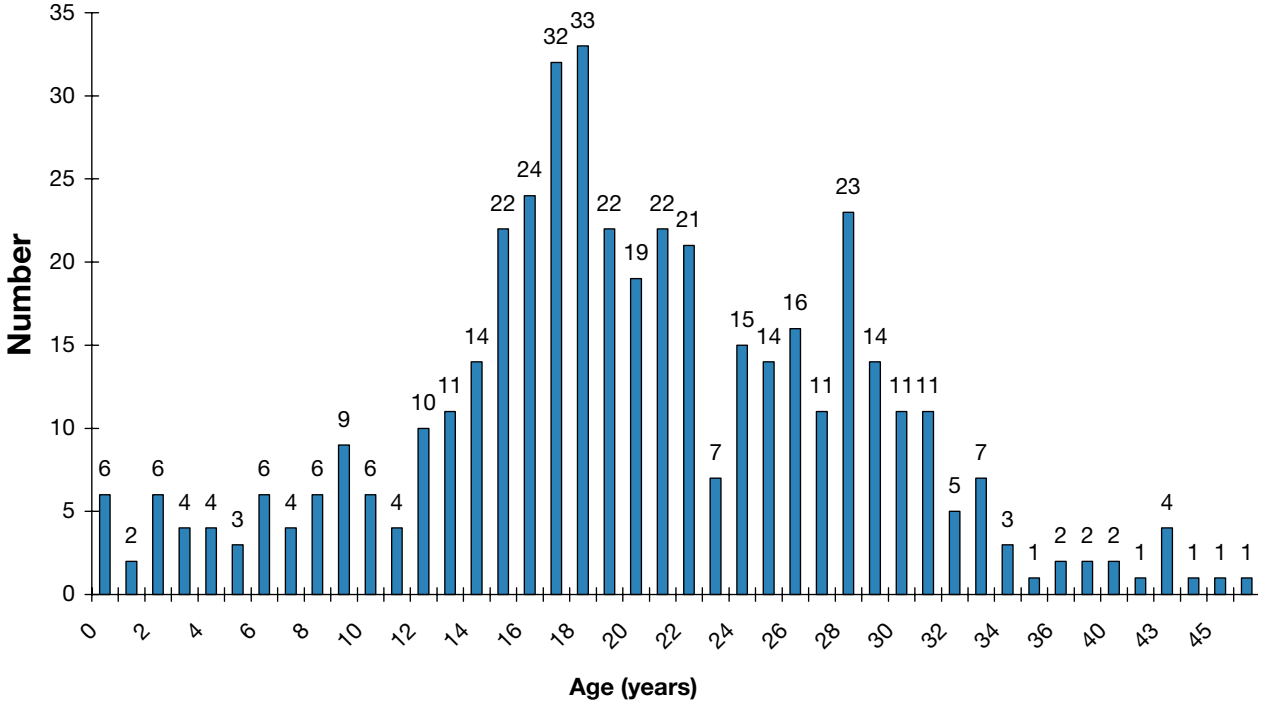


FIG. 1. Number of reactors worldwide by age (as of 31 December 2002).

nuclear power plant personnel training with guidance on evaluating and continuously improving training systems.

The Agency also completed a technical document on the use of control room simulators for nuclear power plant personnel training. While it focuses on training for control room personnel using full scope simulators, it also covers the use of these simulators (full scope or limited) for training other plant personnel. The report is intended to contribute to improved safety by providing new and better methods for training personnel other than operations personnel with simulators.

Modern information technology techniques can improve and enhance the efficiency of application of the SAT process and greatly enhance the retrievability of training information for the staff at nuclear power plants. In this regard, a CRP was completed on information management solutions for SAT applications, summarizing lessons learned and providing guidance for upgrading information management in Member State SAT programmes. The project emphasized computer based information management systems to improve operational efficiency and increase safety performance.

The Agency has published extensively on quality assurance and quality management (QA/QM) through its Safety Standards, Safety Reports, Technical Reports and Technical Documents. A meeting was convened in 2002 to develop a strategy for harmonizing quality standards between the Agency and other organizations. Specifically, the Code and Safety Guides Q1–Q14 in IAEA Safety Series No. 50-C/SG-Q, *Quality Assurance for Safety in Nuclear Power Plants and other Nuclear Installations*, are being harmonized with the ISO 9001:2000 international standards to permit a graded approach for implementation. This initiative, which cuts across the Agency and involves the participation of a broad range of external experts, will bring the Agency to the forefront of international QA/QM applications.

A technical report on nuclear power plant outage optimization strategies was published which provides guidance, as well as experience from current operating plants, for overall optimization through systematic outage planning, preparation, execution and post-outage reviews. Included are recent innovative strategies that have reduced refuelling outages to 8–10 days at some plants — 20 to 30 days if major maintenance work is carried out concurrently (Fig. 2). Careful, performance oriented, monitoring is essential for a high level of safety and reliability. The Agency is therefore outlining a common set of outage performance indicators for use before, during and after outage execution.

A CRP on national approaches to correlate performance targets and operations and maintenance costs emphasizes how economic measures can be used to optimize nuclear power plant performance, including safety performance. The CRP is developing indicators that can guide performance improvements

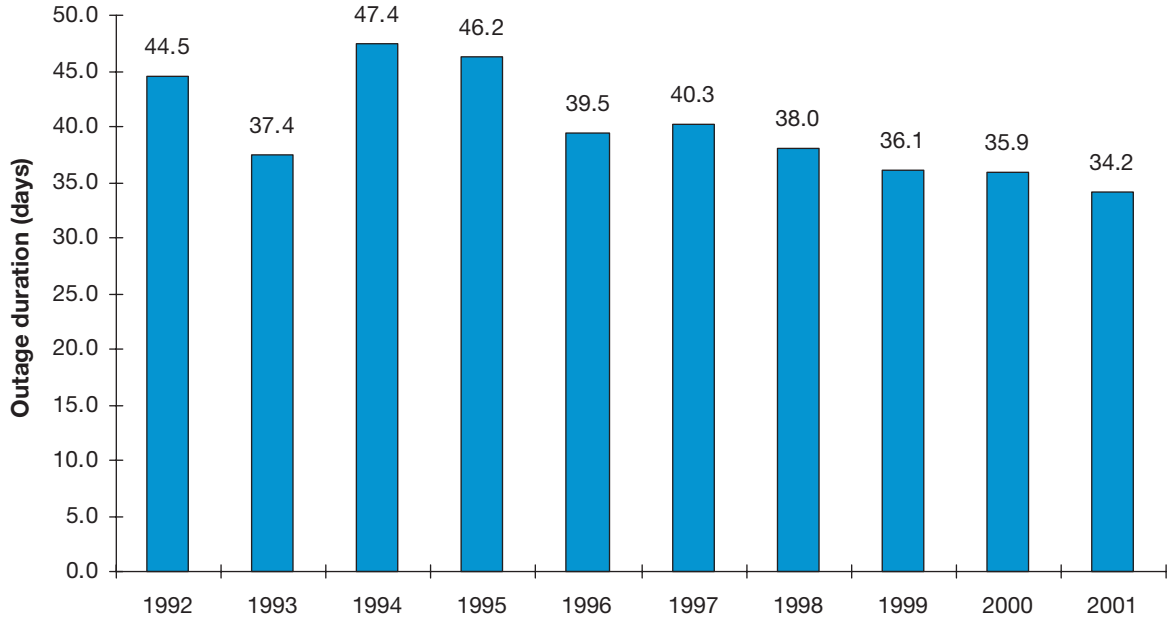


FIG. 2. World average time for planned outages.

within the regulatory, competitive and economic environments of today's plants.

Effective assessments identify when the expense of modernization is offset by the increasing costs of obsolescence, i.e. degraded reliability and availability, increased maintenance and the lack of spare parts, supplier support, functional capabilities and experienced staff. A CRP on the scientific basis and engineering solution for the cost effective assessment of software based instrumentation and control systems resulted in the publication of a document on ways to improve assessment quality and reduce costs.

Member States are showing substantial interest in better understanding and managing component ageing processes, and in creating nuclear power plant life management strategies well in advance to maximize overall economic benefits within the necessary safety and operational margins. In this regard, the age distribution of reactors shown in Fig. 1 indicates that decisions on licence extension, retirement and decommissioning will become increasingly pressing in the future. Activities focusing on ageing and life management strategies in 2002 included:

- A session entitled 'Nuclear Power — Life Cycle Management' at the Scientific Forum during the Agency's forty-sixth General Conference. The participants emphasized the importance of disseminating experience on licence renewal and decommissioning, providing relevant guidance and identifying proven practices for safe and economic operation during both decommissioning and licence renewal.
- An Agency symposium in Budapest on nuclear power plant life management. The symposium:
  - emphasized the role of life management programmes in ensuring safe and reliable power plant operation;
  - stressed the importance of integrating the resources needed for plant life management and operation;
  - identified methodological and technological developments for managing ageing processes and understanding degradation mechanisms;
  - facilitated information exchange on national and international policies and life management strategies.
- Development efforts for an international database on nuclear power plant life management.

Agency databases help in analysing nuclear energy's potential for near term expansion and for its long term contribution to sustainable development. In 2002, the updated Power Reactor Information System (PRIS) was distributed on multiple media to more than 700 registered users. Selected components were also made available on the Internet *(http://www.Agency.org/programmes/ne/nenp/npes/index.htm)*. PRIS was also expanded to include data on non-electrical applications (industrial heat, district heating and desalination) and decommissioning.

The Agency's technical co-operation programme continues to make a significant contribution to the achievement of the scientific and development objectives of Member States. In 2002, scientific support provided to a range of technical co-operation projects emphasized:

- Infrastructure development and general preparation for a country's first (or new) nuclear power plant, with a particular focus on Africa, Asia and Europe;
- Improved operations management to optimize nuclear power plant performance, service life and decommissioning, with regional projects in Europe, East Asia and Latin America;
- Upgrading of nuclear power plant personnel training and qualification in response to emerging needs;
- Engineering aspects of power plant life management, especially in Europe and Latin America.

Table I shows the number of people who received training through these projects.

Nuclear Power Technology Development and Applications

The final report of a three agency study on innovative nuclear reactor development was published in 2002. A co-operative effort of the OECD's IEA and NEA and the Agency, the study reviewed the potential contribution of representative designs for new innovative fission technologies towards meeting the challenges facing such reactors and suggests areas for collaborative R&D. It emphasizes the need to make better use of the experience to date, to increase the cross-fertilization of ideas among those working on various reactor types, to take greater advantage of technologies and components developed in other industries, and to increase co-operation in R&D. The study was provided to both the US led Generation IV International Forum and the Agency's International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO).

Table I. **Training Activities Focusing on Nuclear Power in 2002**

Type of training	No. of people trained
Training courses	92
Workshops/technical meetings	388
Fellowships	40
Scientific visits	22

The Agency initiated INPRO in 2000 to help ensure that nuclear energy is available to contribute in fulfilling energy needs in the 21st century in a sustainable manner, and to bring together both technology holders and technology users to consider jointly the international and national actions required to achieve desired innovations in nuclear reactors and fuel cycles. During the year, INPRO was engaged in a full range of complex issues covering: the prospects and potential of nuclear power within the next 50 years; user requirements for innovative nuclear energy systems in the areas of economics, sustainability and environment; safety; waste management; and proliferation resistance. The INPRO Steering Committee met twice during the year and made extensive comments on the draft report of Phase 1A of the project. The report provides guidance for the evaluation of innovative nuclear reactors and fuel cycles covering all the issues mentioned above. The Committee will complete its review of the report prior to an Agency conference on innovative technologies for nuclear fuel cycles and nuclear power in June 2003. Interim results from INPRO were presented at conferences in Brazil, China, Croatia, France, India, Japan, the Republic of Korea, the Russian Federation, Spain and the USA.

To promote the continuous improvement of water cooled reactors, the Agency manages technical working groups (TWGs) on advanced technologies for LWRs and HWRs. The TWGs provide a global forum for exchanging information on national programmes, offer advice on Agency activities, and marshal support in Member States for co-operative projects. They played a central role in three Agency reports that were published in 2002:

- *Improving Economics and Safety of Water Cooled Reactors: Proven Means and New Approaches* reviews approaches that have improved economics and safety, and identifies promising new possibilities.
- *Heavy Water Reactors: Status and Projected Development* reviews HWR advanced technology related to fuel cycle flexibility, safety and economics, and development needs over the next two decades.
- *Natural Circulation Data and Methods for Advanced Nuclear Power Plant Design* examines

how safety systems based on natural circulation rather than forced flow — making them independent of active components like pumps and diesel generators — can help make safety systems simpler and potentially more economical, thereby potentially reducing costs for future nuclear power plants. It also describes several new designs that incorporate passive systems based on natural circulation.

On the basis of the report on natural circulation data, planning began in 2002 for a new CRP on natural circulation phenomena, modelling and reliability of passive systems that utilize natural circulation**.** The CRP will co-ordinate work in industrialized and developing countries on water cooled reactors using passive safety systems, including current advanced LWR designs and future supercritical water reactor designs.

Computer based tools are becoming standard components of training programmes. To assist Member States in nuclear education and training, the Agency sponsors the development of nuclear reactor simulators which operate on personal computers and which simulate responses of a number of reactor types (BWRs, PWRs and HWRs) to operating and accident conditions. These are training tools for university professors on nuclear energy and are also available to individual students, engineers and scientists. Major activities in 2002 included workshops on the application and development of advanced nuclear reactor simulators for educational purposes, and a special session at a workshop on nuclear data and nuclear reactors.

A new CRP, 'Studies on Advanced Reactor Technology Options for Effective Incineration of Radioactive Waste', was begun to help prove the practicality of long lived radioactive waste transmutation. It will provide a comparative assessment of the transient behaviour of advanced transmutation systems and the potential benefits for the back end of the nuclear fuel cycle that can be expected from partitioning and transmutation.

Work related to high temperature gas cooled reactors (HTGRs) focused during the year on: (1) physics and thermal-hydraulic code benchmarking; (2) advances in fuel technology; and (3) the potential for freshwater co-generation. With respect to physics and thermal-hydraulic code benchmarking, a CRP on HTGR performance evaluation completed its comparison and evaluation of participant calculations and prepared the CRP's first technical document for publication. The publication addresses thermal-hydraulic benchmark problems for the Japanese HTTR and the Chinese HTR-10 gas cooled reactors and compares different modelling approaches used by the various participants. A new CRP was started on advances in fuel technology, and an initial meeting was held on the advantages of HTGRs for desalination as a result of the availability of cost free waste heat. Data and information dissemination was also enhanced through refurbishment of the Agency's HTGR web site *(www.iaea.org/htgr)*. The HTGR knowledge base continued to attract more visitors in 2002, with an average of more than 25 000 hits every month.

The International Nuclear Desalination Advisory Group (INDAG) held its sixth meeting to exchange information on national and interregional progress and to review the Agency's work in this area. In other work, the Agency co-operated with the World Council of Nuclear Workers (WONUC) and the Moroccan Association of Nuclear Engineers (AIGAM) in convening a conference on nuclear desalination in Marrakesh. The conference highlighted technological advances in nuclear desalination, safety, economics and financing in the context of overall global water needs for sustainable development.

The Agency's interregional nuclear desalination project was expanded beyond its ongoing Indonesia–Republic of Korea joint study, with Tunisia embarking on a similar feasibility study with the Commissariat à l'énergie atomique of France, and Pakistan enlisting Agency assistance in launching its own demonstration project. A nuclear desalination unit will be coupled to the KANUPP plant in Karachi, with commissioning planned for 2005. And India started commissioning tests of its demonstration unit at Kalpakkam, while finalizing construction work on the distillation part of the unit.

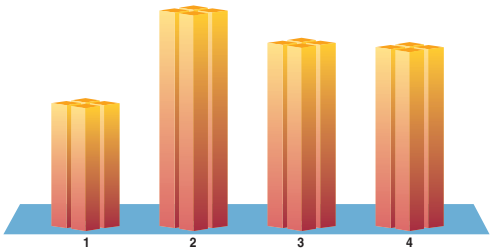
A new CRP on the economic analysis of nuclear desalination was launched in February. New publications include a report on the status of nuclear desalination plant design concepts, including a review of current experience as well as the status of cogeneration plants and dedicated heat plant concepts. The small and medium type reactors proposed range from water cooled to gas cooled and lead–bismuth designs. The desalination technologies proposed cover the spectrum of multi-stage flash, multi-effect distillation and reverse osmosis designs. Another publication completed during the year addressed the market potential of non-electric applications of nuclear energy.

Nuclear Fuel Cycle and Material Technologies

Objective

To increase the capabilities of interested Member States for policy making and strategic planning, technology development and implementation of safe, reliable, economically efficient, proliferation resistant and environmentally sound nuclear fuel cycle programmes.

Regular budget expenditure: $2 035 258
Extrabudgetary programme expenditure (not included in chart): $235 128



1. Uranium Production Cycle and Environment: $354 259
2. Nuclear Fuel Performance and Technology: $625 711
3. Spent Fuel Management: $534 092
4. Nuclear Fuel Cycle Issues and Information Systems: $521 196

Key Issues and Highlights

- A new report, *Environmental Remediation of Uranium Production Facilities*, was published jointly with the OECD/NEA. It presents the results of a survey of remediation activities in Member States.
- A study was completed on delayed hydride cracking in zirconium alloys. In the past, this has led to pressure tube failures in CANDU reactors and is thus of serious concern to all operators of PHWRs.
- A document on *Technical Aspects of Improving Proliferation Resistance of the Nuclear Fuel Cycle* was prepared which identifies the technologies that can enhance proliferation resistance and outlines how the resulting improvements can be measured.

Uranium Production Cycle and Environment

Accurate reporting of uranium resources is essential for planning nuclear development activities and for analysing nuclear power's potential role in national sustainable development strategies. In 2002, the Agency completed a study of uranium resource reporting by Member States over the past ten years. The study focused on differences in reporting practices, particularly for in situ resources in comparison with recoverable resources, i.e. in situ resources adjusted for mining and processing losses. The study found that many Agency Member States have reported only in situ resources, although recoverable resources are more relevant for intermediate term planning and are therefore the reporting standard for a majority of OECD/NEA Member Countries. The study has therefore been submitted to the Joint NEA/IAEA Uranium Group and to key Agency Member States with the recommendation that they also report recoverable resources in the future.

Two technical meetings were held in Beijing in September. The first reviewed recent developments in both the production of and demand for uranium resources, with special emphasis on China's own geology and on in situ leach mining. The second, a meeting of the Joint NEA/IAEA Uranium Group, completed a questionnaire for *Uranium 2003: Resources, Production and Demand* ("Red Book"). The questionnaire was then distributed to Member States in December.

A new report, *Environmental Remediation of Uranium Production Facilities,* published jointly with the OECD/NEA, presents the results of a survey of remediation activities in Member States. The remediation programmes surveyed typically include the following eight elements: (1) specific plans in compliance with relevant laws; (2) limits on residual impacts on the environment and the public; (3) proper containment of contaminants; (4) control of radon and radioactive dust emissions; (5) protection of water resources from contamination; (6) assessment of

human radiation doses; (7) minimization of future maintenance; and (8) minimization of any limits on public access to the site.

Another report, *Technologies for the Treatment of Effluents from Uranium Mines, Mills and Tailings* (IAEA-TECDOC-1296), also deals with production site remediation. It covers the full range of mining and milling effluents and provides details on treating effluents, on properly containing contaminants and on protecting water resources from contamination.

Radioelement mapping using gamma ray spectrometry data was the subject of another technical document that was prepared during the year. It discusses a range of case studies in which radiometric surveys were used to prevent unnecessary public exposure to radiation. Because gamma rays are the most penetrating form of radiation, from both natural and human made sources, gamma ray spectrometry is a powerful tool for monitoring and assessing radiation in the environment. The document also provides guidelines for the use of this technique, shares experience and describes the success stories in this field.

Nuclear Fuel Performance and Technology

The Agency began a new CRP on the 'Improvement of Models used for Fuel Behaviour Simulation' (FUMEX II) to assist Member States in improving the predictive capabilities of computer codes used in modelling fuel behaviour for extended burnup. Organizations from 19 countries and two international organizations (the European Commission and the OECD/NEA) are participating in the project. Improvements related to FUMEX I, which was completed in 1996, will focus on fuel thermal performance, fission gas release and pellet–cladding interaction at burnups above 50 MW·d/kg heavy metal (HM). The project will also address the performance at extended burnup of codes used for transient analysis, such as for reactivity initiated and loss of coolant accidents. This is a co-operative effort to integrate Agency codes with the OECD/NEA–IAEA International Fuel Performance Experiments (IFPE) Database.

Delayed hydride cracking (DHC) has in the past led to pressure tube failures in CANDU reactors and is thus of serious concern to all operators of PHWRs. It may also contribute to fuel cladding failure in other types of water cooled reactors. In this regard, a study was completed as part of a CRP on DHC in zirconium alloys used in PHWRs. The CRP achieved a very effective transfer of know-how at the laboratory level in three technologically important areas: (1) controlled hydriding of samples to predetermined levels; (2) accurate measurement of hydrogen concentrations at the relatively low levels found in pressure tubes and RBMK channel tubes; and (3) determination of DHC rates across a range of temperature and stress conditions. A new experimental technique to study short sections of fuel cladding tubes was developed by one of the participating laboratories, and it is anticipated that a new CRP will follow up with a detailed research programme using the technique to elucidate axial slitting of fuel cladding. Many of the study's results have already been published in scientific papers, and a formal report is being prepared.

To address the issue of fuel performance under today's already demanding operating conditions the Agency convened a Technical Committee Meeting on the causes and mitigation of fuel failures in water reactors. The meeting confirmed that failure rates have now been reduced to 10^{-5} (or 10 parts per million) or lower in nearly all countries operating nuclear power plants. To further reduce failures for the sake of better fuel cycle economics and shorter outages for system cleaning, the meeting focused attention on failures caused by flow induced vibration (FIV), as well as covering more traditional causes such as manufacturing defects, debris, improper fuel handling and pellet–cladding interaction. FIV has been a major cause of PWR fuel failure during the last decade, as shown in Fig. 1. It includes a number of different mechanisms and conditions, such as jetting at the baffles, excess cross-flow at the core periphery, excess cross-flow at the core bottom (vessel flow anomaly), distribution of mixing vanes, and their orientation in the grids, all of which need further research. To help compile data systematically, and to identify problematic conditions early, it was strongly recommended to utilities and fuel vendors that for all failures they carry out a detailed inspection/post-irradiation examination of affected fuel, analyses of reactor specifics and circumstances, loop tests, and modelling and simulation experiments.

The Agency helped to organize two international conferences on nuclear fuel, one on water chemistry in nuclear reactor systems, in April in Avignon, France, and the other on the characterization and quality control of nuclear fuels, in December in Hyderabad, India. Apart from organizational work and arranging for fuel specialists from developing countries to attend both conferences, the Agency organized discussions in Avignon on the first results of a CRP on data processing technologies and diagnostics for water

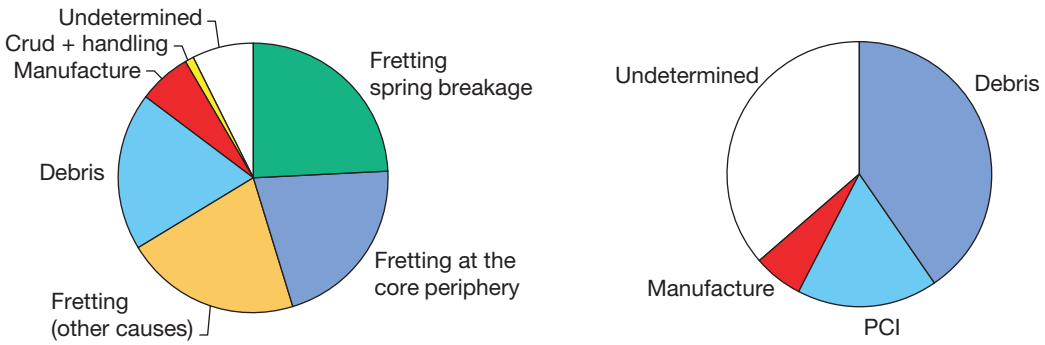


FIG. 1. Causes of rod failure in Framatome–ANP fuel between 1991 and 2002 for PWRs (left) and BWRs (right) (PCI: pellet–cladding interaction). Flow induced vibration includes all three categories of fretting in the figure.

chemistry and corrosion control in nuclear power plants. At the Hyderabad conference, the Agency presented key papers on advanced nuclear fuel cycles and advanced methods of fuel quality control.

Spent Fuel Management

Inventories of spent nuclear fuel are growing. By the end of 2002, about 255 000 t HM of spent fuel had been discharged globally. Approximately 84 000 t HM of spent fuel had been sent to reprocessing, with the remaining 171 000 t HM currently in storage. Figure 2 shows past trends and future projections through 2015 for spent fuel arisings, reprocessing and storage. The global pattern seen in the figure necessarily masks substantial variations, in both historical and projected trends, among different regions of the world due to different levels of nuclear development and different national spent fuel policies.

The Agency completed a CRP on spent fuel performance assessment and research (SPAR) and associated work on the application of burnup credits. Related work on the impact on extended storage of advanced fuel design, advanced reactor operations and mixed oxide fuel is currently under way. A new CRP was also begun on optimizing storage cask capacity.

To provide guidance to experts from Central and Eastern European Member States operating WWER and RBMK nuclear power plants, the Agency convened a technical meeting on dry spent fuel storage technology. A technical document prepared on the basis of this meeting will review the status of spent fuel storage and the associated R&D in Eastern Europe.

The selection of a technology for interim spent fuel storage is becoming an important issue for utilities and authorities in many Member States. Work began on a document to help guide the selection of options for away-from-reactor storage, which is anticipated to be in great demand in the immediate future. It addresses the full range of technical and non-technical factors that must be considered and criteria for the careful assessment of all options, taking into account the relevant functional requirements for the storage facility. Guidance on procedures and methods for project implementation is also provided, together with updated information on technical developments and other relevant trends.

A critical issue for technology selection will be the relative economic attractiveness of different options. A Technical Committee Meeting reviewed the existing data available in Member States as a first step towards updating those data and providing a consistent, broadly applicable approach to economic evaluation.

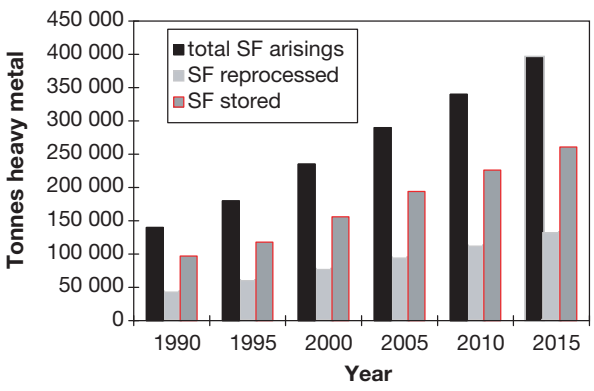


FIG. 2. Cumulative worldwide spent fuel (SF) arisings, reprocessing and storage, 1990–2015.

This was supplemented by activities providing guidance on data requirements and the maintenance of records for long term spent fuel management.

The development of guidelines on information management as required for long term spent fuel management was the focus of another set of activities that began in 2002. Currently, no consistent system has been established that could be used as an international reference. The availability of such a system is also in line with the requirements laid out in the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management that entered into force in June 2001. Using the services of consultants, the Agency identified technical and institutional features that should be considered in establishing data and record keeping requirements for spent fuel management. These will be compared in 2003 with national practices in Member States, and a preliminary draft set of recommendations will be formulated.

Nuclear Fuel Cycle Issues and Information Systems

To better address the challenges associated with technological innovation, fissile material management and the transfer of nuclear fuel cycle information, the Agency merged its Technical Working Group on Nuclear Fuel Cycle Options (TWG-NFCO) with its Advisory Group on Spent Fuel Management. The new group met for the first time in July to exchange and review information on the back end of the fuel cycle and to formulate advice on priority research and information needs. Complementing these efforts, work began on a technical document on the current status and future trends of high enriched uranium covering inventories, non-proliferation, physical protection, potential utilization and market issues.

Many Member States are examining the possibility of incorporating advanced partitioning and transmutation (P&T) techniques into the nuclear fuel cycle to destroy long lived radiotoxic elements. To support the progress made in the development of P&T techniques in general, a group of experts examined alternative methods and the appropriate scope for creating a database of important properties of minor actinides.

The nuclear fuel cycle industry has been reshaped in the past few years in response to increased competition as a result of the liberalization, deregulation and internationalization of electricity markets. An additional important impact on the market has been the introduction of excess nuclear materials from military programmes. To take account of these new developments, the Agency began updating the publication *Country Nuclear Fuel Cycle Profiles* (Technical Reports Series No. 404).

Increased proliferation resistance is a key objective of current work on innovative nuclear fuel cycles and systems. The Agency prepared a technical document on improving proliferation resistance that identifies the technologies that can enhance proliferation resistance and explains how the resulting improvements can be measured.

An important aspect of the Agency's nuclear fuel cycle programme is the development and maintenance of databases and simulation systems. These data sources, when regularly updated and revised, provide essential technical support for fuel cycle activities in Member States. For example:

- The Nuclear Fuel Cycle Information System (NFCIS) lists fuel cycle facilities around the world;
- The World Atlas of Uranium Deposits (UDEPO) provides information on the locations, geology, reserve components and grades of uranium deposits;
- The Nuclear Fuel Cycle Simulation System (VISTA) is used to calculate and estimate fuel cycle service requirements.

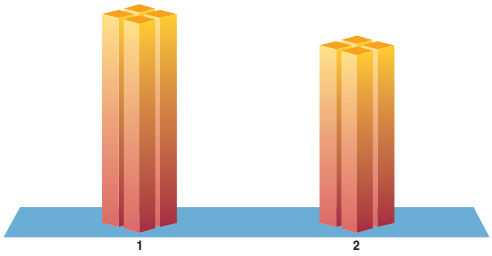
In addition, Agency wide efforts continued to integrate all nuclear fuel cycle databases and simulation software into a single package that would be available on the Internet for Member States.

Analysis for Sustainable Energy Development

Objective

To increase the capability of Member States to carry out their own energy and electricity sector analyses and investment planning, including the objective analysis of nuclear technologies and their alternatives for the purposes of sustainable energy development, and to ensure that Member States and various international organizations have access to state of the art information on nuclear power in the context of *Agenda* 21 (the action plan of the 1992 United Nations Conference on Environment and Development) and mitigation of climate change.

Regular budget expenditure: $2 382 938



1. Energy Modelling, Databanks and Capacity Building: $1 285 036
2. Energy–Economy–Environment (3E) Analysis: $1 097 902

Key Issues and Highlights

- Two Agency initiated "Type-2 Partnerships" were submitted at the request of the World Summit on Sustainable Development (WSSD) Secretariat — one on 'Indicators for Sustainable Energy Development' and the other on 'Designing Country Profiles on Sustainable Energy Development'.
- Four major national studies on future energy strategies were completed — for Indonesia, Lithuania, Poland and Sudan.
- In line with the outcomes of the ninth session of the Commission on Sustainable Development (CSD-9) and the WSSD, the Agency stepped up its capacity building activities related to sustainable energy planning, including training courses, the dissemination of improved data and analytical tools, new national studies and a workshop for training the trainers.

Energy Modelling, Databanks and Capacity Building

The international community, at CSD-9 in 2001 and WSSD in 2002, concluded that energy is central to sustainable development and that the lack of local planning and assessment capabilities in many developing countries is among the principal obstacles to progress. The CSD called on national governments and international organizations to focus on capacity building for sustainable energy development. The Agency's own efforts in this area include helping interested Member States, particularly those from developing regions, build the planning and analysis capacity to guide future choices for sustainable energy development. This assistance can include:

- transferring modern planning methods, tools and databanks;
- training for model set-up and application;
- interpreting, synthesizing and applying model outputs to policy formulation.

In 2002, the Agency substantially increased capacity building activities for sustainable energy development in Member States. Three major training events — one each for Asia, East Europe and Sub-Saharan Africa — and four national training courses were organized. In addition, one interregional training workshop was organized jointly with the International Centre for Theoretical Physics (ICTP) in Trieste. Altogether, more than 180 professionals from 46 developing countries and countries with transition economies took part, with the training covering the Agency's planning and assessment models and databanks. To leverage Agency resources, the Agency conducted its first workshop for 'training the trainers', which will speed capacity building, create regional training expertise that can be called on in future training programmes, and broaden the availability of modern models, tools and databanks in interested Member States.

Important updates to Agency databanks in 2002 included revision of the Energy and Economic Databank (EEDB), with the assistance of UNDESA, the World Bank, UNIDO, the World Energy Council, OECD/IEA, and the French Commissariat à l'énergie atomique. The EEDB update contains information on trends in energy production, energy use, nuclear power development and other energy technologies. Also updated was the Agency's database on energy, electricity and nuclear power estimates, which includes, among other things, a range of projections for nuclear power development up to 2020. Table I shows the latest high and low projections. The low scenario assumes only the completion of firm plans for new nuclear power plants and the retirement of old ones that have been announced by governments and utility companies. The high scenario reflects additional power plants that are included less firmly in government and utility plans, but are judged to be highly plausible by experts convened by the Agency.

The Agency also regularly updates and enhances its energy planning models to address the evolving priorities of Member States and other users. Major enhancements in 2002 focused on assessing the economic competitiveness of different energy options in restructured and liberalized energy markets with increased environmental controls.

In addition to general training and model maintenance, dissemination and support, the Agency provides direct assistance through its technical co-operation programme to interested Member States for national energy studies. Eight studies were conducted in 2002 — for Armenia, Bulgaria, Indonesia, Lithuania, Mexico, Poland, Sudan and the Syrian Arab Republic. Four were completed, with the remaining four near completion at the end of the year. Each study examines major energy planning issues in the respective country, analysing the technical, economic and environmental benefits and costs of *all* energy options. Long term scenarios for national energy development are also developed. In Armenia, Lithuania and Poland, these studies contributed to the preparation of national energy strategies and mid-term national plans. The results of the Lithuanian study, which focused on the broad issues associated with decommissioning the Ignalina nuclear power plant, were presented directly to members of the Lithuanian Parliament.

Table I. **Estimates of Total Electricity Generation and the Contribution by Nuclear Power (tw·h: terawatt-hour)**

Country group	2001			2010			2015			2020		
	Total elect.	Nuclear		Total elect.	Nuclear		Total elect.	Nuclear		Total elect.	Nuclear	
	TW·h	TW·h	%	TW·h	TW·h	%	TW·h	TW·h	%	TW·h	TW·h	%
North America	4342	841.2	19.4	5324	854	16	5632	819	15	5926	787	13
				5597	883	16	6085	895	15	6586	916	14
Latin America	1083	29.0	2.7	1271	29	2.3	1444	42	2.9	1621	43	2.7
				1546	43	2.8	1980	65	3.3	2441	78	3.2
Western Europe	3040	871.2	28.7	3606	810	22	3872	756	20	4191	605	14
				3805	868	23	4186	905	22	4569	1013	22
Eastern Europe	1736	284.7	16.4	1794	319	18	1966	346	18	2105	350	17
				1973	347	18	2338	402	17	2676	447	17
Africa	472	13.3	2.8	539	13	2.5	624	14	2.3	704	14	2.0
				617	14	2.3	774	27	3.4	918	30	3.2
Middle East and South Asia	1254	19.3	1.5	1551	41	2.6	1810	43	2.4	2095	42	2.0
				1721	47	2.7	2149	70	3.3	2658	92	3.5
South East Asia and the Pacific	648			795			911			1034		
				902			1100			1331	13	1.0
Far East	3088	484.8	15.7	3454	671	19	3869	754	19	4318	748	17
				4277	730	17	5163	920	18	6177	1114	18
World Total Low estimate	15 663	2543.6	16.2	18 334	2738	15	20 129	2774	14	21 994	2588 1	2
High estimate				20 439	2932	14	23 774	3284	14	27 357	3703	14

A CRP was completed on the role of nuclear power and other energy options in meeting international goals on greenhouse gas (GHG) emission reductions. The CRP's country case studies confirmed that in those countries with nuclear power, it has contributed, and continues to contribute, to the avoidance of GHG emissions. That is, were these countries not using nuclear power, they would be using predominantly fossil sourced generation alternatives producing significant air pollution and GHG emissions. In some countries new nuclear power plants also constitute a cost effective option for future GHG emission reductions. The Kyoto Protocol has not yet entered into force, nor would its limits be an immediate constraint in most of the countries represented in the CRP — they are economies in transition whose GHG emissions dropped sharply due to post-Cold War economic dislocations and are projected to be still below their Kyoto limits between 2008 and 2012. However, the CRP's studies showed that nuclear power can definitely help limit aggregate GHG emissions from Annex I countries during the first Kyoto commitment period (2008–2012) and thus help meet overall international goals for GHG reductions. More broadly, the CRP results showed that nuclear power is a cost effective, immediately available option for deep GHG emission reductions after 2012.

To assess the effectiveness of its capacity building activities, and as part of a new Agency process for programme self-evaluation, a survey was conducted of the end-users of energy planning and analysis models, data and services. The results show that the Agency's efforts have been deemed extremely helpful by the large majority of users. Many Member States have adopted and institutionalized Agency tools for national energy planning and, in some cases, to prepare national communications to the UNFCCC on GHG inventories. Agency tools are also being used for teaching and research at universities and research institutes. There is strong continuing interest in capacity building for sustainable energy development. To facilitate data dissemination, a web site providing information on all Agency activities in the field of sustainable energy development was created *(www.iaea.org/worldatom/Programmes/Energy/pess/pessindex.shtml)*.

Energy–Economy–Environment (3E) Analysis

To complement the national and regional studies that use the Agency's energy planning and analysis tools, the Agency undertakes selected studies that look particularly at interactions among the energy system, international markets, national economies and the environment. The focus is on economics and competition, environment and climate change, and sustainable energy development. Two such economic studies — both at the plant level — were initiated in 2002 in response to Member State interest. The first was on the assessment of compliance costs associated with increasing environmental regulation. The second was on cost assessment for major plant modifications such as upgrades, life extension and safety enhancements.

At the global level, the Agency provides input to a variety of UN deliberations and negotiations, including the WSSD and the Conferences of the Parties (COPs) to the UNFCCC. The WSSD was a major focus in 2002. In addition to the Agency's non-energy related contributions to sustainable development, presentations at Prepcom 3, Prepcom 4 and the WSSD highlighted its capacity building work for comprehensive energy planning, including efficiency improvement and carbon trading options, as well as the full range of supply alternatives. Fact sheets tailored to the WSSD were prepared on capacity building for sustainable energy development, Indicators for Sustainable Energy Development (ISED), and nuclear power and sustainable development.

The WSSD emphasized "Type 2 Partnerships", as they came to be known, "as mechanisms for the delivery of the globally agreed commitments by mobilizing the capacity for producing action on the ground". Over 250 such partnerships were announced at Johannesburg. The WSSD Secretariat asked the Agency to identify two of its capacity building activities as Type 2 Partnerships — specifically, the next stage of the ISED project and a new project starting in 2002 on Designing Country Profiles on Sustainable Energy Development (CPSED).

The first of these, Phase II of the ISED project, began in May 2002. It includes a new CRP to streamline and introduce the ISED package into the statistical regimes of participating agencies in Member States. Governmental partners are from Brazil, Cuba, Lithuania, Mexico, the Russian Federation and Slovakia. Other partners are the OECD/IEA, Eurostat, UNECE, UNDESA, the United Nations Divisions of Sustainable Development and Statistics, and OLADE. In 2002, all participating Member States compiled historical data, defined energy priority areas and selected relevant indicators from the ISED package to assess their current situations and evaluate current energy policies.

The CPSED project is designed to demonstrate, apply and transfer to interested Member States the

techniques needed to develop country profiles. First, the existing situation and current trends in a country are quantified using the indicators of the ISED project. These and the Agency's energy planning tools are then used to marry an assessment of past performance with a forward looking modelling package for monitoring the consequences of policy choices and course corrections. The project provides individual countries not just with assistance in creating a profile, but also with the means to replicate it as needed for continued policy guidance. Phase I of the project focuses on Brazil. Principal partners are the Centre for Biomass (CENBIO) of the University of São Paulo and the Graduate School of Engineering (COPPE) of the Federal University of Rio de Janeiro. The expert committee that oversees the project includes representatives of the Ministry of Environment for the State of São Paulo, the Federal Ministry of Mines and Energy, the Federal Ministry of Science and Technology, UNDESA, UN ECLAC, OLADE, and the World Energy Council member committee in Brazil.

The Agency's expertise in economic and financial assessments of nuclear energy's current prospects and potential was recognized in repeat requests for such analyses in internationally recognized financial publications. A strong emphasis this year on the economics of technology learning culminated in several presentations and publications, for example at the Tenth International Conference on Nuclear Engineering (ICONE–10) and the annual meetings of the American Nuclear Society.

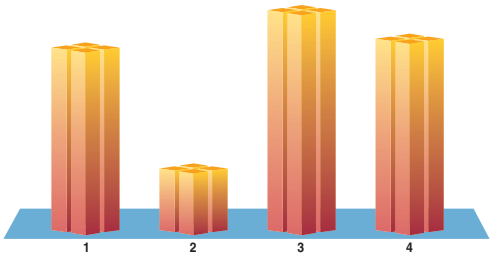
Within the Agency, economic analyses are also being provided increasingly as part of engineering, environmental or other technical assessments. Examples in 2002 include: an economic assessment of non-energy applications of nuclear technology (desalination, the hydrogen economy); expansion of efforts to provide training in cost–benefit analysis training for radiotherapy clinic administrators; and adaptation of the scenarios in the special report of the IPCC on emissions scenarios for the Agency's INPRO initiative depicting the future demand for energy services that might be satisfied using nuclear power. These adapted scenarios were presented and reviewed at an international meeting of the council of the Russian Academy of Sciences in Moscow.

Nuclear Science

Objective

To increase Member State capabilities in the development and application of nuclear science as a tool for their economic development.

Regular budget expenditure: $7 390 084
Extrabudgetary programme expenditure (not included in chart): $21 518



1. Nuclear and Atomic Data: $2 055 189
2. Research Reactors: $682 231
3. Nuclear Research Facilities and Instrumentation: $2 482 871
4. Maintenance of Knowledge in Nuclear Science and Technology: $2 169 793

Key Issues and Highlights

- User retrievals from the Agency's nuclear data web site grew by 32%.
- The Agency initiated a CRP on 'Improvement of the Standard Cross-sections for Light Elements', which will have a major impact on nuclear applications libraries.
- The Agency organized the 19th Fusion Energy Conference, which was held in Lyon, France. In addition, under Agency auspices the parties to the International Thermonuclear Experimental Reactor (ITER) finalized the Co-ordinated Technical Activities. They have requested continued Agency participation during the next phase, the ITER Transitional Arrangements.
- Within the framework of a tripartite initiative of the Agency, the Russian Federation and the USA, the first pilot shipment of Russian origin research reactor fuel from Uzbekistan to the Russian Federation, was negotiated and prepared. Shipment will take place in 2003.
- The Agency convened a major meeting on managing nuclear knowledge to identify priorities, and a subsequent General Conference resolution called for a greater Agency focus on: nuclear knowledge management; workforce ageing and data and knowledge retention; and assistance to Member States in preserving nuclear education and training.

Nuclear and Atomic Data

All nuclear technologies depend on atomic and nuclear data to provide accurate descriptions and quantitative understanding of the underlying processes employed for both energy and non-energy applications. The Agency co-ordinates a number of international networks and conducts in-house studies to help establish and maintain an extensive range of data libraries. In this regard, use of the Agency's nuclear data web server (*http://www-nds.iaea.org*) grew by 32% in 2002 due to regular updates and the addition of new data libraries developed through CRPs. Figure 1 shows these increased queries, across all geographical regions. Table I also shows a significant increase in requests for CD-ROMs.

Significant progress was made in 2002 on a new version of the primary nuclear reaction database that

Table I. **User Requests for Nuclear Data, 2000–2002**

Requests	2000	2001	2002
Internet retrievals from the main Agency nuclear databases	9642	12 894	20 773
Access through the Internet to other Agency files and information	11 472	16 153	18 135
Information on CD-ROMs	648	883	1108
Off-line retrievals	2557	2231	2548

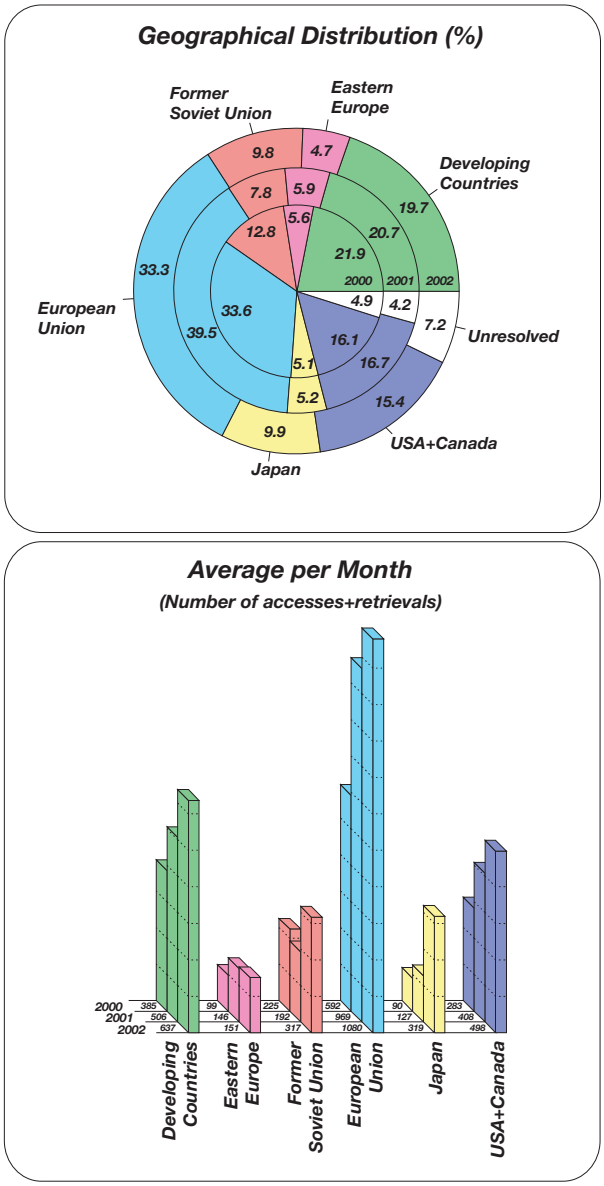


FIG. 1. Web accesses and retrievals for the IAEA–IPEN nuclear data services (IPEN, in Brazil, is the Agency's nuclear data mirror site web server in Latin America).

combines bibliographic (CINDA) and experimental (EXFOR) data. The database will be accessible through the web. The completed work packages include:

- Preparation of EXFOR and all related software;
- Documentation and transfer of administration functions to database managers;
- Creation of important segments of the CINDA database software.

In September the first meeting of a CRP on 'Improvement of the Standard Cross-sections for Light Elements' was held to define the work plan and the benchmarking procedures to be employed. The preparation of these standards data will have a major impact on all applications based data files and recommended procedures. The results from this CRP will be a useful input for the creation of more comprehensive libraries of this type by Member States.

Extensive data evaluations were completed in a CRP on 'X Ray and Gamma Ray Decay Data Standards for Detector Calibration and other Applications'. These new and revised data will improve the accuracy and reliability of nuclear measuring techniques for a wide range of scientific and industrial applications. The final library will be assembled, and documentation completed, by the end of 2003.

Cancer treatment using therapeutic radioisotope based nuclear medicine is becoming increasingly important, requiring evaluated nuclear data for the production of radioisotopes and to determine their decay characteristics. A CRP was initiated in 2002 to generate this information; preparations were made for the first Research Co-ordination Meeting in June 2003.

Nuclear fusion research is advancing at a rapid pace around the world. As part of its work in this area, the Agency convened a Technical Committee Meeting on 'Atomic and Plasma-interaction Data for Fusion Science and Technology' in Jülich, Germany. The main focus was on likely data needs in atomic and plasma-surface interactions and on specific data needs for fusion research.

Future fusion machines (such as ITER) will use the deuterium–tritium reaction and will have strict limits on the amount of tritium that will be allowed to accumulate inside a machine. A CRP on the tritium inventory in fusion reactors was initiated with the aim of quantifying interaction and transport of tritium within fusion reactors. The initial Research Co-ordination Meeting reviewed current data and research needs and formulated a comprehensive work plan.

Research Reactors

Under a regional technical co-operation project on research reactor spent fuel options in Latin America, workshops and training courses were convened in Latin American countries in four areas: (1) characterization of current spent fuel inventories; (2) harmonization within the region of safety rules and regulations for the management and transport of spent fuel; (3) public outreach; and (4) study of all options for the long term management and disposition of spent fuel.

Work began during the year on two new projects. The first involved the preparation of a compendium of purpose-built facilities for research reactors so that designers can take advantage of the operating experience gained over the last 50 years. This experience has shown that the designs of specialized facilities can often be mutually exclusive. The second task concerns the development and qualification of new high density LEU research reactor fuels based on uranium–molybdenum alloys that will allow conversion from HEU to LEU of the highest flux reactors and make available a reprocessing fuel to replace silicide fuel, which has no reprocessing option.

The aim of a tripartite initiative of the Agency, the Russian Federation and the USA is the management and disposition in the Russian Federation of Russian origin research reactor fuel currently at facilities abroad. A meeting was convened to consider preliminary plans for fuel shipments, and the first pilot shipment of Russian origin fuel — from Tashkent, Uzbekistan, to Mayak in the Russian Federation — was negotiated and prepared. Shipment will take place in 2003, with the plan being to develop a programme for shipments from other participating countries. Successful implementation of this programme will alleviate safety concerns about corroded spent fuel at several facilities, while reducing proliferation risks associated with the remaining inventories of Russian origin HEU fuels.

A new CRP on 'Corrosion of Research Reactor Aluminium-clad Spent Fuel in Water' was initiated. It involves research in eight countries to obtain a better understanding of localized corrosion affecting aluminium based fuel cladding, and of water chemistry conditions that minimize such corrosion.

In a CRP on small angle neutron scattering (SANS), collaboration between laboratories in developing and developed countries resulted in the development of specialized detectors, monochromators and beam converging systems. These new components will help in the development of better SANS devices for materials investigations.

Financial constraints, ageing of facilities and lack of trained staff have hampered the operation and effective utilization of research reactors. A strategic plan is thus an essential tool in justifying the resources required for operation and management control of all relevant activities. To assist Member States in developing such plans, the Agency organized a workshop on 'Strategic Planning for Research Reactors' under a technical co-operation project for the Asian region. The main objective was to provide guidance to managers in preparing a strategic plan for their facilities. The importance of SWOT (strength–weakness–opportunities–threats) analysis as a management tool was stressed and a 'typical' strategic plan was presented for demonstration. The workshop's success was such that this activity will now be extended to other regions.

Nuclear Research Facilities and Instrumentation

In the field of fusion energy, the Agency organized the 19th Fusion Energy Conference, in Lyon, France. Significant advances were reported on the magnetic as well as inertial confinement of plasma for energy production. In magnetic confinement, the bulk of the work reported was on tokamak systems, but the physics and technology of more compact systems like stellarators and reversed field pinches have made significant progress, indicating their potential for the future. The technical details of four sites offered for ITER were presented at the conference.

In nuclear fusion research, spherical tokamaks, spheromaks and field reversed configurations are forerunners of potentially less expensive and more compact fusion reactors. The Agency convened a Research Co-ordination Meeting to review the status of research and chart directions for future work. The final report provides a road map for enhancing the potential of compact toroid plasmas for fusion power. To help foster co-operation and joint experiments between developed and developing countries, the Agency also sponsored workshops at ICTP on plasma diagnostics and industrial applications.

Under Agency auspices, the parties to ITER, i.e. Canada, the European Union, Japan and the Russian Federation, finalized the Co-ordinated Technical Activities, completing the engineering design of a 500 MW device. Four sites have been offered for ITER, and technical evaluations of these sites are nearing completion. The ITER parties have requested continued Agency participation during the next phase, the ITER Transitional Arrangements.

Nuclear techniques can contribute significantly to the development of new and modified materials relevant to information technology, energy management, environmental protection and human health. In 2002, an Agency advisory group reviewed current trends in ion beam applications. The group recommended greater networking between scientists from developed

and developing countries because R&D requires both ion beam facilities and a range of analytical techniques for materials characterization.

The Agency published the final report for a CRP on developing and characterizing semiconductor material by ion beams. It presents important results on diamonds, prepared by chemical vapour deposition, as radiation detectors in a high radiation environment, gallium arsenide for manufacturing devices working at high temperatures and high power, and lithium niobate for optical wave guides.

In a review of 12 software packages from different vendors for ion beam analysis, validation methods were identified to test accuracy, estimate errors and quantify differences between the programs. The review also revealed a continuing need for more data evaluation and model development. In another project, commonly available gamma ray analysis programs for routine low level and environmental sample analysis were compared. The comparison identified needed improvements in most of the software packages and the complementary software required for others.

To better define the thermal history of sedimentary basins in Algeria, and to estimate hydrocarbon reserves, the Agency helped the Centre for the Development of Nuclear Techniques and the National Geological and Mining Research Organization to establish a fission track dating laboratory. In Croatia, the Agency helped set up an electrostatic ion beam accelerator for ion beam analysis and materials modification.

The Agency's Laboratories at Seibersdorf provided technical support for activities related to the use and maintenance of nuclear instrumentation in Member States. Key efforts included:

- Characterizing materials by using accelerator based techniques in support of quantification procedures for the X ray fluorescence (XRF) analysis of biological and environmental samples;
- Improving the sample positioning system at the Agency's beam line in Zagreb, Croatia;
- Characterizing depleted uranium particles using microfluorescence;
- Evaluating software for XRF analysis;
- Developing a precise relocation procedure for radioactive microparticles;
- Developing a fundamental parameter method (including software) for XRF analysis with simultaneous excitation by iron-55 and cadmium-109 radioisotope sources;
- Installing and testing a new XRF spectrometer to meet system requirements for quality assurance and quality control;
- Assessing major interference effects in the XRF analysis of air particulates;
- Developing an instrument for recording environmental parameters with a global positioning system capability.

Maintenance of Knowledge in Nuclear Science and Technology

The use of nuclear technology relies heavily on the accumulation of knowledge — both technical information in documents and databases and knowledge in people, e.g. scientists, engineers and technicians. Recent trends emphasize the need for better nuclear knowledge management. The main reasons are that the nuclear workforce is ageing, and fewer young people are studying in nuclear fields at the university level. Indeed, a growing number of universities have given up nuclear education programmes altogether (Fig. 2).

In June, the Agency convened a meeting on managing nuclear knowledge, with the participation of experts from academia, industry and government. The meeting identified six priorities:

- Integration of existing nuclear data and information bases (in the Agency and in Member States) in the form of an easily accessible 'Nuclear Knowledge Portal';
- Promotion of the networking of institutions for nuclear education and training in Member States in co-ordination with existing activities;
- Development of guidance documents on the preservation of nuclear knowledge;

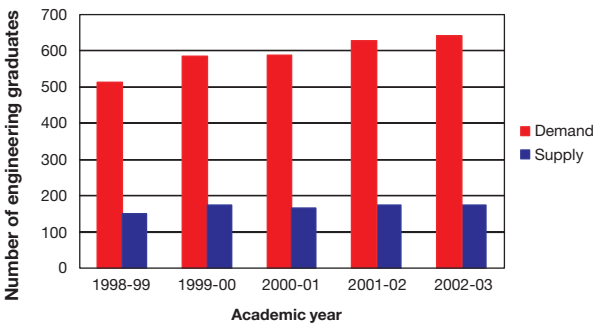


FIG. 2. Gap projected by the Nuclear Engineering Department Heads Organization between the near term supply and demand of nuclear graduates in the USA.

- Implementation of targeted 'preservation of knowledge' projects;
- Design and implementation of outreach activities that improve the general knowledge in society of the benefits of nuclear science and technology;
- Assistance in the development of curricula for internationally accepted higher university degrees on nuclear technology, e.g. by networking universities.

In September, the Agency's General Conference approved a resolution calling on the Agency to: increase the attention given to nuclear knowledge management activities; increase awareness of these activities; assist Member States in preserving nuclear education and training; promote networking; and identify ways to address the problems of workforce ageing and data and knowledge retention. In parallel, the Agency launched a new web site to disseminate information on its activities (*http://www.iaea.org/km/*), as well as two pilot projects — one on fast reactors and another on gas cooled reactors (GCRs).

Despite more than 40 years of R&D around the world on fast reactors, work in this area is currently confined to China, India, Japan, the Republic of Korea and the Russian Federation. Moreover, information is in danger of being lost even in these Member States as both the workforce and key facilities age. The Agency launched a new initiative on fast reactor technology knowledge preservation that seeks to establish a comprehensive international inventory of data and knowledge that could form the basis for fast reactor development 20–40 years from now. A web site *(http://www.iaea.org/inis/aws/fnss/index.html)* in sup-port of this initiative, and a parallel, web accessible, database on R&D programmes related to accelerator driven systems, continue to draw steadily increasing attention as sources of information and publications.

In the case of GCRs, knowledge has been accumulating for over half a century. The archives of milestone projects, such as DRAGON in the UK and AVR in Germany, contain valuable information for supporting current high temperature gas cooled reactor (HTGR) projects and future technology developments. Under this project, the Agency began building a knowledge base on HTGRs incorporating publicly available technical information.

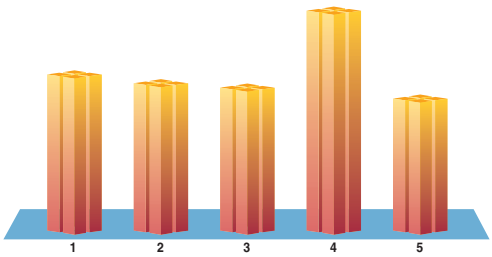
Food and Agriculture

Objective

To enhance capabilities within Member States for alleviating constraints to sustainable food security by the application of nuclear techniques.

Regular budget expenditure: $10 033 871
(including $1 846 321 from FAO)

Extrabudgetary expenditure
(excluding FAO): $263 532 (not included in chart)



1. Soil and Water Management and Crop Nutrition: $1 969 237
2. Plant Breeding and Genetics: $1 853 169
3. Animal Production and Health: $1 798 299
4. Insect and Pest Control: $2 745 731
5. Food Quality and Safety: $1 667 435

Key Issues and Highlights

- Capacity building was strengthened at both technical and policy levels to promote informed decision making on nuclear applications.
- Africa was the focus of increased Agency efforts in support of the United Nations 'Millennium Development Goals'. Significant progress was made at political, institutional and technical levels in tackling three strategically important constraints to sustainable agriculture in the region, i.e. the tsetse fly and trypanosomosis through the sterile insect technique (SIT), rinderpest and low reproductive efficiency of livestock through better diagnostic and intervention packages, and the low productivity of crops and cropping systems by developing improved varieties, cultivars and management practices using mutations and isotope techniques.
- The International Consultative Group on Food Irradiation (ICGFI) requested its Joint FAO–WHO–IAEA Secretariat to determine the interest among Member States in contributing to a new inter-governmental forum on food irradiation for improving the quality and safety of food supplies.

Soil and Water Management and Crop Nutrition

Many developing countries are coming under increasing pressure to intensify their agricultural production systems to meet their food requirements, but without degrading the environment. To meet this strategic goal, they need to identify and deploy management practices that promote both efficient and sustainable uses of their land and water resources. This integrated approach was successfully developed in eight countries of Latin America and the Caribbean and implemented through a network of multi-disciplinary, inter-institutional teams that conducted 42 field trials to test new management approaches. For example, the introduction of conservation farming practices such as zero-tillage and incorporation of crop residues reduced soil erosion and increased wheat yields and fertilizer use efficiency in southern Chile, compared with traditional cereal monoculture under intensive tillage with straw burning. Local farmers' associations promoted these technologies through media campaigns. Other major achievements included training of over 200 agricultural scientists, recognition of six isotope analytical laboratories by the Agency as regional laboratories for isotope analyses and the preparation of technical publications.

The high cost and limited supplies of manufactured fertilizers are major barriers to improving soil fertility and agricultural productivity in many developing countries. These problems can be alleviated by management practices that allow farmers to reduce costs by making the best use of all the nutrient sources available to them. Application of sewage sludge to agricultural land in Egypt raised yields of oilseed crops in sandy desert soils through the increased supply of nutrients and improved soil water-holding capacity.

Gamma irradiation of this sewage sludge and wastewater eliminated human pathogens.

The efficient use of scarce water resources is vital for agricultural productivity in many developing countries with arid and semi-arid climates. A technical co-operation project in eight countries of the West Asia region demonstrated that drip irrigation of vegetable crops and cotton saved as much as 30% of irrigation water without loss of crop yield or quality. In addition, delivery of soluble fertilizers through drip irrigation systems reduced nutrient losses, optimized crop uptake and minimized adverse effects on the environment. The results of this project influenced government policy in the Syrian Arab Republic and Jordan to restrict inefficient surface irrigation practices in favour of drip irrigation systems (Fig. 1).

Seven publications, including three technical documents, the proceedings of an international symposium, one training manual, one FAO Water Reports Series monograph and a special issue of the journal *Nutrient Cycling in Agroecosystems*, were issued in response to the growing demand from Member States for latest information about applications of nuclear techniques for improving the management of natural resources in agriculture.

Plant Breeding and Genetics

The cut flower market has an annual turnover of around $20 000 million. Many developing countries are trying to enter this lucrative and highly competitive global market in an effort to diversify and improve the overall competitiveness of their agricultural sectors. Malaysia and Thailand embarked on efforts to improve the competitiveness of their floriculture industries by developing new varieties with desired flower characteristics using gamma irradiation to produce mutations. A gamma growth chamber established at the Nuclear Technology Centre of Kasetsart University in Thailand has led to the official release of 22 mutant varieties of canna, six in chrysanthemum and many promising mutants in curcuma and other ornamentals. In Malaysia, one Dendobrium mutant was recently released and a 'gamma greenhouse' is now under construction to extend the approach to other flowering plants. The sustainability of the techniques has been promoted through a training programme on mutation assisted breeding for growers of ornamental flowers.

FIG. 1. On the basis of results from an Agency technical co-operation project, drip irrigation systems are beginning to replace surface irrigation schemes in arid areas. Shown here is a drip irrigation system in the Syrian Arab Republic.

Wheat is an essential crop for household food security in Kenya but its yield is low in drought prone areas. The Kenyan Agricultural Research Institute (KARI) was supported through a national and a regional technical co-operation project to develop wheat varieties that are more tolerant to drought. Seven years after seeds of the late maturing and tall wheat variety 'Pasa' were treated with mutagens, the breeding line KM 14 was developed. After evaluation for three seasons it was released in Kenya as Njoro-BW1 (BW = bread wheat), with many of the characteristics demanded by farmers and consumers alike, including short stature, early maturity under lowland conditions, good seed yield, moderate resistance to rust, high protein content, and good milling and baking qualities. In 2002, 300 multiplication plots of Njoro-BW1 were set up on farmers' fields. Other breeding lines developed through mutations are currently part of the Kenyan National Wheat Performance Trials.

About 900 million hectares of land worldwide have low crop productivity because of salinity and the poor quality of water used for irrigation. Considerable efforts have been made to increase the tolerance of rice to salt through conventional breeding, but progress has been slow because of the complex genetic nature of the tolerance trait. As an alternative approach, the Agency's Laboratories at Seibersdorf have pursued mutation induction using gamma irradiation. Seeds of two popular rice varieties, Bicol and IR29, were used for mutation induction, and after several generations six mutants of Bicol showing higher tolerance than the parent and two salt tolerant IR29 mutants were selected for further evaluation using molecular methods and in field trials. Using DNA techniques, a molecular tag for identifying mutant germplasm in future breeding programmes was developed. However, further investigations on genetically segregating mutant populations are needed

to confirm whether and to what extent the molecular markers are linked to the genes responsible for salinity tolerance.

Animal Production and Health

The control of transboundary animal diseases requires, amongst other things, reliable diagnostic methods based on reagents that can be produced in national or regional laboratories. During 2002, the Agency established sustainable production in over 15 African Member States of diagnostic kits for rinderpest and African swine fever based on immunoassay technology. The capability for differential diagnosis of rinderpest from other diseases using molecular methods was established in seven countries in Asia, seven in Africa and four in Latin America.

Through the production of CD based training materials and the provision of specialized training on quality systems management, over 25 Member States now have the ability to meet internationally agreed requirements for freedom from rinderpest. Six laboratories are already on the way towards accreditation under the ISO/IEC 17025 standard.

A further constraint to efficient livestock productivity in developing countries is the low genetic potential of their indigenous breeds of animals to produce milk and meat. This potential can be improved by the efficient delivery of artificial insemination services and the training of farmers in breeding management. These were promoted by the Agency through the transfer of progesterone radioimmunoassay (RIA). Inputs focused on enhancing the ability to sustain the use of RIA through local production of standards and quality controls in national laboratories and the production of iodine-125 labelled progesterone tracer in regional laboratories. Over 25 laboratories are now providing diagnostic support to veterinarians, technicians and farmers.

International trade issues concerned with the residues of veterinary drugs in animal derived food commodities are important for developing Member States seeking export markets for their produce. A number of laboratories were assisted by the Agency during 2002 in developing their capacity to screen for a range of these residues. Some now have quality systems in place, and laboratories in Malaysia and South Africa have achieved accreditation by recognized national authorities, thereby meeting export requirements.

Insect and Pest Control

The Agency continued its support to African Member States and the African Union to implement the Pan African Tsetse and Trypanosomosis Eradication Campaign (PATTEC) through one regional and six national technical co-operation projects. It encouraged close subregional co-operation through the development of binational or subregional strategic planning for integrated and area wide intervention campaigns using SIT (Fig. 2). It also joined FAO and WHO in the Programme Against African Trypanosomiasis (PAAT), which is a forum of major stakeholders to develop and implement technically sound standards and guidelines and harmonize efforts on tsetse and trypanosomosis interventions at the field level.

A workshop on PAAT–PATTEC harmonization led to the respective roles and responsibilities of the mandated organizations and major stakeholders being identified, criteria being established for identifying priority areas and delineating the approach for intervention against African animal trypanosomosis, namely the area wide integrated pest management

FIG. 2. A tsetse trap set up in the Ethiopian valley system. According to PAAT and PATTEC, this area has very high potential for sustainable, high productive agriculture and livestock development if it was free of tsetse.

concept in the wider context of sustainable agriculture and rural development. The workshop resulted in the first joint press release from the African Union, the Agency, FAO and WHO, and highlighted the consensus reached on joint international action against the tsetse and trypanosomosis problem.

Tsetse mass rearing will play an essential role in supporting the development of tsetse SIT programmes in Africa. A recently completed CRP led to the identification of major improvements to tsetse mass rearing systems and protocols, which are being transferred to rearing centres in Africa.

In other areas of SIT application, progress was made in the New World Screwworm eradication programme in Jamaica, and collaboration continued with the Arab Organization for Agricultural Development and FAO on a feasibility study for area wide intervention against the Old World Screwworm fly in the Middle East.

A regional effort between Israel, Jordan and the Territories Under the Jurisdiction of the Palestinian National Authority to control the Mediterranean fruit fly (medfly) using SIT and prevent the introduction of exotic fruit fly species resulted in a functional field team and a fruit fly identification laboratory being set up in Gaza. Aerial releases of sterile medfly males, jointly carried out by Israel and Jordan over the Arava/Araba Valley, contributed to an increase in exports of commodities to medfly free markets in the USA to $5 million in 2001 and to $8 million in 2002. In support of this project, the Agency's Laboratories at Seibersdorf shipped five million sterile male pupae per week to Israel to suppress medfly populations in the area.

In similar pest suppression work, mango growers in a pilot area in Thailand doubled their gross revenues by exporting 60% of their production to countries such as Canada, Malaysia and Singapore after SIT was used to control the Oriental fruit fly.

Food Quality and Safety

International standards are essential for facilitating trade in food and agricultural products between nations and for promoting food quality and safety within national boundaries. The Agency does not set such standards, but in recent years has increased its flow of information to the standard setting process within the relevant mandated international bodies. This was done mainly through scientific and technical outputs generated from CRPs, in-house research at its laboratories at Seibersdorf and deliberations within the International Consultative Group on Food Irradiation.

Significant progress was made in reaching international consensus on new and improved standards for ensuring the safety and quality of food in trade. With respect to food irradiation, revisions to the Codex General Standard for Irradiated Foods were agreed at the 34th session of the Codex Committee on Food Additives and Contaminants (CCFAC) and will be considered at its next session in 2003 for possible adoption at the 25th Session of the FAO/WHO Codex Alimentarius Commission (CAC).

At its 19th annual meeting in November 2002, ICGFI decided to continue international co-operation in the field of food irradiation by forming an International Forum for Food Irradiation under the aegis of the Agency, FAO and WHO. The legal framework, objectives and areas of activities will be circulated to the constituents of CAC and the International Plant Protection Convention (IPPC) with a view to encouraging broader participation within the agriculture and health sectors of Member States.

In addition to improving food safety, treatment with ionizing radiation is effective in eliminating insect pests of quarantine importance in fresh horticultural commodities in international trade. Recognizing this, as well as the results generated through a recently completed CRP on the subject, the Standards Committee of the IPPC approved *Guidelines for the Use of Irradiation as a Phytosanitary Measure* under the International Standards for Phytosanitary Measures. In related work, a highlight of an FAO/IAEA workshop was a trade trial of irradiated orchids conducted through commercial channels from Thailand to Australia to demonstrate the effectiveness of irradiation as a quarantine treatment against *Thrips palmi,* a target pest of Australia.

In the drive to improve access to information, the Agency implemented a dual Internet/CD-ROM strategy to aid in knowledge acquisition and retrieval of data on key food safety and security issues. The International Database on Insect Disinfestation and Sterilization (IDIDAS) now includes a Worldwide Directory of SIT Facilities and information on 308 pests of economic or quarantine importance. The International Food Contaminant and Residue Information System (INFOCRIS) was also upgraded to facilitate the addition or updating of information over the Internet in multimedia formats, and 560 new

pesticide entities or records were added to improve global availability of information on agrochemicals.

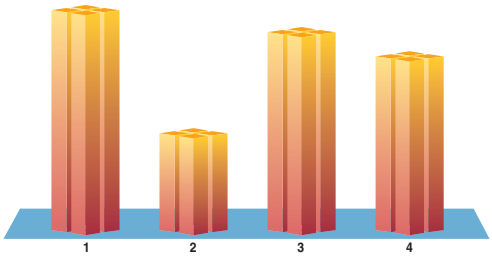
Key elements in the WTO's Agreement on the Application of Sanitary and Phytosanitary Measures (SPS) are the validation and accreditation of analytical methods, which are necessary to ensure the reliability and international acceptance of the results of food contaminant analyses and to remove some of the existing technical barriers to trade for developing countries. In addition to guidelines on method validation, training courses involving 64 participants from 34 Member States were held to address this problem. Analysis of questionnaires demonstrated that the participants are now better prepared and are applying their knowledge in their home countries. Concrete evidence of this is the growing number of laboratories that have achieved accreditation, including laboratories in Costa Rica and Singapore while laboratories in Colombia, Ecuador, Guatemala and Kenya have established compliance with ISO/IEC standard 17025.

Human Health

Objective

To enhance capabilities in developing Member States to address needs related to the prevention, diagnosis and treatment of health problems through the development and application of nuclear techniques.

Regular budget expenditure: $5 447 756
Extrabudgetary programme expenditure (not included in chart): $81 693



1. Nuclear Medicine: $1 742 732
2. Applied Radiation Biology and Radiotherapy: $758 411
3. Dosimetry and Medical Radiation Physics: $1 572 620
4. Nutrition and Effects of Contaminants on Human Health: $1 373 993

Key Issues and Highlights

- New procedures, developed as a result of Agency activities, strengthened the role of isotope based molecular methods in the management of important infectious diseases.
- Radiotherapeutic treatment of cancer remained a core priority.
- An international symposium was held in Vienna to review the status of standards and codes of practice in medical radiation dosimetry.
- The efficacy of nuclear methods in the management of multi-nutrient food supplementation was reconfirmed.

Nuclear Medicine

The Agency co-ordinated the development of an isotope based molecular method for use in multi-drug resistant tuberculosis (TB). Compared with the conventional technique, this method provides a simpler and more rapid procedure and has improved sensitivity. A total of 2150 samples, including 610 resistant TB strains, were subjected to strain typing. The Russian Federation immediately adopted the method, where it was used to demonstrate active infection transmission in a prison.

Isotope molecular methods were further developed for mutation analysis in 290 patients from Cyprus, India, the Islamic Republic of Iran, Mauritius, Pakistan and Thailand who were suffering from ß-thalassemia (a blood disorder). It was found that a milder form of the disease could be explained through well characterized mutations. The outcome of the study means that it will be possible to develop a simplified diagnosis strategy for families at risk and also to advise on the cost effective management of patients with a milder form of the disease.

Nuclear cardiology can play a significant role as a cost effective tool in patient management. In this regard, the involvement of cardiologists is critical for the expansion of nuclear cardiology services. The Agency convened an international symposium on cardiovascular nuclear medicine in Beijing, which was the largest international nuclear cardiology meeting in terms of the number of participating countries. The conference noted that currently the use of myocardial perfusion imaging in developing countries is quite low as compared with developed countries like the USA. For example, China with a population of over 1.3 billion carried out less than a million nuclear scans in 2001 (0.08% of the population per year), whereas the USA with a population of 275 million had nearly 5 million scans per year (1.8% of the population per year). The expansion of nuclear cardiology services and improvement of the quality of nuclear cardiology practices in developing countries were thus recognized by conference participants as major tasks requiring concerted international action.

Other key issues that were identified included: (a) further expansion of clinical applications, especially risk stratification and prognostication in patients with coronary heart diseases; (b) transfer of information on nuclear cardiology to clinicians, especially cardiologists

and primary care referring physicians; (c) increased training in nuclear medicine and cardiology to increase nuclear cardiology services; and (d) improved technology to produce better and less expensive equipment.

The first issue of the new quarterly *World Journal of Nuclear Medicine* was launched at the 8th Congress of the World Federation of Nuclear Medicine and Biology (WFNM&B) in Santiago, Chile. The main objectives of the journal are to promote research in nuclear medicine globally and particularly in developing countries, as well as to enhance good practices in nuclear medicine. The Agency is providing startup help to the WFNM&B in the publication of the journal with a financial contribution of $10 000 per year for two years (2002–2003).

A prototype of a PC based nuclear medicine computer system for upgrading semi-digital gamma cameras was developed, tested and validated. Eight Internet based teaching/self-study modules were developed on several nuclear medicine topics. The structure of a new Internet home page for instructors in nuclear medicine was developed containing case studies, multimedia training packages, slide shows and links to relevant web sites for collaborative research, teaching and self-study in nuclear medicine.

Thirty renal study and 32 cardiac study software phantoms were tested and validated for quality assurance. The tests were carried out as part of a comparison of clinical application software employed by nuclear medicine laboratories using software phantoms developed by the Agency and the European Association of Nuclear Medicine Sub-committee COST-B2 project.

The Agency plays a vital role in the introduction, promotion and integration of nuclear medicine techniques in the health care systems of developing Member States. One important aspect of this function is facilitating information exchange. To this end, the Agency developed and validated a conversion programme between two international medical file and image format standards, i.e. Interfile 3.3 and DICOM 3, for medical file transmission and exchanges between nuclear medicine centres.

Applied Radiation Biology and Radiotherapy

Brachytherapy, which is radiation treatment delivered by sealed sources placed temporarily into body cavities, is a very important method of cancer treatment, particularly in cancer of the uterine cervix and the esophagus, which are common cancers in many developing countries. Many more patients can be treated by a single high dose rate (HDR) brachytherapy machine than by using multiple low dose rate (LDR) brachytherapy units. However, some developing countries are still using LDR because HDR appears to cost more to install and maintain, thereby depriving patients of treatment in some cases. The Agency has developed a financial model that will help institutions evaluate the costs and benefits of HDR, not just in terms of the absolute cost but the cost per patient treated.

There is much current interest in combining radiotherapy with complementary non-nuclear technologies for improving the outcomes of cancer patients. Research projects in this area were concluded in 2002. The addition of Mitomycin-C, a chemotherapy agent that in some circumstances has been shown to also act as a radiation sensitizer to radiotherapy for cancers of the head and neck, was studied in a clinical trial with nearly 600 patients from 8 institutions. The research will lead to more rational utilization of Mitomycin-C and similar drugs in the treatment of head and neck cancers.

The Agency's activities in radiation therapy also included the study of non-malignant conditions such as atherosclerotic artery disease (blocking of the arteries). Millions of patients all over the world with athero-sclerotic coronary artery disease are treated every year by angioplasty and stent placement (artery clearance and support), but restenosis (re-blocking) of the blood vessels is a major cause of morbidity and mortality. These patients can benefit from endovascular brachytherapy, which assists in retarding further blockages. Using the services of consultants, the Agency assessed the state of the art in the field of endovascular brachytherapy and identified areas that require further investigation for the optimum utilization of this technology.

Dosimetry and Medical Radiation Physics

In collaboration with WHO, the Agency maintains a network of Secondary Standards Dosimetry Laboratories (the SSDL network) within Member States for the correct measurement of ionizing radiation, which is essential for the safe and effective diagnosis and treatment of patients as well as for monitoring radiation levels for persons exposed occupationally.

The SSDL Scientific Committee, an advisory committee to the Agency, conducted a detailed examination of all of its activities in dosimetry and medical radiation physics. Among others, a recommendation for the introduction of a Medical Physics Investigation Team was proposed to resolve and mitigate the possible misadministration of doses to patients, detected either by the IAEA/WHO postal dose audit programme, or upon request by hospitals in Member States.

An international symposium on standards and codes of practice in medical radiation dosimetry was organized by the Agency in Vienna from 25 to 28 November to foster the exchange of information and highlight recent advances in research in this field. A key issue was knowledge of the accuracy of radiation doses delivered to patients, which is essential for the safe and effective diagnosis and treatment of disease. Such accuracy in dose measurement is an integral part of a comprehensive quality assurance programme to ensure that the technology is used properly and has the intended effect on patients. Recommendations were made emphasizing the importance of education and training of health care workers, the need for improved infrastructural services in medical physics and diagnostic radiology to support the new treatment methodologies and quality control and assurance programmes to provide the auditing tools necessary to demonstrate the effectiveness of nuclear technology. Recommendations specific to dosimetry emphasized the need for robust dose standards, with well characterized uncertainty estimates, and wider application of the Agency's dosimetry code of practice, *Absorbed Dose Determination in External Beam Radiotherapy* (IAEA Technical Reports Series No. 398).

A plenary session entitled "Meeting the Needs" was held during the symposium on medical radiation dosimetry. The purpose of this session was to draw attention to the impending crisis in cancer management in developing countries. According to a presentation by WHO's International Agency for Research on Cancer (IARC), the incidence of cancer in developing countries is expected to increase by about 50% within the next decade, primarily because of the increase in lifespan as a result of improved standards of living (Fig. 1). The Agency has a unique opportunity to help its Member States address the seriousness of this prediction by increasing its efforts to transfer cancer treatment technology and to develop expertise locally for its safe and effective use.

A report on the use of bio-dosimetry with tooth enamel was published for use in retrospective dose assessments of accidentally exposed persons. More accurate evaluation of the dose received would enable the selection of appropriate countermeasures to mitigate the effects of the irradiation. A second report was published on standardized methods to calibrate the radiation sources most commonly used in brachytherapy and in the rapidly growing field of cardiovascular angioplasty. Harmonized methods for source strength and patient dose determination should simplify the comparison of treatment results and form a solid basis for the improvement of treatment techniques.

Nutrition and Effects of Contaminants on Human Health

Agency research on stable isotopic techniques for the prevention of degenerative diseases in developing countries was completed, contributing to the search for solutions to the problem of obesity that is reaching epidemic proportions in developing countries. An important outcome has been the development of a harmonized standard protocol applicable to multi-country studies for body composition and physical activity measurements. The results suggest that total body fat and its topography are perhaps the most important predictors of the evolution of the insulin resistance syndrome. Importantly, these studies in several developing countries highlighted the role of dietary intake, including variations in the quantity, composition and quality of the diet and the relationship of body composition to physical activity patterns, in understanding the immediate risk factors associated with non-communicable diseases.

The results of an evaluation of the Community Nutrition Project in Senegal were used to refine the Senegalese Nutrition Programme planned for imple-

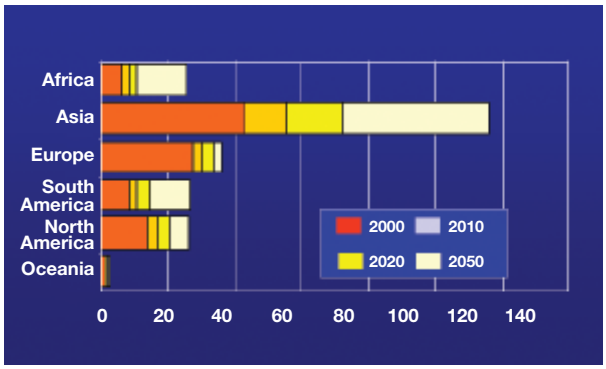


FIG. 1. Increase in the number of cases of cancer worldwide by region. Courtesy of Sharon L. Whelan (IARC).

Isotope Techniques in Action in Developing Countries

An Asian regional technical co-operation project measured the effectiveness of multi-nutrient supplementation, guiding the industrial sector in choosing the best fortificants for national nutrition initiatives that address micronutrient malnutrition. Another regional project, in Latin America, on isotopes for evaluating nutrition intervention programmes, resulted in the extended use of isotopic techniques in understanding human body composition. Such projects build and strengthen capacity in the use of nuclear and related isotopic techniques for nutritional monitoring. For example, a project focusing on Latin America led to modifications of existing programmes for enhancing the effectiveness of national health initiatives in Chile, Cuba and Mexico.

mentation between 2002 and 2012. In related work, the findings from an evaluation of national Supplementary Feeding Programmes in Ghana on the nutritional status of mothers and infants using stable isotope techniques will be used by the Ministry of Health to strengthen future nutrition projects in the country.

The prevalence of low birth weight (LBW) is estimated to range between 3 and 38% worldwide, with the majority of cases occurring in less developed countries (in fact reaching 24% of all births annually and resulting in 30 million infants being identified with intra-uterine growth retardation (IUGR)). Low birth weight is a major determinant of mortality, morbidity and disability in neonates, infancy and childhood, and also has a long term impact on health outcomes in adult life. It also results in substantial costs to the health sector and imposes a significant burden on society as a whole. To address this problem, the Agency, together with WHO, held several meetings on IUGR and the impact of ageing at which common areas in the field of nutrition for joint IAEA–WHO projects in 2003 were identified.

A recently completed regional technical co-operation project on trends in air pollution resulted in the 15 participating countries acquiring the capability to assess air particulate pollution using reliable and standardized methods. In addition, a network of analytical laboratories and institutions involved in environmental pollution monitoring or air quality management was established, and baseline data on airborne pollution in the ambient air in metropolitan centres were collected. Other examples of Agency regional technical co-operation projects are given in the box above.

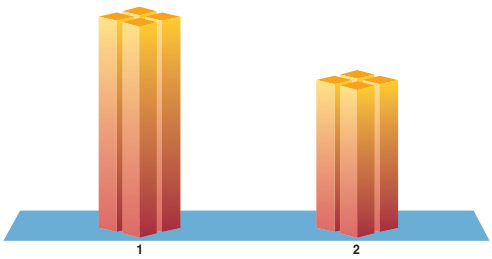
A novel approach to biomonitoring was used in a research project on the validation and application of plants as biomonitors of trace element atmospheric pollution. Project participants were trained in the use of mosses, lichens or plants in assessing the levels of atmospheric deposition of heavy metals. Biomonitoring surveys were carried out in the 14 participating countries, spread over large geographical areas under different climatic conditions, revealing individual pollution sources for each area. Graphical pollution distribution maps were then created for each country, which provided the authorities with an illustrative assessment of air pollution levels. The results were also disseminated in a range of technical publications.

Water Resources

Objective

To increase the capability of Member States to improve the integrated management of water resources and geothermal resources, as well as specific water supply infrastructures, through the use of isotope technology.

Regular budget expenditure: $2 695 023



1. Isotope Methodologies for the Protection and Management of Surface Water, Groundwater and Geothermal Resources: $1 579 712
2. Reference Isotope Data and Analysis for Hydrologic Applications: $1 115 311

Key Issues and Highlights

- On behalf of the UN system, the Agency celebrated World Water Day 2002 with the theme of "Water for Development".
- The Agency moderated interagency events on water resources at Preparatory Committee meetings of the World Summit on Sustainable Development (WSSD), and at the Summit itself in Johannesburg.
- A new CRP on isotope monitoring of river discharge attracted a large number of proposals from both developed and developing Member States, reaffirming the relevance of the research topics undertaken and the role of the Agency in international research.
- A new age-dating capability for young groundwater using helium-3 and tritium was developed by the Agency to provide improved services to Member States for groundwater age assessment.

Isotope Methodologies for the Protection and Management of Surface Water, Groundwater and Geothermal Resources

The role of the Agency in water resources management was substantially enlarged through its promotion of the use of isotope hydrology. The Agency's presentation at a panel discussion on water at the WSSD in Johannesburg emphasized the part that science and technology can play in meeting the goals for sustainable development of water resources. Two interagency 'side events' on water resources management highlighted the *World Water Development Report* (WWDR) to which the Agency contributed. The document is being produced as an interagency synthesis report on the state of freshwater resources around the world.

The potential impact of climate change on water resources is an issue of concern that is being investigated by many international scientific programmes. Characterization of moisture sources in local precipitation is of importance to better understand climatic relationships. The Agency maintains the database of the IAEA–WMO Global Network for Isotopes in Precipitation (GNIP). The Internet site for this database *(www.isohis.iaea.org)* has graphical representations of data as well as animations of monthly maps which have been developed to provide a visual evaluation of spatial and seasonal variations in isotope data. The role of global isotope data from GNIP was highlighted at a meeting of the Global Energy and Water Cycle Experiment (GEWEX) project, which is managed by WMO and focuses on international efforts in hydrology and meteorology to develop an understanding of the Earth's energy and water cycle. In addition, a joint project is being formulated to use isotope data from GNIP for improved modelling of moisture sources in precipitation. One of the benefits of this project is a strengthening of GNIP.

A Memorandum of Understanding was signed between the Agency and UNESCO to launch the Joint International Isotopes in Hydrology Programme (JIIHP). The first meeting of the JIIHP steering

"Water for Development": Celebration of World Water Day 2002

The Agency launched the World Water Day 2002 celebrations, at its headquarters in Vienna, by stressing the role of science and technology in the use and management of water resources. As the lead organization for this event on behalf of the UN system organizations, the Agency initiated and co-ordinated a number of activities and events. Among the highlights were:

- A press release — distributed worldwide — that underlined the challenges of water for development;
- An art exhibition by children from schools in Uganda and Austria on 'Water for Development';
- A dialogue on water for development, with distinguished speakers from governments, non-governmental organizations and intergovernmental agencies.

Nearly 3000 copies of promotional materials were distributed, and a summary report on the celebrations was produced.

The Honourable Mrs. Bijoya Chakravarty, Minister of State for Water Resources in India, addressing the gathering at the inaugural session of the World Water Day 2002 celebrations on 22 March 2002 at the Vienna International Centre.

committee in June 2002 produced a work plan for 2002–2005 and led to the initiation of training activities. As part of this joint programme, a training course in hydrogeology was organized at the Institute of Fluid Mechanics and Environmental Engineering of the University of Uruguay, in Montevideo, with trainees from the Latin American region.

The development of academic training programmes focusing on the use of isotope techniques for hydrologists is a key requirement for the transfer of water sector skills to developing countries. Isotope hydrology is now included in a post-graduate programme at a university in India; the Agency also assisted the College of Water Resources and Environmental Engineering at Hohai University, Nanjing, China, to establish its new post-graduate semester course.

Stable isotopes of water and radioactive tracers have been used in the regular monitoring programme of geothermal production fields in Central American countries, with the results being used to support decision making on geothermal reservoir

management. This contributed to the improved management of the Miravalles geothermal field in Costa Rica, which had encountered a rapid decline in reservoir pressure over the last eight years of power generation.

Reference Isotope Data and Analysis for Hydrologic Applications

The Agency is developing a tritium–helium isotope measurement capability for the age-dating of young groundwater with the aim of integrating the use of helium isotopes in methodologies for water resources assessment. High tritium concentrations in precipitation resulting from atmospheric nuclear testing provided an easy means for determining the presence of post-1950 groundwater recharge and for estimating travel times to the water table. The atmospheric tritium concentration has, however, been decreasing and is currently almost at its pre-1950 natural level. Tritium–helium dating has been shown to be an effective and powerful tool for obtaining groundwater ages of the order of 1 to 50 years. The expected outcome is an improved ability of Member States to use isotope applications for the assessment and protection of groundwater resources.

A new CRP with 17 research groups worldwide was launched in March 2002 with the aim of developing a methodology and a monitoring network to understand hydrological processes in large river basins. The research will:

- Show the potential of isotope tracers in discerning the underlying causes of variability in the water-cycle of large river basins;
- Develop and test the application and transferability of isotope techniques in a wide range of hydrological settings over the next five years;
- Contribute to a better scientific understanding of water cycling processes on a larger scale, and seek to clarify the potential value and limitations of incorporating isotope techniques in a global network for isotopes in rivers.

Three technical co-operation projects related to aquifer systems were initiated in collaboration with UNESCO and UNDP/GEF. These projects — shared by several countries in northern Africa — focus on investigations of the:

- Nile Basin Aquifer system shared by the Democratic Republic of the Congo, Egypt, Ethiopia, Kenya, Sudan, the United Republic of Tanzania and Uganda.
- Nubian Aquifer system shared by Chad, Egypt, the Libyan Arab Jamahiriya and Sudan.
- Northwestern Sahara Aquifer system shared by Algeria, the Libyan Arab Jamahiriya and Tunisia.
- Iullemeden Aquifer system shared by Mali, Niger and Nigeria.

Isotope techniques will be employed to understand the recharge/discharge processes as well as groundwater dynamics for sustainable development and management of these aquifer systems. Successful implementation is expected to lead to improved socioeconomic development in the regions. A similar project on the Guarani Aquifer in the Latin American region has already been initiated.

Several technical co-operation projects in water resources development and management were implemented in the African, Middle Eastern and Asian regions. In these projects, the application of isotope methods was demonstrated to be a powerful tool to build a scientific basis for policy and management decisions, as shown below:

- In Senegal, the successful contribution of isotope techniques for the determination of aquifer parameters resulted in the formulation of a new World Bank funded programme to prepare the national water management strategy;
- In Morocco, isotope results were used to revise the groundwater flow and transport model developed for the Tadla Plain;
- In Yemen, the isotope investigation of groundwater system in the Sana'a Basin identified the nature and source of recharge to shallow groundwater for understanding the efficacy of artificial recharge measures;
- In the Philippines, a project on the water supply for Davao City on the island of Mindanao provided a scientific basis for judicious groundwater management and protection in the region.

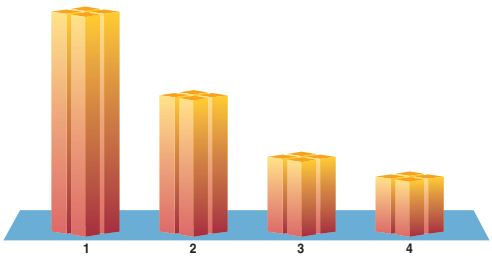
Protection of the Marine and Terrestrial Environments

Objective

To increase the capability of Member States in the identification and mitigation of marine and terrestrial environmental problems due to radioactive and non-radioactive pollutants.

Regular budget expenditure: $3 238 961

Extrabudgetary programme expenditure (not included in chart): $644 790



1. Measurement and Assessment of Radionuclides in the Marine Environment: $1 462 124
2. Transfer of Radionuclides in the Marine Environment: $905 350
3. Monitoring and Study of Marine Pollution: $499 655
4. Measurement and Assessment of Radionuclides and Non-Radioactive Pollutants in the Terrestrial Environment: $371 832

Key Issues and Highlights

- The underground counting laboratory for low level radionuclide measurements at the IAEA Marine Environment Laboratory (IAEA-MEL) was inaugurated in November 2002.
- Advanced aquaria facilities at IAEA-MEL were upgraded to incorporate tropical regimes for radiotracer studies of heavy metals arising from mining activities in sensitive tropical ecosystems.
- IAEA-MEL collaborated with the Caspian Environment Programme on a contaminant screening project with results that will guide environmental management in the Caspian Sea region.

Measurement and Assessment of Radionuclides in the Marine Environment

The IAEA-MEL Global Marine Radioactivity Database (GLOMARD) was used to estimate radiation doses to critical groups in the northeast Atlantic region arising from: civil nuclear site discharges; solid radioactive waste disposals in the northeast Atlantic Ocean; fallout from Chernobyl and past nuclear weapons testing; and naturally occurring radionuclides. The estimated radiation doses from marine pathways to critical groups in the region fell below the annual dose threshold for the public recommended by the Council of Europe.

A computer model, which can be used on a global scale for predicting the transport of radioactive discharges from nuclear facilities and for modelling emergency situations on a regional scale, was developed to estimate the dispersion of radionuclides in the world's oceans. Caesium-137 profiles in sea water, calculated using global fallout data, agreed well with experimental data obtained between the 1960s and 1990s at more than 150 sites, mainly in the Pacific and Atlantic Oceans.

Analyses of seawater samples collected during an expedition to radioactive waste dumping sites in the northeast Atlantic, organized in conjunction with the Institute of Radioecology in Hamburg, were completed. Measured concentrations of tritium, strontium-90, caesium-137 and plutonium isotopes in the water column did not show clear evidence of leakage from dumped containers of radioactive wastes.

Major concerns have arisen recently over the deteriorating environmental condition of the Caspian Sea, especially in terms of observed sea level changes. Recent climatological studies show that the sea level fluctuations are caused by variations in the river inflows, with lesser impacts from rainfall and evaporation. Oceanographic and isotopic investigations of the Caspian Sea were used to develop a model to explain past environmental changes, and in this way to help protect this unique ecosystem from the impact of human activities.

Prince Albert of Monaco inaugurated the IAEA-MEL Underground Counting Laboratory (UCL) in

November 2002. As an extension of existing facilities, UCL provides new and sensitive instrumentation for the detection of low level radioactivity in the ocean, in an environment that significantly reduces background radiation around the detectors. Detection limits for the analysis of radionuclides are improved by more than a factor of ten. This in turn allows measurements using smaller amounts of sea water, or other marine samples, significantly reducing sampling costs. Extrabudgetary contributions from the Governments of Monaco and Japan supported UCL's construction.

Assistance was provided to Member State laboratories in the framework of the Agency's Analytical Quality Control Services (AQCS) programme for the analysis of radionuclides in the marine environment. Intercomparison exercises, proficiency tests, provision of reference materials, and training in analytical quality management were organized (Fig. 1). Certification of the reference material IAEA-384 (Fangataufa Lagoon sediment) was completed and the material is now available to laboratories for quality assurance and quality control of analytical data.

Transfer of Radionuclides in the Marine Environment

Nuclear techniques have significant advantages in the evaluation of the behaviour, transport, fate and impact of radionuclides and conventional contaminants in the marine environment. IAEA-MEL studied these processes, focusing on tropical and other pollution sensitive coastal ecosystems. Radiotracer experiments were carried out to investigate the bioaccumulation and retention of radionuclides and toxic heavy metals in key marine biota from tropical coastal environments exposed to metal contamination from land based mining activities. Contamination of lagoon ecosystems in New Caledonia, where mining is the main resource of the island, was selected as a model case study, and a joint research effort was carried out in collaboration with the French Institute of Research for Development (Noumea IRD Centre). The findings suggest that certain lagoon organisms could be excellent bioindicators of metal and radionuclide contamination, which is important for decision makers involved in establishing coastal zone monitoring and management criteria.

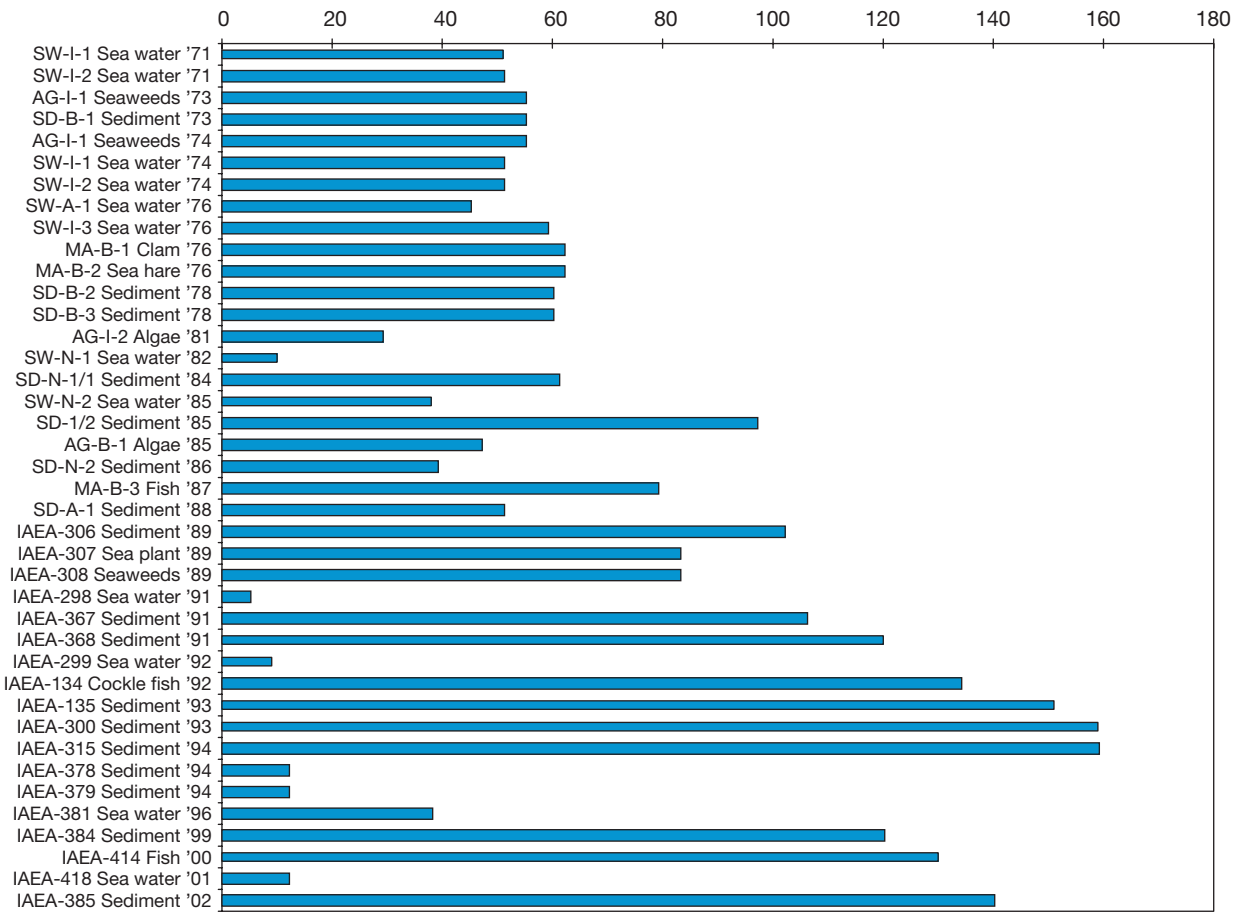


FIG. 1. Number of laboratories participating in intercomparison exercises and proficiency tests organized by IAEA-MEL for radionuclides in the marine environment.

The surface microlayer of the sea, i.e. the upper few hundred micrometres of its surface, is an important — but also one of the least understood — regions of the marine environment. It is generally enriched in metals, organic matter and contaminants, yet its role in the transfer of pollutants to underlying waters, or to the atmosphere, is not well known. In a project supported by the European Union and various institutes, IAEA-MEL carried out field experiments to examine the structure and role of biological communities involved in the transfer of persistent pollutants at the air–sea interface, and to assess the importance of the surface microlayer as an accumulator of radionuclides. Measurements have already demonstrated that particulate carbon and polonium fluxes at 40 cm below the surface microlayer were closely related, confirming the strong affinity of polonium for organic matter. Knowledge of the behaviour of such natural radionuclides in the surface microlayer can furnish clear insights into the transfer and fate of other metal contaminants.

Financial losses to fishing industries from harmful algal bloom (HAB) events are significant, often reaching several million dollars per event in areas with extensive wild or cultured shellfish industries. The incidence of HABs is increasing, and has additionally led to illness and loss of life. Two national technical co-operation projects, in Chile and the Philippines, received technical support from IAEA-MEL, as did a regional RCA project and another interregional project. The goal in all of these efforts was to assist in toxin testing by transferring technology, specifically the use of radiolabelled receptor binding assays, for harmful algal toxins. Under the interregional project (and in close collaboration with the Agency's Laboratories at Seibersdorf), development work began on the technical aspects of radiolabelling these toxins with tritium.

Monitoring and Study of Marine Pollution

Quality assurance programmes promoted by the Agency assist Member State laboratories and regional laboratory networks in gathering reliable environmental data. Worldwide intercomparison exercises are implemented that utilize specific marine samples for use as reference standards. For example, an Agency sediment sample (IAEA-417) was distributed to laboratories for the analysis of chlorinated pesticides and petroleum hydrocarbons. Ninety-seven laboratories in 46 countries participated, including 74 laboratories belonging to the UNEP Regional Seas laboratory network.

The analytical capability and efficiency of the Marine Environmental Studies Laboratory (MESL) was improved in 2002 by the acquisition of a unique ultra-sensitive solid sample analyser (AMA-254) for mercury, a heavy metal poison of increasing concern in marine foods. This ability to track inorganic, organic and radioactive forms of mercury in the sea has made MESL an international centre of excellence in marine pollution.

The Caspian Environment Programme (CEP) is an intergovernmental initiative involving the five Caspian littoral states, namely Azerbaijan, the Islamic Republic of Iran, Kazakhstan, the Russian Federation and Turkmenistan. IAEA-MEL collaborated with the CEP on a contaminant screening project, and assisted in an overall assessment of marine pollution in the region which resulted in some important and hitherto unknown findings that will impact on environmental management in the Caspian Sea region.

Measurement and Assessment of Radionuclides and Non-radioactive Pollutants in the Terrestrial Environment

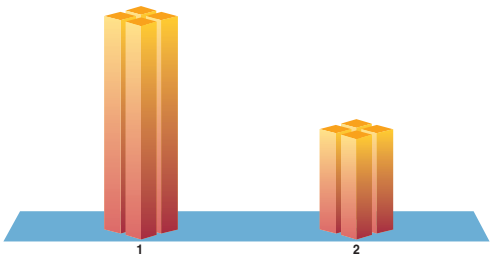
In support of a special reserve fund technical co-operation project on the 'Assessment of the Radiological Situation in Kuwait with Respect to Depleted Uranium (DU) in the Environment', the Agency's Laboratories at Seibersdorf carried out an evaluation of the existing DU data in the Kuwaiti database and organized an intercomparison exercise with the counterpart Kuwaiti Radiation Protection Laboratory. The evaluation and intercomparison results led to an International Advisory Group recommendation that a comprehensive sampling campaign be undertaken, in collaboration with UNEP, to support the assessment. A summary report containing all Agency and UNEP results is being prepared and will be included in the assessment.

Physical and Chemical Applications

Objective

To increase Member State capabilities in the application of radioisotopes and radiation processing and as tools for sustainable economic development.

Regular budget expenditure:$2 253 170



1. Radiochemical Applications: $1 538 619
2. Radiation Processing, Radiography and Radiotracer Applications: $714 551

Key Issues and Highlights

- Improved electrodeposited targets were developed for the more cost effective production of thallium-201, the most widely used radioisotope for the diagnosis of heart disease, and palladium-103, an isotope with expanding uses in the treatment of prostate cancer.
- An educational package on computational fluid dynamics for the modelling of simple flows in chemical reactors was distributed.

Radiochemical Applications

Therapeutic radiopharmaceuticals and radioactive miniature sealed sources are new developments that have medical applications. Since the production and effective quality assurance of miniature sources can be technically challenging, a new CRP in this field was initiated. Twelve laboratories worldwide will study methodologies for the production of iodine-125 and palladium-103 miniature sources and the development of techniques and devices for assembling and sealing them, and for their quality assurance and control. As a result of research activities, the technology for preparing a very reliable thallium-203 target for the production of thallium-201, and a rhodium-103 target for the production of palladium-103 with copper backing, was developed. These targets result in high yields of the sources and more cost effective production.

Collaboration with WHO in the field of radiopharmaceuticals is being expanded. The development of publications on the production, specifications and quality control of radio-pharmaceuticals was identified as an area of co-operation between the two organizations. As part of the process, the revision of the general introduction on radiopharmaceuticals in the *International Pharmacopoeia* to reflect current developments was completed.

Research in the field of radioanalytical chemistry on new applications of prompt gamma neutron activation analysis (PGNAA) was initiated as part of a new CRP.

Therapeutic Radiopharmaceuticals

Recent advances in tumour specific peptides/monoclonal antibodies (MoAb), new radionuclides and bifunctional complexing agents have led to the development of a large number of radiolabelled biomolecules as potential therapeutic radiopharmaceuticals for the treatment of different cancers. The development of laboratory methods for the reliable and efficient comparative evaluation of promising therapeutic radiopharmaceuticals is important for the rapid identification of the optimal agent for treatment of a specific cancer. Research into developing reliable methodologies for comparing and predicting the effectiveness of therapeutic radiopharmaceuticals was initiated with the participation of 15 laboratories worldwide.

The participants, from nine Member States, are exploring new methods for the analysis of high technology materials, of large containers for examination of nuclear waste, and of pharmaceuticals and pure chemicals for light element contamination.

With the assistance of an expert group, the Agency assessed the state of teaching and applications in radiochemistry, including the educational status of radiochemists in Member States. The recommendations of the group addressed the continuing need for more radiochemists in the fields of nuclear power, nuclear waste treatment, nuclear medicine and industry. One response was to start a programme to develop electronic training tools in radiochemistry. Through technical co-operation projects, national capabilities in the preparation of reference standards were augmented in Poland and Brazil. Measurement capacity was upgraded in Tunisia and Greece through the delivery of advanced nuclear analytical equipment. Fellowships, expert missions and workshops were offered to enhance the quality of analytical procedures in nuclear laboratories in developing Member States. The promotion and implementation of quality systems is in accordance with ISO requirements to obtain national accreditation (Fig. 1).

The new *Analytical Quality Control Service (AQCS) Reference Materials Catalogue for 2002–2003* was issued in the first quarter of 2002. A total of 3000 copies were distributed during the year. The Agency's AQCS web site (*http://www.iaea.org/programmes/aqcs*) was made fully operational in 2002, providing on-line facilities for ordering reference materials and timely information for Member States. The web site has been receiving approximately 500 hits per month, and there are a growing number of on-line orders being placed for reference materials.

A feature of the AQCS is the organization of inter-comparisons and proficiency tests for use in research projects and in the technical co-operation programme. Examples in 2002 included proficiency tests for: the determination of alpha, beta and gamma emitting radionuclides in a soil matrix; samples in two different matrices (soil and cabbage); and the determination of trace elements in a soil and sediment matrix. Over 170 laboratories worldwide have taken part in the exercises. Additionally, orders for AQCS products to a value of $76 650 were received from approximately 200 customers.

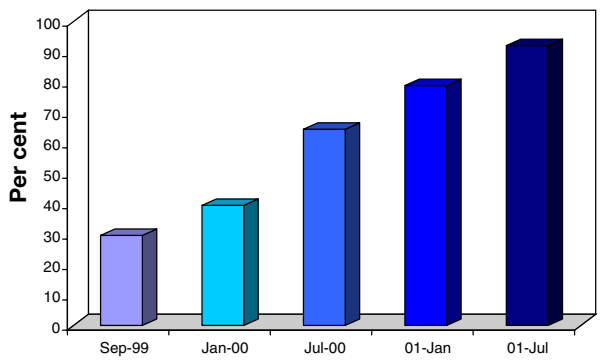


FIG. 1. Per cent compliance with ISO 17025 requirements for 12 laboratories in radiochemical analysis, 1999–2001.

Radiation Processing, Radiography and Radiotracer Applications

Taking advantage of new developments in radiation processing and electron beam technology, and in response to increasing demands for the development of promising environmental applications for the protection of human health and for water security, the Agency facilitated technology transfer to Member States through a number of technical co-operation projects and a CRP. The projects covered such areas as: the production of hydrogel dressings for medical purposes, manufacture of heat shrinkable materials for industrial applications, upgrading of electron beam accelerators for industrial applications and irradiation of sewage sludge for increased crop production.

The production and use of advanced composites, biomaterials and nanomaterials, and the processing of natural polymers were identified as emerging technologies in a series of expert meetings convened by the Agency. The experts concluded that for the modification of biomaterials, radiation technology can offer unique solutions in such areas as replacement tissues, unique polymer grafted cell culture surfaces, and the modification of nano-scale surfaces for applications in the emerging field of nanotechnology, such as biochips. In addition, a technical report was prepared on new analytical techniques for the understanding of radiation effects in polymers. The potential uses of analytical methods for the evaluation of the effects of radiation on organic polymers were considered from the following phenomenological viewpoints: molecular weight changes, oxidative processes, additives, low molecular weight products and weight changes. Reviews of recent developments involving the control of degradation effects in the radiation processing of polymers, and the use of ionizing radiation in the processing of natural and synthetic polymers were also carried out, and applications of these technologies for changing molecular weight and for bulk property and surface modification were identified.

Remediation of Polluted Water and Wastewater by Radiation Processing

Industrial and municipal activities can lead to the contamination of surface and groundwater. Radiation treatment, or a combination of radiation technology with conventional biological/chemical/physical processes, may help in the remediation of such contaminated waters. Owing to the importance of this issue, the Agency initiated a CRP with the participation of nine Member States. The results presented at the first Research Co-ordination Meeting have shown that the destruction of different compounds and biological contaminants can be achieved with moderate doses of radiation.

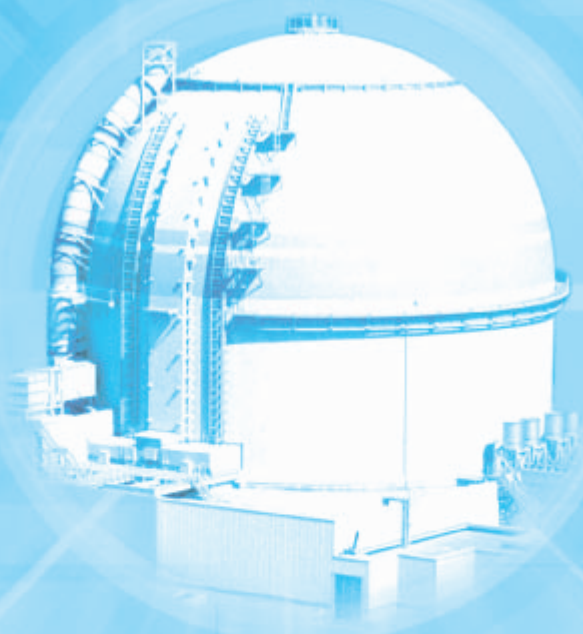
Promoting and supporting sustainable industrial growth in developing Member States is one of the objectives of Agency technical assistance programmes. Through a CRP, an educational package on computational fluid dynamics (CFD) was developed to model several simple flows in industrial processing units. The CFD–residence time distribution integrated software will help industry tracer groups to acquire more reliable information on complex processes, leading to the better design and optimization of chemical engineering reactors.

Overall, 2002 saw a range of new proposals for R&D projects in the field of oil production, industrial tomography and radioanalytical methodology. In particular, radioisotope technology has already produced significant results in oil production. For example, in Vietnam, the White Tiger oil reservoir was studied, with radiotracers being injected to help define an accurate flooding model. The optimization of water injection increased oil recovery by 3–5% and decreased operational costs, resulting in a large net benefit to the country.

The training and certification of personnel in non-destructive testing (NDT) techniques are key aspects in the building of a national industrial infrastructure. An updated version of *Training Guidelines in Non-destructive Testing Techniques, 1991 Edition* (IAEA-TECDOC-628), was published in 2002 to help streamline and harmonize training and certification schemes in Member States. In addition, more than 15 national technical co-operation projects were supported with the aim of establishing NDT centres, training staff and supplying equipment.

In the field of nuclear techniques for humanitarian demining, one device showed positive results in the laboratory and was selected for field tests under a regional technical co-operation project in Europe. The device, known as PELAN (Elemental Analysis by Pulsed Neutrons), was developed by a laboratory in the USA and weighs about 20 kg. It determines the relative concentration of carbon, oxygen, nitrogen and other elements in the anomalies identified by a metal detector, thus determining if explosives are present. Field tests at a dummy mine field in Croatia showed that the device, at its present state of development, is capable of identifying antipersonnel and antitank mines. Research groups in the Netherlands and the United Kingdom have been requested to look into the possibility of improving the sensitivity of this device. Another Agency research project has shown that handheld/portable systems based on neutron back-scattering, developed in the Netherlands and South Africa, hold promise for the detection of mines in dry soils.

Safety

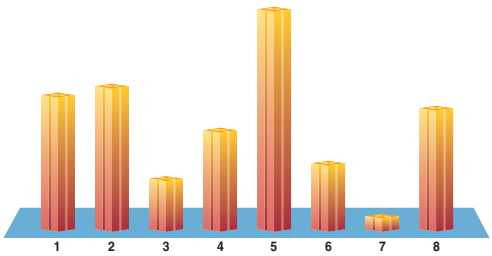


Safety of Nuclear Installations

Objective

To increase the capability of Member States to achieve and maintain a high level of safety in nuclear installations under design, construction or operating.

Regular budget expenditure: $6 852 874
Extrabudgetary programme expenditure (not included in chart): $3 067 684



1. Regulatory Infrastructure for Nuclear Safety: $1 091 423
2. Development of Safety Assessment Methods and Tools: $1 160 064
3. Engineering Safety of Small and Medium Sized Reactors and New Nuclear Power Plants under Construction: $404 804
4. Engineering Safety of Existing Nuclear Installations: $807 928
5. Operational Safety: $1 789 308
6. Research Reactor safety: $525 794
7. Safety of Fuel Cycle Installations: $99 222
8. Fostering Harmonization in Nuclear Safety: $974 331

Key Issues and Highlights

- Seven Safety Guides were published, with eight more approved and in the process of being published.
- There was continuing demand for Agency safety review services. They showed a general improvement in the safety of nuclear power plants and implementation of corrective safety measures, and progress in enhancing the effectiveness and technical capabilities of regulatory bodies.
- Progress was made towards the establishment of an international Code of Conduct on the safety of research reactors.
- An international conference on safety culture in nuclear installations was held in Rio de Janeiro, Brazil.

Regulatory Infrastructure for Nuclear Safety

Four Safety Guides were published covering various aspects of legal and governmental infrastructure for the safety of nuclear facilities (see Table A20 in the Annex for a list of all Safety Standards issued in 2002). These support the Safety Requirements on legal and governmental infrastructure for safety published in 2000.

The Agency's International Regulatory Review Team (IRRT) service studies the effectiveness of regulatory bodies and exchanges information and experience. Recent follow-up IRRT missions indicate that these bodies have been making significant progress in resolving issues raised during previous missions. In 2002, revised guidelines for the IRRT service were published that included lessons from several years of experience gained in conducting IRRT missions.

The Incident Reporting System (IRS), operated jointly with the OECD/NEA, exchanges information on unusual events at nuclear power plants and seeks to increase the awareness of actual and potential safety problems. As in 2000 and 2001, the number of reports submitted continued to decrease in 2002. Analysis of the answers to a questionnaire sent to the national IRS co-ordinators shows that fewer resources are being dedicated to the preparation of these reports by Member States.

Development of Safety Assessment Methods and Tools

Peer reviews of a probabilistic safety assessment (PSA), as carried out in International Probabilistic Safety Assessment Review Team (IPSART) missions, can enhance the quality of the PSA, thus strengthening its credibility for supporting safety related decisions. In

a mission conducted to the HFR research reactor at Petten in the Netherlands, the "Risk Scoping Study" developed for this installation made use of simplified PSA techniques adjusted to the particular design and operational features of a research reactor.

As part of the extrabudgetary programme 'Accident Analysis and its Associated Training Programme for the RBMK-1000 Kursk-1 NPP', a study was published to evaluate, define and establish a sustainable accident analysis infrastructure at the plant. A second phase is continuing with the development of an Integrated Training and Accident Analysis System (ITAAS) to provide a safety analysis capability and associated training to plant personnel and to the Russian regulatory body.

A CRP to develop the Agency's framework for the implementation of safety performance indicator systems for nuclear power plants was completed. The CRP has helped the participating plants to adapt and fine-tune the Agency framework to their particular needs. In turn, they have provided feedback to the Agency on the use of the framework and proposed improvements.

Engineering Safety of Small and Medium Sized Reactors and New Nuclear Power Plants under Construction

A Safety Guide, *Instrumentation and Control Systems Important to Safety in Nuclear Power Plants*, was published in 2002, the third in a series supporting the new Safety Requirements for design published in 2000. Three other Safety Guides on design safety have been approved and will be published in 2003, and a further six are at an advanced stage of preparation.

Missions on the safety of new nuclear power plants were conducted in China. Two missions were related to fire hazard analysis and core design and fuel management at the Tianwan nuclear power plant project, while three focused on reviewing draft utility safety requirements for evolutionary nuclear power plant designs.

Building upon assistance provided to South Africa, the Agency is working on the development of a general approach for assessing the safety of the design of advanced and innovative reactors, and more broadly for all reactors (including research reactors) with characteristics that differ from those of LWRs. In this regard, a new method was developed for the safety assessment of innovative reactors based on the defence in depth principle.

Engineering Safety of Existing Nuclear Installations

A safety review mission to Kozloduy, in Bulgaria, reviewed the results of more than a decade of safety upgrades and assessments at units 3 and 4, including a series of actions recommended by various Agency review teams. The team concluded that the operational and design safety at Kozloduy now corresponds to the level of improvements seen at plants of similar vintage elsewhere. Many of the safety measures adopted for these plants in the design, operation and seismic areas exceeded those that were foreseen.

The Agency has a long-standing project to provide assistance to the Islamic Republic of Iran with respect to the construction of the Bushehr nuclear power plant, and particularly to the preparation and review of the preliminary safety analysis report (PSAR). Seven missions in the design safety area were conducted during 2002, some to the reactor site and some to the Russian Federation, where the plant's designers are based. A large mission in September reviewed answers provided by the contractor to recommendations from the Agency. The Agency team suggested a final review of the PSAR in 2003.

Agency missions visited the Armenia nuclear power plant during 2002: two in relation to a seismic re-evaluation of the plant and one to review the plant's ageing management programme. The support to the seismic re-evaluation programme was concentrated on a review of the geotechnical investigations, on a review of the evaluation of the structural capacity and on the development of a probabilistic seismic hazard assessment. The support given to the ageing management programme included a review by Agency experts of the regulatory requirements and plant procedures developed by the Armenian organizations.

A CD-ROM was issued in 2002 entitled *IAEA Guidance on Ageing Management for Nuclear Power Plants*. This collects all of the safety standards and other Agency documents that provide guidance on the effective management of the physical ageing of systems, structures and components important to safety for nuclear power plants.

Intergranular stress corrosion cracking of austenitic stainless steel piping in BWRs has been a major safety concern since the early 1970s. Similar degradation was

found in RBMK reactor piping in 1997. An extrabudgetary programme initiated in 2000 to assist countries operating RBMK reactors in addressing this issue was completed in 2002 (see *www.iaea.org/ns/nusafe/ebpigscc.htm*). The programme's results included: improvements in the quality and reliability of in-service inspection; comparison of flaw assessment methods leading to a set of recommendations on inspection requirements; development of improved methods for the repair and mitigation of cracks; and recommendations for other mitigation strategies based on water chemistry.

Operational Safety

Four Safety Guides published in 2002 supported the Safety Requirements document for the operation of nuclear power plants. The new Guides discuss the operating organization, core management and fuel handling, maintenance, surveillance and in-service inspection, and the recruitment, qualification and training of personnel. The suite of safety standards on operational safety is now close to completion, and these standards will form the basis for the Agency's operational safety review services.

The Agency's review services often trigger requests from the Member States visited for further activities linked to topics identified by the reviews. During 2002, workshops were conducted on managing the early termination of nuclear power plants and on configuration management. Seminars were held on operational safety during commissioning and for inspectors from the corporate office of the operating organization on the Operational Safety Review Team (OSART) methodology.

In 2002, three OSART missions, five OSART follow-up visits and five preparatory meetings were carried out. On average, the rate of resolution of and compliance with the Agency's recommendations in follow-up missions has continued to improve over the last five years and in 2002 reached 97%. Improvements were observed in safety management, industrial safety, plant material conditions, reporting criteria and analysis of low level events, standards for quality management systems, and expanded use of safety performance indicators.

The Agency held an international conference on 'Safety Culture in Nuclear Installations' in Rio de Janeiro in December 2002. The conference demonstrated that safety culture is now recognized throughout the world as a mature concept and a crucial element of nuclear safety. The most important conclusions from the conference related to the need for further development and use of assessment models that can serve as indicators of safety culture, more effective means for enhancing safety culture and better definition of the appropriate role of the regulator in relation to an operating organization's safety culture.

Research Reactor Safety

In 2001, the General Conference endorsed a decision of the Board to request the Secretariat to develop and implement, in conjunction with Member States, an international research reactor safety enhancement plan. Two of the tasks in this plan were to prepare a Code of Conduct on the safety of research reactors and to conduct a survey of research reactor safety in Member States.

A meeting of experts in December 2002 agreed on the draft text of a Code of Conduct. The objective of the Code is to achieve and maintain a high level of nuclear safety in research reactors worldwide through the enhancement of national measures and international co-operation. The draft Code specifies the respective roles of the State, the regulatory body, the operating organization and the Agency's Secretariat in pursuing this objective.

With regard to the survey, 55 of the 67 Member States that have or plan to construct research reactors had responded at the end of 2002, although only about half of the States responding have as yet provided information on all of their research reactors. Of the 55 States that responded, 41 stated that they observed standards that were identical or similar to the Agency's safety standards. One of the main findings from these responses was that most, but not all, of the reactors reported to be in a state of extended shutdown were in Member States with good regulatory supervision programmes.

Three Integrated Safety Assessment of Research Reactors (INSARR) missions were carried out in 2002, and a pre-INSARR mission visited Viet Nam. The Agency also conducted expert missions on research reactor safety where it has a specific responsibility to monitor the safety of research reactors provided under its project and supply agreements. During 2002, expert missions visited research reactors in three States and two follow-ups to earlier missions were also conducted.

Safety of Fuel Cycle Installations

At the request of the Commission on Safety Standards, the Secretariat is developing a set of standards to address the safety of non-reactor nuclear fuel cycle facilities. Safety Requirements for fuel cycle and isotope production facilities and two Safety Guides covering mixed oxide and uranium fuel production facilities are being prepared.

To complement these publications, a technical document was issued on procedures for conducting PSAs for non-reactor nuclear facilities. The aim is to promote a standardized framework, terminology and form of documentation for these PSAs. The report indicates that the depth of analysis should be commensurate with the risk posed by the facility.

Fostering Harmonization in Nuclear Safety

The International Nuclear Event Scale (INES) is used by 60 countries for facilitating rapid communication to the media and the public regarding the safety significance of events at all installations associated with the civil nuclear industry, as well as events involving the use of radiation sources and the transport of radioactive material. A total of 27 events were reported in 2002, of which 7 were at level 1, the lowest level of safety significance, 13 were at level 2 and 3 were at level 3 (Fig. 1).

The Nuclear Events Web-based System (NEWS), managed jointly by the Agency, OECD/NEA and

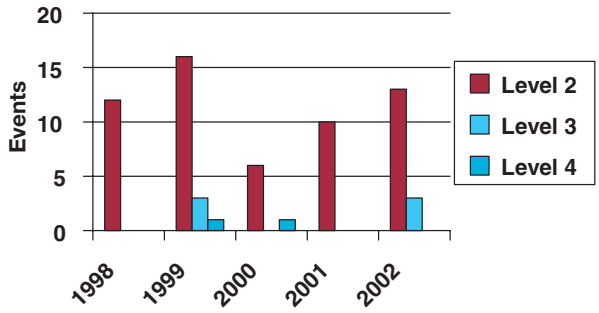


FIG. 1. Reporting of events to INES, 1998–2002.

WANO, is designed to provide authoritative information rapidly on the occurrence of nuclear events. Following a period of trial use, NEWS began to be used for the exchange of reports and related information provided by Member States under the INES system. Over the course of 2002, the number of users who registered for NEWS increased by a factor of two and the number of visits to the site per month by a factor of three. The system can be accessed at *www-news.iaea.org/news/*.

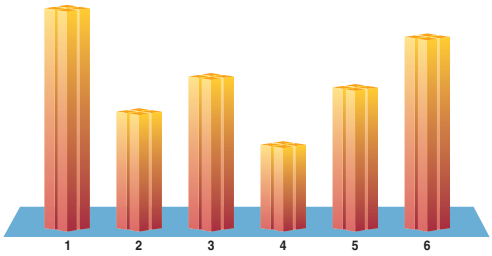
More than 80 training events of various types were conducted on nuclear safety in 2002 to enhance knowledge, understanding and use of the Agency's nuclear safety standards by Member States. As one element of its strategic plan for education and training in nuclear safety, the Agency began a review and advisory service for national education and training programmes. The first four such missions were conducted during 2002 under the extrabudgetary programme on the safety of nuclear installations in the South East Asian, Pacific and Far Eastern regions.

Radiation Safety

Objective

To achieve global harmonization and raise the levels of protection of people against radiation exposure and of safety of radiation sources, and to ensure that the Agency properly discharges its health and safety responsibilities with regard to its own operations.

Regular budget expenditure: $4 754 623
Extrabudgetary programme expenditure (not included in chart): $541 130



1. Radiation Safety Standards and Provisions for their Application: $1 158 001
2. Safety of Transport of Radioactive Material: $678 155
3. Occupational Radiation Protection: $717 909
4. Radiological Protection of Patients: $444 427
5. Safety of Radiation Sources: $744 045
6. Nuclear and Radiation Emergencies: $1 012 086

Key Issues and Highlights

- More than 30 additional Member States joined the Agency's technical co-operation model project on upgrading radiation protection infrastructures, bringing the number of participating States to 87.
- Changes to the Agency's Transport Regulations were approved for issue in 2003, and incorporated into the UN Model Regulations.
- Two TranSAS missions — to Brazil and the United Kingdom — were conducted, and three more are planned.
- An international conference on occupational radiation protection, held in Geneva, produced findings that will form the basis of an action plan.
- An action plan on the radiological protection of patients was agreed.
- Work progressed on a revision of the Code of Conduct on the safety and security of radioactive sources and a categorization system for such sources.
- Safety Requirements on preparedness for and response to nuclear and radiological emergencies were published, and the interagency Joint Plan was updated.

Radiation Safety Standards and Provisions for their Application

For several years a substantial part of the Agency's assistance in the radiation and waste safety fields has been delivered through a model technical co-operation project on upgrading radiation safety infrastructures (88 participating States at the end of 2002), with the Agency's nuclear safety programme providing technical support. As part of this project, peer reviews of the effectiveness of regulatory infrastructures were conducted in Bangladesh, Belarus, El Salvador, Georgia, Turkey and Uzbekistan. Of the 52 Member States that were original participants in the project, 33 had been peer reviewed by the end of 2002. In addition, nine new participants have recently undergone peer reviews of their radiation safety infrastructure through other programmes, notably a project in Latin America.

The Agency established a steering committee of Member State representatives to oversee the implementation of its 'Strategic Approach to Education and Training in Radiation and Waste Safety' (endorsed by Resolution GC(45)/RES/10C). At its first meeting in November 2002, the committee made recommendations to the Secretariat on implementation of the strategy, the establishment of selection criteria for international trainers and the setting up of a Web based inter-centre network.

The Agency's post-graduate course on radiation safety and the safe use of radiation sources was held in the African, East Asian and Pacific, European, Latin American and West Asian regions. For the first time it was held in French in Morocco, primarily for students

from Francophone African States. The course was also held in Arabic in the Syrian Arab Republic, in English in Malaysia, in Russian in Belarus and in Spanish in Argentina. The syllabus for this course**,** *Postgraduate Educational Course in Radiation Protection and the Safety of Radiation Sources: Standard Syllabus* was published in 2002.

Safety of Transport of Radioactive Material

Two Safety Guides supporting the Agency's *Regulations for the Safe Transport of Radioactive Material* (the 'Transport Regulations') were published in 2002. The first, *Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material,* is intended to be used in conjunction with the Regulations, and aims to provide guidance to users on proven and acceptable ways of complying with and demonstrating compliance with the Regulations. The other Guide, *Planning and Preparing for Emergency Response to Transport Accidents Involving Radioactive Material*, is intended to provide guidance to public authorities, consignors, carriers and emergency response authorities in dealing effectively and safely with transport accidents involving radioactive material.

The Agency's Transport Safety Standards Committee in February approved a set of changes to the 1996 edition of the Transport Regulations. The modified regulations will be published in 2003. The United Nations Sub-Committee of Experts on the Transport of Dangerous Goods in December adopted corresponding changes to its *Model Regulations for the Transport of Dangerous Goods*, which will allow the modified requirements to be incorporated into the mode specific regulations of other international organizations — such as ICAO (for transport by air), IMO (by sea) and UNECE (on land and inland waterways) — with effect from 2005.

Two Transport Safety Appraisal Service (TranSAS) missions were conducted in 2002 to appraise the implementation of the Transport Regulations in Brazil and in the United Kingdom, and two further missions — to Panama and to Turkey — are scheduled for 2003. The appraisal team that visited the United Kingdom did not find any issues that were safety critical, though a number of suggestions were made to streamline transport regulatory practices. Its report was published soon after the mission. The report on the mission to Brazil is being prepared.

Occupational Radiation Protection

All staff and external experts who might be exposed to radiation as a result of their work for the Agency are routinely monitored for occupational exposure. A total of 543 Agency staff were monitored routinely during 2002, along with 1221 other individuals monitored on an ad hoc basis. The latter group includes technical co-operation experts and participants in Agency training courses and missions. The personal doses measured ranged from 0.2 to 7 mSv, with an average of about 1 mSv, well below the limit for occupational exposure of 20 mSv.

A quality management system (QMS), based on ISO 9001 and ISO 17025, has been developed for all operational services carried out in the Agency's radiation monitoring and protection laboratories. Implementation of the QMS started in June 2002 with a view to achieving accreditation during the 2004–2005 programme cycle. During the last quarter of 2002, an internal audit of the QMS was carried out. Areas of improvement were identified and are being addressed. A management review of the system was also performed to analyse achievements, difficulties and deficiencies in the implementation process.

In accordance with the Agency's statutory requirement to provide for the application of its safety standards to its own operations, the Agency's 'Radiation Protection Rules and Procedures' must be based on the Agency's safety standards, particularly the *International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources* (BSS) (Safety Series No. 115). A thorough review of the Rules and Procedures was carried out and a revised set drafted for finalization and approval in 2003.

As called for in General Conference Resolution GC(43)/RES/13, the Secretariat organizes international intercomparison exercises for monitoring purposes with a view to helping Member States comply with dose limits and harmonizing the use of internationally agreed quantities and assessment methods recommended in the Agency's safety standards. One such intercomparison involved 36 laboratories focusing on the determination of the activity of alpha emitters in urine samples.

The experience from the first ten years of operation of the OECD/NEA–IAEA Information System on Occupational Exposure (ISOE) was published. One of the main conclusions was that: "Active participation of a large number of utilities in this programme has

contributed to a reduction in occupational exposure at nuclear power plants worldwide."

An international conference on 'Occupational Radiation Protection: Protecting Workers Against Exposure to Ionizing Radiation' was held in Geneva in August. It was convened jointly by the Agency and the ILO, and was co-sponsored by a number of other international organizations. While recognizing the widespread success of the optimization/as low as reasonably achievable principle in reducing occupational exposure, the conference identified a number of areas requiring greater attention. These include: harmonization of terminology and quantities; controlling occupational exposure to natural sources; protection of medical staff during interventional radiology; prevention of accidents in industrial radiography; and protection of pregnant workers. Also emphasized was the importance of co-operation between workers, employers and regulators in improving occupational radiation protection. The findings were communicated to the Board and the General Conference and are being used by the Agency and the ILO as a basis for an action plan in this area.

Radiological Protection of Patients

A Safety Guide on radiological protection for medical exposure to ionizing radiation, jointly sponsored by the Agency, PAHO and WHO, was published. It provides recommendations on how safety requirements can be applied to protect patients, comforters and visitors of patients against exposure to ionizing radiation in medical practice in compliance with the BSS. Specifically, recommendations cover the establishment of guidance levels for diagnostic medical exposures, acceptance testing processes for radiation equipment, calibration of radiotherapy units and the reporting of accidental medical exposures.

As recommended by the 2001 Málaga conference on the radiological protection of patients in diagnostic and interventional radiology, nuclear medicine and radiotherapy, the Agency formulated an action plan based on the findings of the conference. The Board of Governors approved the plan in September 2002, and implementation is proceeding. Areas highlighted in the action plan include education and training, information exchange, provision of guidance and assistance to Member States in the implementation of safety standards, research on radiation doses in new technologies, and the collection and dissemination of information on accidental medical exposure.

Four new CRPs were initiated in 2002 relating to the radiological protection of patients. The projects will address: the possibility of establishing guidance levels for interventional radiology; avoidance of unnecessary dose to patients while transitioning from analog to digital radiology; quantitative evaluation and promotion of patient dose reduction approaches in interventional radiology; and dose reduction in computed tomography while maintaining diagnostic confidence. Another CRP, on image quality and patient dose optimization in mammography in Eastern European countries, ended in 2002 and a final report is in preparation.

Safety of Radiation Sources

In August 2002, technical experts from 17 Member States and 2 international organizations prepared a draft revised Code of Conduct on the Safety and Security of Radioactive Sources. To support the revision of the Code, a new categorization system for sources was developed, taking account of a larger range of possible exposure scenarios. As a result, the categorization is expected to be more generally applicable in radiation safety. It is intended that this categorization system will be presented along with the draft revised Code of Conduct to the Board of Governors in September 2003.

An initiative involving the Russian Federation, the USA and the Agency was launched in 2002 with the aim of locating, recovering, securing and recycling 'orphaned' sources in the Newly Independent States. Missions were conducted to the Republic of Moldova and Tajikistan.

Nuclear and Radiation Emergencies

A Safety Requirements publication, *Preparedness and Response for a Nuclear or Radiological Emergency* (Safety Standards Series No. GS-R-2) — jointly sponsored by the Agency, FAO, ILO, OCHA, OECD/NEA, PAHO and WHO — was published.

In response to requests for assistance under the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency, missions were sent to Afghanistan, Bolivia, Uganda and the United Republic of Tanzania. In Afghanistan, a powerful cobalt-60 source from an old radiotherapy unit and several less powerful sources found in disused

laboratories were secured and made safe. In Bolivia, the mission assisted in the analysis of an event in which an iridium-192 radiography source was inadvertently carried, unshielded, on an eight hour journey on a public bus. The two events in Africa involved helping to ensure that radioactive materials that had apparently been illicitly trafficked into these countries and had been seized by the authorities were safe and secure.

As part of ongoing assistance to Georgia, the Agency supported radiological surveys of selected areas of the country. The first phase in June sought to recover two more strontium-90 sources believed to be lost in a specific region of Georgia, but the sources were not found. The second phase — aimed at assisting the Georgian authorities in locating and recovering other known or suspected orphaned sources in the country — was conducted in September 2002, but no sources were found.

New editions of the interagency *Joint Radiation Emergency Management Plan of the International Organizations* (the 'Joint Plan') and the *Emergency Notification and Assistance Technical Operations Manual* (ENATOM) were published. These documents take account of a number of developments since the 2000 editions, particularly the publication of Safety Standards Series No. GS-R-2 referred to above, feedback from the first meeting of competent authorities, lessons identified from exercises and events, recommendations from the Inter-Agency Committee on Nuclear Accidents, and increased recognition that emergency situations can arise from both accidents and deliberate acts.

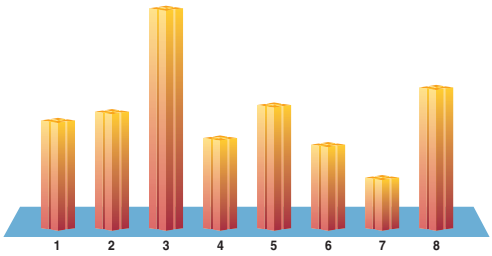
Management of Radioactive Waste

Objective

To increase global harmonization in the policies, criteria, standards and provisions for their application, as well as in methods and technologies, for achieving safety in radioactive waste management, in order to protect humans and their environment against potential health effects attributable to actual or potential radiation exposure to radioactive waste.

Regular budget expenditure: $5 495 914

Extrabudgetary programme expenditure (not included in chart): $928 685



1. Radioactive Waste Safety Standards and Provisions for their Application: $633 538
2. Safety of Disposable Radioactive Waste: Managing Non-Reusable Radioactive Materials and Arranging for their Disposal: $678 106
3. Technologies for Disposable Radioactive Waste Management: $1 283 170
4. Safety of Dischargeable Radioactive Waste: Protection of the Public and the Environment: $582 251
5. Safety of Residual Radioactive Materials: Termination of Practices, Decommissioning of Installations and Restoration of Sites: $714 573
6. Technologies for the Decommissioning of Installations and Restoration of Sites: $490 163
7. Management of Disused Sealed Radioactive Sources: $291 620
8. Radioactive Waste Management Information: $822 493

Key Issues and Highlights

- Safety standards were published on the management of waste from the mining and milling of radioactive ores.
- Two international conferences were held, one on 'Safe Decommissioning for Nuclear Activities', in Berlin, and the other on 'Issues and Trends in Radioactive Waste Management', in Vienna.
- Reports were published on technologies for the management and disposal of waste and disused sources, and on the safety, institutional and non-technical aspects of decommissioning and site remediation.
- An 'Indicator of Sustainable Development for Radioactive Waste Management' was developed.
- A *Radioactive Waste Management Registry* was developed and the software package made available to Member States.

Radioactive Waste Safety Standards and Provisions for their Application

The Secretariat was requested by the General Conference in 2000 "*to develop*…radiological criteria for long-lived radionuclides in commodities, particularly foodstuffs and wood". It was decided to approach this issue via a broader solution covering this and a number of related issues. Member State experts agreed in February 2002 on a draft Safety Guide that includes a set of criteria in the form of levels below which materials are considered to be outside the scope of regulation. The Secretariat has revised the draft to take account of the comments from the Agency's Radiation Safety Standards Committee and the Waste Safety Standards Committee (WASSC) and from Member States, but agreement has not yet been reached.

Progress on safety standards for the geological disposal of waste continued, with the OECD/NEA agreeing to co-sponsor the Safety Requirements publication. In 2002, WASSC approved the framework for related safety guidance and is expected to approve a draft of the Safety Requirements in March 2003 for submission to Member States.

Safety of Disposable Radioactive Waste: Managing Non-Reusable Radioactive Materials and Arranging for their Disposal

The Agency has a programme of work based on conclusions and recommendations from the 2000 Córdoba conference on the safety of radioactive waste management. The programme highlights seven actions, including assessment of the safety implications of the

extended storage of radioactive waste and development of a work programme aimed at addressing the broader social dimensions. A document on long term storage was completed and will be published as an 'international position paper' in 2003. In addition, work commenced on evaluating the generic safety of long term storage through the application of safety assessment methods.

An international conference on 'Issues and Trends in Radioactive Waste Management' was held in Vienna in December, in co-operation with the European Commission and the OECD/NEA. One of the main findings was the wider recognition of the crucial importance of public acceptance of waste management practices, and a resulting increase in emphasis on non-technical, societal issues and on dialogue with a wide range of stakeholders. The conference findings will be used by the Agency to fine-tune the programme of work described above.

The final report of a CRP on the 'Improvement of Safety Assessment Methodologies for Near Surface Disposal Facilities for Radioactive Waste' (ISAM) was completed in 2002. Having developed the methodologies through the ISAM project, the Agency then initiated a follow-up CRP on the 'Application of Safety Assessment Methodologies for Near Surface Waste Disposal Facilities' (ASAM). This project will address safety reassessment and disposal of disused radiation sources and mining waste, together with the regulatory review of safety assessments.

Considerable efforts have been made on the safe disposal of spent sealed sources. A technical document was prepared on the safety of their disposal in borehole facilities, and a related report addresses the use of safety assessment in determining waste acceptance criteria for near surface disposal facilities. In addition, a safety report on surveillance and monitoring for near surface disposal facilities was completed.

Ten training courses and workshops on the safety of radioactive waste management were held during the year. The training covered all aspects of waste management and disposal, with a number of specialist courses in safety assessment for disposal facilities.

Technologies for Disposable Radioactive Waste Management

To facilitate international co-operation and promote consensus on geological disposal, the Agency established in 2001 a network of centres of excellence for training in and demonstration of waste disposal technologies in underground research facilities (URFs). Discussions in September 2002 between the Agency, the network members and potential users of the URFs resulted in the establishment of a proposal and work plan for an interregional technical co-operation project that includes training on site characterization techniques and co-ordinated research activities.

A recently published report describes institutional and financial arrangements in 20 Member States considering different options for the long term management of HLW and/or spent nuclear fuel (SNF). Information is provided on the amounts of HLW and SNF expected to be generated and on expectations concerning geological repositories.

With the aim of facilitating information exchange between the scientific community and the public, the Agency developed a multimedia CD-ROM that explains the current internationally accepted views on the concept of geological disposal of radioactive waste. The CD-ROM is aimed at responsible authorities, politicians, opinion leaders, the interested public and organizations in Member States.

A regional technical co-operation project for the East Asian region on the near surface disposal of radioactive waste from non-power applications was completed and a project report issued. The project helped participating States identify suitable repository concepts for their national programmes and supported the establishment of a regional forum for sharing experience on methods for assessing the associated safety issues.

Safety of Dischargeable Radioactive Waste: Protection of the Public and the Environment

International interest in the protection of the environment against ionizing radiation has grown rapidly in recent years. A technical document published in 2002 describes the different ethical considerations in protecting the environment and interfaces them with the scientific and legal background in order to derive a firmer basis for policy making with respect to radiation and the environment. This work, and responses to the discussion document, will form one input into the development of safety standards in this area.

In July, the Agency co-operated with Environment Australia and the Australian Radiation Protection and Nuclear Safety Agency in organizing a symposium in Darwin on the protection of the environment from ionizing radiation. The discussions concluded that a credible, systematic, international approach to the protection of the environment is needed to meet the commitments of Member States. Moreover, this mechanism should be transparent, flexible, and consistent with the approaches applied to other environmental stressors and with the principles for the radiological protection of humans.

Safety of Residual Radioactive Materials: Termination of Practices, Decommissioning of Installations and Restoration of Sites

A Safety Guide on the *Management of Radioactive Waste from the Mining and Milling of Ores* was published. Waste from mining and milling activities contains only low concentrations of radioactive material but it is generated in large volumes in comparison with waste from other facilities. The Guide provides recommendations for managing this waste in a manner consistent with the 1999 Safety Requirements publication on the near surface disposal of radioactive waste. A related Safety Report that elaborates on the recommendations set out in the Safety Guide, *Monitoring and Surveillance of Residues from the Mining and Milling of Uranium and Thorium*, was also published in 2002.

A large number of nuclear installations around the world are currently being considered for decommissioning. A Safety Report on *Safe Enclosure of Nuclear Facilities During Deferred Dismantling* was published to help Member States ensure that a nuclear installation that will be or has been placed in a safe enclosure mode is maintained in a safe state until the final dismantling is performed and the facility or site is released from regulatory control.

This issue was also addressed at an international conference on 'Safe Decommissioning for Nuclear Activities', held in Berlin in October 2002. Three of the main findings from this conference concerned the importance of early and systematic planning for decommissioning and of adequate funding for decommissioning, and the continued lack of internationally accepted criteria for the release of materials and sites from regulatory control in the course of decommissioning.

In February, at the request of the Kuwaiti Government and in co-operation with UNEP and WHO, the Agency organized a sampling campaign in Kuwait covering 11 sites identified in 2001 as having been affected by depleted uranium residues. A report on the results of the sampling is scheduled to be completed in 2003.

Technologies for the Decommissioning of Installations and Restoration of Sites

A report published in 2002 addresses record-keeping aspects of the decommissioning of nuclear facilities. Published information and guidance on this topic are relatively scarce compared with the coverage of technological aspects of decommissioning. Lack of proper attention to recordkeeping may result in a waste of resources and can also lead to safety problems.

Experience has shown that progress in remediating sites with radiological contamination from sources such as mining and milling, past practices or accidents often depends on societal conditions. This problem was addressed in a report published in 2002 on non-technical factors influencing decision making in environmental remediation. The factors that need to be considered include the sociocultural and socioeconomic contexts, funding sources and availability of funds, public perception and stakeholder issues.

A recently completed technical co-operation project in Ukraine focused on the establishment of plans and infrastructure for the decommissioning of Ukrainian WWER plants. Particularly important is the establishment of a financial mechanism to collect decommissioning funds. Major project achievements include the setting up of a national network of all parties active in decommissioning planning, and the release of a decommissioning strategy document advising the Ukrainian decision makers on viable decommissioning strategies.

Another technical co-operation project, in Latvia, achieved a significant milestone with the testing and commissioning of a cementation plant for liquid waste. This plant is intended to serve the needs of a decommissioning project at the Salaspils research reactor near Riga.

Management of Disused Sealed Radioactive Sources

Disused sealed radioactive sources present a significant waste management challenge in many

developing Member States. During 2002, the Agency assisted Colombia, the Dominican Republic, Kuwait, Morocco and Singapore in rendering national inventories of spent radium sources safe. In addition, a special operation was carried out in Thailand where a high activity cobalt-60 source was conditioned for long term storage without the use of a hot cell. Another conditioning operation, involving an americium-241 source used as a static eliminator, was conducted in Ethiopia.

To help build capacity in Member States, a report on the management of spent high activity radioactive sources was published and a document on the conditioning of long lived sealed radioactive sources is being finalized. Generic technical procedures for conditioning high activity and long lived sources were also developed during 2002.

An important activity involves the assessment of disposal options for disused radioactive sources. For developing countries that use only a limited range of nuclear applications involving a relatively small number of sealed sources, the cost of disposing such sources may be prohibitive. An African regional technical co-operation project demonstrated the technical feasibility of the borehole concept for the disposal of disused radiation sources. This could provide a safe and cost effective disposal option for developing countries.

Radioactive Waste Management Information

A new Web page provides public access to reports from the Agency's Net Enabled Waste Management Database (NEWMDB), to consolidated radioactive waste inventory reports and to the series *Radioactive Waste Management: Status and Trends*. The page also acts as a Web portal to Agency documents and reports in the field of radioactive waste management (see *http://www-newmdb.iaea.org/reports.asp*).

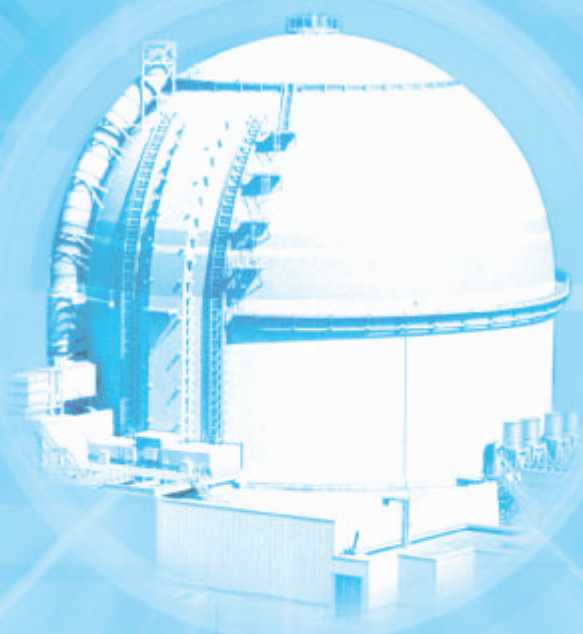
In February 2002, development of an 'Indicator of Sustainable Development for Radioactive Waste Management' (ISD-RW) was completed. This provides a measure of both the current status of waste management in a Member State and progress made towards the sustainability of management. The measure can be used at the national level or for a particular sector, for example medical and industrial applications. The ISD-RW was submitted to the United Nations in November for inclusion in its list of core indicators. Information on the development and use of ISD-RW is available via e-mail *(ISD-RW@iaea.org)*.

The Agency's *International Catalogue of Sealed Radioactive Sources and Devices* has been further developed, and now includes basic technical data, design features and illustrations for more than 2800 radioactive source models and 400 devices, as well as the address and company history of more than 990 manufacturers and distributors. It has been used to respond to a number of requests from Member States for the identification of sources.

The *Radioactive Waste Management Registry* was finalized and the software package made available to Member States on request. The registry is a managerial tool for recording and reviewing information on all types of radioactive waste, from generation to disposal, and provides an overview of the various steps involved in waste management.

A new project on the management of radioactive waste provides hands-on training to Member States on various quality assurance practices and procedures, which are integrated into waste management systems. The first training session was carried out at the Malaysian Institute for Nuclear Technology Research in August. Similar training will be carried out for the Latin American and European regions in the future.

Verification and Security

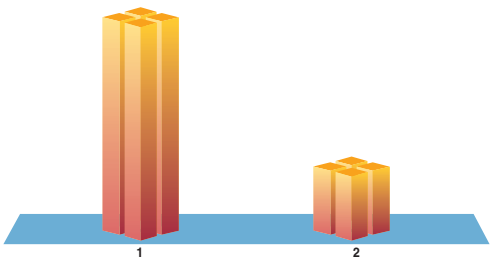


Safeguards

Objective

To provide the international community, in the most effective and efficient manner, with credible assurance that States are complying with their safeguards commitments.

Regular budget expenditure: $75 886 681
Extrabudgetary programme expenditure (not included in chart): $19 674 902
Special appropriation for the acquisition of safeguards equipment (not included in chart): $1 830 875



1. Operations: $58 196 095
2. Development and Support: $17 690 586

The Safeguards Statement for 2002

In fulfilling the safeguards obligations of the Agency in 2002, the Secretariat — having evaluated all the information acquired in implementing safeguards agreements and all other information available to the Agency — found no indication of the diversion of nuclear material placed under safeguards or of the misuse of facilities, equipment or non-nuclear material placed under safeguards. On this basis, the Secretariat concluded that, in 2002, with the exception of the nuclear material in the Democratic People's Republic of Korea (DPRK), the nuclear material and other items placed under safeguards remained in peaceful nuclear activities or were otherwise adequately accounted for.

As a result of the unilateral actions of the DPRK to interfere with or remove the Agency containment and surveillance equipment at its nuclear facilities and to expel Agency inspectors, at the end of 2002, the Secretariat was unable to verify that no nuclear material placed under safeguards in the DPRK had been diverted. The DPRK remained in non-compliance with its existing safeguards agreement pursuant to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT).

On 27 November 2002, the Agency resumed inspections in Iraq, pursuant to relevant United Nations Security Council resolutions, now including resolution 1441 (8 November 2002). From then on, the Agency's safeguards activities in Iraq under the NPT safeguards agreement were again subsumed under these resolutions. At the end of 2002, no conclusions had been drawn with regard to the mandate from the United Nations Security Council, pending further verification activities although no evidence was detected of prohibited nuclear or nuclear related activities. The Agency verified the presence of the nuclear material that had remained under safeguards.

In 2002, safeguards were implemented in 28 States with comprehensive safeguards agreements and additional protocols in force or being provisionally applied. Only in such States are Agency safeguards able to provide credible assurance of the absence of undeclared nuclear material and activities. In 2002, for 13 of these States, the Secretariat — having evaluated all the information obtained through activities pursuant to the States' comprehensive safeguards agreements (CSAs) and additional protocols (APs), and all other information available to the Agency — found no indication of undeclared nuclear material or activities. On this basis, and taking into account the conclusion referred to in the first paragraph of this statement, the Secretariat concluded that all nuclear material in those States or under their jurisdiction or control had been placed under safeguards and remained in peaceful nuclear activities or was otherwise adequately accounted for. In the case of the other 15 States with comprehensive safeguards agreements and additional protocols in force, the Secretariat's evaluations for drawing such a conclusion are in progress.

Key Issues and Highlights

- **Approval, signature and ratification of safeguards agreements and additional protocols.**

— In 2002, the Agency stepped up its efforts to encourage and facilitate the conclusion of safeguards agreements and APs on the basis of the Secretariat's Plan of Action, the *Medium Term Strategy* and relevant General Conference resolutions. In this regard, the Agency organized a regional seminar for African States in June and outreach seminars were held in Kazakhstan and Estonia. Furthermore, consultations were held with a large number of States.

— The Agency's Board of Governors approved CSAs for Mali, Tajikistan and the United Arab Emirates, with Mali, Niger and the United Arab Emirates signing such an agreement. Agreements with small quantities protocols entered into force for Kuwait, Mali, The Former Yugoslav Republic of Macedonia and Yemen. Through an exchange of letters, it was confirmed that Albania's sui generis safeguards agreement fulfils NPT requirements.

— In 2002, additional protocols to safeguards agreements entered into force for China, the Czech Republic, Mali and South Africa, bringing the number of APs in force to 28.[1] In Ghana, an AP continued to be implemented provisionally pending entry into force, and measures foreseen under the Model Additional Protocol were implemented in Taiwan, China (Fig. 1).

— The Board approved APs for Chile, the Democratic Republic of the Congo, El Salvador, Haiti, Jamaica, Kiribati, Kuwait, Mali, Malta, Nicaragua, Paraguay, South Africa and Tajikistan, while Chile, Haiti, Kuwait, Mali, Nicaragua and South Africa signed the APs. By the end of 2002, the Board had approved APs for 74 States, 67 of which had signed the protocols.

- **State evaluations.**

— The Agency continued to allocate substantial resources to deal with the increasing workload related to activities for information collection, analysis and evaluation, such as the review of declarations[2] pursuant to an AP and the review of State evaluation reports (Fig. 2). Evaluation of information about a State's nuclear programme for safeguards purposes is an integral part of the process of deriving safeguards conclusions, and is critical for the Agency to draw and maintain conclusions of the non-diversion of declared nuclear material and on the absence of undeclared nuclear material and activities. Drawing such conclusions for the State as a whole is a prerequisite for implementing integrated safeguards at the State level. Fifty-eight State evaluation reports were prepared and reviewed, of which 26 were considered declarations submitted by States pursuant to an AP.[3]

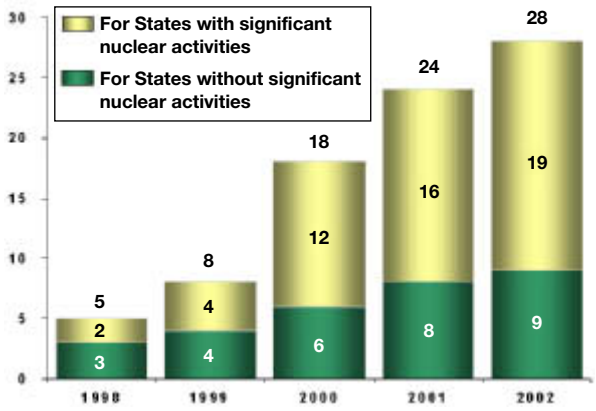


FIG. 1. Number of additional protocols in force. (The numbers exclude Ghana, where an additional protocol is applied provisionally. Measures foreseen under the Model Additional Protocol were also applied in Taiwan, China.)

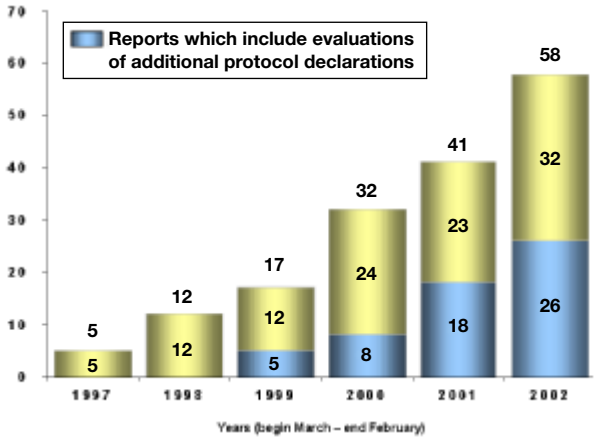


FIG. 2. State evaluation reports (completed and reviewed).

[1] Australia, Azerbaijan, Bangladesh, Bulgaria, Canada, China, Croatia, Czech Republic, Ecuador, the Holy See, Hungary, Indonesia, Japan, Jordan, Latvia, Lithuania, Mali, Monaco, New Zealand, Norway, Panama, Peru, Poland, Romania, Slovenia, South Africa, Turkey and Uzbekistan.

[2] The Model Protocol Additional to the Agreement(s) between State(s) and the International Atomic Energy Agency for the Application of Safeguards (INFCIRC/540 (Corr.)), approved by the Board of Governors in May 1997, provides for a State to declare information about all its activities related to the use of nuclear material to the Agency. Furthermore, it provides for expanded physical access (complementary access) for Agency inspectors to confirm the State's declarations.

[3] An evaluation was also carried out for Taiwan, China.

- **Progress in implementing integrated safeguards.**

— The completed conceptual framework for integrated safeguards was presented to the Board of Governors in March 2002. This framework is meant to guide safeguards implementation in States with both a CSA and an AP in force, where the requisite safeguards conclusions have been drawn. In 2002, the focus was on: further refining guidelines for the use of unannounced and short notice inspections; implementation criteria for research reactors and spent fuel storage facilities; and a methodology for estimating implementation costs.

— Implementation of integrated safeguards in Australia continued successfully throughout the year. A State level integrated safeguards approach for Norway was approved on a provisional basis, including a procedure for unannounced inspections at a research reactor facility. In addition, trials of unannounced inspection procedures were performed at two facilities.

— In preparation for the implementation of integrated safeguards in Indonesia, the safeguards approach and procedures for short notice random inspections were developed.

- **Proliferation resistance.**

— A technical meeting held in October produced a consensus document on the basic definitions and fundamentals of proliferation resistant nuclear energy systems, and on considerations for developing proliferation resistance assessment methodology. Issued as a safeguards technical report, the document provides guidance on the development of future nuclear energy systems, and serves as a basis for considering proliferation resistance in current and future safeguards implementation. It also contributes to the Agency's International Project on Innovative Nuclear Reactors and Fuel Cycles and other related initiatives.

- **Multilateral endeavour to remove fresh HEU from the Vinča research reactor.**

— In August 2002, as a result of an agreement between the Federal Republic of Yugoslavia (now Serbia and Montenegro), the Russian Federation and the USA, about 50 kg of fresh HEU reactor fuel were airlifted from a shutdown research reactor at the Institute of Nuclear Sciences Vinča to a nuclear research centre in the Russian Federation. Agency safeguards inspectors observed the packing of the more than 5000 small HEU fuel items into shipping containers and verified the material before sealing the containers. The operation was carried out under a special security regime.

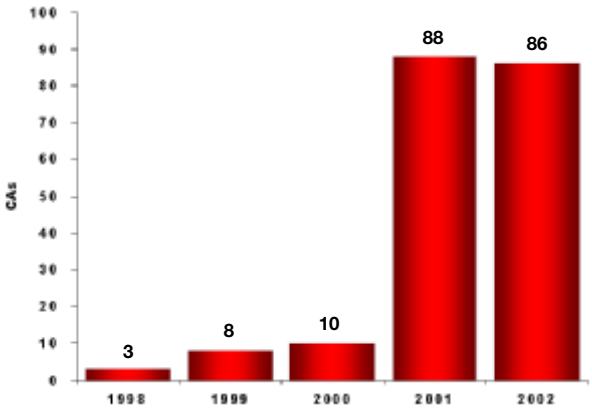


FIG. 3. Complementary access (CA), 1998–2002.

- **Safeguards budget.**

— The safeguards programme, like the rest of the Agency's programmes, continued to be operated within a zero real growth framework. Total expenditures from the Regular Budget, including the special appropriation for the acquisition of safeguards equipment, amounted to $78.5 million at the exchange rate prevalent at the time of disbursement (equivalent to $88.7 million at 0.9229 per US dollar). The chronic underfunding of this programme has led to strain on existing human resources in the face of an of increasing workload, and to excessive reliance on extrabudgetary funds.

Operations

During the year, safeguards inspections were performed at 603 locations in 69 States with significant nuclear activities (and in Taiwan, China). The box on the next page describes the key aspects of the Agency's strengthened safeguards system.

Implementation of additional protocols. In 2002, initial declarations under an AP were received from Bangladesh, Czech Republic, Ecuador, Latvia, Peru and Turkey. China was the first nuclear weapon State to submit a declaration pursuant to Article 2 of its AP. Complementary access was performed in 17 States (Fig. 3).[4]

[4] Complementary access was also performed in Taiwan, China.

The Strengthened Safeguards System — Implementation of Safeguards for States as a Whole

Events in the early 1990s, including the discovery of Iraq's clandestine nuclear programme, highlighted the importance of strengthening safeguards, including the Agency's ability to detect indicators of undeclared nuclear material and activities in States with CSAs. Underlying the implementation of strengthened safeguards was the shifting focus from safeguards implementation at the facility level to the State as a whole. The transition from evaluating quantitative verification activities at individual facilities to integrating this evaluation with qualitative information for the purpose of drawing safeguards conclusions for a State as a whole represents a profound change in the way in which the Agency implements safeguards.

Information is obtained from a variety of sources: from States themselves; by Agency safeguards inspectors in the course of their on-site inspections and other verification activities; from open sources such as the media, professional journals and commercial satellite imagery; and from any other safeguards relevant information available to the Agency.

To draw safeguards conclusions, the results of nuclear material verification activities, particularly failures in attaining specified inspection objectives, are evaluated and their safeguards significance is assessed. These results are considered in light of all safeguards relevant information for the State and are used to: focus facility specific safeguards activities; develop and evaluate the appropriate State level safeguards approaches[5] to ensure that sufficient (but not excessive) activities are conducted to draw and maintain credible safeguards conclusions. This is valid, in particular, for integrated safeguards approaches for States for which the Agency can draw the conclusion of the absence of undeclared nuclear material and activities.

The consistency of information is evaluated for each stage of the State's nuclear fuel cycle. In addition, information is evaluated for the State as a whole to gain an understanding of its nuclear programme and to determine whether information about its nuclear programme and future plans are consistent with its nuclear related R&D activities. The potential significance of inconsistencies or a lack of information about the State's fuel cycle activities are evaluated in the context of potential pathways to the acquisition of weapon usable nuclear material.

Therefore, overall conclusions for a State are not based solely on the results for nuclear facilities, but rather on structured evaluation of both qualitative and quantitative information and its safeguards significance with respect to drawing safeguards conclusions.

Spent fuel verification. Significant resources (12% of the Agency's total inspection effort) were required for verifying the transfer of spent fuel to dry storage. These activities require improved verification methods. Baseline measurements of all spent fuel canisters at a facility in Kazakhstan were successfully completed in 2002 using a spent fuel attribute monitor. These measurements will serve as a reference for re-verification of canned, difficult-to-access, spent fuel in the future.

In addition, the design of the monitoring system for the Chernobyl conditioning facility for spent fuel was completed. The system is now undergoing long term tests prior to installation at the facility.

Remote monitoring (RM).[6] The installation and use of RM systems has resulted in reduced in-field inspection activities. However, the cost efficiency of such systems depends on a variety of factors, including equipment installation, maintenance and communi-

[5] A facility **safeguards approach** is a set of technical measures (such as verification measurements and containment/surveillance devices) chosen for the implementation of safeguards in a given facility. The approach takes into account the specific features of the facility and should provide a capability to detect the diversion and undeclared production of nuclear material. A State level **safeguards approach** considers all facilities and other nuclear related locations in the State, and specifies the combination of safeguards measures and activities to be conducted in order to be able to draw safeguards conclusions for the State as a whole.

[6] These are systems for the remote transmission of safeguards verification data from facilities to regional offices or Headquarters.

cation costs. During 2002, additional RM systems were installed at facilities in Lithuania and the Republic of Korea and upgraded in South Africa and Switzerland. In preparation for the implementation of RM in Taiwan, China, digital surveillance systems were installed at power reactors. Thirty-nine monitoring systems were operating in RM mode in six States by the end of 2002.

Unattended monitoring. At complex nuclear facilities with automated plant operation, unattended assay and monitoring techniques are part of the safeguards approach. An unattended monitoring system primarily employs radiation detection sensors to detect the flow of nuclear material past key points in a facility's process/handling areas. Currently, 81 unattended monitoring systems are operating at 40 facilities in 21 States.

Safeguards analytical laboratories and capabilities. In 2002, the Safeguards Analytical Laboratory (SAL) and the Network of Analytical Laboratories (NWAL) analysed 736 samples of nuclear materials, and 12 samples of heavy water, and reported 1593 analytical results for material accountancy verification of facility operators' declarations. Additionally, 28 samples collected from CAs were received for analyses. The Clean Laboratory of SAL processed 317 environmental samples, 97 field trial air samples and 12 special samples from the Agency's Iraq Nuclear Verification Office (Table I).

Greater co-operation with regional organizations and State systems of accounting for and control of nuclear material (SSAC). Examples of increased co-operation during 2002 include: a technical meeting in May with representatives from 19 State and regional SSACs to identify ways for increasing co-operation between the Agency and SSACs; introduction of joint verification of spent fuel in Japan; development of over twenty procedures for the common use of safeguards equipment with ABACC; and full implementation of the Enhanced Co-operation Agreement (2001 with the Republic of Korea.

Status of the JNFL project. During 2002, the development and implementation of a safeguards approach for the Rokkasho Reprocessing Plant in Japan proceeded according to schedule. Major accomplishments included: installation of the On-Site Laboratory infrastructure, including cells, glove boxes and utilities; development and installation of the solution measurement and monitoring system; development of a software design for the data collection and evaluation system; and design information verification during the construction phase.

Table I. **Verification Activities**

	2000	2001	2002
Person-days of inspection	10 264	10 314	10 084
Number of new or revised Subsidiary Arrangements negotiated			
— General Parts	2	9	3
— Facility Attachments	26	10	12
Nuclear material accountancy measures			
Number of nuclear material samples analysed	621	831	736
Number of nuclear material analytical results reported	1401	1747	1593
Number of environmental swipe samples analysed	224	263	317
Nuclear material under safeguards (in tonnes)			
Plutonium contained in irradiated fuel (including recycled plutonium in fuel elements in reactor cores)	654	690	731.6
Separated plutonium outside the reactor core	72.2	77.5	82.0
High enriched uranium	21.8	20.9	31.8
Low enriched uranium	48 974	50 079	51 226
Source material	91 686	94 940	96 410

Development and Support

Standardization and interchangeability. The Agency is further standardizing portable safeguards equipment to streamline maintenance procedures and to reduce the number of instruments for which inspectors must be trained. As a result, three instruments for radiation monitoring and gamma spectral analysis have been selected for inspection use, each fulfilling specific requirements with regard to functionality and measurement capability.

Digital surveillance. The reliability of the Agency's digital surveillance capability increased significantly when the radiation susceptibility of digital surveillance devices was reduced through the use of radiation hardened components. Consequently, the replacement of analogue surveillance systems with digital surveillance, which had been delayed, is now progressing. In addition: 89 digital surveillance systems were installed, collecting data from 144 surveillance cameras; and 489 cameras, connected to 293 digital surveillance systems, were in operation.

Support for verification activities. The Agency upgraded hardware for solution measurement and monitoring systems for the verification of nuclear material in solution form. Standardized calibration procedures and error estimation routines for tank calibration data were incorporated into software, enabling a thorough, accurate and rapid evaluation of calibration data. As part of essential design information verification activities, calibration data gathered at reprocessing facilities in Japan were evaluated using this enhanced software.

Support for State evaluation. Specific software for analysing data and information related to AP implementation, including CA data, has been developed. The large volume of AP data is now easier to secure, manage and retrieve, thus increasing the efficiency of information review and analysis.

In addition to a large number of databases that are periodically reviewed by the Agency for relevant information, subscriptions to six additional commercial databases now provide a broader range of information on nuclear activities and programmes in Member States. The Agency's open source information system now includes over 5.3 million documents.

In conjunction with open source information, data obtained through the analysis of commercial satellite imagery can be used in verification and evaluation activities. Member State Support Programmes (MSSPs) have provided expertise, data and training in open source information collection and analysis. In particular, Member States provided 46 weeks of technical support for satellite imagery analysis.

Management of State declared information. Secure communication links for transmitting nuclear material accounting reports have been expanded to the Czech Republic, the Republic of Korea and Latvia. In total, 26 Member States are now providing nuclear material accounting information to the Agency by encrypted e-mail.

In response to the recommendation of the Board of Governors regarding the proliferation potential of neptunium and americium (GOV/1999/19 Rev.2), reporting software was developed and implemented that will assist in the processing of information on these elements submitted from Member States.

Training. The number of safeguards courses for individuals in Member States was increased to cover wider regional areas. The content of these training courses was enhanced to assist Member States in fulfilling their obligations under safeguards agreements and APs. Eleven regional and international training courses were conducted in nine countries.

Courses for Agency inspectors were updated and enhanced. These included two Introductory Courses on Agency Safeguards (ICAS) for 30 new inspectors and courses on specialized topics such as: plutonium verification techniques; environmental sampling; the nuclear fuel cycle and proliferation indicators; performing State evaluations; CA, and the nuclear fuel cycle for country officers.

Safeguards glossary. A revised edition of the *IAEA Safeguards Glossary* was issued in 2002, reflecting the changes and additions in terms as a result of advances in strengthening the Agency's safeguards system since the last update of this publication in 1987. The glossary is intended to facilitate understanding of the specialized safeguards terminology within the international community. Over 400 terms are described, with all terms translated into the five official languages of the Agency as well as into German and Japanese.

Member State support. As in previous years, substantial contributions were made through MSSPs to the Agency's safeguards programme. As of 31 December 2002, the following States and organizations had formal support programmes: Argentina, Australia, Belgium, Canada, the European Commission, Finland,

France, Germany, Hungary, Japan, the Netherlands, the Republic of Korea, the Russian Federation, Sweden, the United Kingdom and the USA.

At the beginning of 2002, 246 MSSP tasks were under way addressing needs identified by the Secretariat, of which 80 were completed during the year. Forty-five new tasks were initiated. Of the 211 tasks under way in December 2002, 34% are related to equipment development, 17% to training, 19% to information technology, 18% to destructive analysis and 13% to safeguards concepts.

IAEA Safeguards Information System (ISIS). An ISIS re-engineering project was established in 2002 in recognition that the technology of the ISIS was out of date, difficult to use and costly to maintain, limiting the Agency's ability to develop new, more efficient IT applications. A project plan for phased implementation over approximately four years was formulated. The implementation of the re-engineering project is foreseen for the period 2003–2006 and is expected to have a significant impact on the Agency's budget for the 2004–2005 biennium.

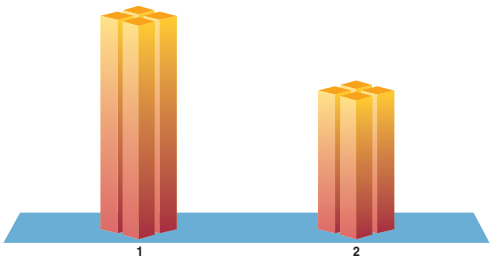
Trilateral Initiative. This initiative, which involves the Agency, the Russian Federation and the USA, was undertaken in 1996 to investigate the technical, legal and financial issues that would arise if the Agency was asked to carry out a new verification role in relation to nuclear arms reduction in the Russian Federation and the USA. Work under the initial task, entrusted to a Joint Working Group, was deemed by the three parties to have been concluded in September 2002. The Agency stands ready to consider assuming a new charge in the trilateral format if and when it is requested to do so, including work related to Agency verification as foreseen under the existing bilateral Russian Federation–USA Plutonium Management and Disposition Agreement.

Security of Material

Objective

To increase Member States' awareness and ability to control and account for and protect nuclear and other radioactive materials from subnational[1] terrorist or other illegal activities, and to detect and respond to such incidents.

Regular budget expenditure: $725 039
Extrabudgetary programme expenditure (not included in chart): $1 851 406



1. Technical, Administrative and Regulatory Arrangements in Member States to Protect and Control Nuclear Materials: $440 513
2. Addressing Illegal Activities involving Nuclear and other Radioactive Materials: $284 526

Key Issues and Highlights

- In response to a resolution from the General Conference, the Agency reviewed its activities relating to protection against nuclear terrorism and developed a plan of activities designed to enhance such protection. The plan was approved, in principle, by the Board of Governors in March 2002. Implementation is well under way with new and revised recommendations, guidelines and methodologies being developed, a substantial increase in the number of evaluation and appraisal missions to Member States as well as training courses, with new and revised training and assessment packages under development.
- The Agency's nuclear security plan of activities is largely funded through extrabudgetary contributions channelled through the Nuclear Security Fund. So far, Member States have pledged in excess of $12 million to the fund, together with substantial and valuable in-kind assistance.
- An Advisory Group on Nuclear Security (AdSec), established by the Director General, has provided valuable advice and made recommendations on the Agency's nuclear security related activities and programmes.
- An open ended group of legal and technical experts preparing a draft of a well defined amendment aimed at strengthening the Convention on the Physical Protection of Nuclear Material (CPPNM) met several times. Substantial progress was made on the draft amendment.

Technical, Administrative and Regulatory Arrangements in Member States to Protect and Control Nuclear Materials

To assist Member States in evaluating their national systems of physical protection, the Agency conducted International Physical Protection Advisory Service missions to Bulgaria, the Czech Republic, Lithuania and Romania. Recommendations for enhancing physical protection and implementing good practices were provided to the appropriate authorities in these countries. Other such missions were conducted to South Africa and Poland.

In response to an increasing recognition of the need to have a 'design basis threat' (DBT) as the basis for part of an effective and efficient State system of physical protection for nuclear material and facilities, the Agency conducted DBT workshops in Armenia, Indonesia, the Russian Federation, Slovenia and Ukraine. The objective was to assist national authorities to develop and maintain a national DBT as a foundation for national physical protection measures. Work has started on documenting the DBT methodology in a guidance document.

[1] In this context, the term 'subnational' refers to unlawful subnational activities.

Other national, regional and international training course and workshops to enhance the level of physical protection for nuclear material and facilities were held in China, Egypt, the Islamic Republic of Iran, the Republic of Korea, Pakistan, Romania, the Russian Federation and the USA. Some of these activities were carried out in partnership with Agency nuclear safety experts in order to take advantage of the synergies between security and safety issues at nuclear facilities (Fig. 1). In this connection, work started on a methodology to help States identify 'vital areas' in nuclear facilities.

Assistance to Member States in establishing and implementing norms and guides for nuclear material accountancy and control continued to make a significant contribution to the physical protection of nuclear material. Effective State Systems of Accounting for and Control of Nuclear Material (SSACs) both deter theft of material and provide prompt warning if theft occurs. In addition to training courses and workshops, guidelines for an SSAC advisory service and a self-assessment methodology were developed.

FIG. 1. An example of an exterior physical protection system for detecting and assessing intruders at a nuclear facility.

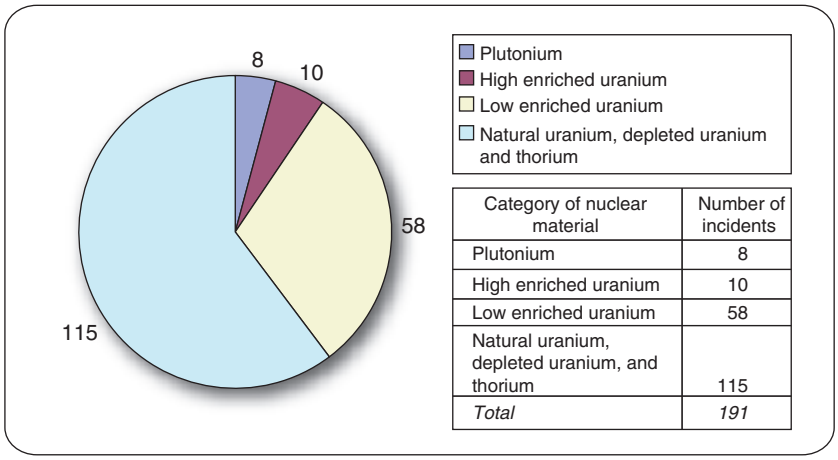
Addressing Illegal Activities Involving Nuclear and Other Radioactive Materials

Illicit trafficking is the consequence of the absence or failure of measures to control and protect nuclear and other radioactive materials. To enhance the 'second line of defence' the Agency provides assistance to Member States to enhance their capabilities to detect the illicit movement of such materials. This assistance took the form of training courses, exercises and workshops for customs and other 'front line' officers in a number of countries. In addition, courses were held on nuclear forensics and on the use of detection equipment for law enforcement agencies.

The Illicit Trafficking Data Base (ITDB), which relies on Member State reports on incidents and seizures, continued to expand. Two more Member States joined the database during 2002 and reports on highlights and trends in illicit trafficking incidents were periodically issued. A total of 45 trafficking incidents, confirmed by Member States, were added to the database in 2002. The analysis of the information helped to identify trends and patterns in the illicit trafficking cases that were reported. Information on incidents reported between January 1993 and June 2002 is presented in Figs 2 and 3.

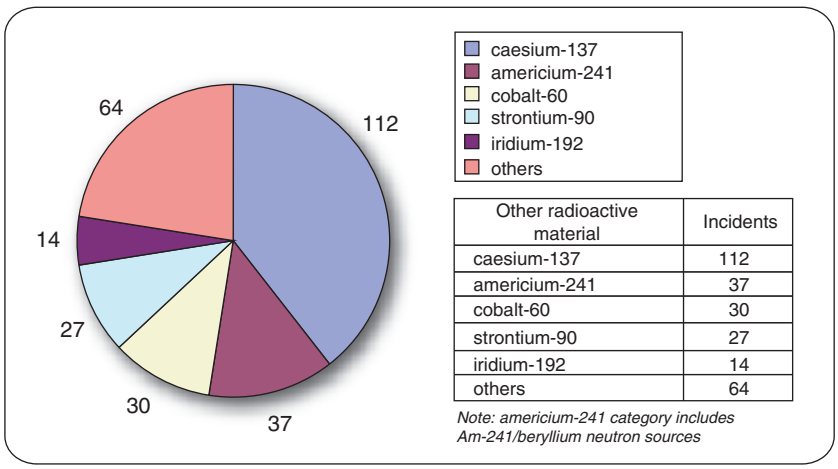
Information from the ITDB is used to improve public awareness of the threats to the security of nuclear and other radioactive materials. Such information has been in great demand. For example, over the twelve month period from mid-2001 to mid-2002, the number of external requests for information from the ITDB increased more than five fold.

The Agency's General Conference in September featured a 'Scientific Forum' focusing on a number of topical issues, among them nuclear security. The keynote speakers discussed issues related to risk assessment, the control of radioactive sources and new approaches to protecting nuclear material and facilities. It was noted that security was not a new concern for the nuclear industry, which had long considered the threat of the theft of special nuclear material and of sabotage. Furthermore, nuclear power plants have the strongest defensive capabilities to be found in the commercial world, the result of inherent defensive capabilities arising from designs to withstand extreme events. Nonetheless, the forum concluded that further measures were needed to improve security measures, to identify and mitigate vulnerabilities, and to refine the assessment of potential threats. On the issue of radiological sources and their potential to be used in radiological dispersion devices (RDDs, or 'dirty bombs'), the session recognized the threat of



Category of nuclear material	Number of incidents
Plutonium	8
High enriched uranium	10
Low enriched uranium	58
Natural uranium, depleted uranium, and thorium	115
Total	*191*

FIG. 2. Distribution of incidents involving nuclear material (January 1993–June 2002).



Other radioactive material	Incidents
caesium-137	112
americium-241	37
cobalt-60	30
strontium-90	27
iridium-192	14
others	64

Note: americium-241 category includes Am-241/beryllium neutron sources

FIG. 3. Distribution of incidents with other radioactive material (January 1993–June 2002).

terrorist use of RDDs and the priority of establishing security measures applicable to sources, which offered the greatest threat.

To assist national authorities in assessing the risks and consequences of seizures of radioactive sources, and to determine appropriate responses, the Agency despatched expert missions to Bolivia and the United Republic of Tanzania at the request of those States. In both cases, the incidents apparently involved illicit trafficking.

The response to seizures of nuclear and other radioactive materials warrants a thorough investigation of the material and its origin. Nuclear forensics, using scientific analysis of the information available, helps to understand the history of the material, thereby providing an opportunity to establish its origin. An Agency conference on advances in destructive and non-destructive analysis for environmental monitoring and nuclear forensics, held in Karlsruhe, Germany, in October, examined the possibility of increasing the availability of nuclear forensics techniques and integrating them into police investigations of illicit trafficking cases.

To improve the detection and characterization of radioactive materials seized by States, a new CRP, 'Improvement of Technical Measures to Detect and Respond to Illicit Trafficking of Nuclear and other Radioactive Materials', was established. The objective is to co-ordinate R&D on improving the detection capability and performance of handheld and portable isotope measurement devices, prepare standardized procedures to detect and examine suspicious packages, and assess the hazard of confiscated material. In addition, the CRP will facilitate the development of a network of analytical laboratories to enable Member States to obtain the required support for nuclear forensics analysis.

Verification in Iraq Pursuant to UNSC Resolutions

Objective

To provide credible assurance that Iraq is complying with the provisions of United Nations Security Council (UNSC) Resolution 687 (1991) and other relevant resolutions.

Key Issues and Highlights

- After the adoption of Resolution 1409 (the 'Goods Review List') in May 2002, the Agency started to review and assess all contracts for the export of goods to Iraq in the context of the United Nations 'Oil for Food' programme.
- Following a series of talks between Iraq and the United Nations and the adoption by the Security Council of Resolution 1441 on 8 November 2002, the Agency was able to resume its mandated activities in Iraq on 27 November 2002, after the suspension of its resolution related field activities for almost four years (Fig. 1).
- In 2002, extrabudgetary programme expenditures amounted to $2 746 110.

Operations

Upon resumption of inspections in Iraq, the main goals were to: re-establish rapidly the Agency's knowledge base of Iraq's nuclear capabilities; ensure that key facilities had not been reopened; verify the location of nuclear material and relevant non-nuclear material; and identify and begin interviewing key Iraqi personnel.

During the first month of inspections good progress was made in re-establishing knowledge of Iraq's nuclear capability, with the bulk of the 80 inspections taking place at State-run or private industrial facilities, research centres and universities.

In carrying out on-site inspections, the Agency's inspectors employed a variety of tools to accomplish their mission. Taking advantage of the 'signature' of radioactive materials, Iraq's rivers, canals and lakes were monitored to detect the presence of certain radioisotopes. In addition, a broad range of environmental samples and surface swipe samples were collected. Carborne and hand held gamma surveys for the detection of undeclared nuclear material were also reinstated.

FIG. 1. Talks between the Agency, UNMOVIC and Iraq at the Agency's Headquarters in Vienna.

Resolution 1441 clearly gave the Agency and UNMOVIC the authority to determine modalities and venues for conducting interviews with Iraqi officials and other persons. In this context, scientists, managers and technicians were interviewed, primarily in the workplace and during announced inspections and in pre-arranged meetings. The information gained during the inspections has been helpful in assessing the completeness and accuracy of Iraq's declaration.

Analysis

As was the case in previous years, the Agency's analytical activities continued to include in-depth analysis of the extensive documentation acquired through the inspection process. This resulted in refinement — but not alteration — of its technically coherent picture of Iraq's clandestine nuclear programme and nuclear related capabilities as of December 1998.

The Agency also reviewed and assessed all available post-1998 information (for example, publications by Member States, open source data, and high resolution commercial satellite imagery). After Iraq provided its semi-annual declaration in early October 2002 and its "Currently Accurate, Full and Complete Declaration" in early December 2002, analytical activities focused on the evaluation of these declarations, merged with all inspection findings, in order to accelerate the assessment of Iraq's nuclear threat and adapt the planned inspection programme to identified priorities.

Export–Import Operations

In Resolution 1409 (2002), the Security Council requested the Agency to evaluate applications submitted to the Office of the Iraq Programme (OIP) related to the export of products and commodities to Iraq. The Agency is responsible for identifying nuclear related items referred to in paragraph 24 of Resolution 687 (1991) or in Section D (Nuclear) of the Goods Review List (GRL)[1], to determine whether such items are either prohibited or require prior approval by the Security Council Committee established by Resolution 661 (1990) (the "Sanctions Committee"). Close co-ordination of efforts with UNMOVIC and OIP permitted the establishment of an efficient mechanism for performing this task. The Agency is required to complete its evaluation of each application within ten days. Over 6700 applications were processed between May and December 2002.

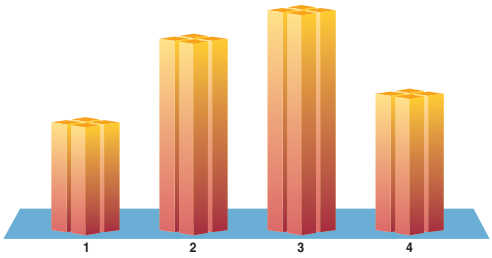
[1] The Goods Review List (GRL) (S/2002/515) is referred to in Resolution 1409 (2002). Section D of the GRL identifies the relevant nuclear related items. This section is identical to the list of nuclear related items to which the export–import mechanism, approved in Security Council Resolution 1051 (1996), applies as well as to Annex 3 of the Agency's Ongoing Monitoring and Verification (OMV) Plan approved in Security Council Resolution 715 (1991), as updated in 2001 (S/2001/561).

Outreach and Information Support Services

Objective

To increase access to, and understanding of, information on the Agency's role and activities on the part of Member States, the scientific community, non-governmental organizations and the general public, and to meet the needs for the exchange of information within the Secretariat and with the Member States through the development of an adequate IT infrastructure, information systems and all types of information resources.

Regular budget expenditure: $17 151 060
Extrabudgetary expenditure for the major programme (not included in chart): $803 030



1. Public Information: $2 827 946
2. Information Technology Infrastructure and Services: $5 013 439
3. Nuclear Information Resources: $5 763 166
4. Conference, Translation and Publishing Services: $3 546 509

Key Issues and Highlights

- As a result of world events in Iraq and the Democratic People's Republic of Korea (DPRK), and also the adoption of a more proactive approach by the Secretariat, there was accelerated public and media interest in the work of the Agency (including its activities related to nuclear applications) and in international nuclear issues.
- The enhanced interest in the Agency's work was also reflected in wider dissemination of Agency publications and increased participation in meetings.
- Greater efforts were made to ensure round-the-clock security of the Agency's IT infrastructure in the light of increased use, and the rising number of intrusion attempts and virus attacks.

Public Information

Interest in international nuclear issues accelerated during the year. The resumption of special United Nations inspections in Iraq, concerns over the safety and security of nuclear or radioactive materials and the question of safeguards in the DPRK all combined to place the Agency at the forefront of news reports in print and web editions of newspapers and magazines, and on television stations. In response to growing media demand, thousands of enquiries were fielded and hundreds of interviews were given to media outlets around the world, resulting in extensive coverage of the Agency's policies and activities. In addition, the *WorldAtom* web site drew increasingly greater attention as coverage expanded and its audience nearly tripled to more than five million hits per month from nearly one hundred countries.

With extrabudgetary funds from the USA, media campaigns were launched on "Eradicating Tsetse Flies" and "Securing Radioactive Sources", resulting in extensive media coverage around the world. A third Agency public service announcement focusing on verification was produced and broadcast on CNN. Print and electronic forms of *Science Serving People (http://www.iaea.org/worldatom/Press/Booklets/Ssp/)*, an in-depth portrait of the human benefits and impacts of Agency projects and programmes throughout the developing world, was produced. The work of the Agency was also publicized through information seminars held in Brazil, Poland and Viet Nam.

Information Technology Infrastructure and Services

Steps were taken to make the collection and dissemination of data in the Agency's scientific and technical databases more efficient. For instance:

- Increased use was made of the Internet to allow data to be captured directly in Member States;
- An information catalogue was produced to increase awareness of the Agency's databases;
- An information service desk was established to aid Agency staff in locating authoritative data.

The 'Desktop 2000' project was completed to ensure that all personal computers were configured in a standard manner. As well as increased security, the project provides more reliable working tools and reduces the risk of incompatibilities occurring when files are exchanged internally or with Member States. A document management, records management and collaborative software product was also selected as an Agency standard. And an information management/IT medium term strategy was approved during the year.

Access to IT services at Headquarters was converted to Virtual Private Network (VPN) technology in order to improve security when used by staff working out of the office. The security of the network was upgraded regularly and no security breaches occurred, in spite of a doubling of the attempts at intrusion and a number of virus attacks. The network 'backbone' was upgraded in preparation for the modernization and standardization of the entire internal network during the asbestos removal project for the VIC.

Considerable effort went into providing support during the UN–Iraq talks and into designing and setting up an information communication technology infrastructure for the Agency's Iraq Nuclear Verification Office premises in Iraq prior to and after the resumption of inspections.

The development of software for specific programme activities included:

- A system for a radiation waste management registry;
- A data acquisition system for the Agency's Power Reactor Information System (PRIS) using the Internet;
- A system for maintaining and publishing the Safeguards Manual;
- Enhancements to the Internet based Waste Management Database;
- A prototype of an Asian Nuclear Safety Network system;
- A simple system for the preparation of Agency programmes;
- A new web site for the conventions on Early Notification of a Nuclear Accident and on Assistance in the Case of a Nuclear Accident or Radiological Emergency.

Nuclear Information Resources

International Nuclear Information System

The International Nuclear Information System (INIS) was able to augment the level and maintain the quality of input into the INIS Database. A total of 71 276 records were added to the database, which represents an increase of 2.7% compared with 2001, and 8.4% compared with 2000. This includes 3839 bibliographic records prepared as voluntary contributions by INIS members (an increase of 93% compared with 2001) and 11 428 records prepared as voluntary contributions by the Agency (an increase of 173% over 2001). At the end of 2002, there were 2 347 302 records in the INIS Database.

The Agency signed an agreement with the American Institute of Physics for the acquisition of electronic bibliographic records. Negotiations were also in progress for similar agreements with three other publishers: Springer-Verlag, John Wiley & Sons and Thomson ISI, and other sources of electronic records are being investigated.

As of the end of 2002, there were 270 062 authorized users of the INIS Database on the Internet. This is a significant increase from last year. Ninety-five universities and academic institutions in 27 Member States benefited from free access to the database, and a further 128 universities were in the process of obtaining it. The INIS Database on CD-ROM had 406 paid and free subscriptions.

The Agency continued its co-operative arrangement with the OECD/NEA Data Bank. In 2002, 913 computer programs (out of 4664) were distributed to users in INIS member countries that were not members of the OECD, a significant increase from last year. In addition, 9 computer programs (out of 107) were contributed from Member States that are not OECD member countries.

A new e-learning module was launched in the INIS Distance Learning Program (DLP) entitled 'How to Search the INIS Bibliographic Database'. This module, also available on CD- ROM, provides guidance on accessing information in the INIS Database, both on the Internet and on CD-ROM.

Two new INIS national projects were evaluated in 2002, with implementation planned to start in 2003. Three requests for fellowships were evaluated. A staff member from the Chinese INIS Centre visited the INIS Secretariat in 2003 to co-ordinate a project to translate the INIS Thesaurus into Chinese

Imaging and archiving work included the processing by the INIS Clearinghouse of 11 221 non-conventional literature (NCL) documents and the production of 24 CD-ROMs. The timeliness of production was improved by 60%. In other work, a microfiche digitization centre was established and a digitization project was started. More than 12 000 NCL documents were digitized during the year.

Systems development included the first release of a new INIS imaging system. Data conversion utilities were developed to convert and manage input received from Elsevier Science BV, the Institute of Physics Publishing (IOPP), the American Institute of Physics and the US-DC 'Rolling Window' service.

The INIS Secretariat continued to assist Liaison Officers in their promotional activities, providing them with information on meetings and conferences taking place in their countries, and sending them promotional material to be used during these events — 145 requests for promotional material from 54 INIS members were fulfilled.

There was a significant effort to promote INIS during the Agency's 46th General Conference. Two side events were organized for the first time to raise the awareness of INIS among decision makers and to demonstrate its benefits.

The 30th Annual Consultative Meeting of INIS Liaison Officers was hosted by the Bulgarian Committee on the Use of Atomic Energy for Peaceful Purposes in Sofia in May 2002.

Library Services

In 2002, the VIC Library reoriented its activities as a result of the termination of common library services to the VIC based organizations on 31 March. A dual programme was implemented to ensure smooth separation of the United Nations Office of Vienna (UNOV) and to concentrate human and information resources on providing services to the Agency and the Permanent Missions located in Vienna (Table I). After the common library services were ended, the VIC Library was renamed the IAEA Library.

As part of efforts to focus the Library's activities on the information needs of the Agency, the *VICLNet* web site was redesigned and further developed. A new intranet based library and information system, *LISNet*, was launched in September 2002. The main features of the new system include: improved navigation and organization of information sources based on the INIS classification scheme; an enhanced search function which allows searches of both print and electronic information sources; and new electronic services.

Closer co-operation between the Library and INIS resulted in an increase in the number of nuclear related resources, all of which were available on *LISNet*. Agency staff had access through *LISNet* to 193 subscribed electronic journals, 208 free Internet journals, 24 databases and 6 commercial electronic information services. Library services to the Member States in 2002 included remote access to *LISNet* and document delivery services to Permanent Missions and to a range of institutions in Member States.

The regular training programme for Library users was conducted with the aim of promoting electronic information services and developing skills in their use: a total of 71 training sessions were held. In addition, guided tours of the Library were arranged for official and other visitors.

Conference, Translation and Publishing Services

The Agency provided support facilities for one Convention meeting and four preparatory meetings, as

Table I. **Services Provided by the IAEA Library**

Service	Number
Answering user queries	6564
External database searches	863
Loan of materials	6065
Routing journal issues to users	7231 (to 481 users)
Fulfilling requests from commercial suppliers	1044
Interlibrary loans	2357
Library reading room	80 journals; 13 newspapers

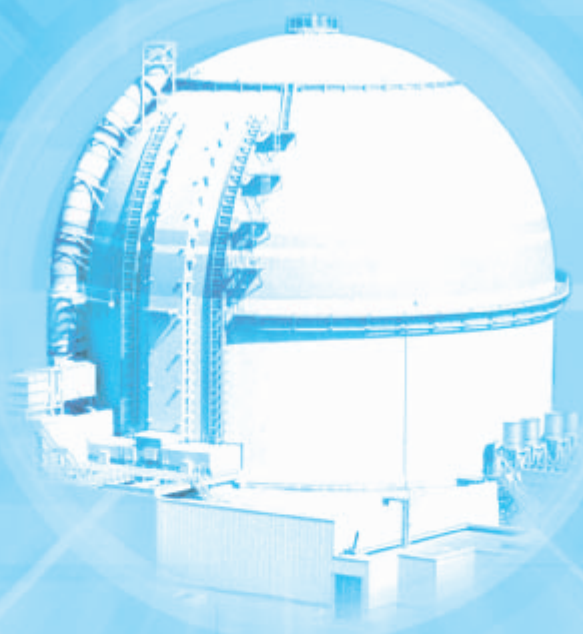
well as for the General Conference, five meetings of the Board of Governors and two meetings of associated committees. Nine conferences and symposia, with a total of 2536 participants, were held in 2002. Eight training sessions, with 396 participants, were also supported.

There was a 10% increase in the total number of pages translated in 2002 as compared with 2001, and a 3% increase in the number of pages translated in-house. By the end of the year, computer assisted translation software was being used regularly for all of the official languages; voice recognition software was also being used for some of these languages. With a view to standardizing the use of technical terms throughout the house, work was accelerated on the development of a centralized multilingual terminology database.

Publishing activities included the production of 198 books, reports, journal issues, CD-ROMs, newsletters and leaflets. The full texts of all publications issued during the year were made available free of cost on the Agency's *WorldAtom* web site (*http://www.iaea.org/worldatom/Books/*). In spite of this, revenue from the sale of print publications went up by 16% during the year, while the number of copies distributed increased by 20%. In collaboration with the Institute of Physics Publishing in the United Kingdom (which produces the *Nuclear Fusion* journal for the Agency), back issues of the journal dating to 1992 were archived on-line (see *http//www.iopp.org*).

The Agency continued its participation in the Frankfurt International Book Fair. It was also present at the European Nuclear Conference 2002 World Expo in Lille, France, and the annual meeting of the International Federation of Library Associations, in Glasgow, United Kingdom.

Management

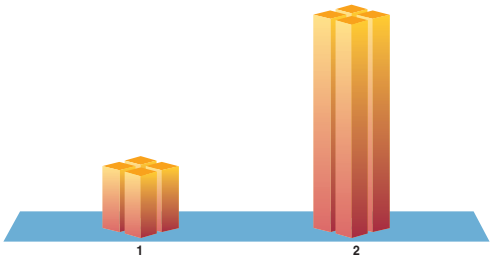


Management of Technical Co-operation for Development

Objective

To further strengthen the technical co-operation programme, and ensure relevance, transparency, effectiveness and efficiency in contributing to tangible social and economic benefits and to the scientific advancement of Member States.

Regular budget expenditure: $12 413 592 *
Extrabudgetary programme expenditure (not included in chart): $243 644



1. Programme Planning and Co-ordination: $2 424 540 **
2. Programme Formulation and Implementation: $9 989 052

Key Issues and Highlights

- A review of *The Technical Co-operation Strategy* during 2002 led to a detailed examination of the programme approval process. As it became apparent that this process could not be looked at in isolation, relevant stages of the entire programming cycle were analysed, leading to the identification of specific problem areas, and follow-up actions were planned for 2003.
- An issue of some concern is the difficulty in implementing certain projects owing to the problems involved in the transportation of radioactive materials. Carriers will not accept hazardous materials, or if they do a high surcharge is applied. This obstacle has already caused delays in some projects. Possible solutions will be discussed at the Agency's International Conference on the Safety of Transport of Radioactive Materials in 2003.
- A new brochure and associated web site, *Science Serving People*, focuses on how the Agency is helping to harness nuclear science and technology to promote development and overcome the challenges of water scarcity, food insecurity, malnutrition, malaria and environmental degradation.
- The size of the technical co-operation programme increased in financial terms to an all time high of $98.1 million. However, new resources in 2002 were the lowest since 1998. Payments to the Technical Co-operation Fund (TCF) were $57.5 million, or 78.8% of the TCF target, thus falling far short of the 85% rate of attainment set for 2002 by the General Conference. Assessed programme costs paid were less than the amount assessed for 2001, resulting in a net increase of arrears. Income from extrabudgetary resources was also down, although new agreements for extrabudgetary partnerships should reverse this trend in 2003.
- Non-governmental organizations (NGOs) represent a new source of extrabudgetary contributions for the technical co-operation programme. An agreement was reached with the Nuclear Threat Initiative to support Agency projects for the decommissioning of the Vinča RA research reactor in the Federal Republic of Yugoslavia (now Serbia and Montenegro).

Programme Planning and Co-ordination

The review of *The Technical Co-operation Strategy*, requests from Member States and improved

* Excluding overall management, co-ordination and common activities of $475 253, which is included in Policy and General Management.

** Excluding overall management, co-ordination and common activities.

application of the Agency's results based programming and budgeting approach all provided the impetus for the development of a programme performance assessment and reporting system. Currently in preparation, this system will be tested in 2004 and should be fully operational in 2005. The virtues of the system include early detection of potential problems and recognition of trends. This will facilitate the introduction of corrective measures to ensure the sustainability of project outcomes. The system will also facilitate compliance with the multiple reporting requirements of the programme.

The Agency continues to strive for greater efficiency in its technical co-operation programme and to provide better service to Member States. One improvement was the development of an intranet system for the electronic preparation of procurement requests. The system, which supports electronic approvals, guides the preparation process and validates the data quality of the requests, has demonstrated savings in time as well as data quality improvements. Web based project management reports in TC-PRIDE (Technical Co-operation Project Information Dissemination Environment) have been improved as well. The provision of detailed financial data ensures that project managers have constant access to relevant data. Enhancements have also been made to TC Web *(http://www-tc.iaea.org/tcweb)*, which is used by both the Agency and Member States. For example, a new link for thematic planning reports has been added to the web site.

The technical co-operation programme budget continued to grow in size in 2002, reaching an all time high of $98.1 million. Net new obligations were also the highest ever, at $74.6 million, and disbursements totalled $74.8 million. However, resources in general showed a downward trend, resulting in the lowest net new resources in five years. The unpredictable nature of the TCF was again made clear when one major donor reduced its pledge by more than $1 million in December, and exchange losses caused a reduction of over $750 000.

Programme Formulation and Implementation

The second meeting of the third Standing Advisory Group on Technical Assistance and Co-operation (SAGTAC III), held in March 2002, helped to refine *The Technical Co-operation Strategy*. Four new strategic objectives were introduced: (1) strengthening of strategic partnerships; (2) a stronger focus on sustainability through government commitment; (3) fund raising; and (4) programme development aimed at improving the self-reliance of nuclear institutions. These objectives guided the development of the technical co-operation portion of the Agency's programme and budget for 2004–2005 and were emphasized in the finalization of the programme for 2003–2004.

One of the basic tools set out in *The Technical Co-operation Strategy: The 2002 Review* is the 'central criterion', or government commitment, which is a key factor in ensuring the sustainability of project benefits and impacts. A project enjoying strong government commitment and support and that addresses an area of real need in which there is a national programme has the best chance for success. During work on the 2003–2004 cycle, the central criterion was used consistently for project selection. At the request of the Board of Governors, the programming process was aimed at designing a more focused programme, with fewer but better formulated projects. As a result, for 2003–2004, the programme will contain 606 projects compared with 697 projects for the previous biennium. This represents a reduction of 13% in the number of individual projects, but not a reduction in the amount of technical co-operation activities. In addition, all project descriptions will include performance indicators.

Country Programme Frameworks (CPFs) played an important role during the year in ensuring that the technical co-operation programme reflects the priority needs of recipient countries. This biennium (2001–2002) saw a greater number of countries with CPFs, either under development or completed, which served to focus project planning on government development priorities and nationally identified needs. So far, 46 recipient countries have approved CPFs, and another 33 have draft CPFs.

Reflecting the current priorities of Member States, as identified during the year, the emphasis of the 2003–2004 technical co-operation programme has shifted somewhat (Fig. 1). For example, activities related to human health will have a higher percentage of the programme than safety related projects. The third highest area of activity is food and agriculture. Also at 11% is human resources development and capacity building. This area of activity covers country programming and pre-project missions as well as human resources development and technology support projects. Nuclear security activities occupy a relatively small place in the programme and are separated from

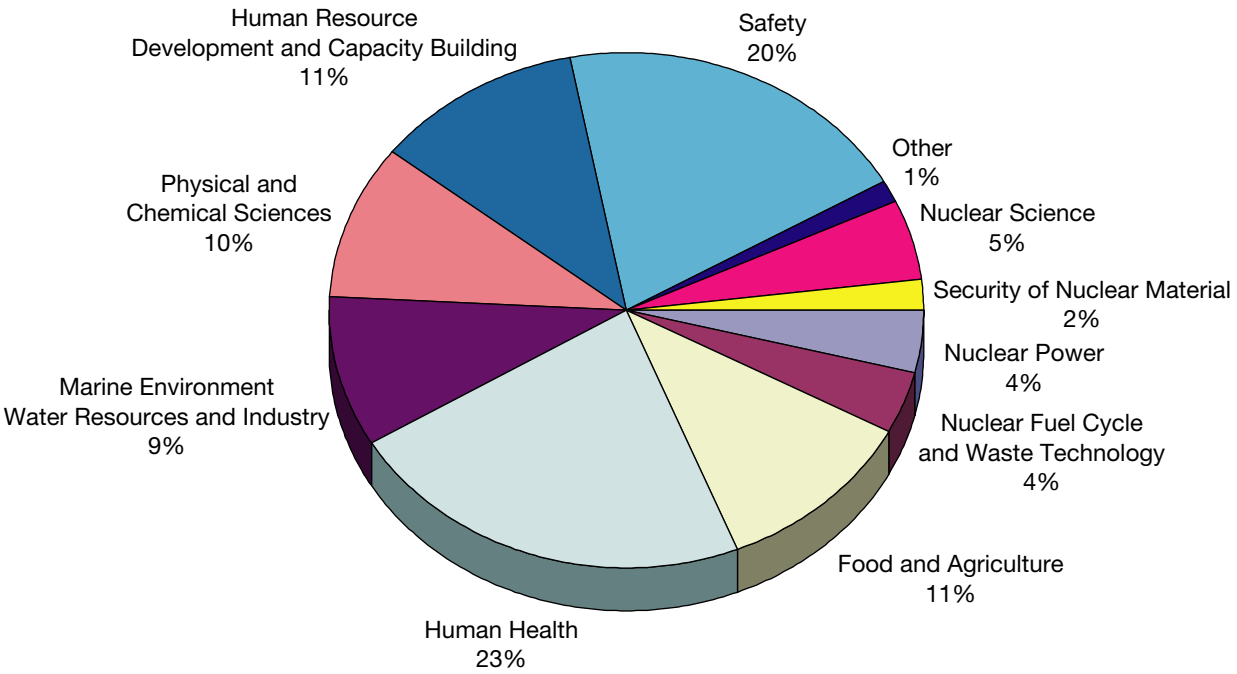


FIG. 1. Distribution of the Agency's technical co-operation programme in the 2003–2004 biennium by area of activity measured in terms of planned budgets.

safety related activities to provide a baseline to compare with future programming.

In Africa, human health is the largest area of activity for the Agency's technical co-operation programme. One of the most significant issues today is the HIV/AIDS pandemic, which is attracting a great deal of political interest and significant attention in the UN system. Extensive upstream work was carried out by the Agency in 2002 to respond to Member State wishes to use technologies and technical co-operation resources in support of UNAIDS/WHO-led collaborative efforts. A new regional project was formulated for the 2003–2004 programme that will focus on building the necessary technical capacities and human resources to enable Africa to undertake a programme on vaccine research and trials. Another related regional project aims to enhance Member State capacity to reduce all forms of malnutrition among the most vulnerable groups, including those infected with HIV/AIDS, through the use of stable isotopes in the evaluation and monitoring of ongoing and planned nutrition intervention programmes. The Agency's work will support the initiatives of FAO, UNAIDS, UNDP, UNFPA/IPAA, UNICEF, WFP, WHO and the World Bank in combating malnutrition and poverty, now exacerbated and complicated by HIV/AIDS.

Teaming with organizations outside of the UN family also brings benefits to other human health issues. During 2002, the Agency's projects in tissue banking had participants in countries from Latin America, East Asia and the Pacific, Europe and Africa. Memoranda of Understanding were signed between the Agency and the following institutions:

- *Musculo-skeletal Transplant Foundation (MTF) in the USA:* This will enable orthopaedic surgeons and transplant co-ordinators from Member State programme to be trained using the facilities and hospitals associated with the work of MTF, the largest tissue bank in the USA.
- *National University of Singapore:* This MoU will establish an international training centre in Singapore to train tissue bank operators, managers and medical doctors from participating countries from all regions. Currently, 22 students from four regions are taking part in an interregional training course at this centre.
- *University of Buenos Aires and the National Atomic Energy Commission of Argentina:* Under this MoU, a regional training centre will be established in Buenos Aires to train tissue bank operators, managers and medical doctors in the Latin America region. Thirteen students from seven Latin American countries are currently receiving training at this centre.
- *International Centre for Biosaline Agriculture (ICBA) in the United Arab Emirates.* In order to further disseminate information about using saline water for irrigation, the Agency signed an MoU with the ICBA.

Extrabudgetary contributions to the technical co-operation programme come in many forms. A new trend is the funding of these activities by NGOs. In August 2002, the Agency completed negotiations with the Nuclear Threat Initiative (NTI), based in the USA, which pledged a grant of $5 million to the extrabudgetary portion of national technical co-operation projects in the Federal Republic of Yugoslavia (now Serbia and Montenegro). These projects focus on the management of spent nuclear fuel and other radioactive waste from the Vinča RA research reactor. NTI paid $500 000 of its pledge in 2002. This is a good example of effective harmonization and co-ordination of international activities. It is also an example of efforts to achieve a major objective of *The Technical Co-operation Strategy*: "To increase the level of funding for technical co-operation activities, particularly from non-traditional sources...".

The success of Agency technical co-operation projects can lead to additional government commitment. An example of a successful activity is the use of isotope hydrology studies to support programmes that make productive use of saline groundwater and wastelands for agriculture. The results of an interregional demonstration project in nine countries have been positive, showing that specially selected crops with food and forage value can be grown using saline water for irrigation. The results have attracted the attention of governments, as they have significant implications for countries with large areas of saline lands. These programmes can be extended at relatively low cost to support the poorest farmers, such as those living in harsh environments, and thus effectively combat desertification. For example, the Government of Pakistan has allocated $3 million to extend this project over the next five years. In the first phase, it will cover an area of over 30 000 hectares, and a possible further extension will increase this to nearly 500 000 hectares. The Government of Egypt has allocated $2 million to extend the results already achieved to new regions of the country. In several other countries, governments have approved the preparation of national projects to expand the area cultivated and help farmers gain experience in growing these crops.

In Latin America, a regional project brought together more than 30 water institutes to solve problems of water shortages and promote the sustainable management of groundwater resources. For the future, the Agency will co-operate with the Organization of American States, the Global Environment Facility and the World Bank on a comprehensive project for the sustainable management of the Guarani Aquifer, the largest freshwater aquifer in Latin America.

An Agency project on upgrading radiation protection infrastructures in Member States, which between 1995

FIG. 2. Participation by developing Member States in the project on upgrading radiation protection infrastructures.

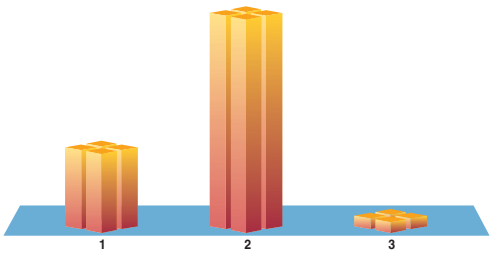
and 1999 acquired 52 participating States, saw that number grow to 88 members by the end of 2002 (Fig. 2). During the year, several participating Member States announced that they had attained all five project milestones (i.e. the establishment of: (1) a regulatory framework; (2) occupational exposure control; (3) medical exposure control; (4) public exposure control; and (5) emergency preparedness and response capabilities), and requested an independent evaluation to verify this achievement. This large scale effort has also been successful in contributing to the physical security of radioactive materials by helping Member States create or strengthen national systems to account for and control these materials.

Policy and General Management

Objective

To ensure the relevance, transparency, effectiveness and efficiency of the management of all the Agency's programmes and activities.

Regular budget expenditure: $46 495 047 *
Extrabudgetary programme expenditure (not included in chart): $725 247 **



1. Executive Management, Policy-making and Co-ordination: $14 414 183 *
2. Administration and General Services: $30 596 686
3. Oversight and Evaluation: $1 484 178

Key Issues and Highlights

- This was the first year of a full biennium (2002–2003) using the results based approach to programming and budgeting. The *Programme and Budgetary Performance Report for 2001* included the first attempt to assess performance based on the indicators specified in the budget for that year.
- 'FinTrack', a new financial tracking system, was launched at the end of the year and is aimed at streamlining funds control by project and programme managers.
- The asbestos removal project for the VIC was delayed, putting on hold plans for moving staff to temporary accommodation.
- An agreement between the Agency and the Municipality of Vienna on the VIC Child Care Centre was signed.

Executive Management, Policy-making and Co-ordination

Full use was made of the results based approach in the formulation of the draft programme and budget for 2004–2005. In addition, extensive consultations were held with Member States to identify their most urgent needs and priorities.

Legal Activities

To support Member States in their development of a comprehensive nuclear law governing radiation protection, nuclear and radiation safety, nuclear liability, safeguards and physical protection, the Agency provided assistance in drafting national nuclear legislation to ten Member States by means of written comments or advice on the legislation submitted to it for review. In addition, at the request of 14 Member States, individual training on issues related to nuclear legislation, was also provided. Participants from nine of these States took part in a two week training course at the Agency's Headquarters. The objectives of the course were to address legal and technical issues relevant to the development of a legal framework governing the safe and peaceful uses of nuclear energy and the Agency's role in its development.

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* Including sums for overall management, co-ordination and common activities of: $593 409 for nuclear power, fuel cycle and nuclear science; $591 394 for nuclear techniques for development and environmental protection; $692 713 for nuclear safety and protection against radiation; $768 795 for nuclear verification and security of material; $475 253 for management of technical co-operation for development.

** Including a sum for overall management, co-ordination and common activities of $278 919 for nuclear techniques for development and environmental protection and for nuclear verification and security of material.

There is greater awareness in Member States of the need to strengthen national legislation covering security measures. In response, the Agency, in the course of providing advice on drafting nuclear legislation, paid special attention to legislative aspects relevant for the protection of nuclear and other radioactive materials.

As in previous years, and further to decisions of the Board of Governors (at its December 1999 and November 2001 meetings) concerning the implementation of the technical co-operation project on upgrading radiation protection infrastructures, assistance continued to be provided to those Member States that are still required to establish a legislative and regulatory framework for the application of adequate health and safety standards for all Agency projects. Such activity included the promulgation of radiation protection laws and regulations, and the designation and empowerment of a national regulatory authority. In addition, in the framework of this project, legal advice was provided in five national workshops for the establishment of a legal framework for preparedness and response to radio-logical emergencies.

Advice was also provided to Member States on the:

- Development of a legal framework governing the safety of radioactive waste management, the physical protection of nuclear material and the safe transport of radioactive material (for Latin American countries);
- Development of national legislation to fulfil States' obligations under the Model Protocol Additional to Safeguards Agreements (for the Baltic countries);
- Establishment of a legal framework governing radiation protection, the safety of radiation sources and the safe management of radioactive waste (for French speaking African countries);
- Development of a legal framework governing the safety of radioactive waste management and the safe transport of radioactive material (for English speaking African countries);
- Drafting of nuclear legislation for individual Member States.

A *Handbook on Nuclear Law* was finalized during the year. Describing the overall character of nuclear law and the process by which it is developed and applied, it is intended to assist legislators, government officials, technical experts, lawyers and users in general of nuclear technology in work related to the development of nuclear legislation.

The open-ended group of legal and technical experts convened by the Director General to prepare a draft of an amendment aimed at strengthening the Convention on the Physical Protection of Nuclear Material (CPPNM) has been working since December 2001. The group has held five meetings in total, but it has been unable to finalize its work. Aware of this situation, the General Conference, in Resolution GC/46/RES/13, noted with concern the lack of progress of the work of the Group and called for the early finalization of negotiations on the amendment.

While the text of the draft amendment is close to being finalized, certain issues remain unresolved. In light of this, at its meeting in November, the Group agreed to hold one further meeting with a view to concluding its task. At the meeting, the Group recognized that in order to ensure the efficient completion of its work, progress on six outstanding issues was needed before the next meeting. Consequently, it was agreed to appoint co-ordinators from the 43 participating Member States to lead subgroups on these issues. The issues relate to: the objectives and scope of the amendment; the language for incorporating the fundamental principles of physical protection into the text; co-operation and assistance in the case of sabotage or threat thereof; a new offence relating to sabotage; and additional provisions relating to extradition. In order to build on the progress made in the intersession, a provisional agenda and the basic organizational measures to be followed by the group were prepared to ensure that issues are dealt with systematically and, once adopted, are not reopened. After extensive work the subgroups proposed texts for consideration at the final meeting in March 2003.

The final meeting of the Group will take place from 3 to 14 March 2003. Following this meeting, States Parties will review the final draft amendment to determine whether, in accordance with Article 20 of the CPPNM, the Director General should be requested to convene an Amendment Conference before the end of 2003 to consider and adopt the amendment.

Administration and General Services

Financial Management

For 2002, the General Conference appropriated an amount of $245.1 million for the Agency's Regular Budget on the basis of an exchange rate of €0.9229 to one dollar, of which $238.7 million related to Agency programmes, $4.6 million to reimbursable work for

others and $1.8 million to the Special Appropriation for the Acquisition of Safeguards Equipment. The General Conference approved budget of $238.7 million for Agency programmes was adjusted to $211.7 million based on the average UN exchange rate actually experienced during the year (1.0724 to one dollar).

The Regular Budget for 2002, at the average UN exchange rate of 1.0724 to one US dollar, amounted to $217.5 million, of which $207.6 million was to be financed from contributions by Member States in accordance with the scale of assessment fixed by the General Conference in Resolution GC(45)/RES/8, $4 million from income from reimbursable work for others, $4.1 million from other miscellaneous income and $1.8 million — representing the Special Appropriation for the Acquisition of Safeguards Equipment — from part of the 1999 cash surplus.

The actual expenditure for the Agency's Regular Budget in 2002 amounted to $214.1 million, of which $212.3 million was related to Agency programmes and reimbursable work for others and $1.8 million to the Special Appropriation for the Acquisition of Safeguards Equipment. The unused budgetary balance from the Agency's programmes and the Special Appropriation amounted to $2.3 million, while the level of reimbursable work for others was $1.1 million lower than the budgetary forecast. The unused budget of $2.3 million represents the unobligated balance of the appropriations carried over to 2003 for continued implementation of the approved 2002–2003 programme. The carryover of unspent programme funds was in compliance with the Board of Governors approval of recommended action contained in document GOV/1999/23 on *Proposed Changes to the Agency's Programme and Budget Process towards Biennial Programming*.

The target for voluntary contributions to the Technical Co-operation Fund for 2002 was established at $73 million, of which Member States pledged $58.3 million.

A total of $67.3 million in extrabudgetary resources were actually available for Agency programmes. This total consisted of $24.1 million unused balance carried forward from 2001 and $43.2 million in additional extrabudgetary funds made available in 2002. The 2002 expenditure amounted to $34.7 million, of which 60% came from funds provided by the USA, mostly to support the programme of technical assistance to safeguards activities. About 13% came from funds provided by Japan and were mainly used to support work on the safety of nuclear installations in countries of South East Asia, the Pacific and the Far East. Another 7% came from European Union Member States, basically to support programmes for Agency safeguards activities. The remaining 20% of the 2002 expenditures were covered by funds from other donors and predominantly financed work in food and agriculture and verification activities in Iraq.

In anticipation of the introduction of full biennial budgeting, a simplified budget update document was introduced for 2003, the budget proposals for that year having already been broadly covered in *The Agency's Programme and Budget 2002–2003* (GC(45)/8). The 2003 budget update dealt only with the price adjustments for that year and amendments arising from the approval in principle of the Action Plan for Protection Against Nuclear Terrorism. Further reflecting the move to results based budgeting and the related programme assessment procedures, the *Programme and Budgetary Performance Report for 2001*, prepared in 2002, incorporated the first attempt to assess performance based on the performance indicators specified in the 2001 programme and budget.

During 2002, various measures were introduced to improve the efficiency of the Agency's financial operations, including automated system improvements in the travel and UNDP payment processes. Despite these efficiencies, there was an ever increasing demand for services resulting from increases in Agency activities such as technical co-operation operations, nuclear security and verification work in Iraq. The 'Financial Tracking System' (FinTrack), a financial systems improvement that was inaugurated in 2002, is aimed at streamlining the funds control processes by providing programme and project managers with direct access to financial information.

Personnel Management

At the end of 2002, there were 2229 staff members in the Secretariat — 1000 in the Professional and higher categories and 1229 in the General Service category. These figures represent 1654 regular, 313 temporary assistance and 161 extrabudgetary staff, as well as 66 cost free experts and 35 consultants. Ninety-nine nationalities were represented among the 725 staff members in posts subject to geographical distribution. In the course of 2002, a total of around 550 staff were appointed, and some 470 consultants were contracted; 140 staff separated from the organization. The number of nationalities represented among staff subject to geographical distribution also increased.

The Secretariat conducted the first comprehensive review of the Provisional Staff Regulations and Staff Rules with the aim of clarifying, streamlining and simplifying them, as well as incorporating the best practices from the United Nations Common System. The amendments to the regulations, including the removal of the word "Provisional" from the title, were approved by the Board of Governors in June.

In view of the continued low number of applications from well qualified women, work started on a web site outlining the important and equal contributions of women to the nuclear field in general and the work of the Agency in particular. A major objective is to showcase the programmes that support the advancement of the quality of life for women and children in Member States.

A policy on the prevention of harassment was promulgated and specific guidelines were issued to improve staff–management communication. A staff mobility policy in support of the sharing of staff skills among different areas of the Secretariat and staff career development was also promulgated.

General Services

During the year, 550 'metres of records' (i.e. the number of metres of shelves containing records or documents in a line) were transferred to intermediate storage space, bringing the total quantity of records in intermediate storage to 3000 metres. In addition, 85 metres of records of historical value were added to the Agency's archives, bringing the total of historical records accessible to Member States to 5000 metres.

The asbestos removal project in the VIC witnessed some progress. Early in the year, a temporary structure was completed for use as alternative office accommodation. Also, the tendering process for the project commenced in November.

Bidding processes were carried out to renew or establish over 40 Long Term Agreements for a wide range of standardized equipment, supplies and services. These agreements reduce lead times in ordering and reduce the number of lower value procurement orders that have to be placed. The tendering, technical evaluation and ordering process in 2002 (over 3800 orders and contracts for a total aggregated value of $36 million) was at a similar level to that in 2001, but took place against a background of improvement and upgrading of the related computer systems and the introduction of electronic based ordering.

The agreement between the Agency and the Municipality of Vienna for the operation of the new and expanded VIC Child Care Centre was signed in August. A subsidy from the Federal Government of Austria and the Staff Welfare Funds of the Agency, UNIDO, UNOV and CTBTO made possible the construction of the new facility. Design and project implementation were undertaken by UNIDO, and administration and project management were provided by the Agency. Originally intended to accommodate 32 children, the facility was expanded to accommodate 148 children ranging in age from three months to six years.

Oversight and Evaluation

Mechanisms for reporting on programme results were presented and agreed to by Member States. These include a 'Mid-Term Progress Report', 'Programme Performance Report' (containing the assessment of outcomes using performance indicators) and evaluations conducted on selected areas of the Agency's programme.

The newly established Office of Internal Oversight Services concentrated on fully integrating the evaluation and management services into a consolidated, independent function covering both regular budget and technical co-operation activities. Significant achievements in 2002 included:

- Completion of 24 audits, reviews and evaluations that included 175 recommendations to management for improvement;
- Training of programme managers and counterparts in self-evaluation techniques;
- Co-ordination of an external management review of the Agency carried out by the Mannet consulting firm.

Annex

Table A1. **Allocation and utilization of Regular Budget resources in 2002**

Programme	2002 Budget GC(45)/8 (at € 0.9229) (1)	2002 adjusted budget [a] (at € 1.0724) (2)	2002 total expenditure Amount (3)	2002 total expenditure % of adjusted budget (3) / (2) (4)	Unused (over-expended) Budget (2) – (3) (5)	Balance (2) – (3) – (5) (6)
Overall Management, Co-ordination and Common Activities	662 000	586 000	593 409	101.26%	(7 409)	0
Nuclear Power	4 664 000	4 166 427	4 128 142	99.08%	38 285	0
Nuclear Fuel Cycle and Material Technologies	2 271 000	2 035 000	2 035 258	100.01%	(258)	0
Analysis for Sustainable Energy Development	2 664 000	2 383 000	2 382 938	100.00%	62	0
Nuclear Sciences	8 158 000	7 516 614	7 390 084	98.32%	126 530	0
Subtotal	**18 419 000**	**16 687 041**	**16 529 831**	**99.06%**	**157 210**	**0**
Overall Management, Co-ordination and Common Activities	659 000	581 970	591 394	101.62%	(9 424)	0
Food and Agriculture	11 006 000	9 964 000	10 033 871	100.70%	(69 871)	0
Human Health	6 232 000	5 667 140	5 447 756	96.13%	219 384	0
Water Resources	2 969 000	2 657 852	2 695 023	101.40%	(37 171)	0
Protection of the Marine and Terrestrial Environments	3 685 000	3 251 000	3 238 961	99.63%	12 039	0
Physical and Chemical Applications	2 519 000	2 273 762	2 253 170	99.09%	20 592	0
Subtotal	**27 070 000**	**24 395 724**	**24 260 175**	**99.44%**	**135 549**	**0**
Overall Management, Co-ordination and Common Activities	764 000	680 000	692 713	101.87%	(12 713)	0
Safety of Nuclear Installations	7 804 000	6 928 000	6 852 874	98.92%	75 126	0
Radiation Safety	5 189 000	4 693 124	4 754 623	101.31%	(61 499)	0
Management of Radioactive Waste	6 159 000	5 495 000	5 495 914	100.02%	(914)	0
Subtotal	**19 916 000**	**17 796 124**	**17 796 124**	**100.00%**	**0**	**0**
Overall Management, Co-ordination and Common Activities	994 000	870 761	768 795	88.29%	101 966	0
Safeguards	86 052 000	76 159 223	75 886 681	99.64%	272 542	0
Security of Material	860 000	763 004	725 039	95.02%	37 965	0
Verification in Iraq Pursuant to UNSC Resolutions (extrabudgetary funding only)						
Subtotal	**87 906 000**	**77 792 988**	**77 380 515**	**99.47%**	**412 473**	**0**
Outreach and Information Support Services						
Public Information	3 207 000	2 828 000	2 827 946	100.00%	54	0
Information Technology Infrastructure and Services	5 746 000	5 028 731	5 013 439	99.70%	15 292	0
Nuclear Information Resources	6 522 000	5 782 659	5 763 166	99.66%	19 493	0
Conference, Translation and Publishing Services	4 018 000	3 531 000	3 546 509	100.44%	(15 509)	0
Subtotal	**19 493 000**	**17 170 390**	**17 151 060**	**99.89%**	**19 330**	**0**
Management of Technical Co-operation for Development	14 690 000	12 902 567	12 888 845	99.89%	13 722	0
Subtotal	**14 690 000**	**12 902 567**	**12 888 845**	**99.89%**	**13 722**	**0**
Policy and General Management						
Executive Management, Policy-Making and Co-ordination	13 598 000	12 113 302	11 292 619	93.22%	820 683	0
Administration and General Services	35 702 000	31 159 678	30 596 686	98.19%	562 992	0
Oversight and Evaluation	1 914 000	1 680 186	1 484 178	88.33%	196 008	0
Subtotal	**51 214 000**	**44 953 166**	**43 373 483**	**96.49%**	**1 579 683**	**0**
Total – Agency Programmes	**238 708 000**	**211 698 000**	**209 380 033**	98.91%	**2 317 967**	**0**
Reimbursable Work for Others	4 552 000	4 018 000	2 906 362	72.33%	0	1 111 638
Total	**243 260 000**	**215 716 000**	**212 286 395**	98.41%	**2 317 967**	**1 111 638**
Special Appropriation for the Acquisition of Safeguards Equipment	1 847 000	1 847 000	1 830 875	99.13%	16 125	0
	245 107 000	**217 563 000**	**214 117 270**	**98.42%**	**2 334 092**	**1 111 638**

[a] Based on the decision of the Board of Governors in document (GOV/1999/15), an amount of $73 124 was transferred to the nuclear safety area to cover the cost of emergency assistance provided to Afghanistan, Bolivia, Georgia, Poland and Uganda. To recover this advance, year-end unencumbered balances in the Regular Budget Appropriation Sections were used.

Table A2. **Extrabudgetary funds in 2002**

Programme	Extrabudgetary budget figures GC(45)/8	Resources			Total resources as at 31 Dec 2002	Expenditure as at 31 Dec 2002	Unused balance as at 31 Dec 2002
		Unused balance as at 1 Jan 2002	Receipts [a] as at 31 Dec 2002	Adjustments as at 31 Dec 2002	(2)+(3)+(4)		(5)-(6)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Overall Management, Co-ordination and Common Activities	110 000	0	0	0	0	0	0
Nuclear Power	1 681 000	651 356	1 637 305	4 528	2 293 189	1 198 032	1 095 157
Nuclear Fuel Cycle and Material Technologies	432 000	264 227	254 470	108	518 805	235 128	283 677
Analysis for Sustainable Energy Development	20 000	0	0	0	0	0	0
Nuclear Science	13 000	52 307	265 957	0	318 264	21 518	296 746
Total	2 256 000	967 890	2 157 732	4 636	3 130 258	1 454 678	1 675 580
Overall Management, Co-ordination and Common Activities	0	0	278 812	0	278 812	116 296	162 516
Food and Agriculture (excl. FAO)	241 000	465 484	122 610	992	589 086	263 532	325 554
FAO	2 834 000 [b]	0	2 150 000	0	2 150 000	1 846 321	303 679
Total	3 075 000	465 484	2 272 610	992	2 739 086	2 109 853	629 233
Human Health	0	192 257	0	4 500	196 757	81 693	115 064
Water Resources	0	0	0	0	0	0	0
Protection of the Marine and Terrestrial Environments	630 000	591 219	564 154	23 179	1 178 552	644 790	533 762
Physical and Chemical Applications	0	8 500	0	0	8 500	0	8 500
Total	3 705 000	1 257 460	3 115 576	28 671	4 401 707	2 952 632	1 449 075
Safety of Nuclear Installations	3 137 000	3 546 235	3 529 500	7 472	7 083 207	3 067 684	4 015 523
Radiation Safety	248 000	488 057	3 589 991	0	4 078 048	541 130	3 536 918
Management of Radioactive Waste	256 000	652 708	784 795	0	1 437 503	928 685	508 818
Total	3 641 000	4 687 000	7 904 286	7 472	12 598 758	4 537 499	8 061 259
Overall Management, Co-ordination and Common Activities	0	3 154	0	(3 047)	107	107	0
Safeguards	7 423 000	15 213 817	19 427 402	(60 274)	34 580 945	19 674 902	14 906 043
Security of Material	197 000	1 022 543	5 542 722	396 666	6 961 931	1 851 406	5 110 525
Verification in Iraq Pursuant to UNSC Resolutions	10 650 000	15 288	2 737 230	1 696	2 754 214	2 746 110	8 104
Total	18 270 000	16 254 802	27 707 354	335 041	44 297 197	24 272 525	20 024 672
Public Information	740 000	809 826	894 568	14 119	1 718 513	759 032	959 481
Information Technology, Infrastructure and Services	0	0	30 000	0	30 000	11 722	18 278
Nuclear Information Resources	12 000	500	32 293	212	33 005	32 276	729
Conf. Transl. and Publishing Services	0	0	0	0	0	0	0
Total	752 000	810 326	956 861	14 331	1 781 518	803 030	978 488
Management of Technical Co-operation for Development	300 000	132 433	337 016	0	469 449	243 644	225 805
Total	300 000	132 433	337 016	0	469 449	243 644	225 805
Policy and General Management							
Executive Management, Policy-Making and Co-ordination	0	60 400	459 700	0	520 100	325 285	194 815
Administration and General Services	0	930	0	0	930	930	0
Oversight and Evaluation	100 000	0	150 000	0	150 000	120 113	29 887
Total	100 000	61 330	609 700	0	671 030	446 328	224 702
Total extrabudgetary	**29 024 000**	**24 171 241**	**42 788 525**	**390 151**	**67 349 917**	**34 710 336**	**32 639 581**

[a] The column "Receipts" includes cash contributions received as well as budgets from FAO, UNEP and UNOPS for approved activities.

[b] The FAO budget includes $1 057 176 estimated costs for FAO Professional staff working in the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture. The salaries of these staff members are paid by FAO and, therefore, are not included in the column of the Agency's resources and expenditures.

Table A3. **Technical co-operation disbursements by Agency programme and region in 2002**
(in thousands of dollars)

Programme	Africa	East Asia and the Pacific	Europe	Latin America	West Asia	Global/ inter-regional	Total
Nuclear Power	240.5	378.2	1566.2	621.9	996.7	58.4	3861.9
Nuclear Fuel Cycle and Material Technologies	189.7	92.8	294.0	276.0	5.2	0.0	857.9
Analysis for Sustainable Energy Development	128.9	151.1	218.6	48.8	44.5	0.0	592.0
Nuclear Science	1560.8	963.3	539.7	932.5	1293.1	304.7	5594.2
Food and Agriculture	5427.9	1968.1	730.4	2345.5	1309.0	609.6	12390.5
Human Health	5879.7	2646.1	2860.6	3112.9	988.0	324.4	15811.6
Water Resources	1708.1	1286.7	125.6	1057.3	285.4	0.0	4463.1
Protection of the Marine and Terrestrial Environments	218.7	127.4	974.0	200.7	192.1	42.4	1755.2
Physical and Chemical Applications	1672.0	1683.9	2007.9	1480.1	1138.3	0.0	7982.1
Safety of Nuclear Installations	252.8	608.4	2198.1	343.1	410.6	0.0	3812.9
Radiation Safety	1245.4	943.9	2452.3	1584.9	972.1	0.0	7198.6
Management of Radioactive Waste	521.4	80.2	1793.9	458.0	158.7	189.1	3201.2
Safeguards	0.0	0.0	22.2	0.0	0.0	0.0	22.2
Security of Material	138.5	52.9	1036.5	106.4	0.0	9.2	1343.5
Public Information	0.0	0.0	0.0	4.3	0.0	21.4	25.7
Information Technology Infrastructure and Services	5.3	37.9	0.0	4.6	0.0	0.0	47.7
Management of Technical Co-operation for Development	771.8	756.5	532.2	1563.8	124.1	1103.3	4851.6
Executive Management, Policy-Making and Co-ordination	164.6	43.6	111.1	11.7	0.0	0.0	331.0
Total	**20 126.2**	**11 820.9**	**17 463.3**	**14 149.4**	**7917.9**	**3357.8**	**74 835.5**

Table A4. **International Regulatory Review Team (IRRT) missions**

Type	Location	Country
Full scope follow-up IRRT`	Bucharest	Romania
Full scope IRRT	Yerevan	Armenia
Follow-up IRRT	Bratislava	Slovakia
Preparatory meeting	Villigen	Switzerland
Preparatory meeting	Budapest	Hungary
Preparatory meeting	Islamabad	Pakistan

Table A5. **Peer reviews of radiation safety infrastructure**

Scope	Country	Project
Implementation of BSS [a]	Slovakia	Model project
Implementation of BSS [a]	El Salvador	Model project
Regulatory infrastructure	Belarus	National technical co-operation project
Regulatory infrastructure	Uzbekistan	Model project
Regulatory infrastructure	Georgia	Model project
Regulatory infrastructure	Bangladesh	Model project
Regulatory infrastructure	Turkey	Model project

[a] BSS: *International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources,* Safety Series No. 115.

Table A6. **Operational Safety Review Team (OSART) missions**

Type	Plant and reactor type	Country
OSART	Tricastin PWR	France
OSART	Santa Maria de Garoña PWR	Spain
OSART follow-up	Gösgen PWR	Switzerland
OSART follow-up	North Anna PWR	USA
Preparatory meeting	Krško PWR	Slovenia
OSART follow-up	Belleville PWR	France
Preparatory meeting	Civaux PWR	France
OSART follow-up	Muehleberg BWR	Switzerland
Preparatory meeting	Rovno WWER	Ukraine
Preparatory meeting	Tianwan WWER	China
Preparatory meeting	Bushehr WWER	Islamic Rep. of Iran
OSART	Angra 2 PWR	Brazil
OSART follow-up	Lingao PWR	China

Table A7. **Peer Review of Operational Safety Performance Experience (PROSPER)**

Type	Plant/location	Country
PROSPER seminar	Armenia-1	Armenia
Seminar on management of safety during changes	Cernavoda	Romania
Operational experience process users group meeting	IAEA	
Workshop on event analysis	Kori	Rep. of Korea

TABLE A8. **Safety Culture Enhancement Programme (SCEP) missions**

Type	Plant/location	Country
Peer review of assessment process at INB	Rio, Angra	Brazil
Assessment of safety management and safety culture	Petten HFR	Netherlands (in co-ordination with INSARR mission)

Table A9. **International PSA Review Team (IPSART) missions**

Type	Plant and reactor type	Country
Level 1, including internal and external hazards	Bohunice V1 WWER	Slovakia
Levels 2 and 3, follow-up of level 1	Petten HFR (research reactor)	Netherlands
Follow-up of level 1	Tianwan WWER	China
Level 1	Bushehr WWER	Islamic Rep. of Iran

Table A10. **Engineering Safety Review Service missions**

Type	Plant/Site	Held in
Review of PSAR	Bushehr-1	Russian Federation
Seismic/foundation review	Bushehr-2	Russian Federation
Preparatory mission for final review of PSAR	Bushehr-1	Islamic Rep. of Iran
Expert mission on strengthening owner's functions	Bushehr	Russian Federation
Expert mission on seismic re-evaluation	Armenia-1	Armenia
Expert mission on commissioning and startup	Bushehr-1	Islamic Rep. of Iran
Review of environmental report	Bushehr	Islamic Rep. of Iran
Review mission on certification of operators	Bushehr-1	Islamic Rep. of Iran
Expert mission to support regulatory review of PSAR	Bushehr-1	Islamic Rep. of Iran
Safety review mission	Kozloduy 3 and 4	Bulgaria
Expert mission on core design and fuel management	Tianwan	China
Expert mission on safety issues related to PSAR	Bushehr-1	Islamic Rep. of Iran
AMAT preparatory meeting	Borssele	Netherlands
Expert mission on utility safety requirements for evolutionary nuclear power plants (3 missions)	Beijing	China
Expert mission on fire hazard analysis	Tianwan	Russian Federation
Review of ageing management programme	Armenia-1	Armenia
Expert mission on seismic re-evaluation	Armenia-1	Armenia

Table A11. **Integrated Safety Assessment of Research Reactors (INSARR) missions**

Type	Location/Reactor	Country
Pre-INSARR mission	Petten HFR	Netherlands
INSARR follow-up	Delft HOR	Netherlands
INSARR	Petten HFR	Netherlands
Follow-up mission	Tashkent WWR-CM	Uzbekistan
INSARR	Pitesti TRIGA II	Romania
Expert mission/SAR update	Serpong	Indonesia
Follow-up of SAR review	Jakarta RSG-GAS	Indonesia
Review of revised SAR	Dhaka TRIGA II	Bangladesh
INSARR	Santiago RECH-1	Chile
Pre-INSARR	Dalat DRR-1	Viet Nam
Review mission	Kinshasa TRICO II	Dem. Rep. of the Congo

Table A12. **Transport Safety Appraisal Service (TranSAS) missions**

Type	Country
TranSAS mission	Brazil
TranSAS mission	United Kingdom
Pre-TranSAS meeting	Panama

Table A13. **Status with regard to the conclusion of safeguards agreements and additional protocols [a, b]** (as of 31 December 2002)

State [c]	SQP [d]	Status of safeguards agreement(s)	INFCIRC	Additional protocol status
Afghanistan	X	In force: 20 February 1978	257	
Albania		In force: 25 March 1988 [1]	359	
Algeria		In force: 7 January 1997	531	
Andorra	X	*Signed: 9 January 2001*		Signed: 9 January 2001
Angola				
Antigua and Barbuda	X	In force: 9 September 1996 [2]	528	
Argentina		In force: 4 March 1994 [3]	435/Mod.1	
Armenia		In force: 5 May 1994	455	Signed: 29 September 1997
Australia		In force: 10 July 1974	217	In force: 12 December 1997
Austria		Accession: 31 July 1996 [4]	193	Signed: 22 September 1998 [5]
Azerbaijan	X	In force: 29 April 1999	580	In force: 29 November 2000
Bahamas	X	In force: 12 September 1997 [2]	544	
Bahrain				
Bangladesh		In force: 11 June 1982	301	In force: 30 March 2001
Barbados	X	In force: 14 August 1996 [2]	527	
Belarus		In force: 2 August 1995	495	
Belgium		In force: 21 February 1977	193	Signed: 22 September 1998
Belize	X	In force: 21 January 1997 [2]	532	
Benin				
Bhutan	X	In force: 24 October 1989	371	
Bolivia	X	In force: 6 February 1995 [2]	465	
Bosnia and Herzegovina		In force: 28 December 1973 [6]	204	
Botswana				
Brazil		In force: 4 March 1994 [7]	435	
Brunei Darussalam	X	In force: 4 November 1987	365	
Bulgaria		In force: 29 February 1972	178	In force: 10 October 2000
Burkina Faso				
Burundi				
Cambodia	X	In force: 17 December 1999	586	
Cameroon	X	*Signed: 21 May 1992*		
Canada		In force: 21 February 1972	164	In force: 8 September 2000
Cape Verde				
Central African Republic				
Chad				
Chile		In force: 5 April 1995 [8]	476	Signed: 19 September 2002
China		In force: 18 September 1989	369(*)	In force: 28 March 2002

[a] This annex does not aim at listing all safeguards agreements that the Agency has concluded. Not included are agreements whose application has been suspended in the light of the application of safeguards pursuant to a comprehensive safeguards agreement.

[b] The Agency also applies safeguards in Taiwan, China under two agreements, INFCIRC/133 and INFCIRC/158, which came into force on 13 October 1969 and 6 December 1971, respectively.

[c] States in bold type are those which are not party to the NPT and whose safeguards agreements are of INFCIRC/66-type. States in italics are those which are party to the NPT but have not concluded a safeguards agreement pursuant to that Treaty; the safeguards agreements referred to are comprehensive safeguards agreements concluded pursuant to the NPT unless otherwise indicated. Safeguards agreements marked with an asterisk denote voluntary offer safeguards agreements.

[d] Small quantities protocol (SQP): States with a legal obligation to conclude a comprehensive safeguards agreement which have nuclear material in quantities not exceeding the limits of paragraph 37 of INFCIRC/153 and no nuclear material in any facility, have the option to conclude an SQP, thus holding in abeyance the implementation of most of the detailed provisions set out in Part II of a comprehensive safeguards agreement as long as these conditions continue to apply. Six States meet the conditions for an SQP but do not have one i.e. Albania, Bosnia and Herzegovina, Côte d'Ivoire, Liechtenstein, Sri Lanka and Tunisia.

Table A13. **(cont.)**

State [c]	SQP [d]	Status of safeguards agreement(s)	INFCIRC	Additional protocol status
Colombia		In force: 22 December 1982 [8]	306	
Comoros				
Congo, Republic of the				
Costa Rica	X	In force: 22 November 1979 [2]	278	Signed: 12 December 2001
Côte d'Ivoire		In force: 8 September 1983	309	
Croatia	X	In force: 19 January 1995	463	In force: 6 July 2000
Cuba		*In force: 5 May 1980* [9]	*281*	*Signed: 15 October 1999*
		In force: 7 October 1983 [9]	*311*	
Cyprus	X	In force: 26 January 1973	189	Signed: 29 July 1999
Czech Republic		In force: 11 September 1997 [10]	541	In force: 1 July 2002
Democratic People's Republic of Korea		In force: 10 April 1992	403	
Democratic Republic of the Congo		In force: 9 November 1972	183	Approved: 28 November 2002
Denmark		In force: 21 February 1977 [11]	193	Signed: 22 September 1998
Djibouti				
Dominica	X	In force: 3 May 1996 [12]	513	
Dominican Republic	X	In force: 11 October 1973 [2]	201	
Ecuador	X	In force: 10 March 1975 [2]	231	In force: 24 October 2001
Egypt		In force: 30 June 1982	302	
El Salvador	X	In force: 22 April 1975 [2]	232	Approved: 23 September 2002
Equatorial Guinea		*Approved: 13 June 1986*		
Eritrea				
Estonia		In force: 24 November 1997	547	Signed: 13 April 2000
Ethiopia	X	In force: 2 December 1977	261	
Fiji	X	In force: 22 March 1973	192	
Finland		Accession: 1 October 1995 [13]	193	Signed: 22 September 1998 [5]
France		In force: 12 September 1981	290 *(*)*	Signed: 22 September 1998
		Signed: 26 September 2000 [14]		
Gabon	X	*Signed: 3 December 1979*		
Gambia	X	In force: 8 August 1978	277	
Georgia		*Signed: 29 September 1997*		Signed: 29 September 1997
Germany		In force: 21 February 1977 [15]	193	Signed: 22 September 1998 [5]
Ghana		In force: 17 February 1975	226	Signed: 12 June 1998 *[16]*
Greece		Accession: 17 December 1981 [17]	193	Signed: 22 September 1998 [5]
Grenada	X	In force: 23 July 1996 [2]	525	
Guatemala	X	In force: 1 February 1982 [2]	299	Signed: 14 December 2001
Guinea				
Guinea-Bissau				
Guyana	X	In force: 23 May 1997 [2]	543	
Haiti	X	*Signed: 6 January 1975* [2]		Signed: 10 July 2002
Holy See	X	In force: 1 August 1972	187	In force: 24 September 1998
Honduras	X	In force: 18 April 1975 [2]	235	
Hungary		In force: 30 March 1972	174	In force: 4 April 2000
Iceland	X	In force: 16 October 1974	215	
India		In force: 30 September 1971	211	
		In force: 17 November 1977	260	
		In force: 27 September 1988	360	
		In force: 11 October 1989	374	
		In force: 1 March 1994	433	
Indonesia		In force: 14 July 1980	283	In force: 29 September 1999
Iran, Islamic Republic of		In force: 15 May 1974	214	
Iraq		In force: 29 February 1972	172	
Ireland		In force: 21 February 1977	193	Signed: 22 September 1998

Table A13. **(cont.)**

State [c]	SQP [d]	Status of safeguards agreement(s)	INFCIRC	Additional protocol status
Israel		In force: 4 April 1975	249/Add.1	
Italy		In force: 21 February 1977	193	Signed: 22 September 1998
Jamaica		In force: 6 November 1978 [2]	265	Approved: 12 June 2002
Japan		In force: 2 December 1977	255	In force: 16 December 1999
Jordan	X	In force: 21 February 1978	258	In force: 28 July 1998
Kazakhstan		In force: 11 August 1995	504	
Kenya				
Kiribati	X	In force: 19 December 1990	390	Approved: 10 September 2002
Korea, Republic of		In force: 14 November 1975	236	Signed: 21 June 1999
Kuwait	X	In force: 7 March 2002	607	Signed: 19 June 2002
Kyrgyzstan	X	*Signed: 18 March 1998*		
Lao People's Democratic Republic	X	In force: 5 April 2001	599	
Latvia		In force: 21 December 1993	434	In force: 12 July 2001
Lebanon	X	In force: 5 March 1973	191	
Lesotho	X	In force: 12 June 1973	199	
Liberia				
Libyan Arab Jamahiriya		In force: 8 July 1980	282	
Liechtenstein		In force: 4 October 1979	275	
Lithuania		In force: 15 October 1992	413	In force: 5 July 2000
Luxembourg		In force: 21 February 1977	193	Signed: 22 September 1998
Madagascar	X	In force: 14 June 1973	200	
Malawi	X	In force: 3 August 1992	409	
Malaysia		In force: 29 February 1972	182	
Maldives	X	In force: 2 October 1977	253	
Mali	X	In force: 12 September 2002	615	In force: 12 September 2002
Malta	X	In force: 13 November 1990	387	Approved: 28November 2002
Marshall Islands				
Mauritania				
Mauritius	X	In force: 31 January 1973	190	
Mexico		In force: 14 September 1973 [18]	197	
Micronesia, Federated States of				
Monaco	X	In force: 13 June 1996	524	In force: 30 September 1999
Mongolia	X	In force: 5 September 1972	188	Signed: 5 December 2001
Morocco	X	In force: 18 February 1975	228	
Mozambique				
Myanmar	X	In force: 20 April 1995	477	
Namibia	X	In force: 15 April 1998	551	Signed: 22 March 2000
Nauru	X	In force: 13 April 1984	317	
Nepal	X	In force: 22 June 1972	186	
Netherlands		In force: 5 June 1975 [14]	229	
		In force: 21 February 1977	193	Signed: 22 September 1998 [5]
New Zealand	X	In force: 29 February 1972	185	In force: 24 September 1998[19]
Nicaragua	X	In force: 29 December 1976 [2]	246	Signed: 18 July 2002
Niger		*Signed 11 June 2002*		
Nigeria	X	In force: 29 February 1988	358	Signed: 20 September 2001
Norway		In force: 1 March 1972	177	In force: 16 May 2000
Oman	X	*Signed:28 June 2001*		
Pakistan		In force: 5 March 1962	34	
		In force: 17 June 1968	116	
		In force: 17 October 1969	135	
		In force: 18 March 1976	239	

Table A13. **(cont.)**

State [c]	SQP [d]	Status of safeguards agreement(s)	INFCIRC	Additional protocol status
		In force: 2 March 1977	248	
		In force: 10 September 1991	393	
		In force: 24 February 1993	418	
Palau, Republic of				
Panama	X	*In force: 23 March 1984* [20]	*316*	*In force: 11 December 2001*
Papua New Guinea	X	In force: 13 October 1983	312	
Paraguay	X	In force: 20 March 1979 [2]	279	Approved: 12 June 2002
Peru		In force: 1 August 1979 [2]	273	In force: 23 July 2001
Philippines		In force: 16 October 1974	216	Signed: 30 September 1997
Poland		In force: 11 October 1972	179	In force: 5 May 2000
Portugal		Accession: 1 July 1986 [21]	193	Signed: 22 September 1998 [5]
Qatar				
Republic of Moldova	X	*Signed: 14 June 1996*		
Romania		In force: 27 October 1972	180	In force: 7 July 2000
Russian Federation		In force: 10 June 1985	327*	Signed: 22 March 2000
Rwanda				
St. Kitts and Nevis	X	In force: 7 May 1996 [12]	514	
St. Lucia	X	In force: 2 February 1990 [12]	379	
St. Vincent and the Grenadines	X	In force: 8 January 1992 [12]	400	
Samoa	X	In force: 22 January 1979	268	
San Marino	X	In force: 21 September 1998	575	
São Tome and Principe				
Saudi Arabia				
Senegal	X	In force: 14 January 1980	276	
Seychelles				
Sierra Leone	X	*Signed: 10 November 1977*		
Singapore	X	In force: 18 October 1977	259	
Slovakia		In force: 3 March 1972 [22]	173	Signed: 27 September 1999
Slovenia		In force: 1 August 1997	538	In force: 22 August 2000
Solomon Islands	X	In force: 17 June 1993	420	
Somalia				
South Africa		In force: 16 September 1991	394	In force: 13 September 2002
Spain		Accession: 5 April 1989	193	Signed: 22 September 1998 [5]
Sri Lanka		In force: 6 August 1984	320	
Sudan	X	In force: 7 January 1977	245	
Suriname	X	In force: 2 February 1979 [2]	269	
Swaziland	X	In force: 28 July 1975	227	
Sweden		Accession: 1 June 1995 [23]	193	Signed: 22 September 1998 [5]
Switzerland		In force: 6 September 1978	264	Signed: 16 June 2000
Syrian Arab Republic		In force: 18 May 1992	407	
Tajikistan		Approved: 12 June 2002		Approved: 12 June 2002
Thailand		In force: 16 May 1974	241	
The Former Yugoslav Rep. of Macedonia	X	In force: 16 April 2002	610	
Togo	X	*Signed: 29 November 1990*		
Tonga	X	In force: 18 November 1993	426	
Trinidad and Tobago	X	In force: 4 November 1992 [2]	414	
Tunisia		In force: 13 March 1990	381	
Turkey		In force: 1 September 1981	295	In force: 17 July 2001
Turkmenistan				
Tuvalu	X	In force: 15 March 1991	391	
Uganda				
Ukraine		In force: 22 January 1998	550	Signed: 15 August 2000
United Arab Emirates	X	*Signed: 15 December 2002*		

Table A13. **(cont.)**

State [c]	SQP [d]	Status of safeguards agreement(s)	INFCIRC	Additional protocol status
United Kingdom		In force: 14 December 1972	175 [24]	
		In force: 14 August 1978	263 [(*)]	Signed: 22 September 1998 [5]
		Approved: September 1992 [14]		
United Republic of Tanzania	X	*Signed: 26 August 1992*		
United States of America		In force: 9 December 1980	288 [(*)]	Signed: 12 June 1998
		In force: 6 April 1989 [1]	366	
Uruguay		In force: 17 September 1976 [2]	157	Signed: 29 September 1997
Uzbekistan		In force: 8 October 1994	508	In force: 21 December 1998
Vanuatu				
Venezuela		In force: 11 March 1982 [2]	300	
Viet Nam		In force: 23 February 1990	376	
Yemen, Republic of	X	In force: 14 August 2002	614	
Yugoslavia, Federal Republic of		In force: 28 December 1973 [25]	204	
Zambia	X	In force: 22 September 1994	456	
Zimbabwe	X	In force: 26 June 1995	483	

[1] Date refers to a sui generis comprehensive safeguards agreement. On 28 November 2002, an exchange of letters entered into force confirming that the safeguards agreement satisfied the requirements of Article III of the NPT.

[2] Safeguards agreement refers to both the Treaty of Tlatelolco and the NPT.

[3] Date refers to the safeguards agreement concluded between Argentina, Brazil, ABACC and the Agency. On 18 March 1997, upon approval by the Board of Governors, an exchange of letters entered into force between Argentina and the Agency confirming that the safeguards agreement satisfied the requirements of Article 13 of the Treaty of Tlatelolco and Article III of the NPT to conclude a safeguards agreement with the Agency.

[4] The application of safeguards in Austria under the NPT safeguards agreement INFCIRC/156, in force since 23 July 1972, was suspended on 31 July 1996, on which date the agreement of 5 April 1973 (INFCIRC/193) between the non-nuclear-weapon States of Euratom, Euratom and the Agency, to which Austria had acceded, entered into force for Austria.

[5] The Agency has received notification from the State that it has fulfilled its own internal requirements for entry into force of the additional protocol concluded with Euratom and the Agency. The additional protocol will enter into force on the date when the Agency receives written notification from all the States and Euratom that their respective requirements for entry into force have been met.

[6] The NPT safeguards agreement concluded with the Socialist Federal Republic of Yugoslavia (INFCIRC/204), which entered into force on 28 December 1973, continues to be applied in Bosnia and Herzegovina to the extent relevant to the territory of Bosnia and Herzegovina.

[7] Date refers to the safeguards agreement concluded between Argentina, Brazil, ABACC and the Agency. On 10 June 1997, upon approval by the Board of Governors, an exchange of letters entered into force between Brazil and the Agency confirming that the safeguards agreement satisfied the requirements of Article 13 of the Treaty of Tlatelolco. On 20 September 1999, upon approval by the Board of Governors, an exchange of letters entered into force confirming that the safeguards agreement also satisfied the requirements of Article III of the NPT.

[8] Date refers to a safeguards agreement pursuant to Article 13 of the Treaty of Tlatelolco. Upon approval by the Board of Governors an exchange of letters entered into force (for Chile on 9 September 1996; for Colombia on 13 June 2001) confirming that the safeguards agreement satisfied the requirement of Article III of the NPT.

[9] Dates refer to INFCIRC/66-type agreements.

[10] The NPT safeguards agreement concluded with the Czechoslovak Socialist Republic (INFCIRC/173), which entered into force on 3 March 1972, continued to be applied in the Czech Republic to the extent relevant to the territory of the Czech Republic until 11 September 1997, on which date the NPT safeguards agreement concluded with the Czech Republic entered into force.

[11] The NPT safeguards agreement with Denmark (INFCIRC/176), in force since 1 March 1972, has been replaced by the agreement of 5 April 1973 between the non-nuclear-weapon States of Euratom, Euratom and the Agency (INFCIRC/193). Since 1 May 1974, that agreement also applies to the Faroe Islands. Upon Greenland's secession from Euratom as of 31 January 1985, the agreement between the Agency and Denmark (INFCIRC/176) re-entered into force for Greenland.

[12] An exchange of letters has entered into force between this State and the Agency confirming that the NPT safeguards agreement satisfies the obligations of the State under Article 13 of the Treaty of Tlatelolco.

[13] The application of safeguards in Finland under the NPT safeguards agreement INFCIRC/155, in force since 9 February 1972, was suspended on 1 October 1995, on which date the agreement of 5 April 1973 (INFCIRC/193) between the non-nuclear-weapon States of Euratom, Euratom and the Agency, to which Finland had acceded, entered into force for Finland.

[14] The safeguards agreement referred to is pursuant to Additional Protocol I to the Treaty of Tlatelolco.

[15] The NPT safeguards agreement of 7 March 1972 concluded with the German Democratic Republic (INFCIRC/181) is no longer in force with effect from 3 October 1990, on which date the German Democratic Republic acceded to the Federal Republic of Germany.

[16] Pending entry into force, the additional protocol is applied provisionally in this State.

[17] The application of safeguards in Greece under the NPT safeguards agreement INFCIRC/166, provisionally in force since 1 March 1972, was suspended on 17 December 1981, on which date Greece acceded to the agreement of 5 April 1973 (INFCIRC/193) between the non-nuclear-weapon States of Euratom, Euratom and the Agency.

[18] The safeguards agreement referred to was concluded pursuant to both the Treaty of Tlatelolco and the NPT. The application of safeguards under an earlier safeguards agreement pursuant to the Treaty of Tlatelolco, which entered into force on 6 September 1968 (INFCIRC/118), was suspended as of 14 September 1973.

[19] INFCIRC/185 also applies to Cook Islands, Niue and Tokelau, but these territories are not covered by the additional protocol, INFCIRC/185/Add.1.

[20] Date refers to a safeguards agreement concluded pursuant to Article 13 of the Treaty of Tlatelolco. A safeguards agreement pursuant to the NPT and the Tlatelolco Treaty was signed on 22 December 1988, but has not yet entered into force.

[21] The application of safeguards in Portugal under the NPT safeguards agreement INFCIRC/272, in force since 14 June 1979, was suspended on 1 July 1986, on which date Portugal acceded to the agreement of 5 April 1973 (INFCIRC/193) between the non-nuclear-weapon States of Euratom, Euratom and the Agency.

[22] The NPT safeguards agreement concluded with the Czechoslovak Socialist Republic (INFCIRC/173), which entered into force on 3 March 1972, continues be applied in Slovakia to the extent relevant to the territory of Slovakia. A new NPT safeguards agreement concluded with Slovakia was approved by the Board of Governors on 14 September 1998.

[23] The application of safeguards in Sweden under the NPT safeguards agreement INFCIRC/234, in force since 14 April 1975, was suspended on 1 June 1995, on which date the agreement of 5 April 1973 (INFCIRC/193) between the non-nuclear-weapon States of Euratom, Euratom and the Agency, to which Sweden had acceded, entered into force for Sweden.

[24] Date refers to the INFCIRC/66-type safeguards agreement, concluded between the United Kingdom and the Agency, which remains in force.

[25] The NPT safeguards agreement concluded with the Socialist Federal Republic of Yugoslavia (INFCIRC/204), which entered into force on 28 December 1973, continues to be applied in the Federal Republic of Yugoslavia to the extent relevant to the territory of the Federal Republic of Yugoslavia.

Table A14. **Number of States having significant nuclear activities at the end of 2000, 2001 and 2002**

	Number of States		
	2000	2001	2002
States with safeguards applied under NPT or NPT/Tlatelolco agreements	60	61	60*
States with safeguards applied under Tlatelolco agreements	1	0	0
States with safeguards applied under INFCIRC/66/Rev.2-type agreements[a]	4	4	4
Nuclear weapon States with safeguards applied under voluntary offer agreements	5	5	5**
States without any safeguards agreement in force	1	1	1
Total number of States with significant nuclear activities[b]	71	71	70

[a] Nuclear weapon States with INFCIRC/66/Rev.2-type agreements in force are not included. Safeguards are also applied to nuclear installations in Taiwan, China.
[b] According to information available to the Agency for the year in question.
* This includes Iraq where safeguards activities are subsumed under activities carried out pursuant to UNSC resolutions.
** At the end of 2002, there were no facilities designated for inspection in the Russian Federation

Table A15. **Approximate quantities of material subject to Agency safeguards at the end of 2002**

Type of material	Quantity of material (t)			
	Comprehensive safeguards agreements[a]	INFCIRC/66[b]	Nuclear weapon States	Quantity in SQs
Nuclear material				
Plutonium[c] contained in irradiated fuel	599.2	31.1	88.5	89 845
Separated plutonium outside reactor cores	13.2	0.1	68.7	10 249
Recycled plutonium in fuel elements in reactor cores	12.4	0.4	0	1605
HEU (equal to or greater than 20% uranium-235)	21.7	0.1	10.0	673
LEU (less than 20% uranium-235)	43 982	3006	4237	13 548
Source material[d] (natural or depleted uranium and thorium)	82 411	1772	12 227	7401
Non-nuclear material[e]				
Heavy water	—	472	—	24
Total significant quantities				123 344

[a] Covering safeguards agreements pursuant to NPT and/or Treaty of Tlatelolco and other comprehensive safeguards agreements.
[b] Excluding installations in nuclear weapon States; including installations in Taiwan, China.
[c] The quantity includes an estimated 95 t (11 872 SQ) of plutonium in irradiated fuel, which is not yet reported to the Agency under the reporting procedures agreed to (the non-reported plutonium is contained in irradiated fuel assemblies to which item accountancy and containment/surveillance measures are applied).
[d] This table does not include material within the terms of subparagraphs 34(a) and (b) of INFCIRC/153 (Corrected).
[e] Non-nuclear material subject to Agency safeguards under INFCIRC/66/Rev.2-type agreements.

Table A16. **Number of facilities under safeguards or containing safeguarded material on 31 December 2002**

Facility type	Number of facilities (number of installations)			
	Comprehensive safeguards agreements[a]	INFCIRC/66[b]	Nuclear weapon States	Total
Power reactors	185 (222)	13 (16)	1 (1)	199 (239)
Research reactors and critical assemblies	139 (150)	7 (7)	1 (1)	147 (158)
Conversion plants	13 (13)	1 (1)	— (—)	14 (14)
Fuel fabrication plants	38 (39)	3 (3)	— (—)	41 (42)
Reprocessing plants	5 (5)	1 (1)	— (—)	6 (6)
Enrichment plants	8 (8)	— (—)	2 (4)	10 (12)
Separate storage facilities	70 (70)	3 (3)	7 (9)	80 (82)
Other facilities	84 (95)	1 (1)	1 (1)	86 (97)
Subtotals	**542 (602)**	**29 (32)**	**12 (16)**	**583 (650)**
Other locations	322 (419)	3 (30)	— (—)	325 (449)
Non-nuclear installations	— (—)	1 (1)	— (—)	1 (1)
Totals	864 (1021)	33 (63)	12 (16)	909 (1100)

[a] Covering safeguards agreements pursuant to NPT and/or the Treaty of Tlatelolco and other comprehensive safeguards agreements.

[b] Excluding installations in nuclear weapon States; including installations in Taiwan, China.

Table A17. **Additional safeguards support provided by States**

States and organizations representing groups of States having formal support programmes	States having R&D contracts and test programmes
Argentina	Austria
Australia	Israel
Belgium	Latvia
Canada	Pakistan
European Commission	Russian Federation
Finland	
France	
Germany	
Hungary	
Japan	
Republic of Korea	
Netherlands	
Russian Federation	
Sweden	
United Kingdom	
United States of America	

Table A18. **Co-ordinated Research Projects — new or completed in 2002**
(A full list of all current CRPs is available on the Agency's WorldAtom web site.)

Nuclear Power

New

Advances in high temperature gas cooled reactor fuel technology

Economic research on, and assessment of selected nuclear desalination projects and case studies

Studies of advanced reactor technology options for effective incineration of radioactive waste

Completed

Information management solutions for systematic approach to training (SAT) applications

Nuclear Fuel Cycle and Material Technologies

New

Corrosion of research reactor aluminium clad spent fuel in water

Disposal aspects of low and intermediate level decommissioning waste

Improvement of models used for fuel behaviour simulation (FUMEX II)

Completed

Spent fuel performance assessment and research (SPAR)

Analysis for Sustainable Energy Development

New

Cost effectiveness of nuclear power compared to carbon dioxide capture and sequestration from fossil fuel power plants

Completed

Role of nuclear power and other energy options in meeting international goals on greenhouse gas emission reductions

Nuclear Science

New

Data for the thorium–uranium fuel cycle

Improvement of the standard cross-sections for light elements

Completed

Comparison of compact toroid configurations: spherical tokamaks, spheromaks and field reversed configurations

Fission product yield data required for transmutation of minor actinide nuclear waste

Nuclear model parameter testing (RIPL phase II)

Use of ion beam techniques for analysis of light elements in thin films, including depth profiling

Food and Agriculture

New

Assessing the effectiveness of soil conservation techniques for sustainable watershed management using fallout radionuclides

Development of strategies for the effective monitoring of veterinary drug residues in livestock and livestock products in developing countries

Improvement of the codling moth sterile insect technique to facilitate expansion of field applications

Physical mapping technologies for the identification and characterization of mutated genes contributing to crop quality

Testing the efficiency and uncertainty of sample processing for the analysis of food contaminants

Completed

Determination of profiles of human bacterial pathogens in foods for experts by introduction of quality assured microbiology assays

Enhancement of the sterile insect technique through genetic transformation of arthropods using nuclear techniques

Evaluation of methods of analysis for determining mycotoxin contamination of food and feed

Table A18. **(cont.)**

Improved attractants for enhancing the efficiency of tsetse fly suppression operations and barrier systems used in tsetse control/eradication campaigns

Irradiation as a phytosanitary treatment of food and agricultural commodities

Use of nuclear and colorimetric techniques for measuring microbial protein supply from local feed resources in ruminant animals

Human Health

New

Improvement in the treatment of acute lymphoblastic leukaemia by the detection of minimal residual disease

Nitrate augmented myocardial imaging for the assessment of myocardial viability

The role of teletherapy supplementary to intraluminal high dose rate brachytherapy in the palliation of advanced oesophagus cancer

Completed

Application of nuclear techniques in the prevention of degenerative diseases (obesity, non-insulin dependent diabetes and coronary heart disease) in ageing

Clinical application of radiosensitizers in cancer radiotherapy

Comparison of clinical applications software between nuclear medicine laboratories by software phantoms developed by COST-B

Development and validation of an internet based clinical and technical study communication system for nuclear medicine

Development of a Code of Practice for dose determination in photon, electron and proton beams based on measurement standards of absorbed dose to water

Electron paramagnetic resonance (EPR) biodosimetry

Genotype phenotype correlation in thalassemia and muscular dystrophy

Molecular typing of *Mycobacteria* strains in multi-drug resistant tuberculosis

Randomized clinical trial of radiotherapy combined with Mitomycin C in the treatment of advanced head and neck tumours

Regional hyperthermia combined with radiotherapy for locally advanced cancer

Validation and application of plants as biomonitors of trace element atmospheric pollution, analysed by nuclear and related techniques

Water Resources

New

Design criteria for a network to monitor isotope compositions of runoff in large rivers

Nuclear and isotopic techniques for the characterization of submarine groundwater discharge (SGD) in coastal zones

Physical and Chemical Applications

New

Comparative laboratory evaluation of therapeutic radiopharmaceuticals

Corrosion and deposit determination in large diameter pipes, with and without insulation, by radiography testing

Development of radioactive sources for emerging therapeutic and industrial applications

New applications of prompt gamma neutron activation analysis (PGNAA)

Remediation of polluted waters and wastewater by radiation processing

Safety of Nuclear Installations

New

Assessment of interfaces between neutronic, thermal-hydraulic, structural and radiological aspects in accident analyses

Safety significance of postulated initiating events for different research reactor types and assessment of analytical tools

Table A18. **(cont.)**

Safety significance of near field earthquakes

Completed
Safety of RBMK type nuclear power plants in relation to external events

Radiation Safety

New
Avoidance of unnecessary dose to patients while transitioning from analogue to digital radiology

Dose reduction in computed tomography (CT) while maintaining diagnostic confidence

Evaluating quantitatively and promoting patient dose reduction approaches in interventional radiology

Exploring the possibility of establishing guidance levels for interventional radiology

Completed
Image quality and patient dose optimization in mammography in Eastern European countries

Management of Radioactive Waste

New
Application of safety assessment methodologies for near surface waste disposal facilities (ASAM)

Security of Material

New
Improvement of technical measures to detect and respond to the illicit trafficking of nuclear and other radioactive materials

Table A19. **Training courses, seminars and workshops in 2002**

Nuclear Power

Courses

Korea International Cooperation Agency/IAEA course on nuclear power policy, planning and project management — Republic of Korea

Regional course on advanced technology for the modernization of instrumentation and control in nuclear power plants — Germany; Republic of Korea

Regional course/workshop for the planning and management of the decommissioning of nuclear power plants — Germany

Seminars and Workshops

IAEA/FORATOM workshop on training on quality management — Belgium

Management workshop on operational and safety issues —Republic of Korea

Regional workshop on managing change in nuclear utilities — Russian Federation

Regional workshop on non-destructive testing in relation to lifetime evaluation — Croatia

Regional workshop on nuclear power plant outage management — Republic of Korea

Regional workshop on optimization of steam generator performance — Ukraine

Regional workshop on the economics of nuclear power plant performance — Hungary

Regional workshop on upgrading training capabilities to respond to emerging needs — Republic of Korea

Specialist workshop on practical experience and improvements — Bulgaria

Workshop on nuclear power plant decommissioning in the Central and Eastern Europe countries — Headquarters

Workshop on pre-service inspection and in-service inspection of WWER-1000 type nuclear power plants — Islamic Republic of Iran

Workshop on quality assurance grading for the Bushehr-1 nuclear power plant — Headquarters

Workshop on the application and development of advanced nuclear reactor simulators for educational purposes — ICTP

Workshop on the application of ISO quality standards to meet IAEA quality assurance standards — Headquarters

Workshop on the development of a system for nuclear power plant manager training — Islamic Republic of Iran

Nuclear Fuel Cycle and Material Technologies

Courses

Regional course for East Asia and the Pacific on the decommissioning of research reactors and other small nuclear installations — Argentina

Seminars and Workshops

Radiological characterization workshop for the Ignalina Nuclear Power Plant — Lithuania

Regional (AFRA) workshop on good management practice in radioactive waste — Ethiopia

Regional workshop on nuclear power plant decommissioning technology and infrastructure building in Central and Eastern Europe Countries — Headquarters

Workshop on the basics of decommissioning — Federal Republic of Yugoslavia

Workshop on the Net Enabled Waste Management Data Base — Headquarters; USA

Analysis for Sustainable Energy Development

Courses

Advanced analysis of domestic greenhouse gas mitigation options with consideration of nuclear power — Indonesia

Development and evaluation of alternative energy strategies in support of sustainable development using the IAEA's new tool MESSAGE — Romania

Economic evaluation of electricity generation options using the IAEA's WASP model — Tunisia

Enhanced energy system analysis for sustainable development — ITCP

Historical evolution of Indicators of Sustainable Energy Development (ISED) and the use of this information for designing guidelines for future energy strategies in conformity with the objectives of sustainable development — ICTP

Table A19. **(cont.)**

Medium to long term planning for electricity generation using the IAEA's WASP-IV model — Syrian Arab Republic

Use of the IAEA's energy models — Italy

Use of the IAEA's MAED model for the evaluation and projection of energy demand — Italy

Use of the IAEA's WASP model — Bulgaria

Nuclear Science

Courses

BATAN Accelerator School national course — Indonesia

Group fellowship training on the maintenance of nuclear spectroscopy instruments — Agency's Laboratories, Seibersdorf

National course on maintenance, troubleshooting and repair of instruments constructed with surface mounted devices — Kenya

National course on the application of the EPTSoft package for teaching on nuclear instrumentation — Sudan

National course on the application of the Multisim 2001 package for teaching on nuclear instrumentation — Ethiopia; Sudan; United Republic of Tanzania

National course on the X ray fluorescence analysis of geological and environmental samples — Sudan

Regional course (AFRA) on repair and maintenance of microprocessor based nuclear systems — Algeria

Regional course on digital signal processing — Agency's Laboratories, Seibersdorf

Seminars and Workshops

Advanced workshop on the repair and maintenance of microprocessor and microcontroller based instruments — Sudan

Interregional workshop to assess the utilization of developed ICT based training/learning materials for the maintenance of nuclear instruments — USA

National laboratory workshop on nuclear physics teaching — Angola

Regional workshop (AFRA) on the repair and maintenance of liquid scintillation counters — Kenya

Food and Agriculture

Courses

Course (RAF) on the use of nuclear techniques in nitrogen and water dynamics in rain fed arid and semi-arid areas — Senegal

Course (RCA) on the use of nitrogen-15 techniques for identifying management practices for the efficient use of nitrogen fertilizers in wetland rice soils — Malaysia

Course on mycotoxin methodologies, sample processing and QA/QC and ISO 17025 principles — Agency's Laboratories, Seibersdorf

Course on use of the neutron probe for drought tolerance screening — Kenya

Interregional course on mutant germplasm characterization using molecular markers — Agency's Laboratories, Seibersdorf

Interregional course on the use of the sterile insect and related techniques for the integrated area wide management of insect pests — Canada

National course on marker assisted selection and DNA fingerprinting in rice — Viet Nam

National course on mutation techniques for the improvement of field crops — Yemen

National course on on-farm trials of improved finger millet mutants — Zambia

Regional course on establishing a national GIS capacity for ongoing and planned tsetse/trypanosomosis intervention campaigns — Burkina Faso

Regional Latin America course on fruit fly management with emphasis on the sterile insect technique — Guatemala

Seminars and Workshops

FAO/IAEA training workshop on advanced instrumental techniques in pesticide residue analysis — Agency's Laboratories, Seibersdorf

FAO/IAEA training workshop on techniques in integrated soil, water and nutrient management for sustainable rice–wheat cropping systems in Asia — Headquarters

Table A19. **(cont.)**

FAO/IAEA workshop (RCA) on irradiation to ensure microbiological safety of food — India

FAO/IAEA workshop (RCA) on use of irradiation to ensure quarantine security of food and agricultural commodities — Australia

FAO/IAEA workshop on implementation of quality assurance/quality control measures in pesticide residue analytical laboratories — Malaysia; Agency's Laboratories, Seibersdorf

International workshop on mycotoxins: "An attempt to harmonize mycotoxin training programmes worldwide" — USA

National seminar on the assessment of wheat quality — The Former Yugoslav Republic of Macedonia

National training workshop on feed supplementation strategies and reproduction of camels and yak — Mongolia

National training workshop on livestock disease control — Yemen

National training workshop on livestock disease diagnosis and epidemiology — Mongolia

National training workshop on urea molasses multinutrient blocks and feed supplementation strategies — Thailand

National workshop on applications of induced mutation and molecular tools in horticultural crops including ornamental plants — Malaysia

National workshop on black pepper improvement: Cell and tissue culture, breeding and induced mutations and molecular markers — Sri Lanka

National workshop on gas chromatography and the application of nuclear techniques — Colombia

Project co-ordination workshop (RCA) on the restoration of soil fertility and sustenance of agricultural productivity — Thailand

Project co-ordination workshop (RER) on fertigation for improved crop production and environmental protection — Greece

RCA project formulation workshop on measuring soil erosion/sedimentation and associated pesticide contamination — China

Regional training workshop on the application of molecular markers in disease diagnostic and mutant characterization in date palm — Algeria

Regional West Asia workshop on tephritid fruit flies trapping and fruit sampling — Greece

Train the trainers workshop (AFRA) on improved breeding data management and integration of progesterone based farmer services in artificial insemination systems — Morocco

Train the trainers workshop on the development of information communication technology based materials for refresher courses for cattle artificial insemination technicians — Uganda

Training workshop (RAF) on the use of nuclear techniques in soil, water and nutrient management in rain fed arid and semi-arid areas — Headquarters

Training workshop (RCA) on management and utilization of field and laboratory data for breeding support services to livestock farmers — Bangladesh

Training workshop (RCA) on the use of caesium-137 techniques for establishing soil redistribution and its relationship to soil quality parameters — China

Workshop (RCA) of national consultants on evaluation of breeding bulls and semen quality control — Pakistan

Workshop on establishing quality systems in veterinary diagnostic testing laboratories — Colombia

Workshop on irradiation as a critical control point to ensure microbiological safety of food — USA

Workshop on the South African Development Community's veterinary laboratory capacities and accreditation procedures — South Africa

Human Health

Courses

Course on basic clinical radiobiology (IAEA/ESTRO) — Russian Federation

Course on basic clinical radiobiology (IAEA/ESTRO) — Sweden

Course on dose determination in modern radiotherapy: Beam characterization, calculation and verification (IAEA/ESTRO) — Italy

Course on dosimetry and quality assurance in diagnostic radiology — China

Course on evidence based radiation oncology: Methodological basis for clinical application (IAEA/ESTRO) — Spain

Table A19. **(cont.)**

Course on imaging for target volume determination in radiotherapy (IAEA/ESTRO) — Portugal

Course on implementation of a quality assurance programme in diagnostic radiology — Armenia

Course on modern brachytherapy techniques (IAEA/ESTRO) — Portugal

Course on physics for clinical radiotherapy (IAEA/ESTRO) — Belgium

Course on quality assurance/quality control in diagnostic radiology — Armenia

Course on radiotherapy treatment planning: Principles and practice (IAEA/ESTRO) — Ireland

National course on nephro-urology — Uruguay

National course on routine applications of nuclear medicine procedures — Syrian Arab Republic

Regional course and workshop on radionuclide treatment of liver cancer — Viet Nam

Regional course for medical physicists on the establishment of the protocol for quality assurance and quality control in mammography — Panama

Regional course for technicians and technologists on quality assurance and quality control in mammography — Cuba

Regional course in clinical dosimetry — Venezuela

Regional course on application of radionuclide techniques in the management of diabetic complications — Uzbekistan

Regional course on cardiology and oncology for nuclear medicine technologists — Islamic Republic of Iran

Regional course on clinical aspects of brachytherapy in uterine cervix cancer — Japan

Regional course on conventional and molecular methods for susceptibility testing of drug resistant TB — South Africa

Regional course on interventional nuclear medicine — Headquarters

Regional course on molecular and radioisotopic techniques for virological laboratories — Costa Rica

Regional course on nuclear medicine in the management of thyroid disorders — Morocco

Regional course on nuclear oncology — Philippines

Regional course on prevention, early diagnosis, management, radiotherapy treatment delivery and verification, palliation and psychosocial aspects of cervical cancer — Morocco

Regional course on the application of radionuclide techniques in medical emergency practice — Malta

Regional course on the application of radionuclide techniques in the management of coronary artery disease — Tunisia

Regional course on the application of radionuclide techniques in the management of diabetes mellitus — United Arab Emirates

Regional course on the clinical application of radionuclides in the management of inflammation and infection — Syrian Arab Republic

Regional course on therapeutic nuclear medicine — Romania

Seminars and Workshops

National seminar on neonatal screening — Mongolia

National workshop on neonatal screening programme — Viet Nam

Regional workshop on quality assurance for treatment planning systems — Morocco

Regional workshop on quality assurance in radiotherapy: Physical and technical aspects — United Republic of Tanzania

Regional workshop on radiation oncology departmental management decision making — Algeria

Regional workshop on scintimammography, sentinel lymph node detection and intraoperative surgical probe technology in the management of breast cancer — Poland

Regional workshop on the implementation of Technical Reports Series No. 398 — Tunisia

Regional workshop on the management of quality systems — Viet Nam

Technical trouble shooting workshop on current problems of specimen collection and transport — Bangladesh

Workshop on air biomonitoring — Mexico

Workshop on food fortification (IAEA/ADB) — Thailand

Table A19. **(cont.)**

Workshop on isotopic and related techniques to assess air pollution — China

Workshop on quality assurance in radiotherapy — Thailand

Workshop on stable isotope applications in body composition measurements — Mexico

Workshop on the application of advanced data analysis methods to ambient aerosol compositional data — New Zealand

Workshop on the elimination of micronutrient malnutrition in Asia (IAEA/ADB) — Thailand

Workshop on total quality management, evidence based practice and technology — Uzbekistan

Water Resources

Courses

Advanced regional course on isotope data interpretation — USA

Course on the application, advantages and limitation of mathematical models — Peru

Interregional course on advanced techniques in the application of isotopes and radioactive tracers to geothermal reservoir management — Mexico

National course on groundwater field methods — Ethiopia

National course on groundwater modelling using the M3 code, geostatistics and optimization of the groundwater monitoring network — Ethiopia

Regional course on advanced numerical groundwater modelling for water resources management — Viet Nam

Regional course on isotope hydrology with particular emphasis on dam safety — Tunisia

Regional course on radiotracer techniques for geothermal reservoir management — Costa Rica

Regional course on the use of methodologies of isotope hydrology — Morocco; Uganda

Seminars and Workshops

Executive seminar (RCA) for water resources managers on isotope use in managing and protecting drinking water — Malaysia

National training workshop on isotope hydrology — Kenya

National workshop on isotope hydrology with particular emphasis on stable and radioactive isotopes — Bangladesh

National workshop on the monitoring network — Colombia

National workshop on the use of isotopes as alternative techniques in dam safety and dam sustainability — Malaysia

Regional (RCA) training workshop on the tracer demonstration technique in isotope hydrology with particular emphasis on dam safety — Sri Lanka

Regional (RCA) workshop on dissemination of information on use of isotopes in dam safety and sustainability — Republic of Korea

Regional workshop on hydrogeochemistry — Chile

Regional workshop on the use of artificial tracers in hydrogeology — Ecuador

Technical review workshop on the sustainable development of groundwater resources — Headquarters

Workshop on managing shared aquifer resources in Africa — Libyan Arab Jamahiriya

Workshop on new strategies for an integrated science approach to enhance understanding of hydrological and ecological processes across scales (IAEA–UNESCO/IHP) — Poland

Protection of the Marine and Terrestrial Environments

Courses

Course on oil hydrocarbons in marine environmental samples — Algeria

Course on the analysis of organic contaminants (petroleum hydrocarbons and chlorinated pesticides) in marine biological and sediment samples — IAEA-MEL; Bahrain; Oman

Course on the analysis of trace metals in marine biological and sediment samples — Bahrain; IAEA-MEL; Kuwait; Oman

Table A19. **(cont.)**

Physical and Chemical Applications

Courses

Regional course on introduction to basic training in non-destructive testing, level 3 — South Africa

Regional course on non-destructive testing and in-service inspection in the petroleum and petrochemical industries — Republic of Korea

Regional course on non-destructive testing in-service inspection in the petroleum industry — Algeria

Regional course on proficiency tests in the radiographic and ultrasonic testing of welds — Republic of Korea

Regional course on prompt gamma neutron activation analysis — Chile

Regional course on quality assurance/quality control in nuclear analytical techniques — Malaysia

Regional course on radiation treatment of industrial and municipal wastewater — Tunisia

Regional course on radiography testing for level 3 with basic non-destructive testing and RT method examination — Islamic Republic of Iran

Regional course on radiotracers in wastewater treatment — Brazil

Regional course on the preparation and quality control of radiopharmaceuticals for immunoscintigraphy based on monoclonal antibodies — Peru

Workshops

Regional workshop on condition monitoring of civil engineering by using non-destructive testing methods — Morocco

Regional workshop on non-destructive inspection of concrete structures — Syrian Arab Republic; Lebanon

Regional workshop on process optimization using tracers in the petrochemical industry — Republic of Korea

Regional workshop on prompt gamma neutron activation analysis applications in the mining, cement and processing industries — China

Regional workshop on the benefits of using radioisotope technology in industry — Indonesia

Regional workshop on the radiation processing of natural polymers for health care applications — Malaysia

Regional workshop on the thin layer activation technique for monitoring corrosion in industry — China

Regional workshop on the validation of low activity and portable nucleonic gauges for the optimization of coal and mineral resources recovery — Viet Nam

Workshop on the marketing of nuclear analytical services — Poland

Safety of Nuclear Installations

Courses

Course on regulatory control of nuclear power plants — Germany

Regional basic professional course on nuclear safety — France

Regional course on electronics for the instrumentation and control of research reactors and small nuclear facilities — Argentina

Regional course on management of the operational safety of nuclear power plants — Germany

Regional course on safety analysis related to lifetime extension — Slovenia

Regional course on safety assessment of nuclear power plants to assist decision making — Spain

Regional course on the use of computer codes for accident management — Croatia

Regional train the trainers course on nuclear safety — USA

Seminars and Workshops

Focused safety culture workshop: Ignalina — Lithuania

IAEA–OECD/NEA workshop on advanced nuclear reactor safety issues and research needs — France

ICTP workshop on earthquake engineering — Italy

INES seminars — Canada; Netherlands; Slovakia; Sweden; USA

International workshop on future European Union needs in materials for research reactors (FEUMARR) —France

International workshop on the safety of first-generation WWER-440 nuclear power plants — Slovakia

Joint HSK–IAEA–OECD/NEA workshop on regulatory decision making processes — Switzerland

Table A19. **(cont.)**

Joint management workshop — Republic of Korea

Joint WANO–IAEA workshop on fire protection issues at nuclear power plants — Hungary

National workshop on review, assessment, inspection and enforcement activities related to nuclear power plants — China

National workshop on risk monitors and probabilistic safety assessment applications — China

National workshop on: strategies for safe operation: Risk informed management — China

National/extrabudgetary programme workshop on the operation and maintenance of the research reactor Serpong — Indonesia

OSART seminar at BNFL — United Kingdom

OSART workshop — China

Regional workshop on computer codes for deterministic safety analysis (conservative and best estimate calculations) — Czech Republic

Regional workshop on experience and good practices in the management of safety identified in IAEA and other missions — Slovenia

Regional workshop on licensing over the life cycle of nuclear power plants — Lithuania

Regional workshop on operational safety during new unit commissioning and startup — Russian Federation

Regional workshop on risk informed decision making — Hungary

Regional workshop on safety analysis methodology and computer code utilization — Republic of Korea

Regional workshop on the application of event analysis methodologies on selected events with special focus on organizational factors — Hungary

Regional workshop on transparency and communication of nuclear safety issues — Slovenia

Review workshop on the commissioning programme for the Tianwan nuclear power plant — Czech Republic

Safety culture workshop for the European Commission Joint Research Centre High Flux Reactor — Netherlands

Safety management and safety culture — Russian Federation

Seminar on field inspection techniques — Bulgaria

Seminar on recent advances in seismology — Slovakia

Seminar on severe accidents and accident management — China

Seminar on the applicability of guidelines for the self-assessment of safety and security in nuclear installations — Pakistan

Seminar on the IAEA safety culture programme at the USNRC — USA

Seminar on the methodology used by OSART — Ukraine

Seminar on the OSART methodology applied to field inspections — France

Seminar on the results of the IAEA extrabudgetary programme on mitigation of intergranular stress corrosion cracking in RBMK reactors — Headquarters

Seminar on the safety and security of nuclear installations — Hungary

Seminar on ultrasonic inspection of piping repaired by overlay welding — Ukraine

Seminar on ultrasonic testing qualification pilot study — Ukraine

Third workshop on high energy piping at the 28.8 m level at SUJB headquarters — Czech Republic

Workshop for Industrias Nucleares do Brazil (INB) — Brazil

Workshop for training inspectors of the Indonesian regulator BAPETEN — Indonesia

Workshop/lecture on the IAEA Safety Guide 'Format and content of safety analysis reports for nuclear power plants' — Slovak Republic

Workshop on accident management and emergency preparedness for research reactors — Republic of Korea

Workshop on documentation for use in regulating nuclear facilities — Ukraine

Workshop on education and training — Czech Republic

Workshop on emergency operation procedures (EOP) — China

Workshop on engineering safety assessment of nuclear power plant systems important to safety — Russian Federation

Table A19. **(cont.)**

Workshop on enhancement of safety culture — Armenia

Workshop on external event probabilistic safety assessment — China

Workshop on harmonization of probabilistic safety assessment methodology approaches for WWER-440 reactors and comparison of PSA results — Slovakia

Workshop on inspector training — China

Workshop on living probabilistic safety assessment and applications — Russian Federation

Workshop on management of operational safety and safety culture for the nuclear fuel fabrication industry in Japan — Japan

Workshop on methodology for identification of vital areas for nuclear power plants (organized by Sandia National Laboratories) — Ukraine

Workshop on nuclear safety education and training — China

Workshop on operations — Indonesia

Workshop on physical protection and vulnerability — Islamic Republic of Iran

Workshop on probabilistic safety assessment and applications — Armenia

Workshop on safety analysis methodology and computer code utilization for research reactors — Republic of Korea

Workshop on safety culture for senior management — Ukraine

Workshop on self-assessment of operating performance — China

Workshop on Spanish experience with design basis reconstitution — Spain

Workshop on strengthening the management of operational safety at nuclear power plants and utility organizations — Romania

Workshop on strengthening the management of operational safety through self-assessment of operational performance — Czech Republic

Workshop on training in inspection techniques — Thailand

Radiation Safety

Courses

European course on radiation protection and the safety of sources — France

Post-graduate educational course in radiation protection and nuclear safety — Argentina

Post-graduate educational course in radiation protection and the safety of sources — Belarus; Malaysia; Morocco; Syrian Arab Republic

Regional course for instructors on evaluation and response to nuclear emergencies — Argentina

Regional course for trainers in radiation protection facilities under radiation control — Japan

Regional course on assessment of occupational exposure due to the intake of radionuclides — Islamic Republic of Iran

Regional course on authorization and inspection in industrial and research irradiators — Argentina

Regional course on authorization and inspection in industrial radiography — Brazil; Turkey; Venezuela

Regional course on authorization and inspection in nuclear medicine — Brazil; Cuba; Peru

Regional course on authorization and inspection of medical practices — United Arab Emirates

Regional course on occupational radiation protection and safety — Japan

Regional course on practical response to a radiological emergency — Australia; Latvia

Regional course on radiation protection and safety in diagnostic and interventional radiology — France; Kenya; Kuwait; Malaysia

Regional course on radiation protection and safety in industrial radiography — United Kingdom

Regional course on radiation protection and safety in nuclear medicine — Albania

Regional course on radiation protection and safety in radiotherapy — Turkey

Regional course on the organization and implementation of a national programme for the control of radiation sources — Croatia; Czech Republic; Indonesia; Mexico

Regional course on the safe transport of radioactive material — South Africa

Table A19. **(cont.)**

Seminars and Workshops

Regional workshop on calibration of radiation measuring instruments for radiation protection — Jordan

Regional workshop on procedures for medical response during radiological emergencies — Croatia

Regional workshop on radiation protection applied to radioisotope production — China

Regional workshop on radiation protection, waste management and quality assurance in nuclear medicine — Philippines

Regional workshop on radiation safety in industrial radiography — India

Regional workshop on regulatory authorization and inspection of radiation sources in diagnostic radiology and radiotherapy — Libyan Arab Jamahiriya

Regional workshop on the assessment of occupational exposure due to external radiation — Morocco; Tunisia; Viet Nam

Regional workshop on the establishment of a judicial framework in radiation protection — Headquarters

Regional workshop on the improvement of national personal monitoring systems — Headquarters

Regional workshop: Intercomparison exercise aimed at assessment of individual doses due to internal radiation — Headquarters

Waste Safety

Courses

Regional course on radiation protection aspects in radioactive waste management — Republic of Moldova

Regional course on safety assessment methodologies for near surface waste disposal facilities — Russian Federation

Regional course on the decommissioning of research reactors and other nuclear facilities — Argentina

Regional course on the preparation of a safety analysis report for near surface disposal facilities — United Republic of Tanzania

Regional course on the radiation protection aspects of radioactive waste management — Indonesia

Regional course on the safety of radioactive waste management – Chile; Syrian Arab Republic

Workshops

Regional workshop on the derivation of acceptance criteria for near surface waste disposal facilities — Czech Republic

Regional workshop on the effect of ionizing radiation on the ecological situation of countries from the Caucasian region and Caspian Sea basin — Azerbaijan

Regional workshop on upgrading near surface waste disposal facilities — Hungary

Safeguards

Courses

Course on implementation of state systems of accounting for and control of nuclear material — Russian Federation

National course on accounting and control — Algeria

Regional course on IAEA safeguards — Japan

Regional course on state systems of accounting for and control of nuclear material — Japan

Seminars and Workshops

Regional seminar on safeguards agreements and the additional protocol — Kazakhstan

Safeguards seminar on accounting, reporting and inspection activities — Switzerland

Seminar for African States on the non-proliferation of nuclear weapons — South Africa

Workshop on IAEA safeguards — Republic of Korea

Workshop on IAEA safeguards activities — Russian Federation

Workshop on nuclear material accounting and reporting — Ukraine

Workshop on safeguards for natural uranium conversion plant operators — Islamic Republic of Iran

Table A19. **(cont.)**

Outreach and Information Support Services
Regional public information seminar on Central Europe's nuclear challenges — Poland
Policy and General Management
Workshop on the development of a legal framework governing the safety of radioactive waste management, physical protection of nuclear material and the safe transport of radioactive material for countries of Latin America — Argentina

Table A20. **Publications issued in 2002**

Nuclear Power

Comparative assessment of thermophysical and thermohydraulic characteristics of lead, lead–bismuth and sodium coolants — IAEA-TECDOC-1289

Cost drivers for the assessment of nuclear power plant life extension — IAEA-TECDOC-1309

Country nuclear power profiles: 2001 edition — IAEA-CNPP-2001

Country nuclear power profiles: 2001 edition (CD-ROM) — IAEA-CNPP/2001/CD

Decommissioning costs of WWER-440 nuclear power plants — IAEA-TECDOC-1322

Design concepts of nuclear desalination plants — IAEA-TECDOC-1326

Developing an economic system to enhance nuclear power plant competitiveness — Technical Reports Series No. 406

Harmonization and validation of fast reactor thermomechanical and thermohydraulic codes and relations using experimental data — IAEA-TECDOC-1318

Harmonization of the licensing process for digital instrumentation and control systems in nuclear power plants — IAEA-TECDOC-1327

Heavy water reactors: Status and projected development — Technical Reports Series No. 407

Improving economics and safety of water cooled reactors: Proven means and new approaches — IAEA-TECDOC-1290

Information technology impacts on nuclear power plant documentation — IAEA- TECDOC-1284

Natural circulation data and methods for advanced nuclear power plant design — IAEA-TECDOC-1281

Nuclear power plant outage optimization strategy — IAEA-TECDOC-1315

Nuclear power reactors in the world: April 2002 — Reference Data Series No. 2/22

Operating experience with nuclear power stations in Member States in 2001 — Annual publication

Quality standards: Comparison between IAEA 50-C/SG-Q and ISO 9001:2000 — Safety Reports Series No. 22

Safe and effective nuclear power plant life cycle management towards decommissioning — IAEA-TECDOC-1305

Small and medium sized reactors: Status and prospects — C&S Papers Series No. 14/P

Small and medium sized reactors: Status and prospects (proceedings of an international seminar, Cairo, 27–31 May 2001) — C&S Papers Series No. 14/CD

Solutions for cost effective assessment of software based instrumentation and control systems in nuclear power plants — IAEA-TECDOC-1328

Thorium fuel utilization: Options and trends — IAEA-TECDOC-1319

Verification of analysis methods for predicting the behaviour of seismically isolated nuclear structures — IAEA-TECDOC-1288

Nuclear Fuel Cycle and Material Technologies

Advanced post-irradiation examination techniques for water reactor fuel — IAEA-TECDOC-1277

Advanced post-irradiation examination techniques for water reactor fuel (CD-ROM) — IAEA-TECDOC-CD-1277

Application of ion exchange processes for the treatment of radioactive waste and management of spent ion exchangers — Technical Reports Series No. 408

Decommissioning techniques for research reactors — IAEA-TECDOC-1273

Effects of radiation and environmental factors on the durability of materials in spent fuel storage and disposal — IAEA-TECDOC-1316

Environmental aspects based on operational performance of nuclear fuel fabrication facilities — IAEA-TECDOC-1306

Factors determining the long term back end nuclear fuel cycle strategy and future nuclear systems — IAEA-TECDOC-1286

Fuel behaviour under transient and LOCA conditions — IAEA-TECDOC-1320

Fuel behaviour under transient and LOCA conditions (CD-ROM)— IAEA-TECDOC-CD-1320

Table A20. **(cont.)**

High temperature on-line monitoring of water chemistry and corrosion control in water cooled power reactors — IAEA-TECDOC-1303

Institutional framework for long term management of high level waste and/or spent nuclear fuel — IAEA-TECDOC-1323

Long term storage of spent nuclear fuel: Survey and recommendations — IAEA-TECDOC-1293

Management of low and intermediate level radioactive wastes with regard to their chemical toxicity — IAEA-TECDOC-1325

Management of radioactive wastes from non-power applications: Sharing the experience — 15/CD

Management of spent high activity radioactive sources (SHARS) — IAEA-TECDOC-1301

Non-technical factors impacting on the decision making processes in environmental remediation — IAEA-TECDOC-1279

Radioactive Waste Management Profiles 4: Compilation of Data from the Net Enabled Waste Management Database (CD-ROM) — IAEA/WMDB/4

Radioactive waste management: Status and trends No. 2 — IAEA/WMDB/ST/2

Record keeping for the decommissioning of nuclear facilities: Guidelines and experience — Technical Reports Series No. 411

Reliability assurance programme guidebook for advanced light water reactors — IAEA-TECDOC-1264

Scientific and technical basis for the near surface disposal of low and intermediate level waste — Technical Reports Series No. 412

Socio-economic and other non-radiological impacts of the near surface disposal of radioactive waste — IAEA-TECDOC-1308

Technical and economic limits to fuel burnup extension — IAEA-TECDOC-1299

Technologies for the treatment of effluents from uranium mines, mills and tailings — IAEA-TECDOC-1296

The uranium production cycle and the environment (proceedings of a symposium, Vienna, 2–6 October 2000) — C&S Papers Series No. 10/P

Waste management research abstracts No. 27 — IAEA/WMRA/27/CD

Analysis for Sustainable Energy Development

Comparative studies on energy supply options in Poland for 1997–2020 — IAEA TECDOC-1304

Energy, electricity and nuclear power estimates for the period up to 2020: September 2002 edition — Reference Data Series No. 1

Market potential for non-electric applications of nuclear energy — Technical Reports Series No. 410

Nuclear technology review 2002

Nuclear Science

Atomic and plasma–material interaction data for fusion (APID) — Volume 10

CINDA 2002 — annual publication

Data acquisition for X ray microprobes — Computer Manual Series No. 17

Development and characterization of semiconductor materials by ion beams — IAEA-TECDOC-1292

International bulletin on atomic and molecular data for fusion — IBAMD/61

ITER Council proceedings — ITER EDA Documentation Series No. 23

ITER CTA newsletter — Issue numbers 2–12

ITER technical basis — ITER EDA Documentation Series No. 24

Nuclear data newsletter — Issue number 33

Reference neutron activation library — IAEA-TECDOC-1285

Specialized software utilities for gamma ray spectrometry — IAEA-TECDOC-1275

World survey of activities in controlled fusion research: 2001

World survey of activities in controlled fusion research: 2001, CD edition

X ray fluorescence newsletter — Issue numbers 3 and 4

Table A20. **(cont.)**

Food and Agriculture

Animal production and health newsletter — Issue numbers 35 and 36

Assessment of soil phosphorus status and management of phosphatic fertilizers to optimize crop production — IAEA-TECDOC-1272

Assessment of soil phosphorus status and management of phosphatic fertilizers to optimize crop production (CD-ROM)— IAEA-TECDOC-CD-1272

Development and field evaluation of animal feed supplementation packages – IAEA TECDOC-1294

Dosimetry for food irradiation — Technical Reports Series No. 409

Evaluation of lepidoptera population suppression by radiation induced sterility — IAEA-TECDOC-1283

Food and environmental protection newsletter — Volume 4, Issue numbers 1 and 2

Insect pest control newsletters — Issue numbers 58 and 59

Irradiated sewage sludge for application to cropland — IAEA-TECDOC-1317

Irradiated sewage sludge for application to cropland (CD-ROM) — IAEA-TECDOC-CD-1317

Natural and induced radioactivity in food — IAEA-TECDOC-1287

Neutron and gamma probes: Their use in agronomy — Training Course Series No. 16

Nuclear techniques in integrated plant nutrient, water and soil management (proceedings of a symposium, Vienna, 16–20 October 2000) — C&S Papers Series No. 11/P

Nuclear techniques in integrated plant nutrient, water and soil management (proceedings of a symposium, Vienna, 16–20 October 2000) — C&S Papers Series No. 11/CD

Plant breeding and genetics newsletter — Issue numbers 8 and 9

Soils newsletter — Volume 25, Issue numbers 1 and 2

Study of the impact of food irradiation on preventing losses: Experience in Africa — IAEA-TECDOC-1291

Water balance and fertigation for crop improvement in West Asia — IAEA-TECDOC-1266

Use of isotope and radiation methods in soil and water management and crop nutrition — Training Course Series No. 14

Human Health

Calibration of photon and beta ray sources used in brachytherapy: Guidelines on standardized procedures at Secondary Standards Dosimetry Laboratories (SSDLs) and hospitals — IAEA-TECDOC-1274

Predictive assays and their role in selection of radiation as the therapeutic modality — IAEA-TECDOC-1297

SSDL newsletter — Issue number 46

Use of electron paramagnetic resonance dosimetry with tooth enamel for retrospective dose assessment — IAEA-TECDOC-1331

Water Resources

Isotope aided studies of atmospheric carbon dioxide and other greenhouse gases: Phase II — IAEA-TECDOC-1269

Radionuclide transport dynamics in freshwater resources — IAEA-TECDOC-1314

Stable isotope measurement techniques for atmospheric greenhouse gases — IAEA-TECDOC-1268

Study of environmental change using isotope techniques — C&S Papers Series No. 13/P

The application of isotope techniques to the assessment of aquifer systems in major urban areas — IAEA-TECDOC-1298

Use of isotopes for analyses of flow and transport dynamics in groundwater systems: IAEA-UIAGS/CD — Miscellaneous publication

Water and environment news — Numbers 15 and 16

Physical and Chemical Applications

Development of kits for radioimmunometric assays for tumour markers — IAEA-TECDOC-1307

Directory of cyclotrons used for radionuclide production in Member States — IAEA-DCRP/CD (CD-ROM)

Table A20. **(cont.)**

Guidebook on non-destructive testing of concrete structures — Training Course Series No. 17

Optimization of synthesis and quality control procedures for the preparation of ^{18}F and ^{123}I labelled peptides for nuclear medicine — IAEA-TECDOC-1310

Radiation synthesis and modification of polymers for biomedical applications — IAEA-TECDOC-1324

Reference materials for microanalytical nuclear techniques — IAEA-TECDOC-1295

Training guidelines in non-destructive testing techniques: 2002 edition — IAEA-TECDOC-628/Rev.1

Safety of Nuclear Installations

Accident analysis for nuclear power plants — Safety Reports Series No. 23

Core management and fuel handling for nuclear power plants — Safety Standards Series No. NS-G-2.5

Dispersion of radioactive material in air and water and consideration of population distribution in site evaluation for nuclear power plants — Safety Standards Series No. NS-G-3.2

External human induced events in site evaluation for nuclear power plants — Safety Standards Series No. NS-G-3.1

Guidelines for IAEA International Regulatory Review Teams (IRRTs) — IAEA Services Series No. 8

IAEA guidance on ageing management for nuclear power plants: Version 1, 2002 — IAEA-GNPPA-CD/1

Instrumentation and control systems important to safety in nuclear power plants — Safety Standards Series No. NS-G-1.3

Maintenance, surveillance and in-service inspection in nuclear power plants — Safety Standards Series No. NS-G-2.6

Mitigation of intergranular stress corrosion cracking in RBMK reactors — IAEA-EBP-IGSCC

Operational safety review programmes for nuclear power plants guidelines for assessment —Services Series No. 7

Procedures for conducting probabilistic safety assessment for non-reactor nuclear facilities — IAEA-TECDOC-1267

Recruitment, qualification and training of personnel for nuclear power plants — Safety Standards Series No. NS-G-2.8

Review of methodologies for analysis of safety incidents at nuclear power plants — IAEA-TECDOC-1278

Review of probabilistic safety assessments by regulatory bodies — Safety Reports Series No. 25

Safety culture in nuclear installations — IAEA-TECDOC-1329

Self-assessment of safety culture in nuclear installations, highlights and good practices — IAEA-TECDOC-1321

The operating organization for nuclear power plants — Safety Standards Series No. NS-G-2.4

Radiation Safety

Advisory material for the IAEA regulations for the safe transport of radioactive material — Safety Standards Series No. TS-G-1.1 (ST-2)

Appraisal for the United Kingdom of the safety of the transport of radioactive material — IAEA Safety Standards Applications TranSAS-3

Compendium of neutron spectra and detector responses for radiation protection purposes — Technical Reports Series No. 403

Detection of radioactive materials at borders — IAEA-TECDOC-1312

Directory of national competent authorities' approval certificates for package design, special form material and shipment of radioactive material: 2002 edition — IAEA-TECDOC-1302

Emergency notification and assistance technical operations manual — EPR-ENATOM (2002)

Follow-up of delayed health consequences of acute accidental radiation exposure — IAEA-TECDOC-1300

Joint radiation emergency management plan of the international organizations — EPR-JPLAN (2002)

Medical preparedness and response — EPR-MEDICAL-T-2002/CD

National competent authorities responsible for approvals and authorizations in respect of the transport of radioactive material (2002 edition): National Competent Authorities List No. 33 — IAEA-NCAL-33

Optimization of radiation protection in the control of occupational exposure — Safety Reports Series No. 21

Planning and preparing for emergency response to transport accidents involving radioactive material — Safety Standards Series No. TS-G-1.2 (ST-3)

Table A20. **(cont.)**

Postgraduate educational course in radiation protection and the safety of radiation sources, volume 1: Standard syllabus — Training Course Series No. 18

Preparedness and response for a nuclear or radiological emergency — Safety Standards Series No. GS-R-2

Prevention of the inadvertent movement and illicit trafficking of radioactive materials — IAEA-TECDOC-1311

Radiation protection and radioactive waste management in the operation of nuclear power plants — Safety Standards Series No. NS-G-2.7

Radiological protection for medical exposure to ionizing radiation — Safety Standards Series No. RS-G-1.5

Response to events involving the inadvertent movement or illicit trafficking of radioactive materials — IAEA-TECDOC-1313

Technologically enhanced natural radiation (TENR II) — IAEA-TECDOC-1271

The radiological accident in Gilan — special publication

The radiological accident in Samut Prakarn — special publication

Radioactive Waste Safety

Ethical considerations in protecting the environment from the effects of ionizing radiation: A report for discussion — IAEA-TECDOC-1270

Issues relating to safety standards on the geological disposal of radioactive waste — IAEA-TECDOC-1282

Management of radioactive waste from the mining and milling of ores — Safety Standards Series No. WS-G-1.2

Modelling the migration and accumulation of radionuclides in forest ecosystems: Report of the forest working group of the Biosphere Modelling and Assessment (BIOMASS) programme, theme 3 — IAEA-BIOMASS-1

Monitoring and surveillance of residues from the mining and milling of uranium and thorium — Safety Reports Series No. 27

Radiation legacy of the 20th century: Environmental restoration — IAEA-TECDOC-1280

Safe enclosure of nuclear facilities during deferred dismantling — Safety Reports Series No. 26

Miscellaneous safety publications

Communication planning by the nuclear regulatory body — Safety Reports Series No. 24

Documentation for use in regulating nuclear facilities — Safety Standards Series No. GS-G-1.4

Key practical issues in strengthening safety culture (including booklet) — INSAG Series No. 15

Nuclear safety review for the year 2001 — annual publication

Organization and staffing of the regulatory body for nuclear facilities — Safety Standards Series No. GS-G-1.1

Regulatory control of nuclear power plants — Training Course Series No. 15

Regulatory inspection of nuclear facilities and enforcement by the regulatory body — Safety Standards Series No. GS-G-1.3

Review and assessment of nuclear facilities by the regulatory body — Safety Standards Series No. GS-G-1.2

Topical issues in nuclear safety (including CD-ROM) (proceedings of a conference, Vienna, 3–6 September 2001) — Proceedings Series

Safeguards

IAEA safeguards glossary: 2001 edition — International Nuclear Verification Series No. 3

IAEA safeguards glossary: 2001 edition — International Nuclear Verification Series No. 3, CD-ROM

Security of Material

Handbook on the physical protection of nuclear materials and facilities — IAEA-TECDOC-1276

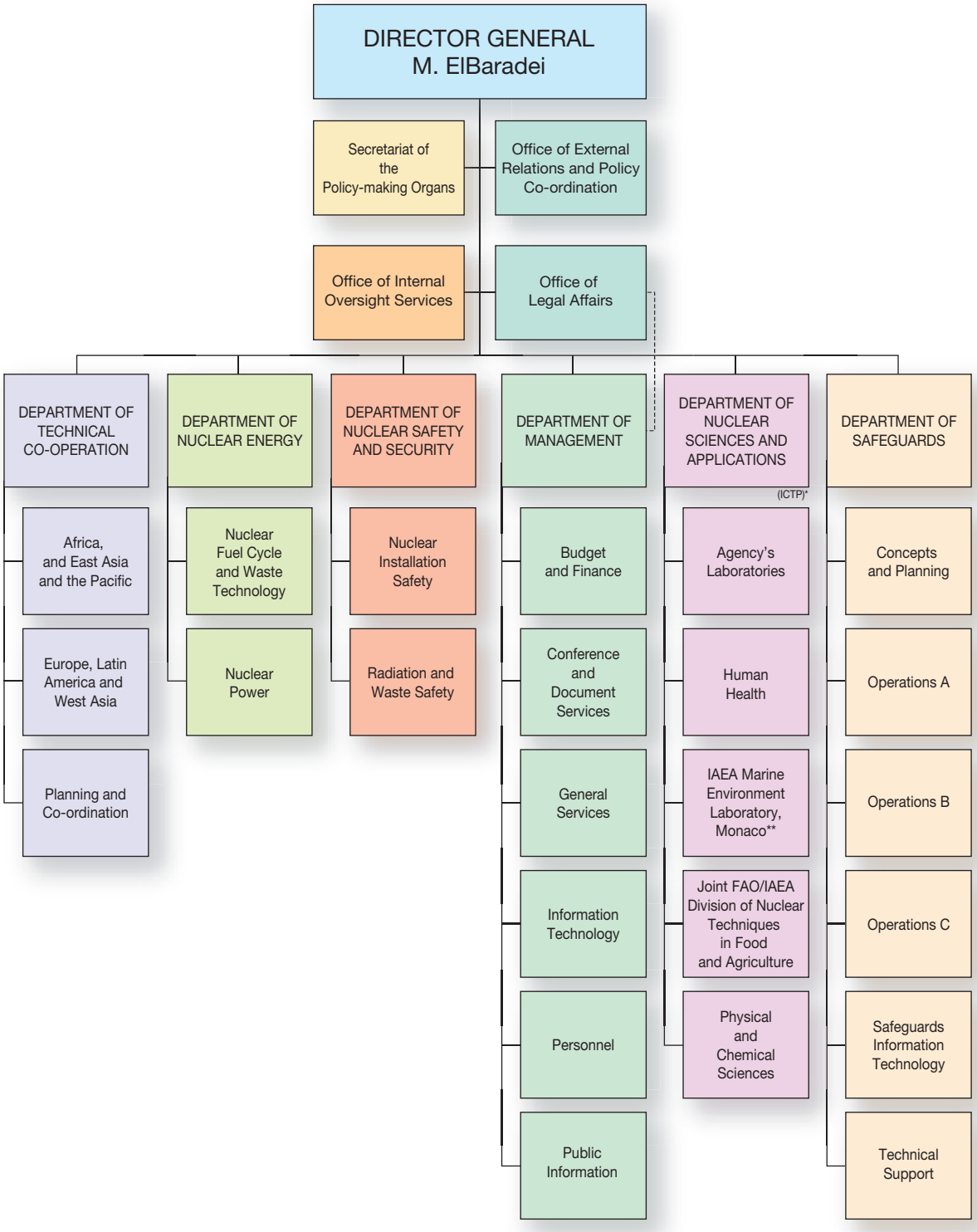
Measures to prevent, intercept and respond to illicit uses of nuclear material and radioactive sources (proceedings of a conference, Stockholm, 7–11 May 2001) — C&S Papers Series No. 12/P

Table A20. **(cont.)**

Outreach and Information Support Services
INIS: Authority list for journal titles — IAEA-INIS-11 (Rev. 28)
INIS: Joint thesaurus — IAEA-ETDE/INIS-1
INIS: Manual for subject analysis — IAEA-ETDE/INIS-3
INIS: Subject categories and scope descriptions — IAEA-ETDE/INIS-2
Nuclear fusion — Volume 41
Management of Technical Co-operation for Development
Science serving people — Special publication

ORGANIZATIONAL CHART

(as of 31 December 2002)



* The Abdus Salam International Centre for Theoretical Physics (Abdus Salam ICTP), legally referred to as "International Centre for Theoretical Physics", is operated as a joint programme by UNESCO and the Agency. Administration is carried out by UNESCO on behalf of both organizations. The Agency's involvement in the Centre is managed by the Department of Nuclear Sciences and Applications.

** With the participation of UNEP and IOC.

"The Agency shall seek to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world."

Article II of the IAEA Statute

IAEA

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